Embedded Surveillance System Using PIR Sensor

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ABSTRACT:
With low power usage security and safety is one of the most discussed topics in almost every field like surveillance, industrial applications, offices, and in general, in smart environments. Traditional surveillance systems suffer from an unnecessary waste of power and the shortcomings of memory conditions in the absence of invasion. In this paper we design a home embedded surveillance system which evaluates the development of a Low-cost security system using small PIR (Pyroelectric Infrared) sensor built around a microcontroller with ultra-low alert power. The system senses the signal generated by PIR sensor detecting the presence of individuals not at thermal equilibrium with the surrounding environment. Detecting the presence of any intruder in any specific time interval, it triggers the signal wakes up the MCU. After the MCU sends the sensor signals to the embedded system, the program starts the Web camera. Our sensing experiment will show that reduction in use of memory required for saving the previous data as well as the system's power consumption.

Keywords: *FOV, MCU, PIR, ultra low alert power, ultrasonic sensor.*

1. Introduction

The major issues as Security and safety is one of the most talked of topics in almost every field like surveillance, industrial applications, offices, and in general, in smart environments. The traditional surveillance systems take a long time to detect whether there is any intruder or not. If there is no intruder, the sensing device which continuous to work and consumes much power [1]. To meet the increased requirements of the IEA (International Energy Agency) we have to reduce the standby power of each electrical apparatus to less than 1 Watt [2-3]. One of the ways to improve power efficiency is accurate control of the apparatus by both software and microcontroller.

Embedded surveillance systems are frequently used in home, office, factory or highway vehicle monitoring and image detection, but this application requires a high performance core, which works against some advantages of embedded systems, such as low power consumption and low cost [1].

The main objective of this project is to reduce the power consumption of traditional home surveillance system by keeping turn off the power supply of indoor sensor and web camera. In this project we also try to reduce use of memory which is required for storing data.

1.1 Surveillance System

Surveillance is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting. The word surveillance is the French word for "watching over".The word surveillance may be applied to observation from a distance by means of electronic equipment (such as CCTV cameras). Surveillance is very useful to governments and law enforcement to maintain social control, recognize and monitor threats, and prevent/investigate criminal activity [6].

A home security and surveillance system is an essential part of any modern automated home. The basic design of a security system begins with analyzing the needs of the inhabitants, surveying existing technology and hardware, reviewing system costs, considering monitoring choices, and finally planning the installation. In addition to perimeter and interior protection offered by a security system, surveillance monitoring includes features that enable the inhabitants to observe environmental conditions inside and outside the home when at home or away from home.

The design of a security and surveillance system should provide for the protection of the entire perimeter of a home as well as visual- and audio-based surveillance monitoring. Security system sensors are available that are designed to detect sound,

window and door intrusion, air movement, body heat, motion, and other conditions that indicate an intruder is present. A good security system design should consider the best plan for existing homes as well as new construction. It should also consider the lifestyle of all the inhabitants, the location of valuables or any items to be protected, how the system is to be controlled, adequate smoke and fire alerting sensors, and the type of emergency response required. The design choices are numerous and varied due to advances in home security technology and the wide availability of compact, low-cost video surveillance systems [7].

1.2. Types of surveillance system

There are various types of home surveillance system that can be very useful in security system. Some of such systems are given below.

1.2.1. Wireless Security Systems:

Wireless home security systems use battery-powered radio transmitters and receivers to connect the various components such as cameras, sensors, area motion detectors, sirens, central controllers, smoke/fire detectors, keypads, and video displays. These types of security systems are usually available at a local hardware store or on the Internet and are often designed for do-it-yourself installation.

Wireless home security systems has some advantages like they are easy to install, they avoid the expensive and time consuming task of installing new wires in the walls of existing homes, Wireless sensors are designed to transmit a unique identification code to a controller, it enable you to take the components with you when moving to a new location, Wireless sensors, motion detectors, and video cameras can often be installed in locations that are not accessible for wired equipment. But it has some disadvantages also such as Wireless system design specifications can limit the distance between sensors, cameras, and the central controller, they require periodic replacement of batteries. Most professional builders recommend wireless systems as a last choice.

1.2.2. Hard-wired Security and Surveillance Systems:

Hard-wired security and surveillance systems use wires installed inside the walls, attics, crawl spaces, and underground to connect the sensors to a central controller. Surveillance cameras or microphones are also wired to speakers, video switchers, and video display monitors. A hard-wired system design normally uses power from the home AC power wiring as the primary source. The main components of a hard-wired system are include a central control panel, sensors, one or more keypads, motion detectors, smoke and fire sensors, cameras, camera switchers, video displays, and sirens.

This System has some advantages such as hard-wired security systems are considered by most contractors to be more reliable than wireless systems, the hard-wired components are usually less visible and more aesthetically pleasing than wireless components, Hard-wired systems do not depend on batteries except for power failure backup protection and disadvantages such as Hard-wired systems are more expensive than wireless systems, problems can arise in the installation of sensors in existing homes where some areas are not accessible for pulling wires inside the walls.[7]

1.2.3. Remote Access Systems:

A remote access system provides the capability to monitor and control a home security system from a location away from the home. A telephone call to the home followed by a key number code allows the caller to obtain status information concerning environmental and alarm system condition. Remote systems can also be programmed to call a specific phone number when certain environmental conditions exceed an established threshold. A special synthesized voice response system provides the caller with an audible report. The caller, with proper coded inputs, can also perform all the same control functions from a distant location that are available on the keypad in the home [7].

This type of traditional surveillance systems suffer from an unnecessary waste of power and the shortcomings of memory conditions in the absence of invasion. The traditional surveillance systems take a long time to detect whether there is any intruder. If there is no intruder, the sensing device which continuous to work and consumes much power. To meet the increased requirements of the IEA we have to reduce the standby power of each electrical apparatus to less than 1 Watt.

2. Proposed System

From the surveillance systems stated above we realized that these systems are in continuously on position although there is no intruder. So it consumes much power and also use large memory of the system for storing the data or picture captured by web camera attached to the system which also in continuously on position.

So to reduce the power consumption of the traditional surveillance system we proposed the embedded surveillance system using ultra low alert power which consists of PIR sensor which is low power sensor.

2.1 System Architecture

Fig. 1 shows the embedded surveillance system which has two groups of sensors, indoor and outdoor. The outdoor sensor group contains a number of PIR and pressure sensors placed near windows and doors of a home. When the outdoor sensors sense an intruder, the MCU is woken up and turns on the power for the indoor PIR and ultrasonic sensors. When this is completed, the decision signal passes to the embedded board GPIO (General purpose input and output). The software module of the power embedded board turns on the Web camera to capture images and user can view the images captured by the home surveillance system through the Internet.

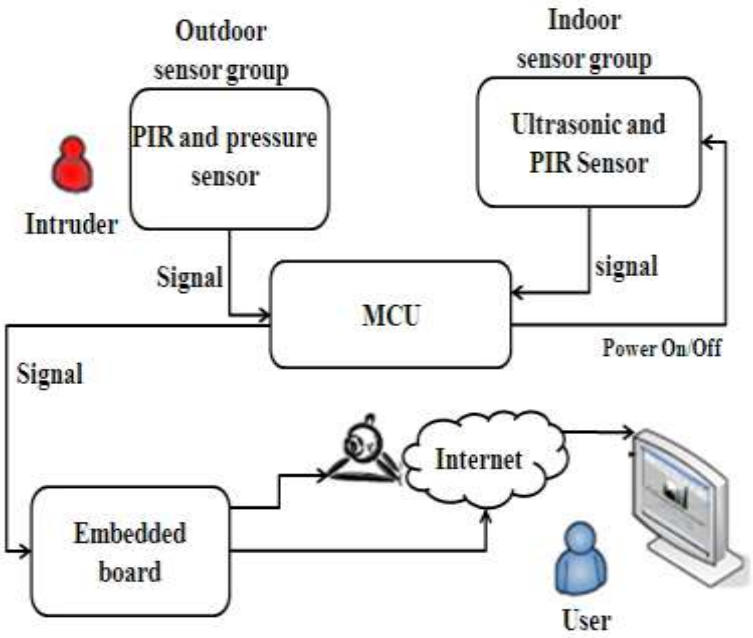

Figure1. Block diagram of the system

In this paper the alerting sensors with low-power consumption are placed near those home windows and doors where an intruder must pass through. Also paper proposes a PIR sensor based low cost security system for home applications in which Passive Infrared (PIR) sensor has been implemented to sense the motion of human through the detection of infrared radiated from that human body. PIR device does not emit an infrared beam but passively accepts incoming infrared radiation. Figure shows the block diagram of whole system. PIR sensor detects the presence of human in the home and generates pulse which is read by the microcontroller. When an intruder enters the sensing area, the sensors wake up the sleeping MCU (Micro Controller Unit) which starts the power supply for the indoor sensors for the signal transmission to the embedded system. The embedded surveillance system determines the sensor results and then decides whether to start the Web camera to capture images. We use the MCU's sleep mode to reduce the alert power consumption for our home embedded surveillance system when there is no intruder so as to improve the traditional surveillance system without wasting the power. To secure embedded surveillance system against theft, crime, fire, etc. a powerful security system is required not only to detect but also pre-empt hazards. Conventional security systems use cameras and process large amounts of data to extract features with high cost and hence require significant infrastructure [4].

2.1. Outdoor Sensor group:

To reduce the power consumption of the alert state we combine pressure switches and PIR sensors [3]. The pressure switches used are thin and placed on the ground. When an intruder invades the area nearby the pressure switches, the PIR sensors wake up the MCU.

2.1.1. Pyroelectric Infrared Sensor (PIR):

PIR sensor is basically made of Pyroelectric sensors to develop an electric signal in response to a change in the incident thermal radiation. Every living body emits some low level radiations and the hotter the body, the more is emitted radiation. Detection range of sensor is 3m to 7m approximately. In order to shape the Field Of View (FOV) of the sensor, the detector is equipped with lenses in front of it. The lens used here is inexpensive and lightweight plastic materials with transmission characteristics suited for the desired wavelength range. To cover much larger area, detection lens is split up into multiple sections, each section of which is a Fresnel lens. Fresnel lens condenses light, providing a larger range of IR to the sensor it can span over several tens of degree width. Thus total configuration improves immunity to changes in background temperature, noise or humidity and causes a shorter settling time of the output after a body moved in or out the FOV.

2.2. Indoor Sensor Group:

For indoor, we use PIR sensors and multi-frequency ultrasonic sensors. In the ultrasonic sensors we use a typical oscillator chip to design a square waveform generator and adjust the resistances and capacitance to generate a multi-frequency ultrasonic transmission. The ultrasonic transducer transforms the voltage waveform into an ultrasonic transmission and the transducer of the receiver transforms the ultrasonic transmission into the voltage waveform. Since the receiver may experience external interference at different frequencies, it is necessary to screen the filter signals outside the receiving frequency and the signal input to the amplifier and the comparator; other ultrasonic sensors are also susceptible to refractive interference, so we use several ultrasonic sensors at the receiving end, the count of the total number of ultrasonic sensors, always being the majority of the sensors triggered, is after the vote sent to the MCU.

It featured by discrete distances to moving objects can be detected and measured by ultrasonic sensor. It also less affected by target materials and surfaces, and not affected by color. It can detect small objects over long operating distances. This sensor is resistant to external disturbances such as vibration, infrared radiation, and ambient noise and EMI radiation.

2.3. Web-camera:

A webcam is a video camera that feeds its images in real time to a computer or computer network, often via USB, Ethernet, or Wi-Fi. Their most popular use is the establishment of video links, permitting computers to act as videophones or videoconference stations. Webcam popularly use for security surveillance, computer vision, video broadcasting, and for recording social videos. Webcams typically include a lens, an image sensor, support electronics, and may also include a microphone for sound.

2.4. Software tools:

Our design consists of the internal MCU software module and the home embedded system software module. In the MCU software module, when an intruder has been detected, the MCU wakes up the majority decision to test the threshold, and then turn on the power supply for the indoor sensors. If the indoor sensors detect no intruder when the outdoor sensors are misjudging, the MCU turns off for the power of indoor sensors and goes back to the sleep state.

We use ARM7TDMI-S Microcontroller as embedded board. It is with real-time emulation and embedded trace support that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB.

2.5. Flowchart:

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misjudging, the MCU turns off for the power of indoor sensors and goes back to the sleep state. Fig. 2 shows the MCU software flow chart.

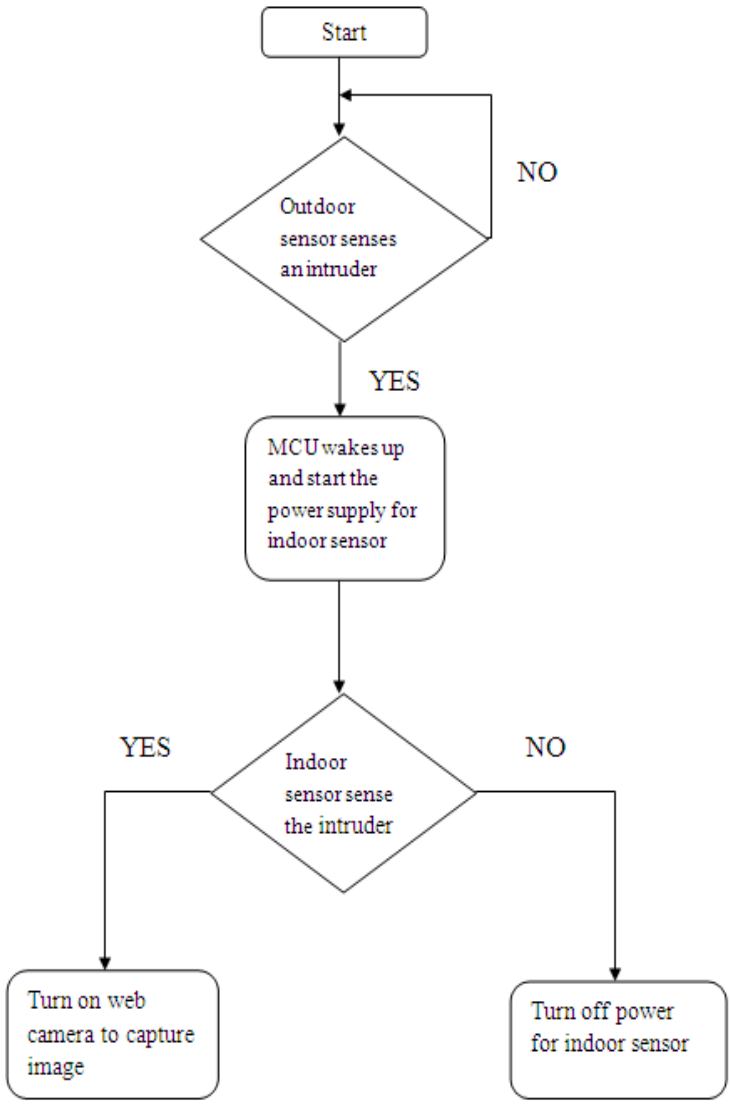

Figure2. Software flowchart

3. Conclusion

3.1 Conclusion:

To secure embedded surveillance system against theft, crime, fire, etc. a powerful security system is required not only to detect but also pre-empt hazards. Conventional security systems use cameras and process large amounts of data to extract features with high cost and hence require significant infrastructure.

So we are trying to develop a surveillance system which is low cost, uses low power, and also uses less memory and more efficient using set of various sensors. In future we don't have to depend on human for the security of our home, offices and other valuable places.

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