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Building Automation Using Wired Communication.

Ms. Supriya Gund*, Ms. Sneha Kumari**, Ms. Alice Joseph***, Prof. Mrs. Madhuri Namjoshi****

*(Department of Electrical Engineering, Bhivarabai institute of technology and research, University of Pune)
**(Department of Electrical Engineering, Bhivarabai institute of technology and research, University of Pune)
***(Department of Electrical Engineering, Bhivarabai institute of technology and research, University of Pune)
****(Department of Electrical Engineering, Bhivarabai institute of technology and research, University of Pune)

ABSTRACT
In this paper, we present the design and implementation of a building automation system where communication technology LAN has been used. This paper mainly focuses on the controlling of home appliances remotely and providing security when the user is away from the place. This system provides ideal solution to the problems faced by home owners in daily life.
This system provides security against intrusion as well as automates various home appliances using LAN. To demonstrate the feasibility and effectiveness of the proposed system, the device such as fire sensor, gas sensor, panic switch, intruder switch along with the smartcard have been developed and evaluated with the building automation system. These techniques are successfully merged in a single building automation system. This system offers a complete, low cost powerful and user friendly way of real-time monitoring and remote control of a building.
Keywords – Building automation, LAN, Security, sensors, Real-time monitoring.

I. INTRODUCTION

The introduction of network enabled devices has proceeded with an unprecedented rate. Due to the obvious advantages of such systems, their influence on the conventional home was predicted and finally, in 1988, the term domotics came to be used.

A modern definition of domotics could be the interaction of technologies and services applied to different buildings in order to increase security, comfort, communication and energy saving.
Building automation is the introduction of technology within the building to enhance the quality of life of the occupants, through the provision of different services such as telehealth, multimedia entertainment and energy conservation.

PIC microcontrollers can be easily used to create building automation appliances. This paper shows the implementation of a PIC microcontroller to create a home controller. The PIC16F8774A was selected for this application because of its versatility as a general purpose microcontroller, its flash program memory, data EEPROM and ample I/O. To demonstrate the feasibility and effectiveness of the proposed system, four devises which are,   a fire detector, gas sensor, safety sensor and smartcard access have been developed and evaluated with the building automation system. All the information regarding the home appliances and parameters

sensed by the sensor will send data to the control room using RS 485. Relays connected within the home environment will be controlled manually by the security present at the control room as and when required.
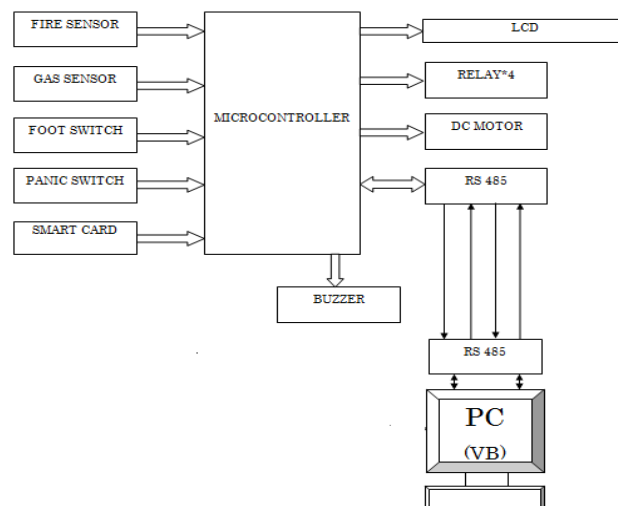
II. METHODOLOGY

Fig.1 Block diagram of Buiding Automation using wired technology.

The figure shows the block diagram of building automation system using wired technology.

In the above diagram it is seen that all the sensors and the smart card is interfaced to the PIC microcontroller. As also after the various instructions are executed the result is shown using the LCD display. Also a provision is made in the system to control the consequences through operation of relays which can be done manually. All this in formation of the working and processing in simultaneously shown n recorded on the control room PC. The PC is interfaced to the system using RS 485. The following components of the block diagram are explained in brief.

a. Sensors

A sensor is a converter that measures quantity and converts it into a signal which can be read by an observer or an instrument. There are innumerable applications for sensors. Applications include cars, machines, medicine, manufacturing and robotics. Sensor is a device, which responds to an input quantity by generating a functionally related output usually in the form of an electrical or optical signal. A sensors sensitivity indicates how much the sensor's output changes when the measured quantity changes. Sensors that measure very small changes must have very high sensitivities. Sensors need to be designed to have a small effect on what is measured; making the sensor smaller often improves thus and may introduce additional advantages.

Fire sensor

Fire sensor used in this project is used to detect a fire around the vicinity. It is a digital sensor which is directly connected to the I/O port pin of the microcontroller. It is a combination of light and temperature sensor. Under normal operating conditions the microcontroller gets an active low signal. When fire is detected, it sends an active high signal to the microcontroller and as per the program the necessary action is taken well on time. The action is taken keeping in mind the type of fire and the cause of the particular mishap.

Gas sensor

the gas sensor used in the proposed system goes by the name MQ-6.ensitive material of MQ-6 gas sensor is SnO_2, which ha lower conductivity with clean air. When the target combustion gas exists, the sensor's conductivity is higher along with the gas concentration rising. MQ-6 gas sensor has high sensitivity to propane, butane and LPG. The sensor could be used to detect different combustible gas especially methane. It is low cost and suitable for a number of applications. Gas sensor is an analog sensor and gives the output in the form of analog signals. The signal is then fed to the ADC which will convert it into digital form. Once converted into analog form, the microcontroller can process the digital gas signal as per the requirement.

b. Smart card

The AT24C02A provides 2048 bits of serial electrically erasable programmable read only memory organised as 256 of 8 bits each. This device is optimized for use in many industrial and commercial applications where low voltage operations are essential. The smart card used in the proposed system facilitates the use of the gate. It is used to provide access to only specified individuals holding the access to the smart card. Also a particular time delay is provided for gate access keeping in mind the security. Thus the smart card used, act as a hall pass.

c. Buzzer

Buzzers are used in the system to indicate or to grab the attention regarding an emergency situation occurred. Buzzer acts as a panic horn which indicates the need of instant attention as the condition goes haywire. Similar purpose is served by it in the proposed system. It is used as an additional measure along with the LCD indication and the data displayed on the PC.

d. Relay

It is on/off switch which uses 12v supply. Here we use 12v single change over relay. These relays are connected to the microcontroller via a relay driver ULN 2803. The relays require a current of 50mA at the time of switching. The microcontroller cannot provide that amount of current because of which we connect a relay driver in between so that the current requirement is fulfilled. It operates in two modes i.e. normally open and normally closed. Different devices can be controlled i.e. they can be turned on/off whenever required.

e. DC Motor

DC motors used are used to physically drive the application as per the requirement provided in the software. The DC motor works on 12v supply. To drive a DC motor, we need a DC motor driver called L293D which used in the proposed system. This DC motor driver is capable of driving 2DC motors at a time. In order to protect the DC motor from back EMF generated while changing the direction of rotation, it is provided with an internal protection suit. We can also provide the back EMF protection suit by connecting 4 diode configurations across each DC motor.

f. RS-485

RS-485 is a standard defining the electrical characteristics of drivers and receivers for use in balanced digital multipoint systems. The standard is

published by the telecommunication industry association (TIA) or electronic industry alliance (EIA). Digital communication networks implementing the EIA-485 standard can be used effectively over long distances and in electrically noisy environment. Multiple receivers may be connected to such a network in a linear, multi-drop configuration. These characteristics make such networks useful in industrial environments and similar applications.

g. Liquid crystal display (LCD)

LCD is used in the proposed system to visualize the output of the application. The 16*2 LCD is used which indicates 16 columns and 2 rows. So, one can write 16 characters in each line. That is in all 32 characters can be displayed on this LCD. LCD is used in the proposed system to check output of different modules interfaced with the microcontroller. Thus LCD plays a vital role n the system to see the output and to debug the system module wise incase of system failure in order to rectify the problem.

III. DESIGN PROCESS

The circuit diagram is like a foundation to the entire proposed system. It is carefully designed so as the various components work cordially. The basic working principle of the system is as follows; the input signals from the various sensors such as fire sensor, gas sensor, switches like he panic switch and foot switch and data from the smart card is taken by the microcontroller. The microcontrollers will hen elect the task to be performed and after processing the task it will then display the output on the LCD. At the same time all the data is been monitored simultaneously on the control room PC screen. Buzzer will be turned ON for the specified operation. If any mishap takes place it is detected and brought under control by operating the relays manually or is taken care by the respective authority, for all this to function smoothly the following circuit diagram is implemented. Each of its part is explained as below.
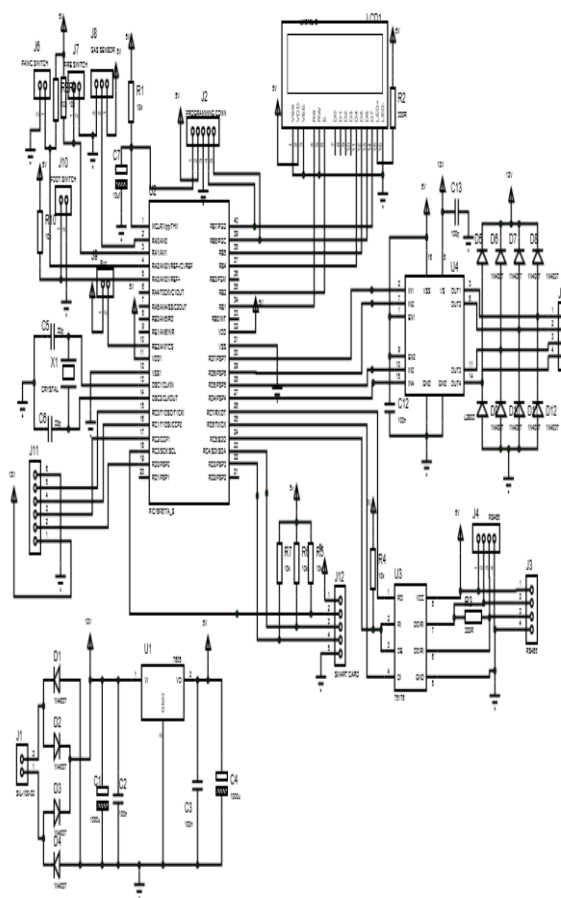

Fig.2 Circuit diagram

a. Power supply circuit

The basic step in designing any system is the power supply required for that system. The steps involved in the following are as follows;

- Determine the total current that the system sinks from the supply.
- Determine the voltage rating required for the different components

The bridge rectifier and the capacitor input filter produce an unregulated DC voltage which is applied at the input of IC 7805. As the minimum drop out voltage is 2v for IC 7805, the voltage applied at input terminal should be at least 7v.
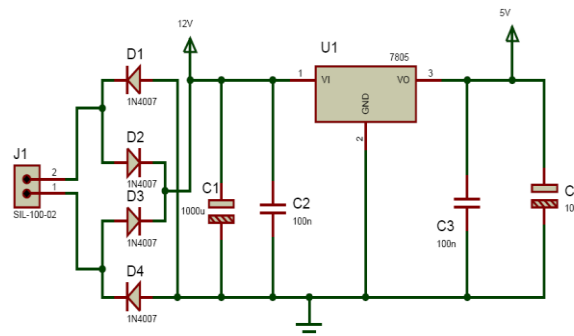

Fig.3 Power supply of circuit

C1 (1000μf/65v) is the filter capacitor and C2 and C3 (100nf) is to be connected across the regulator to improve the transient response of regulator. Assuming the dropout voltage to be 2v, the minimum voltage across the capacitor C1 should be equal to 7v at least.

b. Reset circuit
Reset is used to put the microcontroller into a "known" condition. That practically means that microcontroller can behave rather inaccurately under certain undesirable conditions in order to continue its proper functioning it has to be reset, means all registers would be placed in starting position. In order to prevent from bringing logical zero to MCLR pin accidently, MCLR has to be connected via resistor to the positive supply pole and a capacitor from MCLR to ground. Resistor should be between 5 and 10k and the capacitor can be between 1μf to 10μf. This kind of resistor capacitor combination, gives RC time delay for the microcontroller to reset properly.
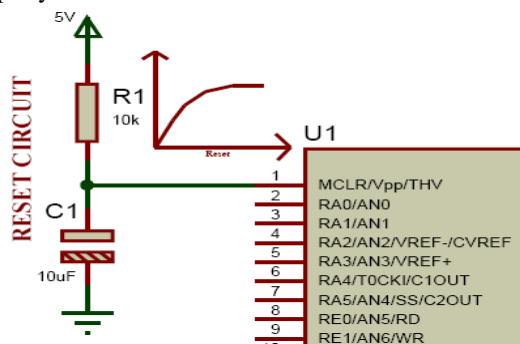

Fig.4 Reset circuit

As shown in the above circuit we are connecting an RC circuit to the MCLR (pin) of microcontroller. The PIC microcontroller has an active low reset; therefore we connect an RC circuit. As shown the capacitor is initially at 0v. it charges via supply through a 10kΩ resistance in series.

c. Crystal circuit
Pins OSC1 and OSC2 are provided for connecting a resonant network to form an oscillator. Typically a quartz crystal and capacitors are employed. The crystal frequency is the basic internal clock frequency of the microcontroller. The manufacturers make available PIC designs that can run at specified maximum and minimum frequencies, typically 1MHz to 16MHz.
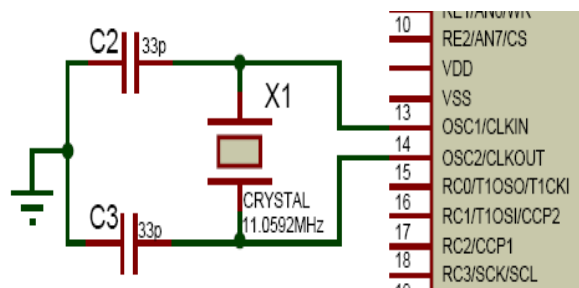

Fig.5 Crystal circuit

In the above figure e are connecting two ceramic capacitors which are basically used for filtering. That is to give a pure square wave to the microcontroller. The basic rule for placing the crystal on the board is in such a way that it should be as close to the microcontroller as possible to avoid any interference in the clock.

d. Liquid crystal display (LCD)
LCD has two power sources
* V_{cc} and GND are at 1 and 2 number pins of LCD and are used to drive the LCD 3mA consumption.
* V_{cc} and GND are 15 and 16 number pins of LCD and used to drive the back light of LCD 100mA current.

LCD data control lines
LCD has 8/4 data lines and 3 control lines. The 4 data lines of LCD (pin 11 to pin 14) are connected to the B port if PIC microcontroller (B4 to B7).
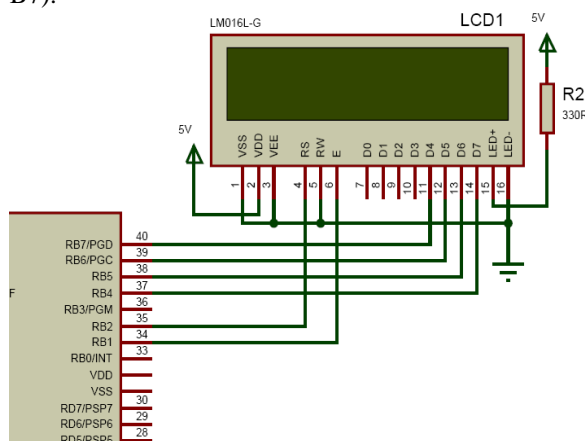

Fig.6 LCD interfacing with the PIC microcontroller

The control lines of LCD are as follows;
*   Register select(RS)
The LCD RS pin is for selecting the data or the code register, it is connected to pin 35 i.e. B2.
*   Read/write(R/W)

The LCD R/W is for choosing between reading and writing on LCD. Here R/W is connected to ground i.e. R/W=0.
• Enable(E)
The LCD E is for enabling or disabling the LCD which is connected to pin 34 i.e. B1. The enable pin is used by the LCD to latch information presented to its data pins. A high-to-low pulse must be applied to this pin.
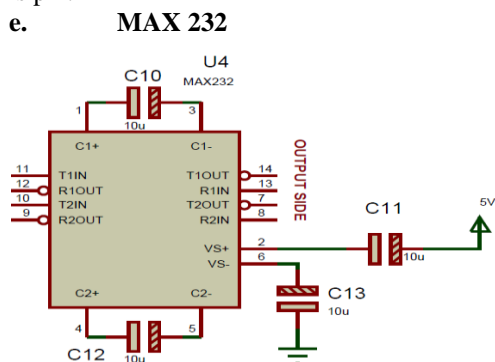
e.   MAX 232

Fig.7 MAX232 circuit and interfacing with the PIC microcontroller

RS 232 IC is a driver IC used to convert the microcontroller TTL logic (0-5) to the RS 232 logic (+-9v). Many device today, work on RS 232 logic such as PC, GPS, GSM etc. So, in order to communicate with such devices we have to bring the logic levels to the RS 232 logic (+-9v).

f.   Microcontroller interface to analog sensors.

The PIC microcontroller has an inbuilt 8 channel MUX and a 10 bit ADC. So the analog sensors in the proposed system are connected to the analog port (port A) of the microcontroller as seen in the figure below. The analog sensors can be connected to the port A of the microcontroller. The pins are AN0, AN1, AN2, etc.
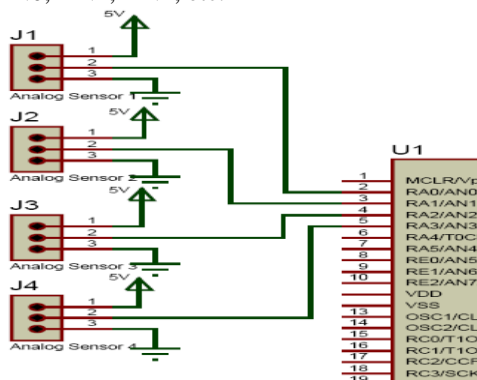

Fig.8 Interfacing of the analog circuit ith the PIC microcontroller.

So the microcontroller didgitalises the analog inputs and the outputs are available in one of the PIC internal ADC registers. The user can thus use this vale of display on the LCD or transmit it to the PC.

g.   Microcontroller interface to DC motor

The proposed system makes ue of a 12v DC motor which is bipolar, that means the DC motor can rotate in both the directions. For this DC motor driver IC L293D is used. The driver IC can drive two DC motors at the same time. The DC motor will be connected at OUT1 and OUT2 of L293D respectively. Driver IC L239D has high noise immunity, over temperature protection and output current capbility per channel is 600mA.
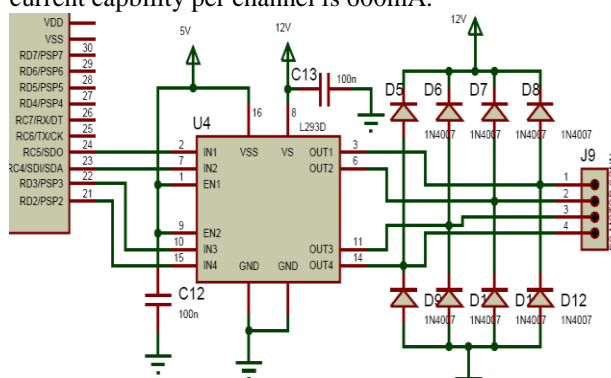

Fig.9 DC motor interfacing with PIC microcontroller.

IV. SIMULATION AND RESULT

Simulation is carried out by using three software in combination namely;
• Microsoft visual C++
• MP lab
• Visual basic 6.0
The scheme of the block diagram describes the result that is observed in the control room on the PC as also displayed on the LCD placed in the vicinity of the building.
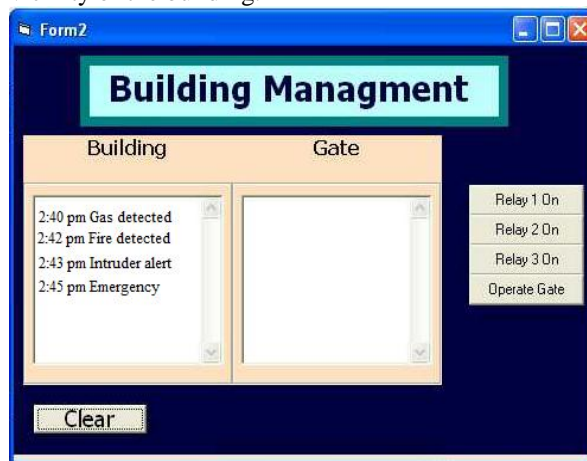

Fig.10 Result on PC screen of control room

The above figure shows the result displayed on the PC of the control room when any unwanted movement is detected in the home environment. As shown it will indicate the particular threat/emergency along with the time when the threat/emergency has occurred. The relay control is also available on the window by which required action can be taken to take care of a particular situation.
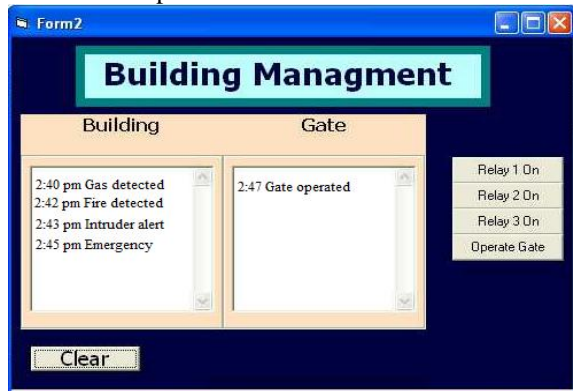

Fig.11 Result on PC screen of control room when smart card is detected.

The above figure is similar to figure 10 the only difference is that in this window indication is observed by the use of smart card. The smart card provides access to only authorized individuals. When smart card is accessed the data on the control room PC gives detail about the respective smart card used along with the time.

V. CONCLUSION

The existing state of building automation systems has been studied, identified and the five areas that hindered consumer adoption of such technologies include; complexity and expense of the architectures, the intrusiveness of the system installations, the lack of interoperability between different home automation technologies, and the lack interoperability between system developed by different manufacturers that utilize the same technology.

A building automation system is proposed and implemented, using wired communication. The use of wired communication technology helps lower the expense of the system and the intrusiveness of the respective system installation. The appropriateness of the proposed architecture and its feasibility has lead to the creation of a low cost, flexible and secure system.

The proposed system being highly developing project with further scope for experimentation, the outcome of it is worthy of further analysis. The critical success for the research will be the completion of a whole cycle of control between a remote device and the building. Once this is done a tedious study has to be carried out about

how users and the system interact. To conclude, this research should help other researchers to set new perspectives of the upcoming BAS projects and thus contribute to a life dreamt by many.

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