Microcontroller Based Fire Alarm System Using Sensory and Monitoring System

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Abstract* – *Fire alarm system plays an important role in maintaining and monitoring the safe of all kind environments and situations. However the usability of many existing fire alarm system is well known but could be produce with high cost. Subsequently, it is not affordable for the low income users. This paper will discuss the design and implementation of a fire alarm system using the microcontroller which is been produced with low cost and with effective outcome. The outcome of this fire alarm system is almost the same compared to the existing fire alarm system in the market which is been produced with higher cost.

1.0 INTRODUCTION

Fire alarm system, is a system where can be used to safe lives and reduce property losses. According to [1] the combine annual losses from flood, hurricanes, tornadoes, earthquakes and other natural disasters total less than those from fires.In this paper, we describe a fire alarm system which will detect and identify the location of the fire caused. The main reason of designing and implementing this fire alarm system is the cost. Due to the low cost, it can be used by all level income users.

1.1 Aim

The main purpose of this project is to design and implement a fire alarm system which can be produced at a low cost with effective and competitive usage. This system is designed to be more users friendly and easy to operate at any level. This fire alarm system is also been designed to be further working vision using minimum hardware at the lower level of processing. These systems are directed at specific applications.

1.2 Project Scope

In a way to achieved above objectives, this project need to be implemented as below:

I. This fire alarm system also incorporates the heat and flame detector that is connected to the infrared smoke detector in parallel.
II. The microcontroller is used as the heart of this fire alarm system that controls the entire operations involved.
III. The fire alarm system is capable to locate and identified the place that is in fire where by it is monitored using the monitoring system.
IV. Capable to display the output from each sensor in the monitoring system.

1.3 System Overview

Based on Figure 1, this fire alarm system consists three parts of detecting sensors which is connected to the microcontroller device. The fire alarm system has smoke detecting capabilities based on infrared sensory. Not only that, the fire alarm system also incorporated the heat and flame detector that is connected to the infrared smoke detectors in parallel. This fire alarm system is considered as a true alarm system when all these three detectors or sensors are triggered. This is to prevent from false alarm triggering and safety precautions.

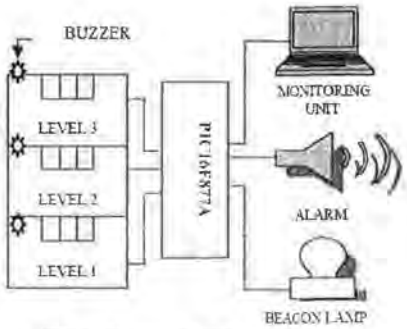

Figure 1: Overview of Fire Alarm System

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The PIC 16F877A microcontroller acts as a heart of the Fire Alarm System, where this PIC will control the entire operating system. All the signal received from the sensors will then judge by the PIC and will consider either enough information to prove the exist of fire or to reset if any of this sensor not responding. Besides that, the fire alarm system also includes a beacon light, a main alarm and buzzer in each level which alerts people. This buzzer and main alarm will be activated once the PIC gets a signal from the three sensors that connected in parallels.

The summary for entire operational of this Fire Alarm System can be illustrated and shown as Figure 2 below:

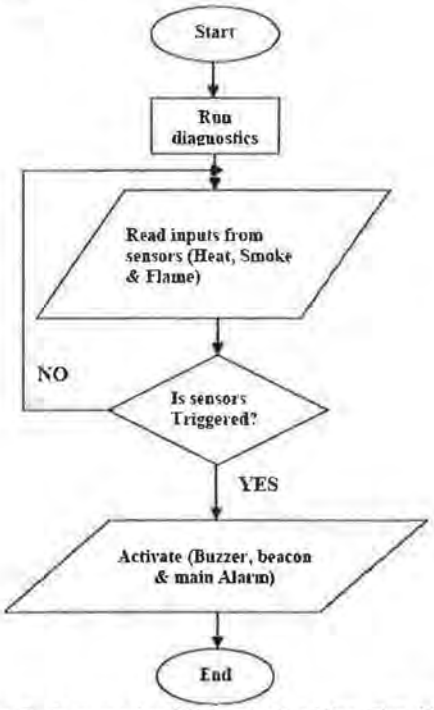

Figure 2: Summarized Flowchart of the Fire Alarm System

Based on the flowchart shown in Figure 2, we know that this PIC 16F877A is the heart of this fire alarm system, therefore it controls the entire operation involved. At the initial stage (when the system is turned ON) the microcontroller awaits signal from all the sensors. Once any of the sensors are triggered, the PIC 16F877A will determine the address of the sensor and trigger its output based on the location address. At the same time the PIC 16F877A will transmit data serially to the monitoring system via the RS 232. The interface component is the environment which we create graphical interfaces with which users will interact. When the system is reset by the user, the microcontroller will reset all its input and output pins as well transmitting serial data to the monitoring system to reset the monitoring system.

The human and hardware interface of this fire alarm system only operates when it receives a serial data input from the microcontroller. At the initial stage, the monitoring area for all three zones is in green in color and the other components (Beacon and Buzzer) remain in normal state. The human and hardware interface then open its communication port in order for it to receive the serial data input. Once it receives the serial data input, it will determine the location of the emergency location of the emergency by referring to the address of the received signal. Then, it will flash the location with the red color, flash the beacon and activate the buzzer. After that, if the user reset the system then it will be back to the initial condition. Then the entire process is repeated in case of fire.

2.0 METHODOLOGY

This fire alarm system can be divided into two main parts. There are the hardware and software parts. These two main parts plays an important role to make the system work properly and effectively. There are few procedures must be consider before proceed to next stage, that is developing the project. The earlier planning is required to make the design and development of this Fire Alarm System. The procedure or related phase has been illustrated as below:-

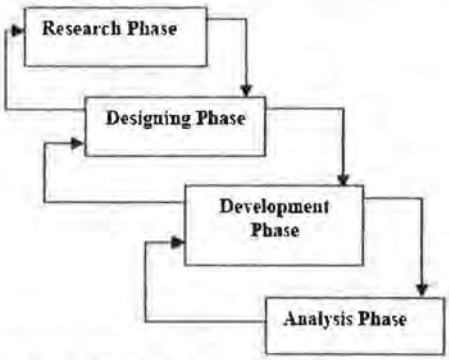

Figure 3: Related phases in developing the Fire Alarm System

2.1 Research Phase

In this phase, a few activities has been carried out such as determining problems, declaration of the research objective by observation and theoretical information that obtain from journals, internet sources, magazines and electrical theses bank.

Based on that, few problems have been identified based on the current research that has been done such as:-

a) Only heat and smoke sensors are used and this can cause fault alarm trigger.
b) There is no any monitoring system to identify the location of the fire.
c) The alarm system is being combined with the burglar alarm in the same

system. This makes the user to get confused and hard to identify caused of the alarm.

2.2 Designing Phase

This phase is divided into two main activities. The first activity involves the designing of the hardware, whereas the second activity involves the designing of the software.

2.2.1 Designing the Hardware

The hardware design involves detection components and the microcontroller. The detection circuit that contain of flame, heat and smoke sensors must be designed so that it connected in parallel each other to avoid from the false alarm trigger. At each level, there will be a buzzer. This buzzer will be activated and evacuate people at the level.

The suitable microcontroller has to choose because this is the important hardware. The PIC 16F877A have been choose because it was user friendly and easy to program. Not forgetting also that this micro controller was extremely suitable on our application which not requires high memory capacity.

2.2.2 Designing the Software

The designing of the software is very important process since this Fire Alarm System fully depends on the program written into the PIC. The action and behavior of the PIC is controlled by the source code in the PIC. Software that needs to design correctly is the Visual Basic for the purpose interfacing the hardware and the monitoring system. This is very important so that the monitoring unit will display and alert peoples with correct information.

2.3 Development Phase

Based on the design obtain from the designing phase, the next step will be the development of the system. The development phase involves two main components to develop, that is development of the hardware and the software. When the software and hardware working properly, the both components then will be combined and the prototype will be build.

2.3.1 Development of the Hardware

In this development phase, there are few activities that will carry out in the hardware as shown in Figure 4

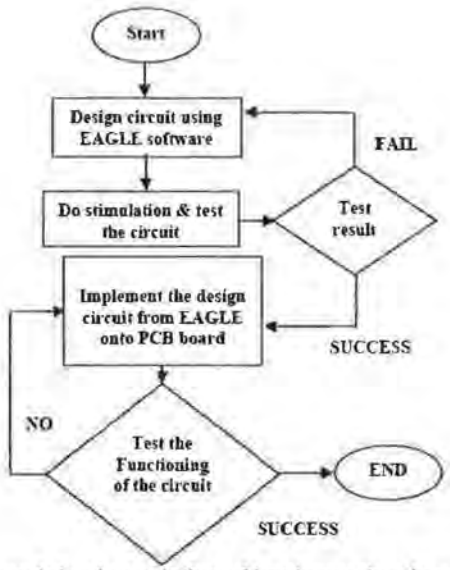

Figure 4: Implementation of hardware development

2.3.2 Development of the Software

Software development is the main criteria in this Fire Alarm System. For this Fire Alarm System, there are three kinds of software that has to use. The EAGLE Software will be use to design and for stimulate the circuit to identify either the circuit working as what we expected or not. The software that has to develop is the Micro C. This software use to write the program into the PIC. To interface the monitoring system and with the PIC, the Visual Basic software is needed to make communication between the user and the computer. The output of PIC will be display in the monitoring system depends to the Visual Basic source code.

2.4 Analysis Phase

Based from the results obtain from the research phase, designing phase and the development phase, the analysis of this system can be done with all the information and results that obtain from previous phase. In this phase, the beneficial of the system to the user, safety of the system to the user, how friendly the system to the user, the cost and other related aspect will be consider and the final decision will be taken after in this phase.

3.0 RESULT

The expending of knowledge on how the Fire Alarm System operates, a closer look on the Graphical User Interface (GUI) is interpreted as shown in Figure 5.

Figure 5: GUI of the Fire Alarm System in Normal Situation

When the system is ready, the PIC 16F877A microcontroller awaits signal from all the nine sensors (3 infrared smoke sensors, 3 heat sensors and 3 flame sensors) associated with it. It is noted that there are three on each of the sensors types in each level. For example, lets take level 1 system into operating mode (refer to Figure 6). When any one of the three sensors triggered, there will be an input signal to the microcontroller. The microcontroller will determine the location from which the sensor has being triggered. Then, it will pulse the output of level 1 which cause the buzzer to beep. At the same time, there will be a signal being sent to the monitoring system. The monitoring system will flash with red color in column of the level 1 to indicate the emergency location.

Figure 6: GUI display when any of one the sensors triggered

On the other hand, if all three of the sensors in the level 1 are triggered, the microcontroller will pulse out the level 1 buzzer; activate the strobe light and siren as well sending a serial data to the Monitoring System as shown in Figure 7.

Figure 7: GUI display when all the sensors triggered

The same operation follows for the other two levels if the sensors triggered.

Figure 8 and 9 shows the hardware that has been developed.

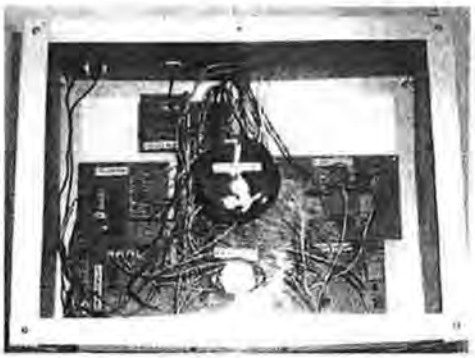

Figure 8: Combination of all circuit

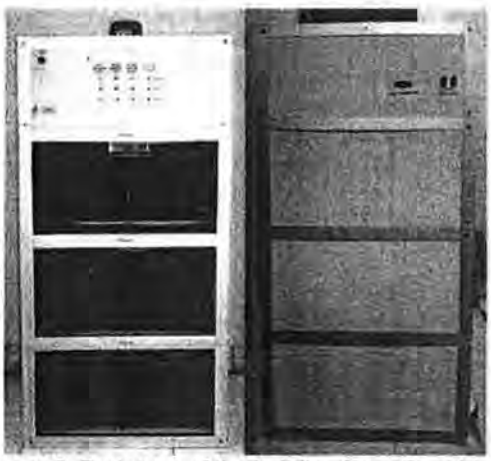

Figure 9: Prototype of the building Front/Back) has been developed.

4.0 CONCLUSION

There are numerous interesting technical issues relating to the design of alarm system. However, if one stands back from these, the key issue is whether it is cost beneficial to try to improve them. The evidence is very clear that at much residential and industrial area the poor performance of alarm systems

is resulting in significant financial loss, environmental challenge and hazard to people. Moreover there are many cases of considerable improvement being achieved from a relatively small investment. The general conclusion is that, implementing the fire alarm system in very low cost is likely to be beneficial to the people and the environment.

5.0 RECOMMENDATIONS

Like any other technical projects, the final aim should be practically in the industrial application. Safety, efficiency and low cost must be the main objective in the society. Hence, a system that has been designed and build should not be saturated on future ideas, as it will be a total waste of time of creating it in the first place. On this matter, this M-FAS is certainly a project that can be developing further in the near future. At the end of this project several recommendations have been identified which could improve the system's performance and capabilities:

i. The fire alarm system that had been designed could be installed with dial up phone system using a dial up modem. It is done via monitoring program, as the program automatically dial up the phone number of the respective parties and sends a voice call repeatedly as well as indicating the exact location of the fire.

ii. Replace the PIC microcontroller with a Programmable Controller if it has more complex system. A more complex system means adding extra devices on the current system such as adding more input channels, adding more outputs like alarms as well as beacon light.

iii. The controller has to upgrade as Programmable Controller has a higher memory storing capacity and it is capable of running many sequential operations at any one time.

6.0 REFERENCES

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