SPEED Journal of Research in ELECTRONICS

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SPEED Journal of Research in Electronics

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AIM and Objectives

The SPEED Journal of Research in Electronics (SJRE) is an research journal, which publishes top-level work from all areas of 'Advances in Electronics and its Interdisciplinary Applications'. Academicians, Students, Researchers, Industrial experts, and Entrepreneurs are encouraged to contribute their work. Journal publishes research articles and review in all domains related to the field of Electronics Science and Technology.

The objectives of the SPEED journal are -

1. To provide a platform to students, academicians, researcher, scientists, engineer and industrial experts to share their knowledge, ideas and contribution in the field of the interdisciplinary applications of electronics as well as advances/recent trends in Electronics.
2. To promote research and development activities in the field of Electronics.
3. To foster interdisciplinary approach between different fields of research with special reference to Electronics / instruments / equipments as tool to probe new avenues and share the cutting-edge development in the field.

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E-mail : principal@fergusson.edu
SPEED_Journal@fergusson.edu
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Editorial

LIFE is **L**iving **I**n **F**ulfillment and **E**njoyment - fulfillment in our professional careers and enjoyment in our personal lives. There is nothing more satisfying than overcoming a challenge that was previously deemed insurmountable. One feels proud realizing that you have grown much more than your expectations. This balance is the core of a quality life and carries with it great benefits of clear thinking, effective decision-making, creativity and a sense of belonging and relatedness. These essential qualities will enable any individual whether a Teacher, Businessman, Doctor, Engineer, Company Executive, Student or Housewife to excel in their lives.

Excellence is a talent or quality which is unusually good and so surpasses ordinary standards. It is about going a little beyond what we expect from ourselves. Most people want to excel as individuals and as members of a team. Personal excellence is not about being a perfectionist but rather it is about pushing yourself hard in order to surpass people's expectations and to excel in everything that you do. Personal excellence is a principle, and it encompasses all good qualities. Excellence does not happen in a vacuum. It needs a collective obsession. It goes beyond motivation into the realms of inspiration. Excellence can be as strong a uniting force as solid vision.

SPEED, Society for **P**romotion of **E**xcellence in **E**lectronics **D**iscipline is a registered society established for promoting excellence. There is one thing that constantly determines success, which is EXCELLENCE. To be human is to live to our highest potential. Excellence is not so much a battle you fight with others, but a battle you fight with yourself, by constantly raising the bar and stretching yourself. The path to excellence is a continual one which requires constant upgrading and skills development. There is no end point in the pursuit of excellence and the "target" is often moving. This underscores the importance and value of continuous improvement.

The effects of electronics on the contemporary society are very significant. In the 21st century we are enjoying well developed electronics. In some form or the other every day we deal with the electronic devices several times. Innovation is the creative development of a specific product, service, idea, environment, or process with the fundamental goal of pleasing customers and extracting value from its commercialization. The increased complexity, packaging density, and functionality of modern cell phones is metaphorically representative of the change in the composition, skill mix, and tightly collaborative focus of the product development teams who innovate to create them. This evolution has resulted in innovations in new products, materials, computer-aided design tools, and manufacturing processes. This has changed the nature and focus of innovation, significantly increasing the diversity of design teams and the need for collaboration across technical and business disciplines.

This **electronic world** was not just the effort of some years or decades, rather it is the result of the hard work of great minds since ages. The history of any science inspires its future generations. Even more than that those who spent their whole life for the inventions/discoveries, they did not do that for themselves rather they did it for the whole society, the whole world. So we should tribute them. It gives me immense pleasure in presenting the first issue of the **SPEED Journal of Research in Electronics.** Research is a tool towards excellence. Systematic innovations result in good quality research. It is well accepted fact that the research is never carried out in isolation. Proper documentation, sharing of methods, procedures and results helps in furtherance of research outcome.

The **SPEED Journal of Research in Electronics** is hoped to provide an approachable platform in the pathway to excellence. All the domains in the field of Electronics including fundamentals, theoretical aspects, modeling and simulations, materials, devices, sensors, actuators, control strategies, hardware designs, algorithms and software, smart systems, communication electronics and ever expanding applications of electronics would form the scope of this journal. Anybody wishing to climb the ladder of excellence may conduct good quality research as a first step and seek for publication in this peer reviewed journal. It is hoped that this would create an excellent eco system for nurturing progressive research culture among academicians.

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Dr. A.D.Shaligram
Editor in Chief
adshaligram@gmail.com

Principal’s desk

Department of Electronic Science was established when college was celebrating its centenary. Established in year 1985, department of Electronic Science has become one of the most fascinating and active departments on the college campus. Electronic Science subject is developed with a focus on bridging the gap between Science and Technology. The Undergraduate course in Electronic Science was introduced in 1985 and Postgraduate course in 1992. The department is also a recognized research center under University of Pune from 1998. Vocational Electronic Equipment Maintenance (EEM) subject was introduced in 2000 at UG level to enhance the Entrepreneur skills.

Exactly after 30 years of its existence, department has taken a bold step to start a research journal in association with the Society for promotion of Excellence in Electronics Discipline (SPEED). With growing necessity of evolving expertise in the field of Electronics, an organization **Society for Promotion of Excellence in Electronics Discipline (SPEED)** was established in 2010 as a registered society. The fundamental aim of the society to exchange information, knowledge and expertise among various stakeholders.

The basic purpose of the SPEED Journal Research in Electronics is to provide a platform to students, academicians, researcher, scientists, engineer and industrial experts to share their knowledge and ideas in the field of the advances in Electronics as well as its interdisciplinary applications. The primary goal of the journal is to promote and share Research and Development activities in the field of Electronics.

I am happy to see that Electronic Science department is taking lead to start its own FIRST Research journal. I extend my best wishes to this endeavor in association with SPEED.

~ Dr. R. G. Pardeshi
Principal
Fergusson College, Pune

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Development of Arm Microcontroller based an Embedded System for Measurement of Soil Moisture

A.B. Ladgaonkar[1], A. M. Pawar[2] and B. P. Ladgaonkar[2]
[1]Department of Electronics and Telecommunication Engineering,
S. K. N. College of Engineering, Vadgaon (BK), Pune.
[2]Post Graduate Department of Electronics
Shankarrao Mohite Mahavidyalaya, Akluj Dist. Solapur - 413 101 (M.S.)

Abstract

In the field of embedded technology, the advancements are taking place due to emerging of 32 bit processing philosophy. The microcontrollers from ARM families are ensuring this 32 bit processing capacities. Emphasizing the deployment of the on chip resources of ARM LPC 2378 microcontroller an embedded system is designed to measure soil moisture. Recently, the agriculturists are demanding high-tech instrumentation to monitor various parameters. Out of various soil parameters, the soil moisture is playing significant roles on the crop growth. Less watering adversely affect on the growth, whereas heavy watering resulting into wastage of water. Therefore, proper watering is essential to enhance the growth of the crop and hence the yield. Considering this demand an embedded system is designed to measure soil moisture and results are interpreted in this paper. The conductivity of the soil increases with increase in the concentration of the water. This supports the fact that water molecules are contributing the electrical conductivity. The sensor, comprising two steel electrodes of length 15cm and separated by the distance of 1 cm, is designed in the laboratory and implemented. The sensor is excited with +5V supply and resulting current is measured. The signal conditioning and data acquisition circuits are wired about PGA.

The on chip ADC of LPC 2378 is deployed. The smart LCD from Hitachi is used to ensure digital readout. The firmware is designed in embedded C using SCARM, the integrated development environment (IDE). For calibration of the system test bed is designed in the laboratory. The system is implemented for the measurement of soil moisture and the results obtained are interpreted.

Keywords: An Embedded system, Soil moisture, ARM microcontroller LPC2378, Soil parameter

1. Introduction

In modern agriculture, the concept of high-tech agriculture is evolving, wherein the agriculture instrumentation plays vital role.

Particularly, in case of greenhouse and polyhouse applications the measurement and control of the parameters such as humidity, temperature, light intensity, soil moisture etc. plays significant role on the yield of the crops. Considering these facts into account, it is proposed to develop an embedded system for measurement of soil moisture.

Presently, it is known that the embedded system, for dedicated applications, development plays vital role in the instrumentation. In the beginning, many peoples are attempted to develop a system based on 8051 microcontroller. However, it is found that because of limited on chip resources the applications of the 8051 are constrained. Therefore, people are diverting their attention towards high performance microcontroller. The microcontrollers from PIC, AVR & ARM series are of promising characters.

Because of less number of codes, high code density, single cycle instructions and pipelining the speed of execution is significantly increased. Moreover, the ARM microcontroller ensures 32-bit philosophy of data acquisition and processing. Developing on chip resources of ARM LPC 2378 microcontroller, an embedded system is designed for measurement of soil moisture of the polyhouse & results are presented in this paper.

Various methods for determining water content of soil, from simple manure gravimetric sampling to more sophisticated remote sensing and Time Domain Reflectometry (TDR) measurements, have been developed by various investigators [3-4]. The measurement of soil moisture by gravimetric method is the traditional method[5]. One common technique is to investigate the AC electrical properties such as, dielectric constant of soil. It is found that the dielectric constant of the soil is sensitive moisture content of the same. Deploying
appropriate calibration method, the dielectric constant measurement can be directly related to soil moisture [1]. However, there are several different types of sensors commercially available, which present different levels of soil water content. In general, a manufacturer's calibration is commonly performed in a temperature controlled room, with distilled water and in easy to manage homogenous soil materials (loams or sands) which are uniformly packed around the sensor[2]. This calibration procedure produces a very precise and accurate calibration for the conditions tested. However, in field conditions variations in clay content, temperature, and salinity may affect the manufacturer's calibration. Therefore, to enhance the reliability of the system under investigation a test bed must be developed in the laboratory.

2. The Soil Moisture Sensor

In market various soil moisture sensing sensors are available, but for present system soil moisture sensor is designed in our laboratory and implemented to this dedicated application. On extensive study, it is found that, the soil moisture sensors are of capacitive type and are used to measure the dielectric constant of the soil under test. The dielectric constant of the water is more than the dry soil. This is because of the fact that dry soil consists of very less number of charge carriers and hence the dielectric constant, which is mainly due to AC conductivity is very less. However, he water is conducting and hence the dielectric constant is high. Therefore, the dielectric constant of the soil is the function of concentration of water in the soil. Hence, by employing the principle of change in dielectric constant with the change in the water content of the soil, the soil sensor can be designed. However, to deploy the capacitive sensor, more complex electronic circuit is essential to design. Therefore, it is always suggested to employ the principle of change in resistance due to water content

Thus, based on this principle the sensor is designed to measure soil moisture. It is our own design and depicted in figure 1.

It consists of two electrodes of stainless steel & are separated with the distance of 2cm. These are fixed at one end and other ends are kept free to insert into the soil samples under investigation. The high quality co-axial shielded cable is used to connect these two electrodes. The electrodes are resistive and it has to be excited with the energy source. Therefore, as depicted in the figure 2 the sensor is excited with 1.5volt. This excitation with low voltage reflects the conductivity due to charge carrier concentration, which is expected and not due to excessive drift velocity. Due to electrical conductivity, the potential is developed across R2. This potential is highly sensitive to concentration of water in the soil. This potential is applied to further electric parts. The characteristics this soil moisture sensor electrode are studied. This sensor is most successful and provides ubiquitous resistive sensor. The feature of the soil moisture sensor is described below.

Extreme low cost with volume pricing

Conductivity based

Probe does not corrode over time

Small size & Rugged design for long term use Consumes less than 600uA for very low power operation

Precise measurement

Measures volumetric water content (VWC) or gravimetric water content (GWC)

Output voltage is proportional to moisture level Wide supply voltage range

It produces water dependent voltage in milivolt range. The response is very fast and highly reliable. Series probes measure the dielectric constant of soil in order to find its volumetric water content[6]. Since the dielectric constant of water is much higher than that of air or soil minerals, the dielectric constant of the soil is a sensitive measure of water content.

3. The Embedded System Design

The electronic circuit designed using ARM LPC 2378 microcontroller of the present embedded system is depicted in the figure 2. The designed embedded system extracts the very weak signal in milivolt from the soil moisture sensor. It is necessary to isolate the sensor from further circuits. Therefore, in order to provide better isolation signal conditioning stage is designed around the instrumentation amplifier AD620, which having very high input impedance. The gain of instrumentation amplifier is adjusted to 1. So AD620 is used here as Buffer amplifier. This helps to match the impedance between output stage of sensor and input stage of ARM microcontroller development board, which is used as a computing device to survive the need of embedded system. This could help to maintain linearity between observed output voltage and input soil moisture.

Initialise variables'!

By proper signal conditioning circuitry the signal, moisture dependant emf, is produced, which is further digitized by deploying on chip ADC of 10 bit resolution. However, as per the need of sophisticated instrumentation, the parameters must be in respective engineering units. That means the water content of soil must be measured in percentage. Therefore, the calibration of the device is essential and the system is further subjected to the process of calibration.

Actually, hardware and firmware are the either sides of the embedded system. Therefore, the firmware is developed in embedded C using SCARM, Integrated Development Environment (IDE).

The developed firmware is depicted through the flow chart [Figure 3]. After successful compiling and building the developed firmware the IDE provides the *.hex file, which is embedded into the flash memory of the target device LPC 2378.

4. Experimental

Emphasizing to the development the ubiquitous embedded system for measurement of the soil moisture using ARM LPC 2378 development board is designed and implemented. The place of implementation of the system is at the farm near to the crop. However, in order to perform experiment in the laboratory the Test Bed is designed. The soil sample under test is taken in the beaker of 500ml capacity. The soil sample of 250gm is taken in the beaker. The density of the soil varies with nature of soil. The soil moisture sensor is inserted in the soil sample under test. The water is added, drop by drop, with the help of graduated burette and observation of relative moisture, are recorded. The experimental set up is shown in figure

4. The system also implemented directly to measure the moisture of the soil at different places of the College garden shown in figure5.

5. Results and Discussion

An embedded system is developed about ARM LPC 2378 microcontroller to measure soil moisture. To measure the water content of the soil a typical sensor is designed and the hardware designed produces emf, which is proportional to the content of water in the soil. However, it is expected to have the observations of soil moisture either in relative units or in absolute units.

Therefore, before implementation the system is calibrated in the respective units.

For calibration of the system a sample of dry soil, of 250gm is taken in the beaker 500ml. The sensor is inserted in the soil & the emf produced by the system is measure in the beginning it was '0'. The water, drop by drop, is added by means of graduated burette. The readings of emf are taken against water in ml and plotted as shown in figure 6. On inspection of figure, it is found that the emf increases almost linear with the water content. The data available is best fitted to the straight line. The empirical relation obtained is

$y = 2.2224x+1.4781$.

This relation is incorporated in the software. Thus, the system is calibrated to the soil moisture in the gravimetric units.

Thus, the ARM LPC2387 embedded system is developed to measure the soil moisture and it is working with great reliability and precision.

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Development of an Embedded System for Monitoring CO_2 and O_2 Levels

Kalpana A. Kulkarni[1], D. P. Londhe, N. M. Kulkarni, A.D. Shaligram[2], M. S. Zambare[3]
[1]Fergusson College, Pune – 411004, [2]University of Pune-411004, [3]Fergusson College, Pune- 411004
[1]Kalpana_181@yahoo.co.in, [2]adshaligram@yahoo.com, [3]drmsz29@gmail.com

Abstract

With the ongoing deterioration of environmental parameters, it has become imperative to know the impact of plants on air quality standards. Study of the co-relation between number of plants and air pollutants is one of the essential activities for better environment. Environment monitoring has become a necessity because of global warming and climate change. A chamber has been designed to monitor CO_2 and O_2 level changes within the specific area with a canopy of plants around. Monitoring of these gas levels is carried out by using solid electrolyte CO_2 sensor and galvanic cell type oxygen gas sensor. Embedded system is designed to process and transmit the data. Received data is transmitted with wireless communication using Xbee protocol. Emphasis is given on the data collection using gas sensors and development of an embedded system for monitoring and analysis of the impact of plants on air pollution.

Index Terms: *Embedded system, environmental chamber, gas sensors, plants, Xbee*

~~I.~~ Introduction

Environmental concerns are growing day by day for human being. The degradation of environment has large impact on plants which are very sensitive to air pollutants. Response of plants to air pollutants needs to be marked. To monitor and control air pollutants requires monitoring system that gives accurate information and guides in making decision about environmental conditions.

There are various methods available for measurement of gas exchanges. A different approach of wireless technology with efficient and affordable sensors is being used in closed chamber to monitor CO_2 and O_2 levels. Closed systems are more appropriate for rapid measurement with single portable chamber being used at different locations. Open type systems are more complex and require detail study of impact of other parameters. The objective of this work is to come up with cost effective, reliable, scalable and accurate air pollution monitoring system with wireless sensor network.

Present work focuses on developing efficient, accurate embedded system for monitoring CO_2 and O_2 levels with plants in closed environmental chamber. A portable and closed system chamber is used to investigate canopy gas exchange. Commercially available electrochemical and resistive heating type sensors were used to sense the gases like CO_2 and O_2. Temperature and humidity is also monitored using Crossbow motes [3].

The calibration technology for the gas sensor, system architecture of wireless pollution monitoring system, field deployment and experimentation with varying physical conditions, design, development and deployment of the system are discussed in the following sections.

~~II.~~ Closed environmental chamber

Chamber is designed to meet the requirement as below:

i. Ability to expose plants to air pollutants under the same environmental conditions at different time intervals.

ii. Ability to study effects of temperature, light, and relative humidity on pollutants levels

iii. Ability to measure the plant pollutant uptake rate.

Chamber description:

The chamber is constructed of transparent acrylic (Plexi glass) [1] of 6-mm thick. With total volume of 0.42 m^3 and reinforced with base plate of $0.5625m^2$, Sensor are attached to the chamber by providing suitable opening. The operating voltage of sensor is 5V (dc) provided through suitable power supply.

~~III.~~ Embedded system development

In environmental measurements wireless technologies are the solutions for remote instrument control and long distance range value reading.

The real time wireless air pollution gas monitoring system designed and developed to obtain fine-grain pollution data of gases. The design and development of the pollution gas monitoring system constitutes the following stages:

i. Gas sensors selection and calibration

ii. Wireless Sensor Nodes configuration

iii. Development of Software and

iv. Field deployment

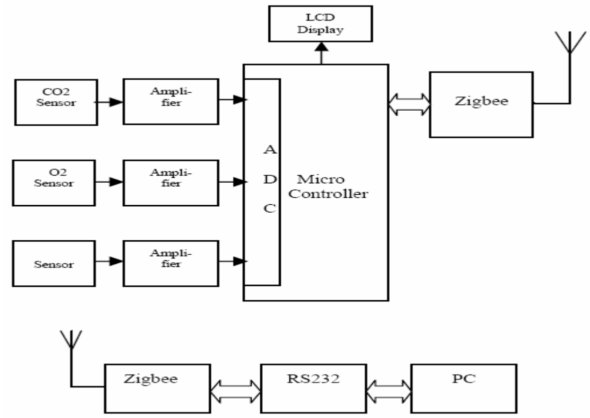

Fig.1 System Hardware Basic Building Blocks

~~IV.~~ Gas Sensors Selection and calibration

Gas sensors are placed in closed chamber. Each gas sensor produces a voltage value corresponding to the gas concentration. Features of sensors used to be taken are high sensitivity to the required gas, fast response time, low power consumption, stable, long life, compact and they should be robust. The observed values are stored in the memory, processed in the base station and communicated with wireless sensor network.

Calibration of Carbon Dioxide (CO_2) sensor:

Figaro’s TGS 4161(Fig.4) [2] is a solid electrolyte (a type of solid state sensor) CO_2 sensor with detection range of 350 to 10,000 ppm [2]. The sensitive element of the sensor consists of a solid electrolyte formed between two electrodes, together with printed heater substrate. CO_2 concentration is measured by monitoring the change in electromotive force (EMF) generated between two electrodes. The measured sensor signal strength was low, typically of the order of 220mV for the atmospheric concentration of 350ppm for CO_2 sensor and was highly unstable. To stabilize and amplify the measured signal, sensor signal conditioning circuits with amplifier and filter were used during calibration process. R and C value selected as per the data sheet TLC 271 of Texas Instrument [3].

Calibration of Oxygen (O_2) sensor:

Figaro's KE-25 (Fig.5) [2] is a unique galvanic cell type oxygen sensor. It provides a linear output voltage signal relative to percentage of oxygen present in a particular atmosphere. The sensor features long life expectancy, excellent chemical durability and it is not influenced by CO_2, CO, H2S, NO_x H_2. It operates at normal ambient temperature and required no warm up time making it ideal for oxygen monitoring for portable applications. Oxygen molecules enter the electrochemical cell through a non-porous fluorine resin membrane and are reduced at the gold electrode with the acid electrolyte. The current which flows between the electrodes is proportional to the oxygen concentration in the gas mixture being measured. The terminal voltages across the thermistor (for temperature compensation) and resistor are read as a signal, with the change in output voltages representing the change in oxygen concentration.

Table1. Specifications of the sensors

Sensor	Range	Sensitivity	Response time
LM 35	-40 to 110^0C	10mV/ ^{0}C	< 2 sec
SY-Hs-220	0 to 100%	0.6ppf/%RH	15sec
CO_2	350-10,000ppm	44 - 72mV	1.5min
O2	0-30%	0.1%	15sec

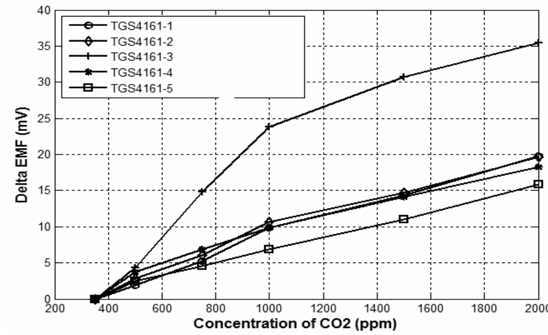

Fig2. Calibration Result for TGS 4161- CO_2 sensor

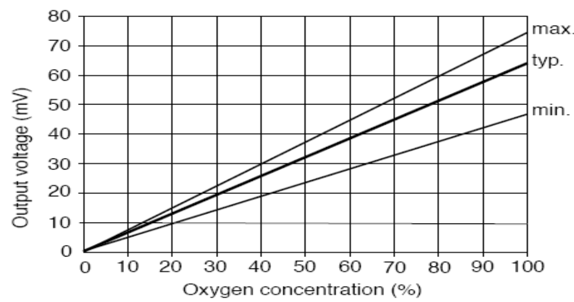

Fig3. Calibration Result for KE-25 O_2 sensor

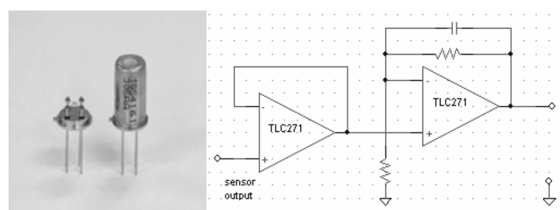

Fig.4. TGS 4161-CO2 sensor & signal conditioning circuit

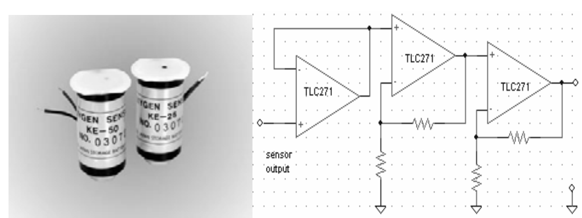

Fig.5. KE-25-O2 sensor and signal conditioning circuit

~~V.~~ Wireless Sensor Nodes configuration

The pre-calibrated commercially available gas sensors are interfaced to wireless sensor motes through the gas sensor board, which are programmed for gas monitoring applications. These motes comprises of low power microcontroller unit, memory, RF transceiver, the sensor interface, power source and firm ware which includes the networking protocol stack. Analog to digital (ADC) port of processing unit are programmed to periodically sample the various gas sensors interfaced to the sensor board. The network formation is managed by the ZigBee networking layer[4]. The network must be in one of two networking topologies specified in IEEE 802.15.4: Star and Peer-to-Peer (Mesh). The collected samples are packetized and sent to the base station at regular intervals.

Wireless monitoring system was designed, developed with Atmega 328 AVR microcontroller board and with Xbee wireless communication protocol.

The ATmeg 328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega 328P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed. In ATmega328P, the Boot Loader Support provides a real Read-While-Write Self-Programming mechanism for downloading and uploading program code by the MCU itself. This feature allows flexible application software updates controlled by the MCU using a Flash-resident Boot Loader program. The Boot Loader program can use any available data interface and associated protocol to read code and write (program) that code into the Flash memory, or read the code from the program memory.

The hardware consists of a simple open hardware design for the board with an Atmel AVR processor and on-board input/output support. The software consists of a standard programming language compiler and the boot loader that runs on the board Arduino Software. Software programs, called sketches, are created on a computer using the integrated development environment (IDE). The IDE enables you to write and edit code and convert this code into instructions that hardware understands. The IDE also transfers those instructions to the controller board (a process called uploading). The software is free, open source, and cross-platform.

Xbee wirless communication protocol:

The XBee is the new short range, low power, low data rate wireless networking technology for many applications. XBee Pro radio is made by Digi (formerly Max stream) which is shipped with firmware implementing the IEEE 802.15.4 protocol. These modules use the IEEE 802.15.4 networking protocol for fast point-to-multipoint or peer-to-peer networking.

XBee-PRO Specifications:

Indoor/Urban: up to 300 feet (100 meters)

Outdoor line-of-sight: up to 1 mile (1500 meters)

Transmit Power: 100 mW (20 dBm)

Receiver Sensitivity: -100 dBm

RF Data Rate: 250,000 bps

~~VI.~~ Development of Software

Base station receives data at regular intervals of time. Software is developed for effective storage and retrieval of data. System consists of two sub-systems, Sensor Node and Base station, both of this sub-system needs separate and accurate programming to get a successful result.

Sensor Node Programming: Sensor Node consists of mainly Sensors, Controller and Transceiver. There is need to program the controller for three tasks:

i. Read data from sensors

ii. Convert this analog data in to digital by the mean of ADC

iii. Give data to transceiver to transmit it over wireless channel

Base Station Programming

The base station programming is much simpler compare to the sensor node programming. Here it does not need the complex programming like reading the data, check if it is valid or not, or convert the analog data in to digital, which is a tedious job to perform in software. Main tasks for base station:

i. Controller receive the data from Transceiver Xbee

ii. Identification of node address from which it is received and displays it.

iii. Give this data to the computer to perform further controlling or data logging applications.

Field Deployment

The objective of the deployment is to collect the pollutant data from different locations. Nodes were placed at different locations to monitor the different gases. Received data is logged in to the database in the form of tables. A web based graphical user interface (GUI) is developed to view the live data. Real time plots of these gases are plotted with the middleware and the GUI. GUI is developed using Visual Basic 6.0 software (Fig.6). As a sensor detects and translate an analog signal, the data will go through a conversion at the ADC and become a digital format. Main objective is to display data received in graphical form. Received data is stored in data base. Also data is displayed on LCD and on serial port.

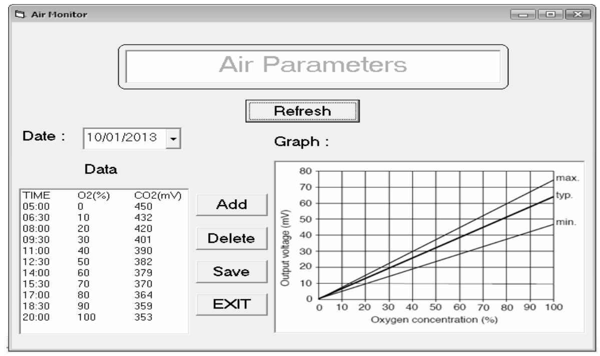

Fig.6. Front Panel of the Monitoring System

Results and Discussion

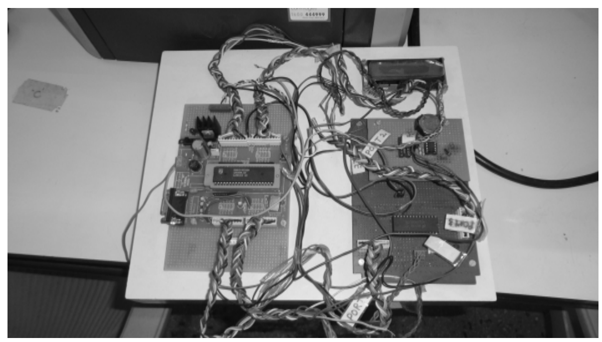

Fig.7. Designed CO_2 O_2 monitoring system

Gas sensors TGS 4161, KE-25gas sensors and Xbee pro modules have been successfully interfaced to the microcontroller. The sensors data is being displayed on LCD as well as on serial window.

A simple GUI has been designed to store a logged data to a text file, so that it can be analysed further. The developed system is lowest cost and energy efficient system. The power consumption of the developed system is minimum.

Table2. Measured parameters

Measured parameter	Min. range	Min. range	Power
Temperature	0^0C	70^0C	250mW
Relative Humidity	0%	100 %	350mW
CO_2	350ppm	450ppm	250mW
O_2	0%	100%	250mW

Conclusion

In this work a low cost, 10bit resolution data logger and successfully monitored concentrations of CO_2 and O_2 levels. GUI developed gives a lucrative look to the functioning of the wireless CO_2 and O_2 monitoring system. Wireless Sensor Networks have proven themselves to be a reliable solution in providing remote sensing environmental monitoring systems. The wireless sensor nodes were adapted according to sense application specific requirements to sense, collect and transmit relevant parameters. The information collected from the network was stored in a local database and made available for displaying. The demonstrated WSN could be used for wide range of gas monitoring applications in different environmental conditions.

Plants growing in closed environmental chamber absorb CO_2 from air until the CO_2 compensation concentration is reached and at the same time O_2 concentration increases. The speed of this process depends on the size and activity of the plants, the starting CO_2 concentration, and the chamber volume.

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Interfacing Different Hardware Controllers to Home Automation Trainer Module

Priti D. Karpe[1], Sandip T. Aghav[2], D. C. Gharpure[3], A. D. Shaligram[4]
Department of Electronic Science, University of Pune, Pune-411007
[1]karpepriti7@gmail.com, [2]sta@electronics.unipune.ac.in, [3]dcg@electronics.unipune.ac.in [4]adshaligram@gmail.com

Abstract

In essence intelligent homes offer new ways of controlling appliances. This may be in the form of remote control from within or from outside the home or through enhanced programmability where several devices could operate in conjunction. This paper reports a home automation system using various sensors. An example would be where a system remembers previous patterns of appliance usage and can turn lights on and off, also it can turn electrical devices on and off to convey the impression that somebody is at home. This is a training module on which IR sensors for windows and door, PIR sensor, temperature sensor, humidity sensor and gas sensor are installed at various locations according to requirement. The main aim of this module is to expose students about various ideas related to home automation technology. It would also provide students an opportunity to write programs on their own and test the system's performance. The platform would provide hands on experience to develop a certain system, according to applicant's need. Also they write algorithms to control the given system. The various ways of doing so are hardwired control of the modules, digital control of the module, the control action can be done using programmability and some interfacing devices such as PLDs, CPLDs and FPGAs. One can also use various microcontrollers such as 8051, AVR, PIC, ARM and get the desired output. Using above mentioned ideas one can build the systems like temperature control system, humidity control system, gas leakage indicating system as well as antitheft alarm system which can play a very important role in home automation. The universality of demonstration of this module using various methods is described in paper.

Introduction

Smart home technology is a collective term for information and communication technology (ICT) as used in houses, where the various components are communicating via a local network. The technology can be used to monitor, warn and carry out functions according to selected criteria. Smart home technology also makes the automatic communication with the surroundings possible, via the Internet, ordinary fixed telephones or mobile phones.

Smart home technology gives a totally different flexibility and functionality than does conventional installations and environmental control systems, because of the programming, the integration and the units reacting on messages submitted through the network. The illumination may for example be controlled automatically, or lamps can be lit as other things happen in the house.

Smart home is the term used for houses with smart home technology installed. Good physical access is a prerequisite for the optimal utilization of the technology. The Home Automation field is expanding rapidly as electronic technologies converge. The home network encompasses communications, entertainment, security, convenience, and information systems.

The goal of home automation has always been to make your home more comfortable and secure, as well as to reduce the time spent managing your home by letting your home do the work that you would normally do, in essence making your home work for you. In addition to comfort and security, automating the home is the best way to regulate energy usage and reduce costs for heating, cooling and lighting.

With advances in processor and wireless communication technologies, sensor networks will be used everywhere in the future life. Home networks are one of the good environments that sensor networks will be deployed. In sensor networks, many sensor devices detect various physical data and send them to the base station [1]

In the emerging smart home training module, sensors will be placed everywhere in the house and measure various physical data such as temperature, humidity, motion, and light to provide information to the controller unit.

Benefits of Home Automation:

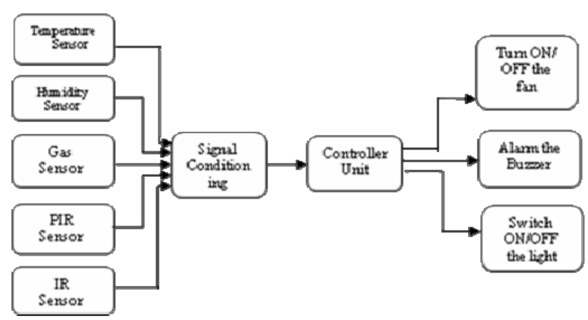
As a first example, consider home lighting. This can account for a significant part of the electric bill, particularly if common lamps are used instead of high efficiency ones. With home automation it is easy to monitor which lights are on and turn them off in places that became vacant. This can be especially handy in the case of children (which tend to never turn off any light).

As an example, let's consider a winter situation and home that needs to be heated. A common heating system allows the users to define set points for different rooms and little else. With home automation, and an adequate control algorithm, many more possibilities exist. The system can behave differently according to the type of room and hour of the day. For example, in the bedroom the system may assure the required temperature some time before wake time, to allow people to get out of bed in an agreeable environment. After people leave the bedroom, the temperature can be allowed to drop significantly. This situation can be maintained until time to go to bed approaches. During the night, the temperature can be reduced a bit while people are sleeping. As the another example consider there is a LPG leakage in the home and no one is present in the kitchen so using the gas sensor one can detect the gas leakage and can avoid the major accident. Various sensors used in the system are as this is a training module therefore all work to be done is on experimental basis. The sensors used and their specifications are listed below:

Temperature Sensor:

Various types of temperature sensors are available in the market and sensor depending upon the use can be implemented. The LM358 is a commonly used temperature sensor which has temperature range of −55° to +150°C. It can be used with single power supplies, or with plus and minus supplies. The LM35 output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in

Block Diagram:



The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies

Humidity Sensor:

Fig. 2 Humidity sensor module

To measure humidity, amount of water molecules dissolved in the air of greenhouse environments, a smart humidity sensor module SY-HS-220 is opted for the system under design [2], [3]. The photograph of humidity sensor SYHS-220 is shown in the Fig. 2. On close inspection of photograph, it is found that, the board consists of humidity sensor along with signal conditioning stages. The humidity sensor is of capacitive type, comprising on chip signal conditioner.

However, it is mounted on the PCB, which also consists of other stages employed to make sensor rather smarter. The PCB consists of CMOS timers to pulse the sensor to provide output voltage. Moreover, it also consists of oscillator, AC amplifier, frequency to voltage converter and precision rectifiers. Incorporation of such stages on the board significantly helps to enhance the performance of the sensor. Moreover, it also helps to provide impediment to the noise. The humidity sensor used in this system is highly precise and reliable. It provides DC voltage depending upon humidity of the surrounding in RH%. This work with +5 Volt power supply and the typical current consumption is less than 3 mA. The operating humidity range is 30% RH to 90% RH. The standard DC output voltage provided at 250C is 1980 mV. The accuracy is ± 5% RH at 250C. As shown in the above figure, it provides three pins recognized as B, W and R. The pin labeled W provides the DC output voltage, whereas the pin labeled B is ground. The VCC of +5V is applied at the pin R. The humidity dependent voltage is obtained and subjected for further processing [4].

LPG gas sensor: MQ 6:

Fig. 3 MQ-6 Gas sensor

Structure and configuration of MQ-6 gas sensor is shown as Fig 3, sensor composed by micro AL_2O_3 ceramic tube, Tin Dioxide (SnO_2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-6 has 6 pin, 4 of them are used to fetch signals, and other 2 are used for providing heating current. The main specifications of the sensor are high sensitivity to LPG, iso-butane, propane, Small sensitivity to alcohol, smoke, fast response, stable and long life and Simple driver circuit.

PIR Motion Sensor SUNROM 1133:

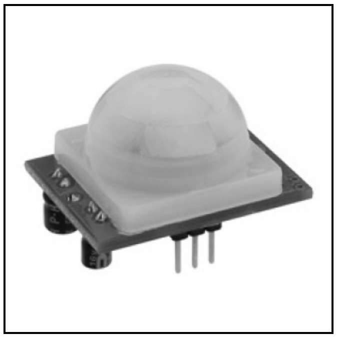


Fig. 4 PIR sensor

The sensor module is shown in Fig. 4.

Compact and complete, easy to use Pyroelectric Infrared (PIR) Sensor Module for human body detection incorporating a Fresnel lens and motion detection circuit. It has high sensitivity and low noise. Output is a standard 5V active low output signal. Module provides an optimized circuit that will detect motion up to 6 meters away and can be used in burglar alarms and access control systems. Inexpensive and easy to use, it's ideal for alarm systems, motion-activated lighting, holiday props, and robotics applications. The Output can be connected to microcontroller pin directly to monitor signal or a connected to a transistor to drive DC loads like a bell, buzzer, siren, relay, opto-coupler (e.g. PC817, OC3021), etc. The PIR sensor and Fresnel lens are fitted onto the PCB. This enables the board to be mounted inside a case with the detecting lens protruding outwards.

IR sensor:

It is a pair of photodiode and a LED which can be considered as an optocoupler. Whenever there is any object between the photodiode and led, the light cuts and the output suddenly drops to zero. The sensor output can be directly given to the controller unit.

The pictorial representation can be given as follows [5] in Fig. 5.

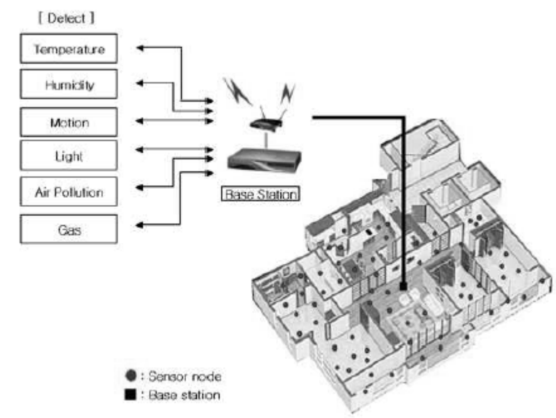


Fig. 5 Pictorial representation of overall system

System designing:

The training module is used to give an exposure to students about various ideas of home automation using various controller modules like CPLDs, FPGAs and different types of microcontrollers. From smart home module 16 channels are taken out to which the sensors outputs are connected as well as other connections are made available for actuators. By taking the sensor output as input to the controller unit, one can monitor as well as control the various equipments in the house.

Pseudo Code

1. Power ON the system.
2. Define I/O ports of microcontroller.
3. Display temperature on the LCD display
4. Assign interrupts for each sensor output depending on requirements.

5. If interrupt regarding

i. Temperature occurs

a. If (temperature< threshold value)

Turn on the heater

Else

Turn on the fan

End if

ii. PIR sensor occurs

a. If (PIR sensor gives high output)

Alarm the buzzer as well as display it on lcd

End if

iii. IR sensor occurs

a. If (interrupt occurs)

Alarm the buzzer and display unauthorized entry

End if

iv. Gas sensor occurs

a. If (gas level> threshold value)

Alarm the buzzer as well as turn on the ventilation

End if

v. Humidity sensor occurs

a. If (humidity>threshold value)

Turn on the exhaust fan

End if

6. Continue with step 5.

The hardware unit of the prototype of the system is represented by the Fig. 5. It contains a controlling unit (base station) which may be a microcontroller, hardwired logic unit or digital control like CPLD or FPGA as the main processing unit and it gets inputs from the temperature sensor (LM35), a humidity sensor (SY-HS-220), IR sensor (LED and photo detector pair), PIR sensor (SUNROM 1133) and a gas sensor (MQ 6). From the data obtained from the sensors the program controls the actuator components (fans, buzzer and lights in the room) to achieve the system requirements. It also uses a LCD display to display the humidity from the sensor. The cooler fans, buzzer and light bulb will be connected to the controller unit using a transistor array and 5V relays (The mechanism used is a normally-open relay switch) since they need an AC power supply to operate. A switch is introduced to manually switch off the light bulbs by cutting off the power supply to the light bulbs.

The requirement of the system is to regulate the temperature to user defined value and monitor the humidity as well as gas leakage in the program while displaying the current temperature value and the humidity value.

The system consists of four subsystems in it and these are,

1] Temperature monitoring and control system

2] Gas leakage indicating system

3] Humidity level monitoring system

4] Motion detection (light ON/OFF) system

The system's temperature monitor and control system works according to the temperature value set by the programmer. First it takes temperature value defined in the program as the set value and maintains the temperature accordingly. It displays the current temperature on the LCD screen for user reference. The temperature inside is reduced accordingly by the aid of fan that is placed in the room. Gas sensor is placed in the kitchen to detect the gas leakage, and if there is a gas leakage the system buzzers the alarm for indication. The IR sensor along with the PIR sensor is used in the room to get the information that the person is coming from the door at night time and accordingly the lights gets turned ON. During the day time the lights doesn't get turned ON. On the other way if there is no human being present in the room and if anyone has left the lights ON then the lights get automatically turned OFF for better energy management system. The humidity sensor is used to monitor the humidity in the room and it displays the humidity on LCD.

By studying all the facts given above the students will get well exposure to the electronic system like home automation or smart home and they will get the better ideas as well as they can implement their own ideas which is the main purpose of this training module

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Comparative Study of Antilock Braking System

Snehal S. Phadtare[1], Y. V. Chavan[2], D.S.Bormane[3]
[1]M.E. student Rajarshi Shahu College of Engineering, Pune University, Maharashtra
[2]Professor, Department of E&TC, Rajarshi Shahu College of Engineering, Pune University, Maharashtra
[3]Principal, Rajarshi Shahu College of Engineering, Pune University, Maharashtra
[1]snehalphadtare@gmail.com, [2]chavan.yashwant@gmail.com, [3]bdattatraya@yahoo.com

Abstract

The automobile industry has geared up for increasing speed making changes in design and fabrication. However, this speed needs to be taken care by studying vehicle dynamics for various parameters like weight of vehicle, braking system, driving condition and driver's security etc. This paper is review paper to study Anti-lock braking system (ABS) approaches used by researchers. The paper discusses the issues of ABS taken into consideration parameter[s] like stopping distance, braking torque, road conditions. To study and compare the results of various researchers is one of the objectives.

Another objective for ABS is this review paper will provide approaches ready for reference. The discussion is also made on various strategies adapted ABS system control action.

Keywords: Antilock Brake System, Neuro fuzzy, Nonlinear control system, PID, Sliding Mode Control.

I. Introduction

The tragedies of accident as noted is seem to be human error in first look. But it is because of system not design or optimizes to tackle critical situation. This can be minimized by redesigning and optimizing the system. The few parameters of this system are: braking distance, braking slip and braking deviation. The variation in these parameter leading to offer brake efficiency is major the concern here.

Recently various electromechanical techniques in automotive industry are being developed effectively. To provide electronic stability for vehicle control systems like ABS, traction control are used [21].

ABS Systems were introduced to the commercial vehicle market in the early 1970s to improve vehicle braking irrespective of road and weather condition [20]. ABS is a safety related feature that assists the driver in deceleration of the vehicle in poor or marginal braking conditions (e.g. wet or icy roads) effectively. In such conditions, emergency braking by the driver in non-ABS-equipped cars results in reduced braking effectiveness, loss of directional control due to the tendency of the wheels to lock [19].

In ABS-equipped cars, the wheel is prevented from locking by a mechanism that automatically regulates braking force to an optimum for any given low-friction condition.

ABS prevents wheels from locking when brakes are applied. Under braking, if vehicle's wheels are locked, then it begins to skid. It will affect system in following ways.

1. It will increase braking distance
2. Steering control will lost
3. Tire wear will be abnormal.

Due to this accident may occur. ABS improves performance of vehicle related to stability, steering control ability. ABS reduces stopping distance in emergency braking. It controls wheel slip for different road surface. During normal braking condition has no effect on service brakes. ABS helps prevent brakes from locking up by pulsing brake pressure to each wheel. It provides safety to driver and passengers. ABS system is non-linear and dynamic in nature.

Now, let us understand working principle of ABS.

II. Principle of ABS

Layne et al. have discussed Equation for vehicle dynamics and one-wheel rotational dynamics. They assumed wind resistance effects and all the vertical dynamics associated with the suspension system are negligible [1]. Consider $\omega_\omega(t)$ is the angular velocity of the wheel, $V_v(t)$ is the velocity of the vehicle the motion of the wheels can be determined by summing the rotational torques which is applied to the wheel. This differential equation is given by,

$$\omega_\omega(t) = 1/J_\omega[-T_b(t) - \omega_\omega(t)B_\omega + T_t(t)] \quad (1)$$

Where,

J_ω : rotational inertia of the wheel,

B_ω : viscous friction of the wheel,

T_b (t) : braking torque (in N-m), and

$T_t(t)$: torque generated due to slip between the wheel and the road surface. Refer Eq. (i), (iii) and (iv) in Appendix 1.

The vehicle dynamics are determined by summing the total forces applied to the vehicle during a normal braking,

$$V_v(t) = (-1)/M_v[F_t(t) + B_vV_v(t) + F_\theta(\theta)] \quad (2)$$

Where,

Mv : mass of the vehicle,

B_v : vehicle viscous friction,

$F_\theta(\theta)$: force applied to the car which results from a vertical gradient in the road. Refer Eq. (ii) in Appendix 1.

Through literature survey of ABS, wheel slip is defined as [5],

$$\lambda = \frac{V - \omega R\omega}{V} \quad (3)$$

Where,

λ : wheel slip,

ω : the wheel angular velocity of tire,

R_ω : wheel rolling radius, and

V : vehicle forward velocity.

For normal driving conditions,

$$V = \omega R\omega \quad (4)$$

From eq. (3) and eq. (4) $\lambda = 0$.This signifies free motion of wheels, where no frictional force is exerted.

Under critical braking condition, we have mathematical equation as follow,

$$\omega = 0, \qquad V \neq 0, \quad (5)$$

From Eq. (3) and Eq. (5) which gives result,

$$\lambda = 1 \quad (6)$$

Eq. 6 signifies wheel lockup condition.

The study of ABS under the different road surfaces is shown in Fig.1. The variation of road adhesion coefficient with respect to wheel slip is plotted [5]. It is observed that desired slip value is 0.2. This maximizes adhesion between tire and road to minimize stopping distance with available friction. Hence, it is necessary to use different control strategy for different road surface.

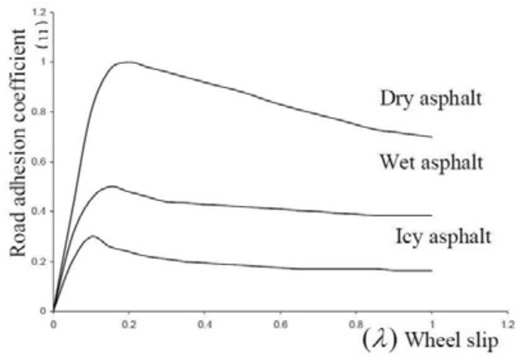

Fig. 1 μ-λ curves for different road conditions

There are several longitudinal tire/road friction models.

In literature Pacejkas Magic formula and Lu-Gre friction model are known.

(Burckhardt 1993) derived expression for μ friction coefficient which is function of slip λ and vehicle velocity υ [23] is given by,

$$\mu x(\lambda, v) = \left[C1\left(1 - e^{-C2\lambda}\right) - C3\lambda\right]e^{-C4\lambda v} \quad (7)$$

Where,

C_1 : Maximum value of friction curve

C_2 : Friction curve shape

C_3 : Friction curve difference between the maximum value and value at λ = 1

C_4 : Wetness characteristic value and is in the range 0.02- 0.04s/m.

For different road surfaces values of C_1, C_2, C_3 parameters (Kiencke and Nielson 2000) are given in Table 1.

Table 1: Friction parameters

	Surface conditions	C_1	C_2	C_3
(1)	Asphalt, dry	1.2801	23.99	0.52
(2)	Asphalt, wet	0.857	33.822	0.347
(3)	Concrete, dry	1.1973	25.168	0.5373
(4)	Cobblestones, dry	1.3713	6.4565	0.6691
(5)	Cobblestones, wet	0.4004	33.7080	0.1204
(6)	Snow	0.1946	94.129	0.0646
(7)	Ice	0.05	306.39	0

Tie Wang et al. have discussed method for accurate road identification [17]. This method uses fuzzy membership function and weibull distribution.

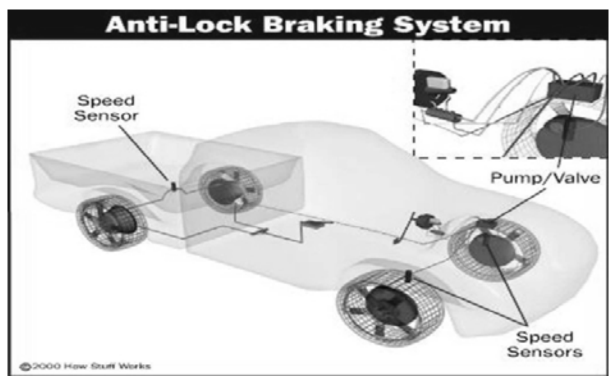

Fig. 2 ABS Components [23]

ABS main components are Speed sensors, Pump, Valves and Controller as shown in Fig.2.

Speed Sensors- The speed sensors are located at each wheel depending on type of ABS. Wheel speed sensors detect speed of rotation of wheels and pass electrical signal to controller [22].

Valves- There is a valve in the brake line of each brake controlled by the ABS. On some systems, the valve has three positions [22]:

1. In position one, the valve is open; pressure from the master cylinder is passed right through to the brake.
2. In position two, the valve blocks the line, isolating that brake from the master cylinder. This prevents the pressure from rising further should the driver push the brake pedal harder.
3. In position three, the valve releases some of the pressure from the brake.

Pump- When a valve reduces the pressure in a line, the pump is there to get the pressure back up. The valve is able to release pressure from the brakes, pump put that pressure back [22].

III. Anti-Lock Brake Types

Anti-lock braking systems use different schemes depending on the type of brakes in use. These will refer by the number of channels controlling valves individually and the number of speed sensors [22].

Four-channel, four-sensor ABS

This is the best scheme. There is a speed sensor on all four wheels and a separate valve for all four wheels. With this setup, the controller monitors each wheel individually to make sure it is achieving maximum braking force [22].

Three-channel, three-sensor ABS

This scheme found on pickup trucks with four-wheel ABS. This has a speed sensor and a valve for each of the front wheels, with one valve and one sensor for both rear wheels. The speed sensor for the rear wheels is located in the rear axle [22].

This system provides individual control of the front wheels, so they can both achieve maximum braking force. The rear wheels, however, are monitored together; they both have to start to lock up before the ABS will activate on the rear. With this system, it is possible that one of the rear wheels will lock during a stop, reducing brake effectiveness [22].

One-channel, one-sensor ABS

It has one valve, which controls both rear wheels, and one speed sensor, located in the rear axle [22]. This system is found on pickup trucks with rear-wheel ABS. This system operates the same as the rear end of a three-channel system. The rear wheels are monitored together and they both have to start to lock up before the ABS kicks in. In this system it is also possible that one of the rear wheels will lock, reducing brake effectiveness [22].

The ABS closed loop control flow [11] is as shown in Fig. 3. It will calculate wheel speed and vehicle speed. It will calculate slip ratio. Based on these parameters it will take control action.

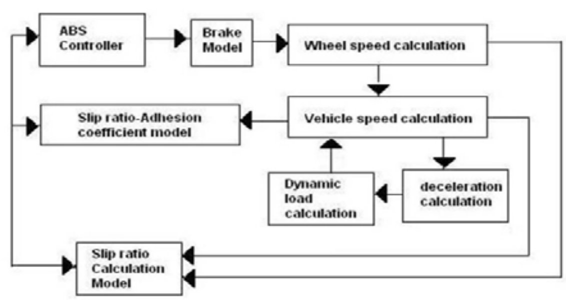

Fig. 3 Closed loop Control Flow of ABS

In this section, we have studied principle of ABS taken into consideration some of the parameter[s], ABS components, and ABS types. Various researchers have designed. Let us discuss few of approaches in next section.

IV. Methods for Design of ABS

Researchers have used fuzzy logic control, sliding Mode control, PID, Neural network, adaptive neuro fuzzy logic to design ABS.

4.1. Fuzzy Logic based Control

Fuzzy logic controller can easily adapt for complex, changeable operation condition [1]. They are easy for tuning parameters. Hence, many researchers used fuzzy logic for implementing ABS.

Jeffery R. Layne et al. have proposed Fuzzy model reference learning control (FMRLC) technique [1]. This maintains adequate performance even under such adverse road conditions. This controller utilizes a learning mechanism which observes the system outputs and adjusts the rules in a direct fuzzy controller. It provides effective braking under adverse road condition as compared to conventional braking system.

Georg F.Mauer[2] has proposed digital controller design which combines a fuzzy logic element and a decision logic network. The controller identifies current road condition and generates a command braking pressure signal, based on current and past readings of the slip ratio and brake pressure. The controller detects wheel blockage immediately and avoids excessive slipping. Fuzzy controller in combination with decision logic for estimation of the road condition is a rapid and effective means to provide braking torque control over operating conditions ranging from dry pavement to black ice. The controller detects wheel blockage immediately and avoids excessive slipping. It responded faster for different road condition.

An intelligent fuzzy control method is used to design system. F. YU et al have proposed control scheme for an ABS controller design is shown in Fig. 4 [3]. This method calculates optimal target wheel slip ratio on-line based on vehicle dynamic states and prevailing road condition. A fuzzy logic approach is applied to maintain the optimal target slip ratio so that the best compromise between braking deceleration, stopping distance and direction stability performances can be obtained for the vehicle. A fuzzy logic approach is applied to maintain the optimal target slip ratio so that the best compromise between braking deceleration, stopping distance and direction stability performances can be obtained for the vehicle. Compared with a fixed-slip ratio scheme, the stopping distance can be decreased up to 15%. It has achieved the best compromise between braking deceleration, stopping distance and direction.

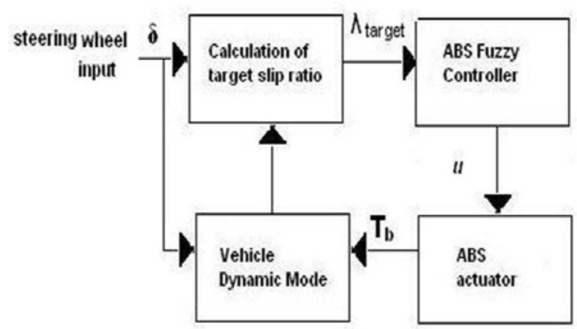

Fig. 4 Fuzzy Logic Control system for ABS

Ahmad Mirzaei et al. have proposed fuzzy controller based on TSK model [4]. It reduces vehicle stopping distance. It maintains wheel slip to desired level, so maximum traction force and wheel deceleration is obtained. All the components of a fuzzy system are optimized using genetic algorithms. Vibration due to torque and slip variations are much higher in fuzzy logic and PI controller. In proposed approach oscillations are less as slip kept at small value by tracking maximum adhesion coefficient. Vehicle has adequate lateral stability and good steerability.

Roozbeh Keshmiri et al. [5] have proposed an intelligent fuzzy ABS controller is designed to adjust slipping performance for variety of roads. Fuzzy-Logic Controllers (FLC) providing optimal brake torque for both front and rear wheels. FLC provides required amount of slip and torque references properties for different kind of roads. This controller has excellent ability to apply continuous brake torque and accordingly determines optimal slip to reduce stopping interval and distance.

Hui Lin et al. have proposed ABS control for Electric Vehicle based on fuzzy logic control [6]. Model is simulated using AME Sim and Simulink software. It is used to control the acceleration and deceleration of the wheel. This saves braking time and braking distance. It improves wheel lateral stability and braking efficiency.

4.2. Sliding Mode Control

A. Harifi et al have designed Sliding Mode Control based on vehicle model [7]. In this design they have assumed 20% uncertainty in center of gravity and 30% uncertainty in total mass of the vehicle. This method controls front and rear wheel slips without chattering. It is robust technique.

M.Oudghiri et al have proposed method which combines fuzzy logic and sliding mode slip control [8]. In this method vehicle motion is controlled by adjusting brake torque. It maintains braking force at maximum. It is suitable for different road conditions.

Yesim Oniz et al. have been proposed better sliding mode control which combines gray system theory and sliding mode control algorithm [9]. It is used to regulate optimal wheel slip depending on vehicle forward velocity. This method has better noise response. The advantage of gray prediction is that it requires only limited data to develop the gray model compared with the conventional controllers which need samples of reasonable size and good distribution of the data to develop an appropriate model. Gray predictors adapt their parameters to new conditions as new outputs become available. Hence, gray controllers are more robust with respect to noise, lack of modeling information, and other disturbances when compared with the conventional controllers.

4.3. PID based Control

Conventional PID controller is simple and practical to implement. Its system parameter need to be adapted corresponding to changing vehicle operation condition. Vehicle systems are complex and nonlinear which gives difficulty in adaption of parameters.

Fangjun Jiang et al. have proposed nonlinear PID control for class of truck ABS [10]. It is robust control and easy for tuning.

Jiang Kejun et al. have proposed technique to design ABS in which combines fuzzy logic and PID control with S function [11]. Fig. 5 shows block diagram of Fuzzy PID control system. This is simulated in MATLAB/Simulink. This method has better result as compared to conventional fuzzy PID.

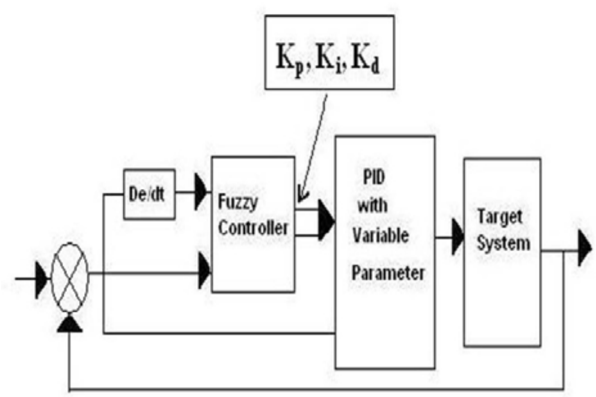

Fig. 5 Structure of fuzzy PID Control System

Bo Lu et al. have proposed algorithm for ABS implementation which combines PID and fuzzy logic [12]. PID parameters are auto regulated by fuzzy reasoning according to actual response of control system.

4.4 Neural Network based control

Chih-Min Lin et al. have proposed a hybrid control system with a recurrent neural network (RNN) for ABS [13]. An RNN with five hidden layer neurons is utilized and the sampling time is 1 m/s.

Erdal Kayacan et al. have proposed method to implement ABS based on grey multilayer feed forward neural network [14]. Fig. 6 gives block schematic of grey multilayer feed forward neural Network (GMFNN) controller. In this scheme, upcoming value of wheel slip is considered instead of its present value, which enables the GMFNN controller to have prediction capability. This controller is robust in the presence of the uncertainties in the system. GMFNN response is more accurate and less oscillatory.

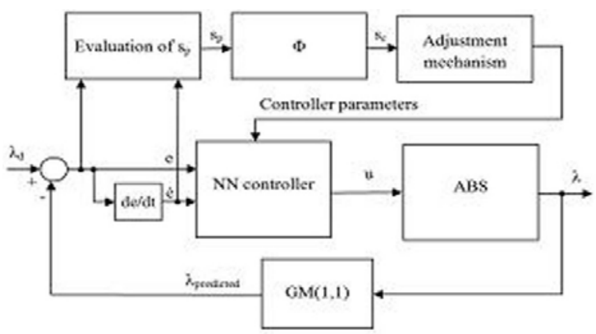

Fig. 6 GMFNN controller structure

4.5 Adaptive Neuro Fuzzy Based Control Approach

Andon V. Topalov et al. have used adaptive neuro-fuzzy approach [15]. This method consists of conventional PD controller and nero-fuzzy feedback controller.

Wei-Yen Wang et al. have designed ABS control based on direct adaptive fuzzy–neural controller (DAFC)[16]. In this method road estimator based on LuGre friction model is used to captures the road conditions effectively. ABS is developed to online-tune the weighting factors of the controller under the assumption that only the wheel slip ratio is available. DAFC can force the output to track the reference slip ratio obtained by the road estimator.

Mojtaba Ahmadieh Khanesar et al. [18]have implemented type-2 fuzzy logic systems (T2FLS) for ABS. They used extended Kalman filter (KF) for the optimization of the parameters of T2FLS.T2FLS trained by KF gives the best results when compared to T2FLS trained by Gradient Descent (GD) and T1FLS trained by KF

4.6 Discussion on Results of Various Researcher's Methods.

For ABS researchers were plotted variation of slip with respect to time. Plot of various researchers are shown below. Refer fig. 7 to Fig.11 From Fig.8 and Fig.9 it is observed that fuzzy control based S-Fuction have better result than conventional fuzzy based PID**.** From Fig.10 observed that GMFNN have better result i.e. (less oscillation) of slip ratio compared with MFNN.

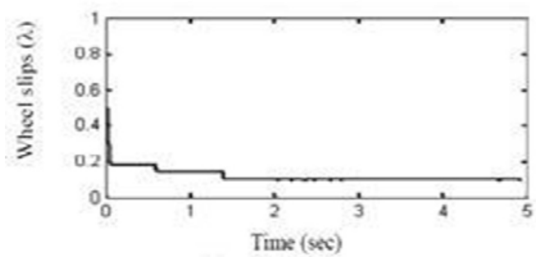

Fig. 7 Plot of front wheel slip in proposed ABS [5]

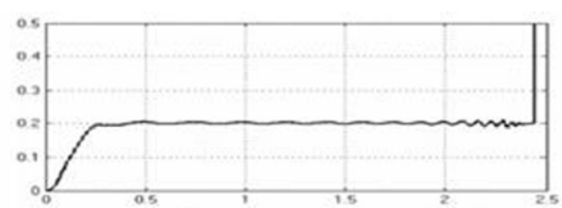

Fig. 8 Slip ratio curve conventional fuzzy based PID for ABS [11].

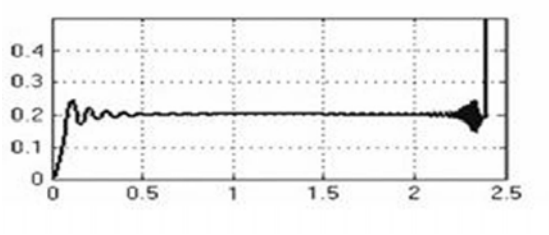

Fig. 9 Slip ratio curve under fuzzy control based S-Function for ABS [11].

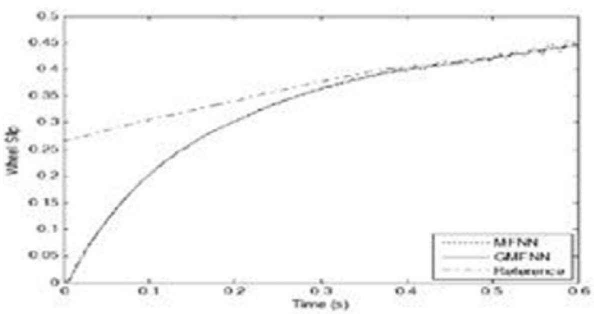

Fig. 10 Wheel slip for MFNN and GMFNN [14].

Acceleration Vs Time

Acceleration of Vehicle for different surfaces which is an input of the controller is also shown in Fig. 11 [5]. This acceleration is reason to determine adaptive slip wheel based on the surface condition.

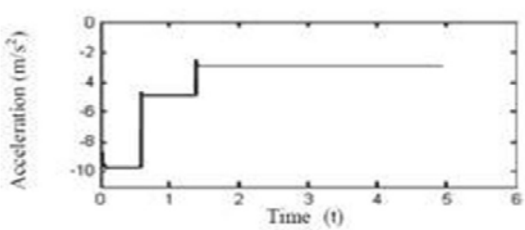

Fig.11 Plot of Vehicle acceleration in proposed ABS[5]

Stopping Distance Plot

Fig. 12 shows stopping distance is improved in optimal target slip ratio. Stopping distance is reduced from 55.66 m to 49.82 m compared with fixed slip ratio.

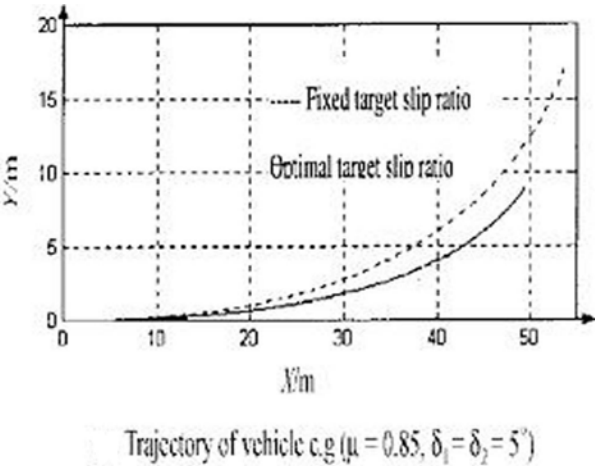

Fig. 12 Simulation result comparison between optimal target slip ratio scheme and fixed target scheme [3].

Slip Angle Vs Time

From Fig. 13 it is observed that slip angle of front wheel and rear wheel increases with the steering angle. Due to this front wheel target slip ratio increases.

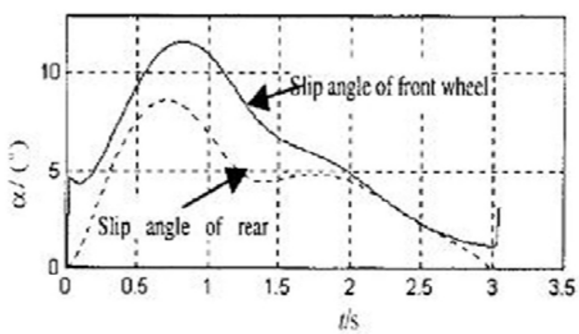

Fig. 13 Slip angle of front and rear wheel [3].

Brake torque Vs time

Braking torque plot of various researchers are shown in Fig. 14 to Fig. 17. From Fig.15 observed that GMFNN have less oscillation than conventional MFNN. From Fig.16 and Fig.17 it is observed that fuzzy control based S-Fuction have better result than conventional fuzzy based PID.

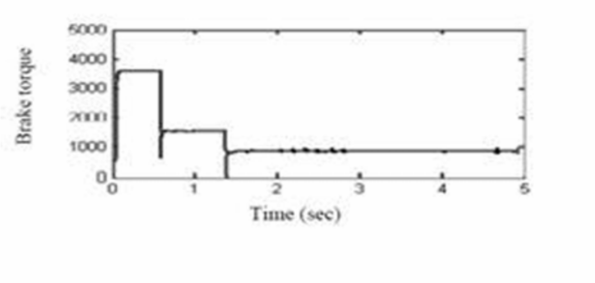

Fig.14 Front wheel applied torque by proposed ABS[5]

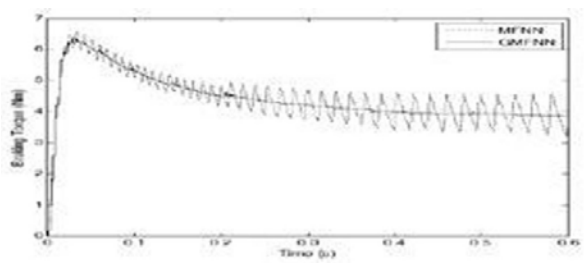

Fig. 15 Braking torque for MFNN and GMFNN [14].

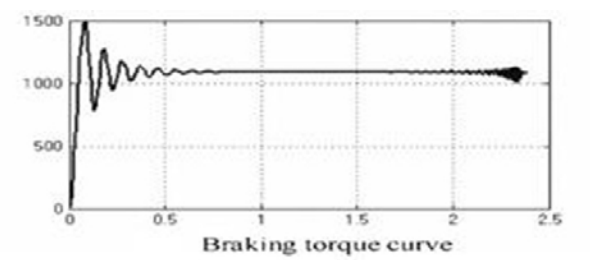

Fig. 16 Braking torque curve under fuzzy control based S-Function for ABS [11].

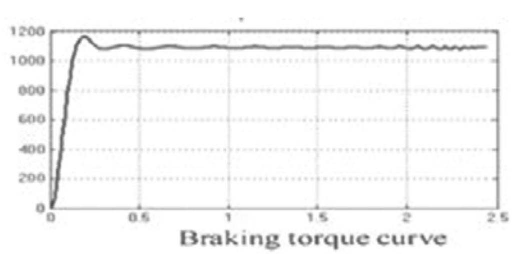

Fig. 17 Braking torque curve conventional fuzzy based PID for ABS [11].

Angular Velocity Vs time

Angular velocity Verses time plotted using NN hybrid control ABS [13]. The simulation results for different road condition are as shown in Fig. 18 to Fig. 21.

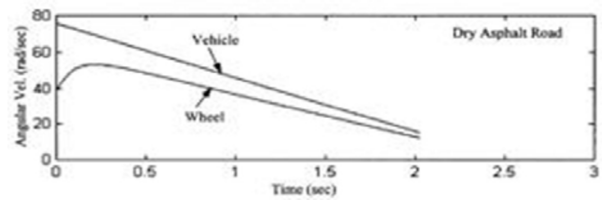

Fig. 18 saturation type sliding mode control for ABS for dry shaft road

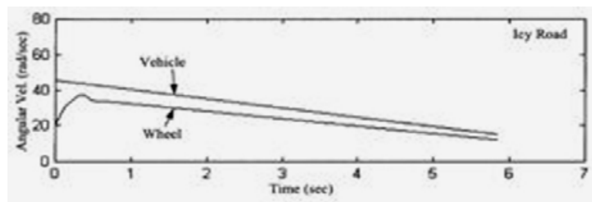

Fig. 19 saturation type sliding mode control for ABS for icy road

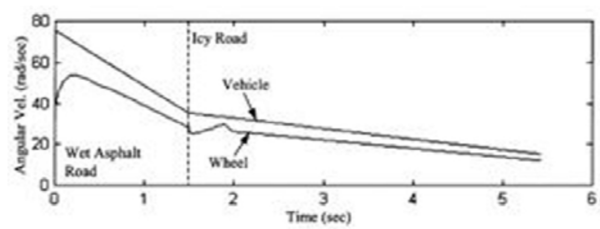

Fig. 20 NN hybrid control ABS for road transition

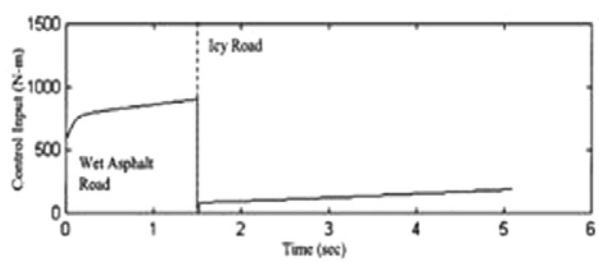

Fig. 21 NN hybrid control ABS for road transition

Fangjun Jiang et al. have given comparison of result for PID, Loop shaping and NPID algorithms [10].They have compared stopping distance refer Table. 2 and wheel velocity refer Table. 3. It is observed that NPID controller has best response than PID and Loop-shaping controller. Loop-shaping controller has better response than PID.

Table 2. Comparison of Stopping distance

	Stopping Distance	PID	Loop shaping	NPID
(1)	Nominal	86.3	61.3	65.9
(2)	Low μ	154.1	139.9	114.6
(3)	High air pressure	91.0	63.4	66.4
(4)	Low air pressure	83.3	62.5	66.7
(5)	Fast brake response	78.5	80.4	64.3
(6)	Slow brake response	94.7	67.6	70.8

Table 3. Comparison of wheel velocity response

	NM (velocity error2-norm)	PID	Loop-shaping	NPID
(1)	Nominal	740.7	216.1	286.1
(2)	Low μ	945.1	694.2	603.2
(3)	High air pressure	770.4	360.2	394.5
(4)	Low air pressure	631.7	241.8	256.8
(5)	Fast brake response	594.6	492.7	229.3
(6)	Slow brake response	818.6	518.2	377.0

Table 4 Performance of different algorithm in noisy and noise free environment based on Integral of absolute error

		Integral of absolute error			
		T2FLS With GD	T2FLS With KF	T1FLS With KF	PID PID
(1)	Noise-Free ABS with constant slip reference value	0.01835	0.01713	0.01711	0.02560
(2)	Noise ABS with constant slip reference value	0.04606	0.04460	0.04540	0.04930
(3)	Noise-Free ABS with velocity-dependent slip reference value	0.02338	0.02037	0.02046	0.02928
(4)	Noise ABS with velocity-dependent slip reference value	0.05768	0.05551	0.05879	0.06037

Table 5 Performance of different algorithms in noisy and noise free environment based on Integral of squared error

		Integral of squared error			
		T2FLS With GD	T2FLS With KF	T1FLS With KF	PID PID
(1)	Noise-Free ABS with constant slip reference value	0.002313	0.002305	0.002305	0.002416
(2)	Noise ABS with constant slip reference value	0.004203	0.004000	0.004000	0.004500
(3)	Noise-Free ABS with velocity-dependent slip reference value	0.002774	0.002742	0.002742	0.002856
(4)	Noise ABS with velocity-dependent slip reference value	0.004963	0.004759	0.005055	0.005600

Table 4 and Table 5 Show the performance of the different algorithms used in ABS on noisy and noise-free environments [18]. These tables give performance of algorithm based on Integral absolute error and Integral squared error. It is observed that Feedback Error Learning structure has much better performance than the conventional PID controller. It can also be observed that T2FLS trained by KF gives better performance than T2FLS trained by GD in noisy environment.

Conclusion

This paper is review paper to study Antilock Braking System. ABS control problem is non linear and dynamic problem. The analysis of various approaches has been studied. The results for various researchers have been discussed. ABS provides electronic stability for vehicle by preventing wheels from locking. The objective of this review paper is to decide new or modify existing approach. New method will improve further performance of ABS. This will improve vehicle stability, effectively reduce the braking distance, reduce stopping time, and improve steering control ability of ABS for different road surfaces .To come with novel method of ABS as embedded system.

Appendix 1: for Mathematical Equation

$T_t(t)$ is a function of the force $F_t(t)$ exerted between the wheel and the road surface. Mathematically $T_t(t)$ is expressed as,

$$T_t(t) = R_\omega F_t(t) \qquad \text{(i)}$$

Where, R_ω is the radius of the wheel.

$F_\theta(\theta)$ is given by,

$$F_\theta(\theta) = M_v g \sin(\theta(t)) \qquad \text{(ii)}$$

Where,

g : gravitational acceleration constant,

θ : angle of inclination of the road.

F_t (t) is expressed as a function of the coefficient of friction and the normal force on the wheel,

$$F_t(t) = \mu(\lambda) N_v(\theta) \qquad \text{(iii)}$$

Where,

$N_v(\theta)$: normal force applied to the tire.

For this model we assume that the vehicle has four wheels and the weight of the vehicle is evenly distributed among these wheels.

As a result, the normal force $N_v(\theta)$ is expressed by

$$Nv(\theta) = \left({Mv\, g}/{4} \right) \cos(\theta(t)) \qquad \text{(iv)}$$

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1. SnehalPhadtare has received Bachelor degree of Engineering in Electronics and Telecommunication from Pune University in 2007. She has done Course in Embedded System Design from Pune University, in 2009. She has 3 years industrial experience in embedded system domain. Her area of interest is automotive embedded system application. She is pursuing Master of Engineering in Digital System in Pune University. She is a member of IEEE.

2. Dr. Y. V. Chavan has completed his Bachelor of Engineering in Electronics and Master of technology in 1989 and 1999 respectively from Nagpur University. He has completed his Ph D (Sep 2011) from RGPV, a state technological University, Bhopal. Previously he worked as Lecturer in Electronics at Pravara Rural Engineeing College Loni, Ahmednagar, (M.S.). He worked as Assistant Professor and Head of Department for Dept of E&TC at Amrutvahini College of Engineering, Sangamner, Ahmednagar (M.S.)-India. He also worked as Assistant Professor at Maharashtra Academy of Engineeing, Alandi, Pune.

He is at presently working as Vice-Principal at RSCOE,Tathawade,Pune. His area of interest is Modeling and Simulation and its implementation using VLSI.

He has interest in Computer Network and published 3/e on the same topic with Umesh Publications, New Delhi (India). He is actively involved in IEEE Student oriented activities. He is instrumental in starting 4-5 IEEE student branches under Pune University. He is senior member of IEEE life member of ISTE, Member of IETE. He is Exe-com member for IEEE Pune Section. He has published 13 Journal Papers in National/International Journals and 15-papers in National/International Conferences.

3. Dr. D. S. Bormane has working as Principal at RSCOE, Tathawade, Pune. He has done his B.E. (EC), M.E. (CSE) and PhD in Electronics and Telecommunication. He has guided four PhD students and eight students are pursuing PhD. He has experience of 25 years. He has guided 15 post graduate dissertations in the field of electronics. He is the life member of ISTE, member of ISCEE Roorkee, member of CSI, fellow member of IETE, senior member of IACSIT, Singapore. He has published about 60 papers in various national, international journals and conference. He is the key person for framing various curriculums at university of Pune.

Design and Construction of Low Cost Keyboard Operated Propeller LED Display

Suraj C.Shinde*, Jaspal.Bange, D.K.Gautam
Department of Electronics, North Maharashtra University, Jalgaon.
*surajshinde79@gmail.com

Abstract

*This paper introduces display design process about hardware and software based on AT89C51RD2 single chip microcomputer. The fundamental and truly ingenious idea behind propeller displays is based on the phenomenon of "persistence of vision." We use a simple external circuit to control the display screen, which can display thirty-six INDIAN characters whose size is 16×16. We can modify the code to change the content of the display. Subtitles can achieve scrolling function and the scroll speed can be adjusted according to requirements. In our project, we are interfacing 3*4 matrix debounce keyboard. In this one time programming is done for keyboard to get multiple inputs from single key of keyboard directly to display making the device user friendly. Entire display is done by using 7 LEDs only which are rotated at various speeds by DC motor and position encoder. This display can show the messages, which is actually displayed by display using 525 LEDs. This display screen has advantages of small volume, simple hardware, compact circuit structure, crystal clear screen and low power.*

Keywords:- LED's, INDIAN character display, AT89C51RD2,Persistence Of Vision, Space multiplexing

I. Introduction

LED display has become an important in the city lighting, modernization and information society with continuous improvement and beautification of living environment.

Project's aim is to control LEDs connected in a row to display some images, and function it as a animation. This project was started with a simple principle which is Persistence of Vision. This phenomenon makes one feel fast moving/changing objects to appear continuous. A television is a common example; in which image is re-scanned every 25 times, thereby appear continuous.[9]

The implemented LEDs turn on and off, very rapidly one after other. Naturally the human eye responds slowly and we get an impression that the lights are on all together making the display readable. A few LEDs placed in a row are attached to a rotating board. They turn on and off at very definite and precise time intervals. All we can see are the lighted dots from the LEDs making a readable display that seems to steady display pattern can be shown.

In the project an array of LEDs, microcontroller, and infrared receiver is placed on the board and is rotated by a motor at a very high rpm. Since MCU is programmed using certain algorithm so at the same time, the board functions as a Display. Here, microcontroller was needed one time programming based on that after interfacing keyboard we give directly input for displaying characters, numbers and symbols.

This article described the design by the LED display relevant principle, and the design of hardware and software structure are described in detail, finally, we simulate for the overall design and analyse the results and making it user friendly.

LEDs, which are in a line equally spaced points. With the board rotating, the move LED ARRAY produce floating image. So the desired image such as clock, words or INDIAN characters can be programmed and displayed [11]. It is easy to use, simplifying the system designed; reduce the size of the system and cost of production design.

II. Background Overview

A. Existing Systems

Existing systems do employ POV principle, but for displaying each pixel, individual LED is used. This results in a huge number of LEDs even for small sized displays. By using a propeller type display, LED count can be kept to a bare minimum.

B. Drawback of Existing System

In existing system, for displaying characters, numbers and symbols every time reprogramming was needed to display different things, So, any other didn't work on that to display something different except engineer because every time programming needed.

C. Proposed System

The proposed system will use interfacing of external 3*4 matrix keypad with microcontroller for changing of the displaying characters, numbers and symbols without microcontroller reprogram. Because of that it becomes user friendly.

III. The Proposed System

A. Overview of the Display

Due to the versatility of the design, it can be widely used in many occasions that need to display information.

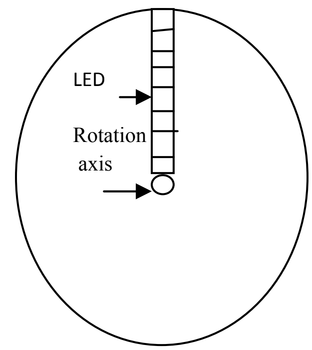


Fig.1: Overview of Display.

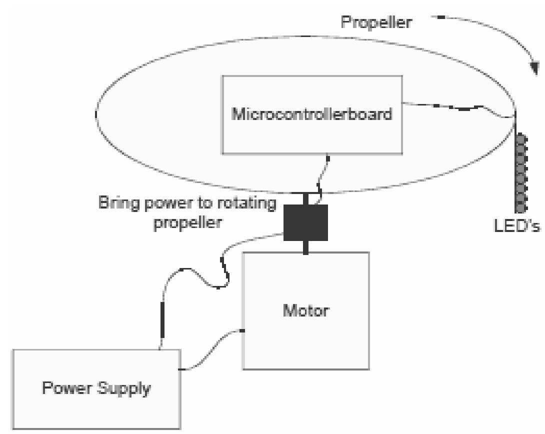


Fig.2 : Mechanical Assembly[7].

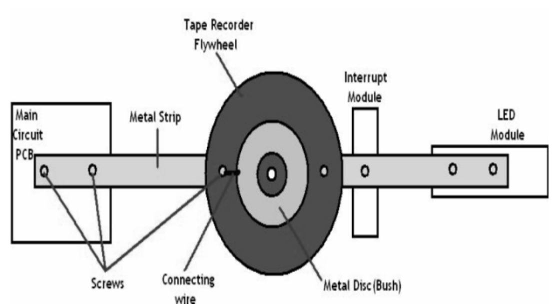


Fig.3 :Bottom View of rotating Assembly.

B. System Overview

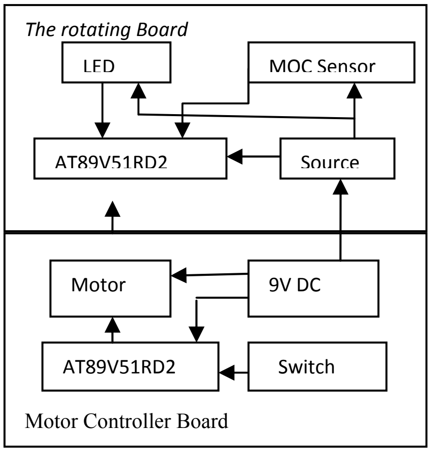


Fig.4 :Block Diagram.

1. Interrupter Module

Interrupter module is our sensor module, consisting of the IR interrupt sensor MOC7811, from Motorola Inc. This sensor was selected from a variety of other alternatives, because of its small size, precise interrupt sensing, and sturdy casing. One great advantage of using this module is, interfacing it with the microcontroller is just a matter of two resistors and a general purpose transistor. Following is the complete circuit diagram of our interrupter module.

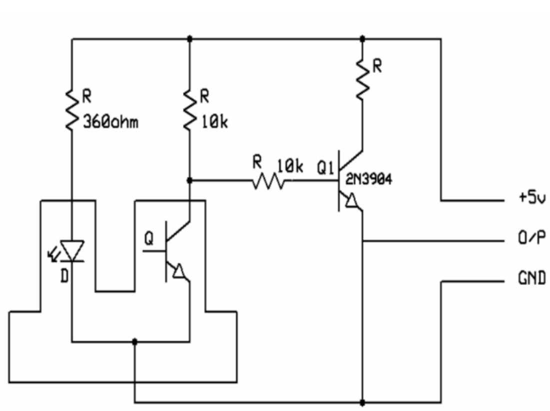
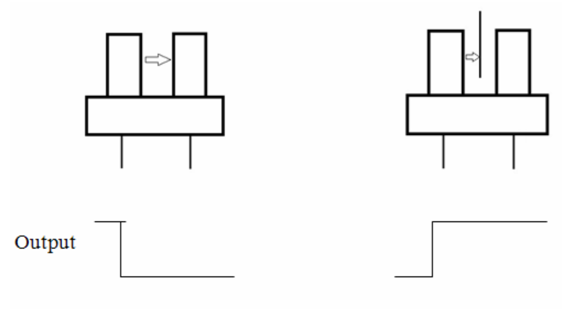


Fig.5 : Circuit Diagram of Interrupter Module[9].



Signal Conditioning :

INT0 pin of our microcontroller is Active Low. That means, occurrence of each interrupt is should be signaled with Low logic level. So, we must invert the output of the sensor.

Transistor 2N3904:

This a general purpose silicon NPN transistor. It is connected in the CE inverting amplifier configuration.

It inverts the output of the photodiode, and also improves the transient response.

2. Microcontroller

This unit is the heart of the complete system.

It is actually responsible for the all process being executed. It will monitor & control all the Peripheral devices or component connected in the system. In short we can say that the complete intelligence of the project resides in the software code embedded in the microcontroller. The controller here user will be of 8051 family. The code will be written in embedded C and will be burned or programmed into the code memory using a programmer. This unit requires +5V DC for its proper operation.

3. LED Module

LED module consisting of 8 bright LED is fixed in another side of the arm of our application. These LEDs are connected with each of the port pin of microcontroller, with a series current limiting resistor of 470 ohm.

4. DC Motor

Repeated scanning of the display is must for continuous vision. This task is achieved using circular rotation of the whole circuit assembly. So, we used a DC motor as the prime mover. By measuring the time difference between two successive pulses RPS can be calculated which further provide RPM value, as shown below:

Power supply given to DC Motor = 9V

Time interval between two successive pulses as seen on CRO = 56.4ms

□RPS = 1 / (56.4ms)

=17

□RPM= 17x60

RPM=1020

5. DC Power Supply

For microcontroller, as well as the DC motor, a regulated DC power supply is required. We have to provide +5V to the microcontroller, while +12V to the motor.

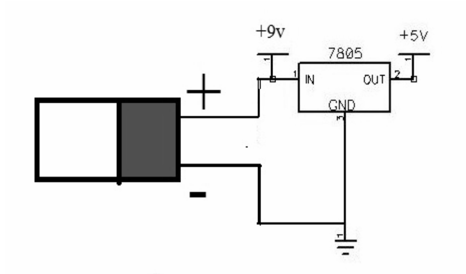


Fig.6 : circuit Diagram of Power Supply.

6. Keypad

Keypad is organized as a matrix of switches in rows and column. The article uses a 4X3 matrix keypad and a Led displaying the output of keypad.

The circuit diagram shows the connection of keypad with the controller. Port P2 of the microcontroller is used to send the data for displaying on the LED.

The concept of interfacing keypad with the MCU is simple. Every number is assigned two unique parameters, i.e., row and column number (n(R, C) for example 6 (2, 3)). Hence every time a key is pressed the number is identified by detecting the row and column number of the key pressed.

Initially all the rows are set to zero by the controller and the columns are scanned to check if any key is pressed. In case no key is pressed the output of all the columns will be high.

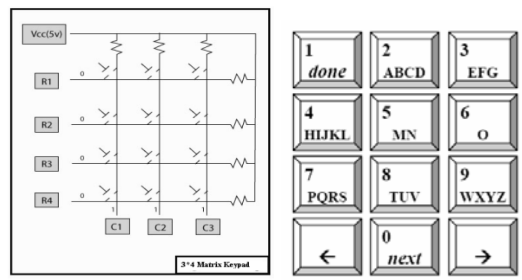


Fig.7.1:Alphabetically Constrained Design(ACD) keypad

Whenever a key is pressed the row and column corresponding to the key will get short, resulting in the output of the corresponding column goes to go low (since we have made all the rows zero). This gives the column number of the pressed key.

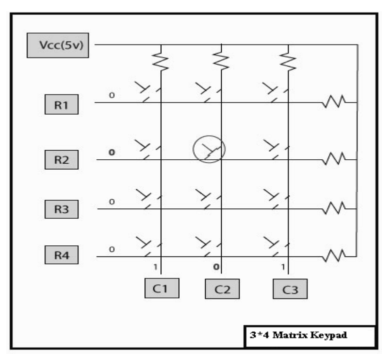


Fig.7.2

Once the column number is detected, the controller set's all the rows to high. Now one by one each row is set to zero by controller and the earlier detected column is checked if it becomes zero. The row corresponding to which the column gets zero is the row number of the digit.

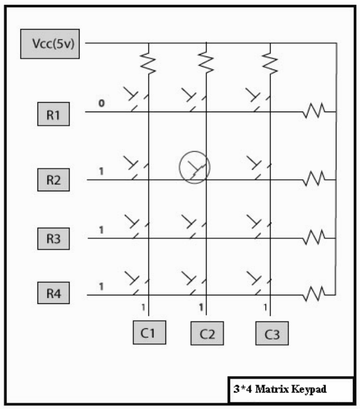


Fig.7.3

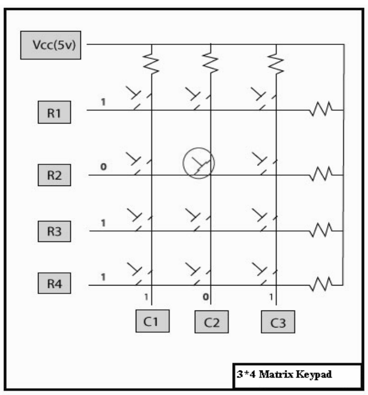


Fig.7.4

The above process is very fast and even if the switch is pressed for a very small duration of time the controller can detect the key which is pressed. The controller displays the number corresponding to the row and column through LED.

Ambiguous keypads are those that assign multiple characters to a single key. Consequently, the mobile device can utilize fewer keys, allowing designers to enlarge each key without increasing the space occupied by the entire keypad (i.e., its footprint).

The 12-key keypad consists of number keys 0-9 and two additional keys (* and #). Characters A-Z are spread over keys 2-9 in alphabetic order. The placement of characters is similar on most mobile phones, as it is based on an international standard. The SPACE character is typically assigned to the 0 key, or sometimes to the # key. Since there are fewer keys than the 26 needed for the letters A-Z, three or four letters are grouped on each key, and, so, ambiguity arises.

C. *Software Design*

(Reference from "The Design and Construction of a low cost Propeller Led Display Chhatrapati Shivaji Institute of Technology, Durg.[9])

Software Design has two routines. Main Routine and Interrupt Routine [9].

A. Main routine:

1. Load proper value in IE register, so that the interrupts INT0 and T0 are enabled. (IE = 83H)
2. Offer higher priority to the INT0 (External) interrupt. (IP = 01H)
3. Configure timer 1 as 16-bit timer, and timer 0 as 8-bit auto reload mode timer. (TMOD = 12H)
4. INT0 should be configured as edge interrupt. (IT0 = 1)
5. Configure port 3 as input port. (P3 = 0FFH)
6. Move input string to the video RAM area. (call 'ramc' function)
7. Start the timers.
8. Initiate an infinite loop.

B. Interrupt Routine

1. External Interrupt:

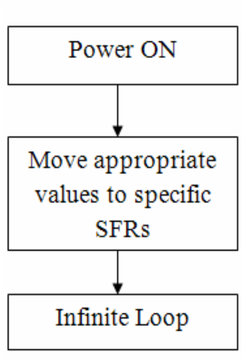
1. Stop the timers.
2. Move th1 and tl1 into convenient registers.
3. Divide this 16 bit value by our total number of segments.
4. Subtract the answer from 256, and load the result in th0.
5. Now, reset the video RAM pointer and character segment pointers to their initial respective positions.
6. Start the timers.
7. Return from interrupt.

2. Timer 0 Interrupt:

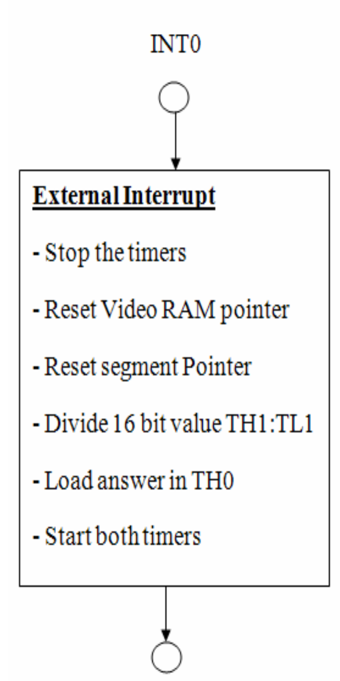
1. Call the display routine.
2. Clear timer overflows flag.
3. Return from interrupt.

D. Flow Chart

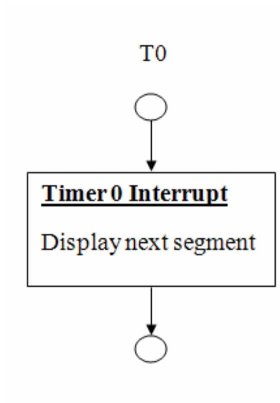
1. Main Routine:



2. Interrupt Routine:



3.Timer 0 Interrupt:



4.Keypad and Display

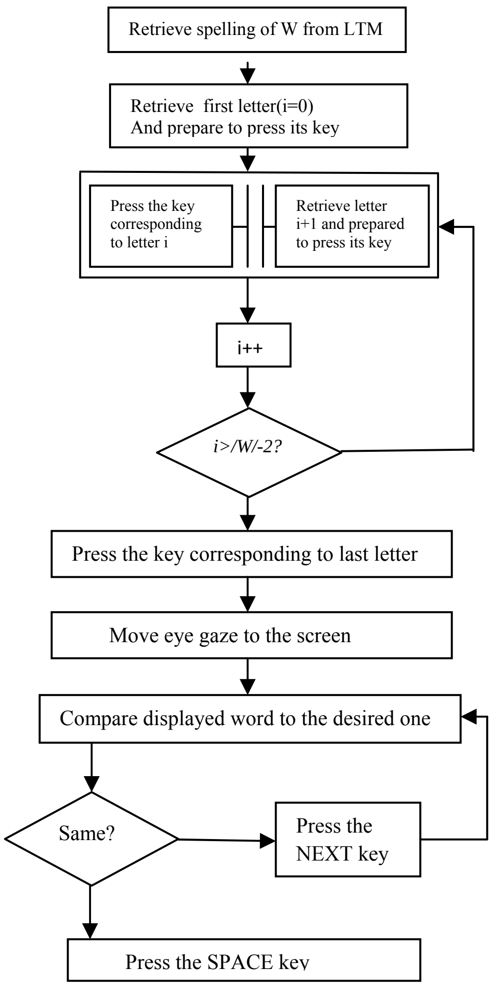


Fig8.1,2,3,4: -A diagram depicting the processes and decisions involved with text entry using an ambiguous keypad.

IV. Simulation Software and Tools

Few softwares and Simulators are used like, 8051 Simulator, Proteus and Micro vision Keil. 8051 Simulator is used to perform simulation of Assembly code, so first we checked our program in 8051 and checked all the values of registers like Accumulator and so on. In Proteus we designed the schematic of the project. Microvision Keil software was used to convert the Assembly code to HEX file and for uploading the program from the computer to programmer. We have used ATMEL series programmer in which we can program various ATMELs ICs and AVR too. After the compilation and simulation of program was accomplished, preparing an editor that can write the AT89V51RD2, and connected with the host computer hardware, that is, we can write AT89V51RD2 chip and download, then, the microcontroller AT89V51RD2 which is written program insert into the IC that has 40 pins. When power is connected, we can debug and run[11].

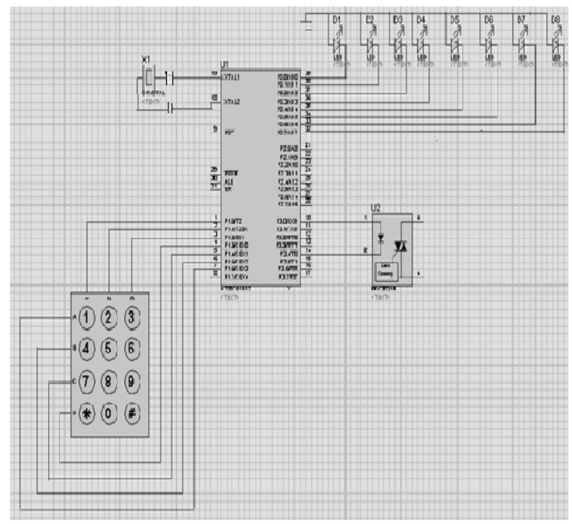


Fig.9: circuit Diagram.

V. Result

DELAY CALCULATIONS
motor speed===1020 RPM
time for one rotation===60 milli seconds
radius =30 cm
perimeter=2*3.414*30=204.84~205
width of led=0.5cm (this indicated the duration of led glow in terms of length of display)
total num of columns(leds)=205/0.5=410
410 leds=60 milli seconds
one led(column)time=146 micro seconds
columns for each letter=6
time for a letter=6*146=876 micro seconds
length for letter=6*0.5=3
total letters’=205/3=68

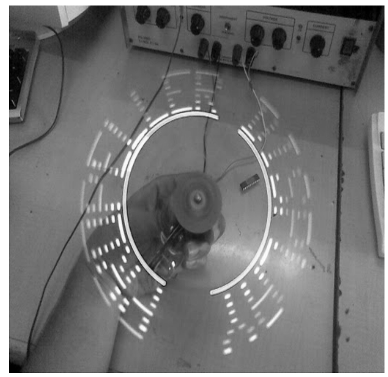
THE CALCULATIONS VARIES ACORDING TO THE GLOW TIME OF LED AND RADIUS OF THE ROTATING ARM
motor speed===1020 RPM
time for one rotation===60 milli seconds
radius =30cm
perimeter=2*3.414*30=204.84~205
width of led=1cm(this indicated the duration of led glow in terms of length of display)
total num of columns(leds)=205
205 leds=60 milli seconds
one led(column)time=292 micro seconds
columns for each letter=6
time for a letter=6*292=1752 micro seconds
length for letter=6
total leters=205/6=34

THESE ARE ROUGH CALCULATIONS BECAUSE THE MOTOR SPEED IS NOT ALWAYS CONSTANT

VI. Applications

Applications can find their way into cost effective solutions for large public displays, information systems. It can directly replace Railway station information displays, bus stands and many more places.

Images Displaying a character string :-



Acknowledgements

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11. *Wireless Dual Purpose Propeller Clock Display Nayab Suhail Hamirani, Asad Ali Shaikh, Peer Mohammad Memon,Yasir Ali Khatri Institute of Information & Communication Technology University of Sindh Jamshoro*

Synthesis, Characterization and Sensing Characteristics of Composite Polypyrrole-Polyethylene Oxide-ZnO As A Carbon Dioxide Sensor

Ankita R.Karule[1], Shrikrishna P. Yawale[2], Sangita S. Yawale[3]
[1]Dept. of Science & Humanities, Government Polytechnic, Amravati
[2]Dept. of Physics, Government Vidharbha Institute of Science and Humanities,Amravati - 444 604, India.
[3]Govt. Pre-Indian Administrative Services Training Institute, Nagpur- 440001, India
[1]ankita.karule@gmail.com, [2]spyawale@rediffmail.com

Abstract

Nowdays, there is great interest in using sensing devices to improve the environmental and safety control/monitor of CO_2 gas because it is known as green house gas contributing to global warming. Instead of metal oxides, conducting polymers have emerging application in the field of gas sensing. Polypyrrole (PPy) - polyethylene oxide (PEO) - zinc oxide (ZnO) composite thin film was synthesized by chemical oxidative polymerization method with the solution of ferric chloride ($FeCl_3$) oxidant in methanol and it is used as a gas sensor. The sensor was used for different concentration (ppm) of CO_2 gas investigation at room temperature. It was observed that response values of sensor vary linearly with the CO_2 gas concentration for an exposition time of 10 min and it shows saturation effect at 700 ppm CO_2. The response and recovery time of sensor were found to be ~4 min and ~10 min respectively. SEM and TG-DTA were used to analyze the sample.

Keywords: CO_2 gas, PPy-PEO-ZnO, SEM, TG-DTA.

1. Introduction

The environment is of great concern to every one. Carbon dioxide (CO_2) is one of the main products of the combustion processes. It is produced when a carbon containing fuel is burned in air. However, since the industrial revolution, the increase in consumption of fossil fuels has prompted an increase in the atmospheric concentration of CO_2 at a rate of about 1.5 ppm per year. Since CO_2 is one of the most common green house gases, increasing emissions could generate problems in near future. So it is necessary to develope high sensitivity, high stability and very short response and recovery time CO_2 gas sensor.

In recent years, a great attention has been paid to the development and application of environmental gas sensors. CO_2 is very difficult to detect by conventional gas sensor due to high stability at ambient temperature. Many efforts have been made to develop chemical sensors based on solid-state technology, exploiting either surface characteristic or the bulk conduction properties of ceramics. Based on the surface characteristic, there are two kinds of sensor; capacitive and resistive type (chemoresister).

Maier et al [1] in 1986, first time demonstrated the CO_2 gas detection, since then many researchers [2]-[6] reported CO_2 gas detection by using metal oxide (MOX) sensor, zeolites and conductive polymer (CP) sensor. Since the chemical property of CO_2 is stable, it was thought that the MOX semiconductor-type sensor could not be use for determining CO_2, while the research [7] reported SnO_2, which adding alkaline oxide is sensitive to CO_2 to some degree, but its preference to CO_2 is bad and the stability is not ideal. In 1990, Ishihara et al [8] found that the complex oxide compound of $BaTiO_3$ and PbO is sensitive to CO_2 and developed a semiconductor capacitive-type sensor for CO_2 gas. Since then, more sensors for CO_2 gas have been introduced.

Polypyrrole (PPy) composite films are highly sensitive to gases but they show a saturation effect at higher concentration of gases [9]-[11]. Komilla Suri et al. [12] reported that iron oxide-polypyrrole nanocomposite sensors showed the maximum response to CO_2 gas as compared to N_2 and CH_4 gases. Waghuley et al. [13] reported the increased sensitivity of a PPy composite sensor in the presence of CO_2 gas, in which the results were explained on the basis of chemisorptions process. In the present study, CO_2 gas sensing properties of PPy-PEO-ZnO sensor were studied. Thermal stability of sensor's material was determined using TG-DTA and SEM studies performed to investigate the surface morphology

2. Experimental

Anhydrous Ferric chloride ($FeCl_3$) (AR-grade), Zinc nitrate from S. D. Fine Chem (India), Ethanol from Changshu Yangyuan Chemical (China) pyrrole from Sisco (India) (AR-grade) and PEO from Across Organic (USA) are obtained All these chemicals were used as purchased.

2.1 Synthesis of ZnO nanoparticles

ZnO nanoparticles were prepared by recipitation method using zinc nitrate and sodium hydroxide as precursors and soluble starch as stabilizing agent. 0.3 g starch is dissolved in 100 ml of distilled water. 10 ml of 0.1 M zinc nitrate is added to starch solution. After complete dissolution of zinc nitrate, 10 ml of 0.2 M sodium hydroxide solution was added. The reaction is allowed to proceed for 2 h after complete addition of sodium hydroxide. After the completion of the reaction, the solution is centrifuged. In order to remove the byproducts and excessive starch bound to the nanoparticles, the precipitate was washed with ethanol repeatedly. The powder of ZnO nanoparticles was obtained after drying at 100^0C. Fig. 1 shows the TEM picture of pure ZnO. The grain size of ZnO is found to be from 20 to 60 nm

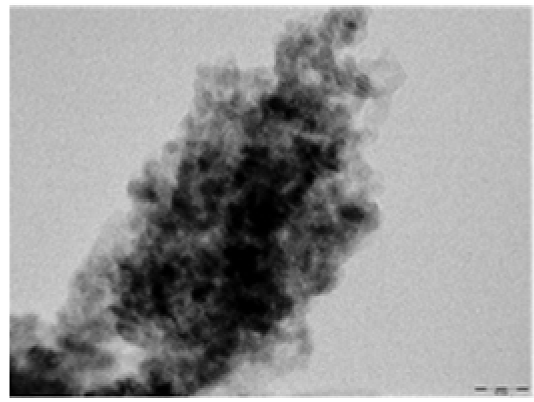

Fig.1

2.2 Preparation of sensor film.

The PPy-PEO-ZnO composites were prepared by chemical oxidative polymerization by using $FeCl_3$ as oxidant in methanol solvent. Firstly, PEO dissolved in methanol. This solution was kept in test tube for 12 h. A suitable amount of oxidizing agent (0.2M) was added to the solution. PEO- $FeCl_3$ solution was homogenized by constant magnetic bar stirring. After this ZnO nanopowder was added to this solution. Then monomer pyrrole was added dropwise to the homogeneous solution of PEO, $FeCl_3$ and ZnO. This mixture was constantly stirred for 3-4 h, a dark black homogeneous solution was obtained which was then poured on chemically cleaned polypropylene plane dish to prepare the films of composite. After evaporation of solvent the thin films were formed.

2.3 Measurements.

The electrodes of conducting silver paint were formed on adjacent sides of the film for good electrical contacts.The film was subjected to CO_2 gas in a chamber. The gas chamber having dimensions 30 x 30 x 30cm^3 with an attached CO_2 gas flow meter (Flowtron make, India having range 1-10 ml/min) was used. The resistance of the film was measured by two probe method.

2.4 SEM and TG-DTA characterizations.

Surface morphological study of composite films was done by using Field Emission Gun -Scanning Electron Microscope (JSM-7600F) operating with an accelerating voltage of 0.1 to 30 KV at SAIF, IIT Bombay, Powai, Mumbai. Thermal studies of the samples were analyzed by Perkin Elmer, USA, Model - Diamond TG/DTA at heating rate of 10^{0}C/min. Inert atmosphere was used.

3. Results and discussion

3.1 SEM analysis

The surface morphology of composite was analyzed by SEM and pictures are shown in fig. 2(a to c). The images are obtained for various magnifications

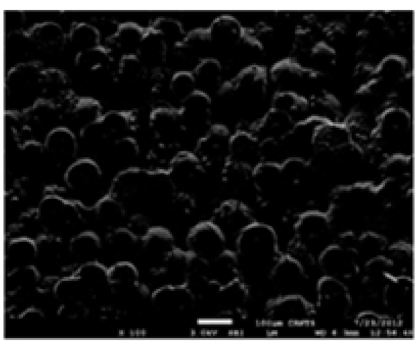

Fig. 2(a)

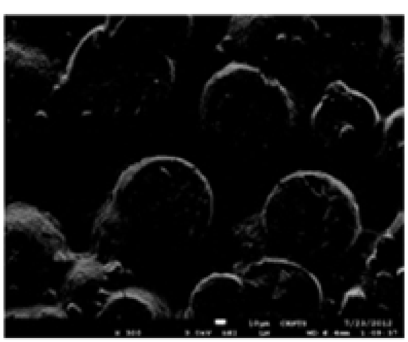

Fig. 2(b)

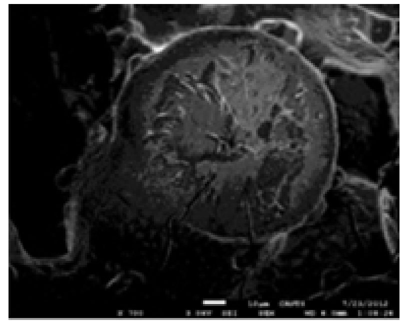

Fig. 2(c)

Fig. 2 SEM pictures of sample at different magnification.

From fig 2, it is seen that the circular shape grannuals having 90 µm size are formed throughout the film. These circular shape grannuals are connected each other. The cracks of 0.1 µm are seen on the surface of the grains. Alongwith the cracks, nanometer size white dots are formed on the surface of the film and these dots are distributed randomly throughout the film. Because of circular grains the voids are created.

3.2 TG-DTA analysis

The TG and DTA curves of composite PPy-PEO-ZnO are shown in fig. 3. In fig. 3, the horizontal portion from 80 to 240 ^{0}C indicates the region where there is no weight loss. In this temperature region the compound is stable. This is an indication of stable physical properties of the compound. The weight loss at 80 ^{0}C is about 10%, which is due to the loss of water molecules and moisture and above 240 ^{0}C a continuous weight loss about 36 % is observed upto 385 ^{0}C. This indicates that compound is not stable in the temperature range 240 to 385 ^{0}C. At the end, i.e. at 609 ^{0}C, the total loss is nearly 75%. An endothermic peak appears at 69.48 ^{0}C on DTA curve. The change in enthalpy ΔH and glass transition temperature (T_g) are found to be 47.0587 J/g and 69 ^{0}C respectively.

3.3 Response to CO_2 gas

The sensor response is defined as

$$S = \frac{R_g - R_a}{R_a} \quad \frac{\Delta R}{R_a}$$

Where R_a is the resistance of sensor in air and R_g is the resistance in presence of CO_2 gas, respectively. The sensitivity variation of sample is displayed in fig.4. The sensitivity of this sensor varies linearly with the CO_2 gas concentration at room temperature (303 K). The sensitivity of the sensor increases with increasing concentration of CO_2 gas. The response is exponential but the saturation effect is seen at higher concentration of CO_2 gas. This indicates the detection limit of this sensor.

T = 303 K

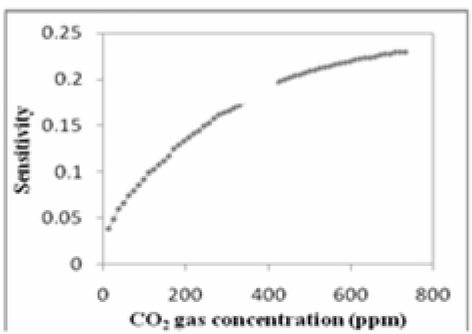

Fig.4. Sensitivity of PPy-PEO-ZnO sensor as a function of CO_2 gas concentration at room temperature.

3.4 Dynamic Response

The dynamic response of the sensor to 300, 500 and 700 ppm of CO_2 at room temperature is shown in fig.5. The response and recovery time, determines the speed of the sensor, are calculated from dynamic response of the sensor. These are important parameters to characterize a sensor. The response time is defined as the time taken to reach 90 % of the response when ppm of gas is changed. The recovery time is defined as the time taken to reach 90 % of the recovery when gas is turned off [14,15].

It is clearly seen that the response is fast (~ min), but to recover the sensor takes longer time (~10min). The process of adsorption of CO_2 gas is reversible. When the sensor is exposed to air, it requires longer time for its resettlement during recovery (Fig.5). This may be due to chemisorptive nature. During desorption process, the bond so formed with π- electrons of PPy surface breaks and retains the polarity of PPy structure.

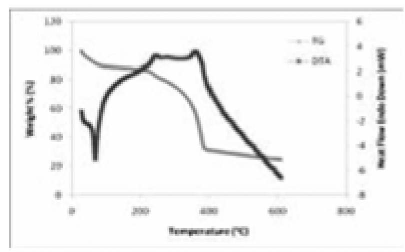

Fig. 3. TG-DTA plots of composite film

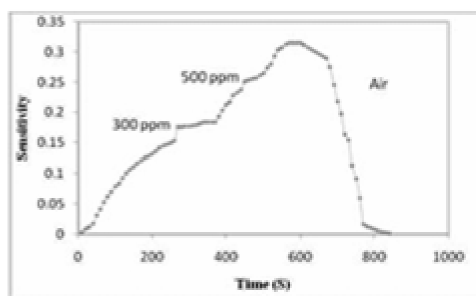

Fig. 5. Dynamic response of sensor to 300,500 and 700 ppm

CO_2 gas concentration at room temperature (303 K)

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An Expert Controller for Greenhouse Climate Control

P. A. Saudagar[1], D. S. Dhote[2], D. R. Solanke[3]
[1]Dept. of Applied Electronics, SGB Amravati University, Amravati (MS), India
[2]Dept. of Electronics, Brijlal Biyani Science College, Amravati (MS), India
[3]Dept. of Applied Electronics, SGB Amravati University, Amravati (MS), India
[1]saudagar.pa@gmail.com, [2]dsdhote@rediffmail.com, [3]solankedr@gmail.com

Abstract

The scope of this paper includes the design and development of an expert controller for controlling the greenhouse climate. An expert controller was designed using the Atmel's 89C52 microcontroller for controlling the humidity and temperature inside the greenhouse. The fuzzy logic control technique was used for the humidity control where as an integrated Fuzzy Logic Control method was used for controlling the temperature inside the greenhouse. The controller could handle two inputs, two outputs and 27 fuzzy rules each for humidity and temperature control, also the facility for monitoring the inside and outside humidity and temperature was provided. The set points for internal humidity and temperature could be defined by the user as per the need of the crop in the greenhouse in different seasons. The separate PWM outputs were generated to control the humidity and temperature according to the set point values.

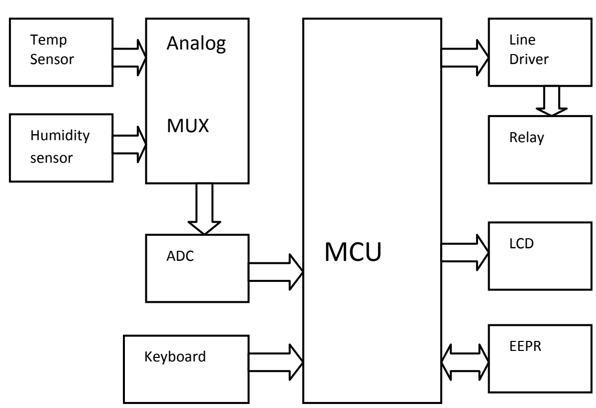
Keywords: FLC, IFLC, Inference, Fuzzy logic, Greenhouse

1. Introduction

The greenhouse is a structure that is covered with a material that is transparent to the visible portion of the electromagnetic spectrum, which is utilized in the growth of plant. The performance of the greenhouse is best when temperature is not too hot and not too cold. It is necessary to maintain suitable temperature at growth stage of several plants.

Also humidity control is an important parameter in greenhouse climate control[1] because excess humidity condenses on the leaf surface where it can enhance disease problems also it condenses on the greenhouse structure where it can reduce the light transmission and encourage rust and rot of the structure itself. So, with the controlled environment in the greenhouse it is possible to increase the quality and quantity of crop produce per unit land in minimum possible time[1][2][3]. Automation in greenhouse is very important for successful management of the greenhouse crops. In the present work a controller was designed which will sense the inside and outside humidity and temperature of greenhouse, displays them on the LCD screen, allows user to set inside humidity and temperature as per the requirement and activate the humidifier or exhausting and heating or cooling systems accordingly. A fuzzy logic approach was used to decide the output for humidifier or exhausting system for controlling humidity whereas the integrated fuzzy logic technique was used to generate the output for heating or cooling systems to control the temperature inside the greenhouse.

SYSTEM BLOCK DIAGRAM



3. Hardware and Software

3.1 HARDWARE

The system hardware was designed using Atmel's 89C52 microcontroller as an MCU, which initialize the system, reads the sensors, displays the values of inside and outside humidity and temperature of the greenhouse along with the set points for both on LCD and take action according to the algorithm developed. The humidity sensor modules SY-HS230B were used for sensing the inside and outside relative humidity of the greenhouse. This sensor module requires +5 Volt supply. The humidity transmitting range is 10 - 95%RH with accuracy of ± 5%RH. For sensing the inside and outside temperature of the greenhouse ICs LM 35 were used. The analog outputs of these sensors were given to the analog multiplexer IC CD 4051 whose output was connected to the analog-to-digital Converter IC ADC0804, which is 8-bit A/D converter IC. A 20x4 LCD display module was used to display the current values of the humidity and temperature and also to display various interactive messages for the user during settings. This module has four rows of twenty characters in each row. The reason behind selection of this module was to have better interactivity between the user and the hardware. The port 2 pins P2.5 and P2.6 were used for controlling the heating and cooling systems whereas the port 2 pins P2.4 and P2.7 were used for controlling the humidifier and exhausting systems. These lines were connected to the solid-state relays through line driver IC ULN2808. The cooling, heating, humidifier and exhausting systems were connected to these solid-state relays so that PWM output could be generated for these systems. A serial EEPROM IC 24C02 was used in the controller to have the backup of the set points made by the user which avoids the need of frequent settings also resumes the proper function in case of power failure. A simple keyboard consisting of three keys was designed for the controller which allows the user to set various parameters as per the requirement.

3.2 SOFTWARE

The software for the controller was developed using assembly language. The modular programming concept was used so that system could be easily upgraded. The major software modules developed were:

a. Initialization Module

b. Sensor module

c. Keyboard and display module

d. FLC module for humidity control

e. IFLC module for temperature control

f. PWM generation module

After reset, the initialization module loads the variables, stack, and other necessary registers to their default values set by the programmer, initialize the timers and start them. The sensor module sense the inside and outside humidity and temperature one by one, converts them to digital equivalent and stores them to the corresponding locations in the internal RAM. The keyboard and display routine sense the keys pressed by the user and display routine displays the various parameters on the LCD. The FLC and IFLC modules are discussed in section 3.3 and 3.4. The timer 1 interrupt was used for generation of PWM outputs for the heating and cooling systems. And the timer 2 interrupt was used for generation of PWM outputs for the humidifier, exhausting systems.

3.2 HUMIDITY CONTROL

For controlling the humidity inside the greenhouse the Fuzzy Logic Control approach was used [4]. The block diagram of Fuzzy Logic controller (FLC) is shown in figure 3.1.

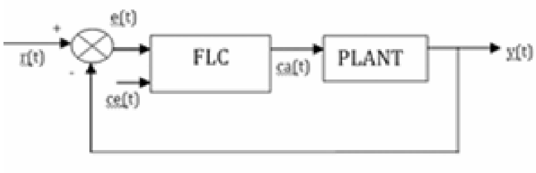


Figure 3.1 block diagram of FLC

Two input variables e_{hum} and ce_{hum} were given to the FLC. The e_{hum} was the error value [] of relative humidity, which was the difference of set point value of Relative humidity and the current value of the relative humidity inside the greenhouse and the difference between the current e_{hum} and pervious value of e_{hum} was defined as change in error ce_{hum}. These values were crisp in nature, which were then converted to the fuzzy values by using triangular membership functions. The error value e_{hum} was fuzzified within the universe of discourse with nine linguistic values NVL (Negative Very Large), NL (Negative Large), NM (Negative Medium), NS (Negative Small), Z (Zero), PS Positive Small), PM (Positive Medium), PL Positive Large) and PVL (Positive Very Large). The universe of discourse for error was (-80, +80)% RH. The change in error ce_{hum} was also fuzzified using triangular membership functions with three linguistic values NEG (Negative), Z (Zero) and POS (Positive). The rule base designed on the basis of knowledge from experts and literature, which consists of 27 rules. The general form of fuzzy logic rule is:

IF (condition) AND (condition) THEN (action). The process of deciding the action is known as inference. The inference process relates the fuzzy state variables e_{hum} and ce_{hum} to the fuzzy control action ca_{hum}. The control action was also fuzzified using triangular membership function and has linguistic values VL (Very Low), L (Low), M (Medium), LH (Little High), H (High) and VH (Very High).

The fuzzy inference engine processes the input data and computes the control outputs using IF-THEN rules. The Mamdani inference was used. These outputs were fuzzy values, which were then converted to crisp value in defuzzification stage. The Center Of Gravity (COG) was met is used for defuzzification. The crisp value obtained from defuzzification stage for the corresponding values of e_{hum} and ce_{hum} were stored in the internal ROM as look up table and the values of e_{hum} and ce_{hum} were used to access these crisp values from the look up table[4]. The value read from the look up table was used as percentage on-time duty cycle for PWM output, which was generated using timer 1 ISR. The PWM output was used to control either humidifier or exhausting system depending on the error value e_{hum}.

3.3 TEMPERATURE CONTROL

For controlling the temperature inside the greenhouse the concept of Integrated Fuzzy Logic was used. Such controller is referred to as Integrated Fuzzy Logic Controller (IFLC). IFLC is an integration of FLC with PID Controller[5]-[7]. The block diagram of IFLC is shown in figure 3.4 where, fuzzy controller has just a supplementary role to support the existed PID control system.

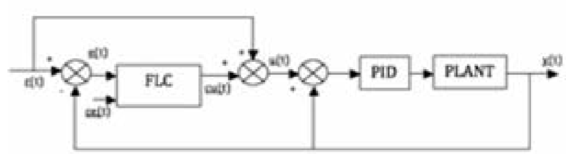


Figure 3.2 Block diagram of IFLC

An FLC was designed to which two input variables e_{temp} and ce_{temp} were given. The e_{temp} was the error value of temperature, which was computed as-

e_{temp}= temperature set point - current value of temperature and change in error ce_{temp} is computed as-

ce_{temp}= current e_{temp}- previous e_{temp}

Both the e_{temp} and ce_{temp} values were crisp values, which needs to be fuzzified. The error value of temp e_{temp} was fuzzified using triangular membership function within the universe of discourse (-40, +40) 0C with nine linguistic values, the linguistic values were NVL (Negative Very Large), NL (Negative Large), NM (Negative Medium), NS (Negative Small), Z (Zero), PS (Positive Small), PM (Positive Medium), PL (Positive Large) and PVL (Positive Very Large). The change in error ce_{temp} was also fuzzified using triangular membership functions with three linguistic values NEG (Negative), Z (Zero) and POS (Positive). For decision making a rule based consisting of 27 rules were defined. The inference mechanism uses the value of e_{temp} and ce_{temp} to drive the conclusion. The IF-THEN rules were used for the inference of the control action for the system. The values inferred were the fuzzy values which were converted to crisp by defuzzification stage using Centre Of Gravity (COG) method. The crisp value obtained from defuzzification stage for the corresponding values of e_{temp} and ce_{temp} were scaled and stored in the internal ROM as look up table and the values of e_{temp} and ce_{temp} were used to access these crisp values from the look up table. The value read from the look up table was added to the temperature set point and it was treated as the new set point for PID controller as shown in Fig. 3.2. The current temperature value was subtracted from the new set point value and the difference was considered as error value en for PID controller. The PID controller generates the new control action vn implemented using the velocity equation[6][7]-

vn = vn-1+kp(en-en-1)+ki(en)T+kd/T(en-2en-1-en-2)

where, vn: Control action by PID controller

vn-1: previous control action

en: current error value of PID controller

en-1: previous error value of PID controller

en-2: previous to previous error value to PID controller

kp: proportional gain

ki: integral gain

kd: differential gain

T: cycle time

In the present algorithm for IFLC, the values of were selected as kp=2, ki=2 and kd=1. After reset, previous values of error and vn were initialized to zero. The value computed by the above equation was scaled within the limits and the scaled value was used for calculation of percentage duty cycle for PWM output, which was generated using timer 1 ISR. The PWM output was used to control either cooling or heating system depending on the error value e_{temp}.

4. Results

The performance of the controller was verified in two sections. The first was to test the proper functioning of the interactive user interface and then to verify the actual control operation of the controller as per the set points made by the user. The user interface was verified testing the functioning of the keys that allows different settings to be made to the controller. It was observed that the controller recognized the key pressed and displays the message accordingly. Also some alerts were generated to guide the user during settings. The set points by the user were memorized by the controller in serial EEPROM. The later part of the performance verification was the test of FLC and IFLC. For his purpose the controller was installed in the greenhouse and its performance was tested by defining the various set points for the humidity and temperature to be maintained inside the greenhouse. The controller generated the outputs accordingly and maintains the climate.

5. Conclusion

The expert controller designed for controlling the greenhouse climate proves satisfactory results in maintaining the humidity and temperature inside the greenhouse as per the settings made by the user. The controller may be useful for the gardeners because of its simplicity, low cost and power consumption. Providing congenial environment to plants by use of such controller the production of vegetables and other crops may be enhanced.

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Online Monitoring of Battery Performance Parameters for Electric and Hybrid Electric Vehicle

V. P. Labade[1], N. M. Kulkarni[2], A. D. Shaligram[3]
[1]Department of Electronic Science, Fergusson College, Pune-4, Maharashtra, India
[2]Department of Electronic Science, Fergusson College, Pune-4, Maharashtra, India
[3]Department of Electronic Science, University of Pune, Pune-7, Maharashtra, India
[1]vplabade@rediffmail.com, [2]nmkulkarni123@yahoo.com, [3]adshaligram@gmail.com

Abstract

Rechargeable batteries like Lithium-ion and Zinc batteries have high levels of energy and power density among other electrochemical batteries such Lead acid battery etc. The high level of energy and power density of these batteries makes them suitable as the energy storage in electric, hybrid electric vehicle, and plug-in vehicles (EV/HEV/PHEV). One of the important requirements in automotive batteries is to monitor their state-of-charge (SOC), state-of-health (SOH), terminal voltage, open circuit voltage and temperature parameters on line. Open circuit voltage, is one of the parameter used for predicting the SOC in the battery, which is not readily available during charge and discharge cycles. Online comparison of the predicted and measured terminal voltage provides a tool for calculating the SOC and SOH. In this research paper attempt is made to design the system for online monitoring of battery performance parameters for battery operated vehicles or plug-in vehicles.

Index Terms: Electric vehicle, Lead Acid Battery, online monitoring, State-of-charge (SOC), State of health (SOH)

I. Introduction

Automobile industry is focused on fuel saving automobile vehicles and/or electric, hybrid electric vehicle, and plug-in vehicles (EV/HEV/PHEV). The rechargeable battery plays major role for deciding many electrical specifications of battery operated vehicle. Rechargeable batteries like Lithium-ion and Zinc batteries have high levels of energy and power density amongst other electrochemical batteries such Lead acid battery [1], [2]. The high level of energy and power density of these batteries makes them suitable as the energy storage in electric, hybrid electric vehicle, and plug-in vehicles. Multi-battery parameter reading or recording is an important way for studying the functions the rechargeable battery. Monitoring of the battery performance parameters gives more information about the battery status and health of the battery. Recently, many commercial data acquisition systems are available and are also powerful. Owing to the improvement of computing power, computer-aided multi-unit acquisition and separation rapidly proliferated during the last two decades. To utilize this technology is, however, not easy since task-specific designs are usually mandatory. To overcome this obstacle, a commercially available National Instrument (NI) USB 6009, data acquisition system is used to evaluate, this research paper describes a design and development of a real time monitoring system for the measurement of battery performance parameters. The battery performance parameters are computed continuously with designed hardware and software setup. The designed system monitors battery related parameters and provides information regarding health of the rechargeable battery [8]. This experimental data could be used to know certain parameters of battery like rate of charging, rate of discharging and power drawn by electrical loads. Real time monitoring system provides key information to the user in an electrical car or battery operated systems or electrical power system in deciding mileage, range, specifications and other related parameters [5].

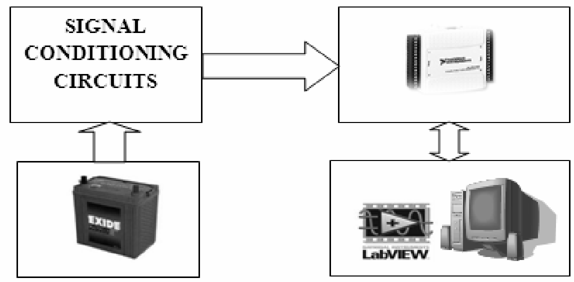

Figure 1.0: Monitoring System of Battery Performance Parameters

Data acquisition is the process of sampling signals that measure real world's physical conditions and converting the resulting samples into digital numbers that can be manipulated by a computer. Data acquisition systems (acronym DAS or DAQ) typically convert analog waveforms into digital values for processing. In this research work DAS is used to read parameters of the rechargeable battery continuously with number of samples per second is decided in the LabVIEW software. The charging or discharging rate of the rechargeable battery or electrical car battery is low or not constant as compare to other physical systems. The 20,000 samples per second, maximum sampling rate is possible for reading data with this card. In case of battery parameter reading process needs lower sampling rate and can be adjusted through DAQ assistant setting of the card through the software. The type of reading data (differential or single ended) can be decided through software Data acquisition applications are controlled by software programs developed using specialized software LabVIEW. This software tools used for building large scale data acquisition systems for rechargeable battery and its graphical programming environments for visualization.

DAQ hardware is what usually interfaces between the signal and a PC. It could be in the form of modules that can be connected to the computer's ports (parallel, serial, USB, etc.) or cards connected to slots in the board. Not all DAQ hardware has to run permanently connected to a PC, for example intelligent stand-alone loggers and oscilloscopes, which can be operated from a Personal Computer (PC), yet they can operate completely independent of the PC.

The block diagram of the system consists of current, temperature and voltage sensing sections followed by its signal conditioning blocks as shown in Fig1.0. The necessary settings are made according to the requirement of the system temperature measurement parameters is very much important because temperature term decides internal resistance of the battery and rate of charging and discharging, and some required electrical quantities or parameters of the battery. The temperature of the battery is read through the sensor LM35 and corresponding output voltage is directly given to the DAS with signal conditioning output of the sensor.

Similarly the current and voltage part is also connected to the DAS system in order to make system ready for reading data continuously. Battery indications are also included in the software code like temperature of battery, lower/higher voltages, Total power of the battery, Remaining power of the battery and Charge holding time, Nominal Voltage and High temperature indications of the battery through emergency indicators. The different loads connected to the battery can be manipulated through software and corresponding load switching unit can be activated in order to use battery for optimum utilization.

The state of charge and depth of discharge are the most significant parameters of the battery. These parameters are used for the improvement of battery operation, performance, reliability and life span. Knowing the state of charge it is possible to avoid an overcharging that would lead to a decrease in working life or even to a battery malfunctions. The malfunctioning of the lead acid battery may cause large economical losses or in the case of more sensitive equipment, even the loss of human lives. The measurement of electrolyte density provides accurate value of battery SOC but for this measurement hydrometer is required and manual intervention is needed for its operation. For this reason online monitoring plays important role for avoiding many problems.

II. Battery State of Charge (SOC)

A key parameter of a battery use in an EV system is the battery state of charge (SOC) [10]. The SOC is defined as the fraction of the total energy or battery capacity that has been used over the total available from the battery. Battery state of charge (SOC) gives the ratio of the amount of energy presently stored in the battery to the nominal rated capacity.

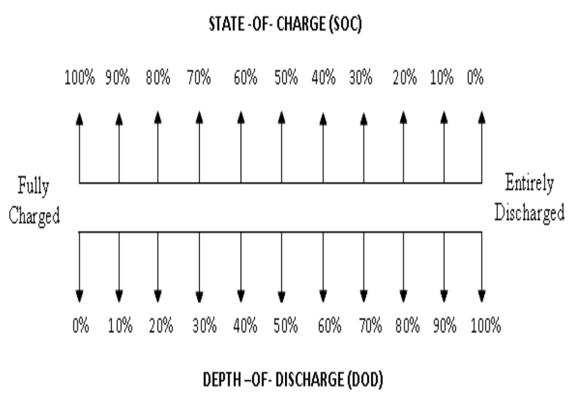

Figure 2: SOC and DOD relation strip

For example, for a battery at 80% SOC and with a 500 Ah capacity, the energy stored in the battery is 400 Ah. A common way to know SOC is to measure the terminal voltage of the battery and compare this voltage of a fully charged battery to table 1 [10]. However, as the battery voltage depends on temperature as well the state of charge of the battery; this measurement provides only a rough idea of battery state of charge.

Table 1: Battery terminal voltage and state of charge

Sr. No.	Terminal Voltage (v)	SOC (%)
1	12.75	100
2	12.64	93
3	12.52	84
4	12.40	73
5	12.32	66
6	12.28	60
7	12.20	50
8	12.00	29
9	11.8	18

III. Depth of Discharge (DOD)

In any type of batteries, the full energy stored in the battery cannot be withdrawn or cannot be fully discharged without causing serious and often irreparable damage to the battery. Depth of Discharge is the amount of energy that has been removed from a battery (or battery pack). It is expressed in a percentage of the total capacity of the battery. For example, 50% depth of discharge means that half of the energy in the battery has been used. 80% DOD means that eighty percent of the energy has been discharged, so the battery now holds only 20% of its full charge.

IV. State of Health (SOH)

It is a figure of merit of condition of the battery compared to the ideal conditions of the battery [5]. The unit of SOH is percent points (100% Battery condition match the battery specification). Typically SOH is 100% at the time of manufacture and will decrease over time and battery use. SOH does not correspond to a particular physical quantity; there is no consensus in the industry on how SOH should be determined. The designer of battery management system may use any of the following parameter to derive an arbitrary value of SOH i.e. internal resistance or impedance or capacitance, capacity, voltage, discharge, ability to accept charge and number of charge discharge cycles.

V. AMP-HOUR Measurement

The battery capacity determines the backup duration of the rechargeable battery. It is primarily defined in ampere hours (Ah) and selected on the basis of backup requirements of an individual. Higher the ampere hour capacity of the battery, larger will be the backup time for the system. The measurement of ampere hour is time consuming and not simple for variety of loads and for automation is also tedious. In this designed system ampere hour measurement is done effectively for variety of loads. A standard battery provides three hours backup time at full load and six hours at half load. One can increase backup duration by installing higher capacity batteries or adding extra batteries in parallel. The designed system measures current along with time so that ampere hour can be displayed on the monitor of the system. This helps to know how much load is connected to the system and corresponding time and how far battery will deliver charge to the load connected to it.

VI. Implementation

The real time battery monitoring system for measurement of different battery parameters are implemented with the help of software LabVIEW 2011 and DAS USB 6009 with some extra electronics for high side current sensing section and temperature sensor circuitry. The extra hardware is required for current sensing section of the setup because the high current of battery cannot be connected directly to the DAS card because of current measurement limitations. This card measures current up to 50mA and electrical car consumes current in terms of ampere. Hence the high side current circuit is designed with suitable gain of the differential amplifier with high CMRR operational amplifier.

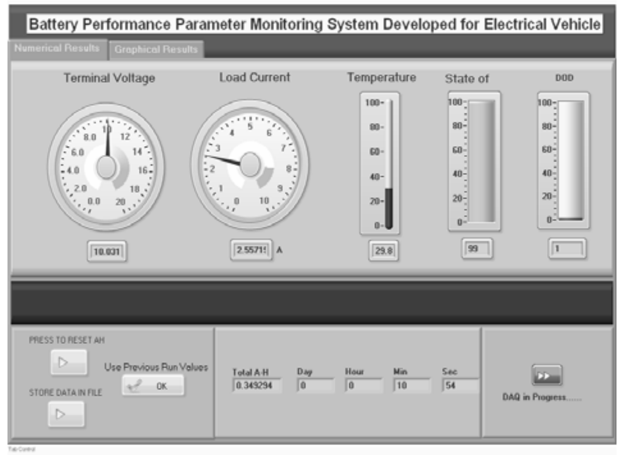

Figure 3: Front Panel of Battery Monitoring System

The electrical load current is converted in to corresponding voltage and then given to the DAS card. The DAS driver software is needed to work DAS hardware on PC or Laptop. The device driver performs low-level register writes and reads on the hardware, while exposing a standard API for developing user applications. The experimental results are stored in particular file as a reference and comparison of previous and current data. The front panel of the designed system for measurement of battery parameters is given as shown in fig.3 and readings for different parameters are monitored as real time setup. This front panel also shows state of charge, depth of discharge, load current, terminal voltage, ampere-hour and backup time of the battery.

VII. Result and Discussion

It is possible to keep continuous track on battery performance. The user of battery operated system will get exact value of charge holding time of the battery and required indications through indicators like displays and emergency alarms.

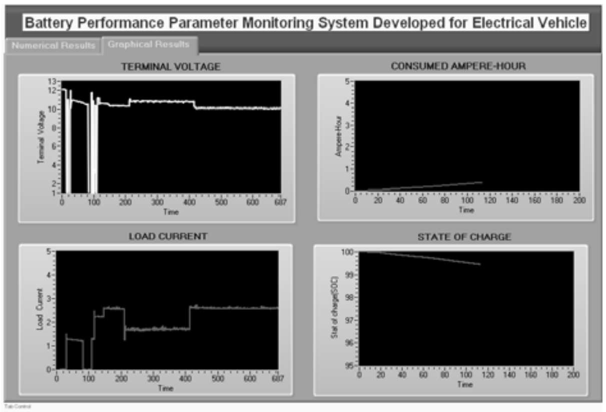

Figure 4: Graphical monitoring SOC and A-H

The fig.4 gives graphical representation of important parameters of the battery. This graphical data can be used to know certain parameters of battery like rate of charging, rate of discharging and power drawn by electrical loads. Real time monitoring system provides key information to the user of an electrical car or battery operated systems or electrical power system in deciding mileage, range, specifications and other related parameters.

In the graphical representation, the graphs are given for ampere hour, state of charge, load current and terminal voltage of the battery.

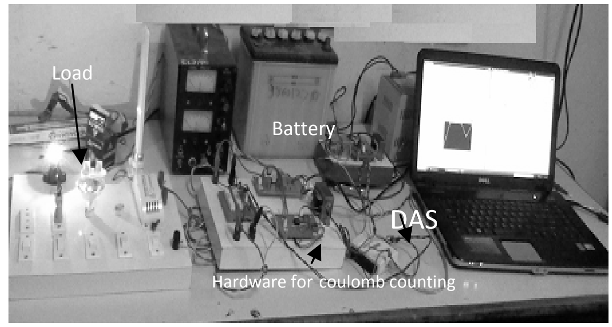

Figure 5: Experimental Setup of battery monitoring system

By knowing these parameters driver information system gives information related to mileage and fuel gauge related information to the driver

The designed system monitors battery related all parameters and provides useful information to the user about health of the rechargeable battery. Through this battery performance parameters and necessary preventive action are suggested through the developed prototype. The setup prototype is shown in the photograph of figure no.5

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A Smart Home Concept Module for Laboratory Training

Aghav S. T.[1], Karpe P. D.[2], Gharpure D. C.[3], Shaligram A. D.[4]
[4]Department of Electronic Science,University of Pune, Pune, 411 007
[1]sta@electronics.unipune.ac.in, [4]ads@electronics.unipune.ac.in

Abstract

Recent progresses in the various fields in science and technology are mainly focusing to use available energy efficiently to make better human life. One way to improve the quality of life is by making the home environment a more comfortable place to live in by turning it into a smart home environment. The terms smart homes, intelligent homes, home networking have been used for more than a decade to introduce the concept of networking devices and equipment in the house. In the present paper we have focused on the development of a laboratory based concept module of "Smart Home". This consists of a 1 BHK mechanical house structure. This structure is made up from low cost materials like acrylic, plywood etc which also has sufficient mechanical strength. To facilitate the goal of smart home it consists of a various sensor modules and few appliances. The sensor modules like IR sensor, humidity sensor, gas sensor, temperature sensor and motion sensor and home appliances like LED light and fan were selected accordingly for the same. The design and fabrication of the same is completed and module is now ready for automation application. All the sensor modules are tested manually to check its individual performance. The present Smart Home concept module will be used to train the students in various aspects like, hands on experience of handling actual sensors, testing of sensor performance in various actual real environments, designing of various automation algorithms according to the application in real system environment. The details of the possible experimental exposure are given in the paper.

Keywords: sensors, smart home, comfort, security, laboratory training.

I Introduction

The home is an important place for the people. It not only affects the overall quality of life, but is also a place where many people (especially older) spend a large part of their time. It is self-evident that constantly improving and developing this area of life takes an important role. A step in this direction is the so-called smart home environments.

A "smart home" can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and connections to the world beyond [1]. Moreover, smart home technology does not simply turn devices on and off; it can monitor the internal environment and the activities that are being undertaken whilst the house is occupied. The result of these modifications to the technology is that a smart home can now monitor the activities of the occupant of a home, independently operate devices in set predefined patterns or independently, as the user requires. Smart home technology uses many of the same devices that are used in assistive technology to build an environment in which many features in the home are automated and devices can communicate with each other. The root of this ability to communicate between devices lies in the use of the 'busline'. A busline is a cable that connects all the devices together and enables interconnectivity between devices in different room throughout the home. Smart home technologies have become, in the last few years, a very active topic of research. However, many scientists working in this field do not possess smart home infrastructure allowing them to conduct satisfactory experiments in a concrete environment with real data. In academic environment also, its huge infrastructure requirements are not allowing the academicians to perform such experiments in laboratory environment. To address this issue, researcher as developed a software simulation tools to simulate the real environment of the home [2, 3]. Such tools simulate the real environment using system models and generate the system data for further studied. Even though there are number of virtual models are available but still it has limitations due to random nature of the environment. This leads inaccuracies in the simulated data.

To avoid above-mentioned limitations, in this paper we have proposed, “A Smart home Concept module for laboratory training”. It is a scale down version of actual smart home infrastructure. This module is developed by taking considerations of real system environment. The purpose of this work is to train the students in the various aspect of real system design working with real environment.

IIA Smart Home Concept Module :

Design Aspects

This is a unique module which gives user a feeling of real environment conditions. For the present work we have focused on following aspects of smart home.

- User convenience
- Security and safety
- Comfort

To achieve these goals following exercises were performed;

- Designing of architectural layout.
- Selection of fabrication materials
- Selection of sensor modules
- Selection of appliances
- Selection of I/O port

E. Designing of architectural layout

A basic 1 BHK (Bed-Hall-Kitchen) layout was selected for the present concept modules. The design was finalized after trying out number of designs on the basic of requirements for the present work. Figure 1 shows the fabricated concept modules of the smart home. The dimensions (Bedroom: 19 cm x 15 cm x 16 cm, Hall: 29 cm x 19 cm x 16 cm, Kitchen: 25 cm x 19 cm x 16 cm with attached toilet and bathroom and also supported by a base with dimension 63 cm x 47 cm) were selected in such a way that its proportion should look like a scale down version actual infrastructure. This will give the feel of actual real system to the students and researchers while performing various experiments. The focused was also on the interior design aspect while designing the architecture. This helps us to transform our concept module closer to the real system. The interior includes the models of attractive tiles on the floor, chairs (2 Nos.), wall mounted LCD, kitchen platform with basin, western style toilet, water storage tank etc. This also gives feel of working in real system environment to the students in the laboratory.

F. Selection of fabrication material:

While designing the scale down version, the main aspect was to select the fabrication material which should be low in cost, light in weight, easy for handling and should maintain the real conditions. To fulfill above mentioned requirements we have tried various options, out of which we zeroed down on ‘plywood’. This material reasonably satisfied our basic requirements. All the plywood walls were oil panted with dark green color. This makes it water resistant and to some extent fire resistant also. Fully transparent acrylic sheet is selected for the roof for the purpose of monitoring the inside conditions externally. The students working with this module can have look at the internal structure trough transparent roof panel. This removable roof panel will be helpful for any troubleshooting or emergency condition.

G. Selection of sensor modules and its placement

For the present work we have focused on user convenience, Security and safety and Comfort on aspects of smart home. The sensor modules required to achieve above-mentioned requirements are selected accordingly. The list of the sensor modules and its expected placement location are given in Table 1.

Table. 1. List of the sensor modules and its expected placement location

SN	**Sensor module**	**Location**
1.	Infrared sensor 1	Hall Door
2.	Infrared sensor 2	Hall window
3.	Infrared sensor 2	Bedroom window
4.	PIR motion sensor SUNROM	Hall side wall
5.	Temperature sensor LM 35	Hall side wall
6.	LPG sensor MQ-6	Kitchen side wall
7.	Humidity sensor SY-HS-220	Kitchen side wall

All the sensor modules will be controlled using a Central Controlling Unit (CCU). The main purpose of CCU is to monitor the sensor outputs and takes the decision of controlling the environment to fulfill the requirement of user convenience, comfort, security and safety. The CCU will be a controller like 8051 series/PIC/ARM/FPGA etc. The Infrared (IR) sensors placed at doors/ windows of the various rooms will be used to save the electricity as well as for security and safely purpose. This sensor module will indicate the statues (open/close) of the doors/windows. According the further circuit will take the decision on the LED light (on/off). The PIR sensor is used to detect the motion in the room which also will help us to control the various appliances. Similarly, the temperature sensor is used to indicate the ambience temperature to the user. It the temperature exceeds the limit; the CCU will send the signal to the alarm. The two major sensors were used in the kitchen environment for the safety purpose, first is LPG sensor and second is Humidity sensor. The LPG sensor senses the leakage of LPG gas in the surrounding environment. Similarly, the humidity sensor senses the humidity in the surrounding environment. If it crosses the limit, the CCU unit will send the signal to the alarm. Figure 2 shows the sensor placement in the concept module of the smart home.

H. Selection of appliances

For the present application we have selected some basic appliances. The list of the appliances and its expected location is given in Table 2.

Table 2. List of the appliances and its expected location

S N	Sensor module	Location
1.	LED light	Hall side wall
2.	LED light	Hall side wall
3.	LED light	Kitchen side wall
4.	Fan	Bedroom ceiling

The LED type lights were selected to be used in hall, kitchen and bedroom to fulfill the requirement. The number of LEDs (4 Nos.) operating on 12 V DC were selected in such a way that it should illuminate the room with reasonable intensity. The SMPS fan is used to provide the ventilation to the bedroom area. These appliances will be controlled using CCU with the help of relays.

I. Decision on concealed wiring :

To perform experiments, the input/output (I/O) connections need to take outside the module. To fulfill this requirement we have decided to use concealed wiring through the wall of the concept module. To pursue this goal, it is decided to use the walls and the underneath section of the module to route the connections of the various sensors as well as appliances to the central I/O connector.

J. I/O port:

This is 48 pin connector provided on the module. All the connections from sensors modules as well as appliances are routed to this connector. The user can select the I/O line of his interests for further processing. After trying out various combinations, the final position of the connector is decided. The CCU will communicate with the sensor modules and appliances using this I/O connector.

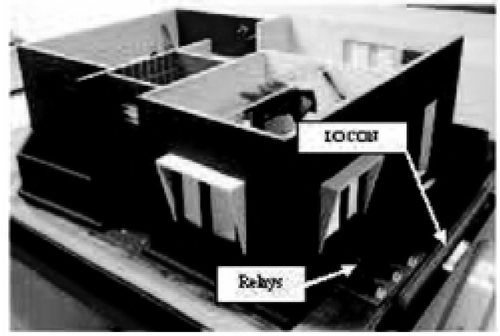

Fig:1. Snapshot of the smart home concept module

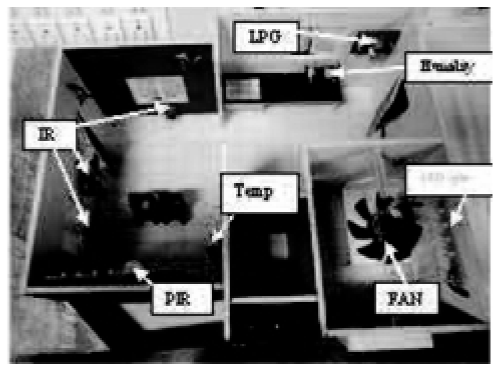

Fig:2. Snapshot of the interior of the smart home

K. Features of "A Smart Home Concept Module for Laboratory training":

Present module is designed to use in laboratory for the students to perform various experiments in real system environment. This laboratory training module has following features:

- A unique scale down version of home helps the students to get feel of real system environment.
- Low in cost, light in weight, easy for handling and should maintain the real conditions.
- Various sensors like humidity, temperature, LPG, IR were used to make home smart.
- Fully transparent acrylic sheet is selected for the roof for the purpose of monitoring the inside conditions externally.

- The LED type lights were selected to be used in hall, kitchen and bedroom to fulfill the requirement.
- The SMPS fan is used to provide the ventilation to the bedroom area. These appliances will be controlled using CCU with the help of relays.
- This is 48 pin connector provided on the module. The CCU will communicate with the sensor modules and appliances using this I/O connector.

IV Conclusion

In this paper we have designed and fabricated a unique smart home concept module for laboratory training. With the help of this module, students will get hands on experience to work with the various real systems. The facilities provided with these modules will help the students to design various control system design. The real system environment will also help to learn the various design aspects in the real field environment.

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Constraints Analysis of Hand Free Interfaces for Infotainment System

Anand. G. Buddhikot[1], Nitin. M. Kulkarni[2], Arvind.D. Shaligram[3], Revati.N. Kulkarni[4]
[1]Department of Electronic Science, Fergusson College, Pune
[2]Department of Electronic Science, Fergusson College, Pune
[3]Department of Electronic Science, University of Pune, Pune
[4]Tata Consultancy Services, Pune
[1]anandbuddhikot@rediffmail.com, [2]nmkulkarni123@gmail.com, [3]adshaligram@gmail.com, [4]revati1_kulkarni@tcs.com

Abstract

The current era is of multi-featured electronic gadgets and computing machines, designed for providing comfort and luxury for modern developing lifestyle. The key features of such products are multi format audio/video playback and internet enabled entertainment. These functions are designed to provide information based media content for enhancing the usability of products. Such infotainment products are now reaching almost everywhere from malls to advance automobiles. With such a wide variety of applications for infotainment systems, different methods of Human Machine Interface (HMI) are evolving, providing new dimensions, in their design. The upcoming interfacing techniques are based on touch screen, audio, and vision technology. The vision based gesture interaction is further evolving as one of the prominent research area in product development. The gesture interfaces are preferred as they are intuitive and quick to response. The research in visual interpretation of gestures would allow the development of potentially natural interfaces to modern electronic gadgets. In response to this potential, the number of different approaches to vision-based hand gesture recognition has grown tremendously in recent years. Thus there is a growing need for systematization and analysis of many aspects of gestural interaction. This paper presents an analytical review on different HMI techniques and identifies a feasible technique to communicate with Infotainment system. Further the implementation of the prominent interface is carried in a view to characterize the constraints and define its usability quotient. The prototype setup for experimental work consists of MATLAB based algorithms for interpreting the interface.

Index Terms: Gesture, HMI, Infotainment, MATLAB, Usability

1. Introduction

The trend towards embedding multimedia, internet and computing features in almost every electronic product has evolved into, totally new family of products called Infotainment Systems. Such infotainment systems are widely used in advanced automobiles, smart homes, consumer products and robotic applications [1]. These modern systems also demand better, natural and efficient interaction techniques. To satisfy such demands the traditional methods of pushbutton, switches, and keyboards are no longer suitable. The major drawback of such interface systems is, they require a physical contact, which may not be feasible in many applications. Instead, natural actions in human-to-human communication, such as speech and gesture provide a wider scope in research for developing enhanced interface. The developments in multimedia featured interactions have now made it possible to use multimedia as a means for interaction. These interfaces consist of audio, video or gesture movements as command inputs to the machine.

The growing popularity of the infotainment products implies the immense user's demand for infotainment products, with better features. Thus exploring infotainment system with different human interactions techniques has become a major research area.

The aim of present research work is focused on designing an interface, for infotainment system which would provide reliable performance. This at first requires a systematic analysis of the different possible methods, for determining a superior method. Further, in the current work a setup has been developed for prominent technique to interact with infotainment system such as a computer.

The developed interface is analyzed to emphasize its constraints and define its usability quotient. This will provide exact rating which would assist in design, to surmount environmental constraints and provide its usability for different applications.

II. Review of Work

Humans naturally use gesture to communicate. Using this process, human can interact with machines without any mechanical devices. Human movements are typically analyzed by segmenting them into shorter and understandable format. It can be used as a command to control different electronic systems. Gesture controlled system is a combination of different tools of technologies like camera, and hardware software integrated control system. These multimedia interactions with infotainment systems are significantly affected by the environmental aspects. The speech interaction system would have audio noise from its surrounding associated with it.

In the present work we have analyzed the techniques that can be used as input to infotainment systems. The Table-1 provides information about different possible interfaces and their pros and cons [2, 3]. Each entry is summarized in different columns of the table. We have classified the technology, applications and usability for the future scope of design.

The sensor based products though cover many applications, have hardware limitations. They require synchronized transmitter- receiver hardware. In case of audio based system, the simplest scenario is speaker dependent, isolated word recognition, on small vocabulary. Further the complexity increases for speaker independent, continuous speech recognition technique with large vocabulary. In any case, speech recognition is highly computational and intensive problem. It requires fast processor and large amount of memory. Many attempts have been made to speed up the process by using various techniques. One of the challenging applications in this area is automated speech synthesizing and converter in cue symbol generation for hearing impaired or disabled and elderly. The information about different interfacing techniques is tabulated in the Table 1. Eventually the gesture control, under the visual based system proves to be the most intuitive and efficient form of technology, and commits as future technology.

Table 1. Survey of Interfacing Techniques

System	Technology	Applications	Conclusion
Sensor based	Keyboard mouse, joysticks, Pen based Interaction, Motion tracking sensors, Pressure sensors	Video game, Robotics and Virtual Reality, humanoid Robots	• Gesture as command • Wearable technique, input device- data glove. • Hardware limitations
Audio based	Speech Recognition, Human made noise/sign detection, Musical Interaction	Wheelchair, Automobiles, mobiles, Robotics	• Audio signal as command • Complex Algorithm • Prone to noise
Vision based	Gesture recognition, Gaze detection, Facial expression analysis, Body movement tracking	Consumer products, Mobile, laptops, smart homes	• Gesture as command • Can be Enhance with Multimodal configuration • Complex algorithm • But most intuitive and efficient communication

Considering the gesture interface as promising one, a survey was made on its usability for different application [4]. The analytical information about gesture interface used for different application is tabulated in Table 2.

Table 2. Analysis of Gesture as Interface

Application	Gesture Molding Technique	Gesture Command
Media Player	Hand Silhouette Movement	Tracking only
Finger Paint	Finger tip	Tracking only
Computer Game control	Image movements	Hand, body poster recognition
Digital eye	Hand model	Tracking only
T.V display control	Template correlation	Tracking only
Hand sign gesture recognition	image	40 sign
Automatic robot instruction	Fingertip position 2D	Tracking only

III. Algorithm and Implementation

User interface through hand gesture recognition was developed using MATLAB to test the feasibility of a gesture input commands, with a minimum configuration. The Fig. 1. is a snapshot of the developed experimental setup. Taking a computer as an infotainment system, the prototype was developed to realize a set of possible commands though gesture interaction.

The system consists of a web cam interface to a general purpose computer system having specification P4- 3 GHz with 2 GB RAM. The MATLAB, software environment was used throughout as it provides high level formalisms that allow the modeling of such systems and also allows automatic generation of code, test and implement these systems.

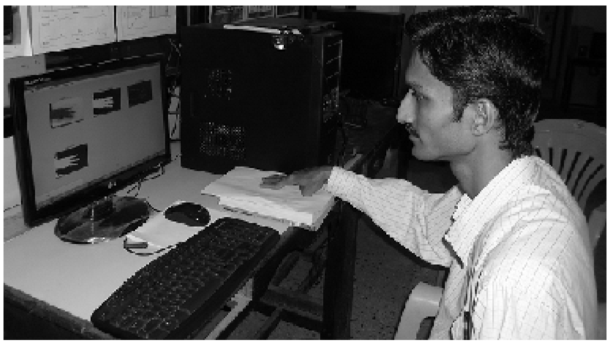

Fig. 1. Snapshot of real time gesture recognition setup

The flow of system designed to recognize a set of commands is described in the Fig. 2.The system can realize commands through finger count. The finger count can be extracted through video data derived from camera. The image is read using MATLAB function [5]. The obtained raw image is then converted to black and white through grey scale thresh-holding. The canny edge detection function is used to detect edges of hand.

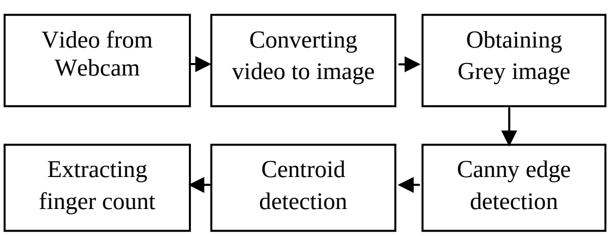

Fig. 2. Flow for Extracting Count

Further using center of gravity technique, center of hand is found and a circle is drawn around it. Finally the number of fingers can be extracted from the count of circle cutting the boarder. Fig. 3. is a snapshot of result obtained at each block.

With a small modification in software the system can be used to determine hand gesture movement, up/down or right left. Here red marker is used which is put on finger tip to determine movement [6, 7].

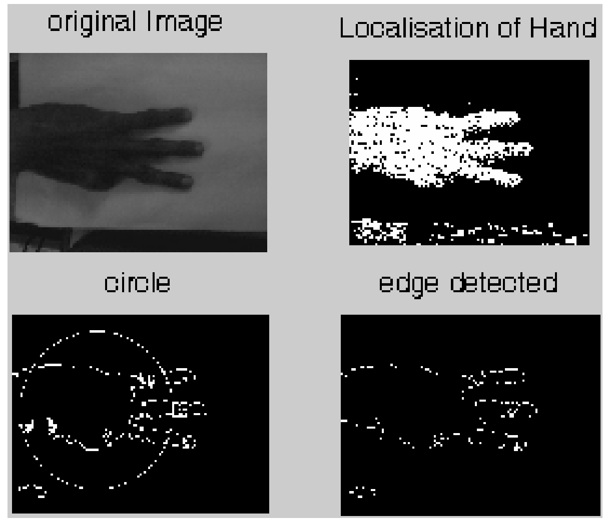

Fig. 3. Snapshot of different stages.

The Fig. 4. shows the flow for recognizing hand gesture movement using the same setup.

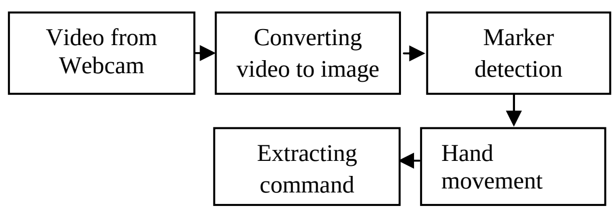

Fig. 4. Flow for recognizing hand gesture movement

The set of possible commands that can be generated from the developed setup and also the possible applications which can use the commands are tabulated in the following Table3.

Table 3. Possible gesture commands

Gesture	Possible Application
Hand movement upwards/Downward	Volume control, Starting application
Hand movement Left/right	Switching application
Finger count	Selecting application /menu
Close/ open Palm	start or stop

IV. Result & Discussion

Hand gesture recognition is a problem that has drawn significant attention and research. There are, however, fundamental limitations to most current systems for vision based gesture detection. Non-uniform lighting conditions, less-than-ideal camera resolution and depth of color limit are some of major constraints. Moreover, the modeling and analysis of hand gestures is a complex method. In vision based solutions such as ours, hand gestures are captured by web cameras which offer resolutions that allow only a general sense of the figure state to be detected. Additionally, the problem of hand-gesture recognition usually occurs in contexts where gestures involving finger conformation are accompanied by movement of the hands relative to the body.

Table 4. Test observations

Gesture	No. of hits	No. of Miss	Recog nition rate
Hand movement upwards/ Downward	10	0	100%
Hand movement Left/ right	10	0	100%
Finger count	7	3	70%
Close/ open Palm	10	0	100%

The experimentation for various possible gesture inputs was carried out. The results that were obtained for different itterations are described in Table 4. The distance between the camera and hand position was kept within four feets. The results that where obtained is ploted in the Fig. 4.

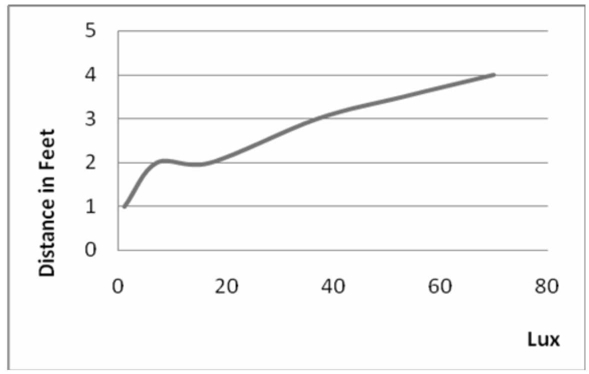

Fig. 4. Distance verses intensity

The result provides the relation between distance and intensity obtianed with optimum preformance. The test was successfully caried out to analyse the basic set of gesture commands which provide 100% recognition rate.

V. Conclusion

The gesture interaction will have significant affect of the camera view field, low light conditions, camera configuration, reflections and responsiveness.

The effectiveness of any Infotainment systems, can predict the acceptance of the entire solution by the intended user. The prototype evaluation done in the present work provides an exact rating of the usability of the web cam based gesture interface for a computer as infotainment applications.

In conclusion, the method fulfilled the initial criteria, by producing a system which could be implemented to control various attributes of an infotainment system. In future, this technique could be used as alternate input source.

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ABSTRACT

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Index Terms : five Index Terms with alphabetic order

I. INTRODUCTION

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B. Figures and Tables

Figures and tables must be centered in the column. Large figures and tables may span across both columns. Figures and table must be numbered using Arabic numerals. Figure and table captions must be in 9 pt Regular font. The style of table is as like the template.

ACKNOWLEDGMENTS

The heading of the Acknowledgment section and the References section must not be numbered.

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Set references as given below in the template When referring to a reference item, please simply use the reference number, as in [2]. Do not use ‘Ref. [3]’ or ‘Reference [3]’ except at the beginning of a sentence, e.g. ‘Reference [3] shows …’ Multiple references are each numbered with separate brackets (e.g. [2], [3], [4]–[6]).

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Affiliations	Times New Roman	10	Center/ Italic
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Abstract	Times New Roman	11	Justified/ Italics
Paragraph	Times New Roman	11	Justified
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