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Design & Implementation of a Low Cost Solution for Security Breach using Passive Infrared Sensor

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Abstract: This paper evaluates the development of a low-power low-cost indoor security system using a Passive Infrared Motion Sensor. The low power PIR sensor detects changes in infrared radiation which occur when there is movement by a person (or object) which is different in temperature from the surroundings. The system is designed around an eight bit microcontroller and covers a wide area (upto 12m) for detection. It senses the signal generated by PIR sensor detecting the presence of an unauthorized person at any time interval. Detecting the presence of an intruder, the system triggers an alarm followed by sms and calls to some predefined numbers through a GSM modem. The system is well tested and found highly responsive.
Key-Words: Flex Sensors, MEMS, Accelerometer, Microcontroller.

1. Introduction

To be safe and secure is one of the major concerns for everybody in day to day life. Humans need safety and security for their life as well as property. They need security against theft, fire in homes, offices, industries, etc. and for this a highly reliable, responsive and powerful security system is required. Lot of conventional camera based costly security systems is available in the market but there is a need to develop a low cost and reliable security system. The paper proposes the use of PIR sensor for motion detection as these are sensitive to changes in heat flux. PIR device does not emit an infrared beam but passively accepts incoming infrared radiation. The sensor is designed to adjust to slowly changing conditions that would happen normally as the day progresses and the environmental conditions change, but responds by making its output high when sudden changes occur, such as when there is motion.

2. Implemented System

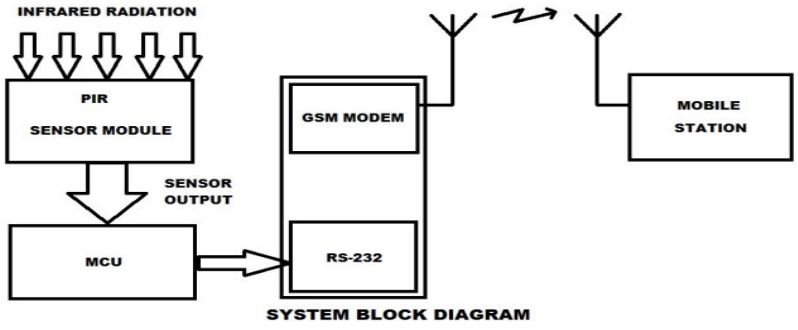


Figure-1: Block diagram of the Implemented System

MCU: The system is built around an eight bit microcontroller i.e. NXP89V51RD2 supporting the following features 40MHz, 5 Volt 8051-based Microcontroller with 32 I/O lines, 3 Timers/Counters, 9 Interrupts/4 priority levels, 64K+8K FLASH, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA. It has built-in UART module which is necessary for passing AT commands to the GSM modem.

PIR Sensor: The sensor used here is a Long distance (12 meters) detection type Panasonic PIR sensor which is lead-free and having a low current consumption of 1µA (micro ampere) during sleep mode and 3µA during standby mode. Low current consumption makes PaPIRS ideal and well suited for battery operated applications. The sensor needs a stability time of 25seconds when started on. The operating voltage is 2.3 to 4.0 volt DC. The PIR sensor module is fed with a +5V on its positive terminal and negative terminal is grounded. The output pin is connected to MCU pin.

GSM Modem: The GSM modem used here is a 'TELIT' GSM modem and it is serially interfaced with the microcontroller via RS-232 port. As GSM modem uses serial communication to interface with other peripherals, an interface is needed between MCU and GSM modem. This segment consists of four parts: DB9 male connector, MAX 232, GSM modem and MCU.

In this security system PIR sensor has been used which is low power, and low cost, pretty rugged, have a wide lens range, and are easy to interface with. Fixing and focusing the PIR sensor is important to give maximum sensitivity and to prevent false detections.

3. Circuit Diagram

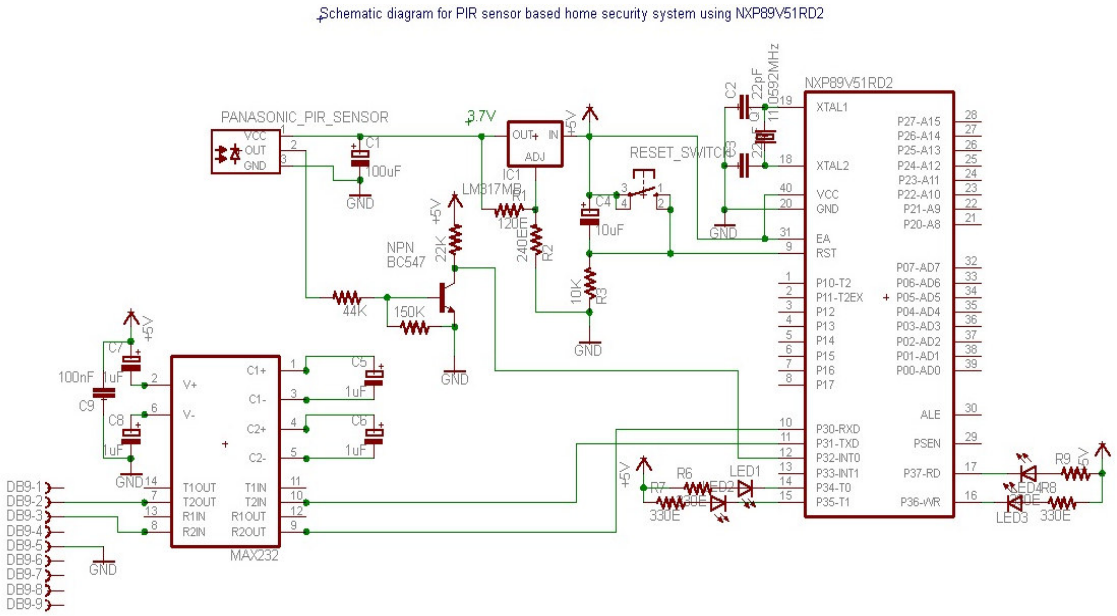
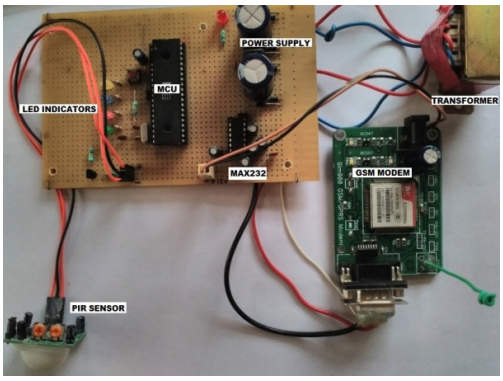
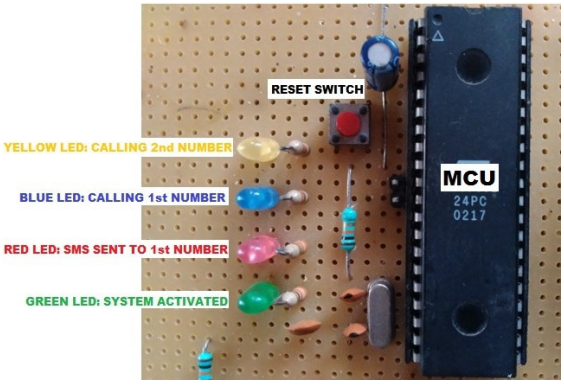


Figure-2: Circuit Diagram of the Implemented System

This work introduces a low-power low-cost security system solution. The system is built around an eight bit microcontroller i.e. NXP P89V51RD2. It is 80C51 core microcontroller with 32 I/O lines, 5V operating voltage from 0 MHz to 40 MHz, 3 Timers/Counters, 9 Interrupts/4 priority levels, 64K+8K on-chip Flash user code memory with ISP, 1K on-chip RAM, SPI, Dual Data Pointers, WDT, 5-channel PCA. It has built-in UART module which is necessary for passing AT commands to the GSM modem. A level converter like MAX 232 is

required in the circuit because the serial port of the pc uses RS232 voltage levels (+12V for logic 0 and -12 V for logic 1) which is much higher voltage than the TTL logic (0V for logic 0 and +5V for logic 1) used by the microcontroller. In this security system PIR sensor has been used which is low power, and low cost, pretty rugged, have a wide lens range, and are easy to interface with. Fixing and focusing the PIR sensor is important to give maximum sensitivity and to prevent false detections. The sensor used here is a Long distance (12 meters) detection type Panasonic PIR sensor which is lead-free and having a low current consumption of 1µA (micro ampere) during sleep mode and 3µA during standby mode. Low current consumption makes PaPIRS ideal and well suited for battery operated applications. The sensor needs a stability time of 2 minutes when started on. The operating voltage is 2.3 to 4.0 volt DC. The PIR sensor module is fed with a 3.3V on its positive terminal using LM317 adjustable regulator and negative terminal is grounded. The output pin is connected to MCU external interrupt pin P3.2 via a switching transistor BC547. Utilization of existing cellular network to alert and inform the system owner about the security breach is made to cope up with ever increasing demand for cheap but reliable security systems. The GSM modem used here is of 'TELIT' make and it is serially interfaced with the microcontroller via RS-232 port. As GSM modem uses serial communication to interface with other peripherals, an interface is needed between MCU and GSM modem. This segment consists of four parts: DB9 male connector, MAX 232, GSM modem and MCU. GSM modem is connected through a DB9 connector to the interfacing circuit.





3. Algorithm Implemented

An algorithm is a step-by-step process that gives an idea of program flow. The source code in assembly/ C can be edited very easily by just referring to this algorithm:

1. Initialize the I/O ports of the microcontroller, declare the system variables, declare the interrupt vector addresses and enable the global interrupts.
2. Delay of 2 minutes as settling time of the PIR sensor.
3. PIR is activated and provides a low output when it senses a significant temperature fluctuation and it gives an interrupt signal on the INT0 pin of microcontroller.
4. The microcontroller responds quickly and service the interrupt. The priority of INT0 is highest among all the other interrupts.

4. Results & Conclusion

After testing and calibrating the proposed system in different environmental conditions the rated and expected results were obtained. Thus a microcontroller based low power, low cost, highly responsive, real time security system with large coverage area using PIR sensor and GSM technology to tackle security breach in homes, offices, shops, etc. is developed successfully and implemented. Proper care must be taken when installing the system. There are four LED indicators that represent the system status indicators. During operation these LEDs follow a specific sequence as per the sequence of Call and SMS delivery by GSM modem. Here green LED is to indicate that the system has been fully activated. Red LED indicates the SMS delivery to the 1st number, Blue LED indicates the Call delivery to 1st number, and Yellow LED indicates the Call delivery to 2nd number. First the system is powered ON. As we have studied that most of the PIR sensors take minimum 2 minutes of settling time to sense the equilibrium temperature and this time is provided by the microcontroller using timer or software delays. After a delay of 2 minutes the Green LED is commanded to turn ON by the microcontroller to show that the system has been activated and ready to tackle any security breach within its range limit. Rest of the LEDs remains OFF until some security breach is detected by the system. These types of systems are always in high demand in every class of the society for security and safety point of view. All they need is a cost effective and reliable system that can ensure the safety of their property in their absence. So this system has proved to be a better alternative for camera based and other costly systems. This system is open for further optimizations. Optimization in power to improve battery back-up, optimization in its detecting range is possible. In this security system PIR sensor has been used which is low power, and low cost, pretty rugged, have a wide lens range, and are easy to interface with. In addition to this, this system can be equipped with glass break detectors to enhance the level of protection. Use of multi-sensor data fusion and complex algorithm can be used to increase the effective FOV for larger spaces. In order to enhance the location accuracy and to enhance the method of processing the PIR sensor signal, use of more advanced techniques such as probabilistic theories and soft computing is left open for the future.

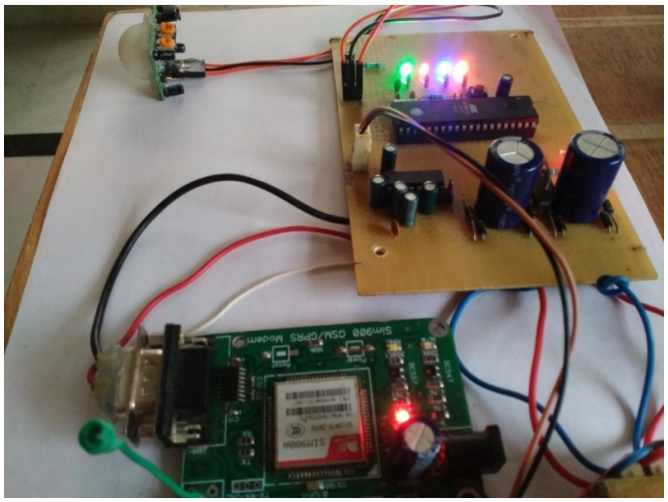


Figure-3: Snapshots of the Implemented System

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