Cost effective Intelligent Surveillance System with secured storage memory

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Abstract **-** Surveillance is most important security systems in home, industrial, office and public places. In this security system is based on the embedded system along with GSM and sensor networks. The human movement is detected using the PIR sensors. In this time, the system triggers an alarm detecting the presence of person in a specific interval of time and simultaneously sends the how many persons are intruder via message to the SMS through GSM Modem. When the security system is activated, the CCTV camera is activated. This highly reactive approach has low computational requirement. Therefore it is well suited for home surveillance system. This surveillance security system implemented using PIC micro controller, camera, gsm and sensors. In this paper, a new design for surveillance using smartphone along with the passive infrared (PIR) sensor and the microcontroller unit (MCU) is proposed. The PIR sensor is attached to the smartphone through the MCU to detect motion. The video is captured only when the motion is detected and the short message services alert is sent to the user straight away. To overcome the memory restrictions of smartphone and to ensure the safe storage of surveillance records, it is uploaded in cloud, and the link is sent to the user through email. The proposed intelligent surveillance system offers cost effective, storage effective, energy efficient, and secured solution as it uses the computation and communication capabilities of the smartphone and the storage capabilities of cloud.

Keywords: PIR senor, smartphone, MCU, intelligent surveillance, cloud video storage.

Introduction

Surveillance is most important field in security 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 them. surveillance systems are habitually used in home, office, factory or vehicle monitoring and image identification, but this system requires a high performance core, which works against some advantages of embedded systems, such as low power consumption and low cost. Surveillance is very helpful to governments and law execution to maintain social control, recognize and monitor threats, and prevent/investigate criminal activities.

Home/office security systems have grown in popularity in recent years, a home/office owner's look for ways to protect their personal space and enhance their home values. It is necessary for every home owner to considering adding a home security system, as burglaries, thefts and murders have become routine in big cities.

PIR sensor are 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 radiation from that human body. PIR device does not emit an infrared radition but passively accepts incoming infrared radiation. PIR sensor notices the presence of human in the home and generates signal which is read by the microcontroller. According to the signal received by microcontroller, a call is acknowledged to mobile station through a GSM modem and thus alerts the presence of human in the home to owner-occupier.

Designed an advanced GSM based electronic security system for home applications using infra red motion detectors and RISC based Micro controller using embedded C language. Infra red motion detectors will sense any intruder with 10 feet and alert the Owner of house or police control room by sending SMS through GSM modem about the intruder.

Related work

In literature, PIR sensors are commonly used in surveillance systems [4], [5], automatic light switching systems [6]–[8] and in motion detectors [8]–[10] as a simple dependable triggers. The surveillance system proposed by [11] uses two sensor sets namely alert sensors and detection sensors. The alert sensor wakes up the detection sensor in case of motion. The detection sensor activates the camera and captures the video.

Thus the standby power usage of the system is reduced considerably. PIR sensors are also used for localization [12], [13] and target detection [14], [15]. To track the motion and its distance [16], an array of PIR sensors are deployed in the environment. An array of four PIR sensors is used to detect the relative direction [7] of human movement. The sensing elements are aligned with four directions N-S, W-E, NW-SE, NE-SW. Based on the PIR signals, a classifier is built to recognize the direction of movement using machine learning technique.

There are systems which intelligently and continuously monitor elderly and ill people at home [17], [18]. The Gait Velocity of elders [19] is calculated using PIR sensors. Gait velocity has been shown to quantitatively estimate risk of future hospitalization and a predictor of disability. Using the data gathered from the sensors and with a mathematical model the Gait velocity is assessed.

In some design the PIR sensor is incorporated with other sensors to provide an accurate and location specific detection. The ultra sound sensors [20] and mobile robots [21] are also used to monitor the surroundings.

There is no surveillance system in literature which uses the computational and hardware abilities of the smart phone. In

this paper we combined the abilities of both PIR sensor and a smart phone for designing an intelligent surveillance system. The camera inside the smart phone is used as an eye of the surveillance system. The PIR sensor is connected to the smart phone through a MCU. The MCU interact with the smart phone through HC-05 Bluetooth module. The smart phone on receiving the motion notification by PIR via MCU activates its camera. The captured video is processed using the computational power of the smart phone. In most of the surveillance systems the data is stored in the disk drives of the computer [12], [23]. This may compromise the security of the data recorded [24].

In our design, the network capabilities of the smart phone are exploited for uploading video into cloud and to notify user through SMS and email. Thus the data is safe in a remote location though surveillance system is damaged or seized by the intruders.

PIR Sensor

Pyroelectricity is the ability of a polar, dielectric material to generate a temporary voltage when there is a change in temperature. The absorbing layer transforms the radiation flux when a change in temperature and the pyroelectric element performs thermal to electrical conversion [25], [26]. The PIR sensor consists of a pyroelectric element along with the circuits to control the sensitivity and delay. The PIR sensor detects the infrared radiation emitted or reflected from an object.

The PIR sensors are used with Fresnel lenses to enhance and shape their FoV (Field of View) [27]. Fresnel lenses are molded out of inexpensive plastic and have a small form factor when compared to the regular lenses [27]. Fresnel lenses are good energy collectors.

Typically an array of Fresnel lenses is used to divide the FoV into several separate fields to improve the sensitivity and efficiency of the sensor.

Implementation Methodology

Bellow figure shows the architecture of the proposed system. The PIR sensor senses the movement in its vicinity and activates the MCU. The MCU sends notification to the smartphone through the Bluetooth module.

When motion is detected by the PIR, the smartphone starts recording it and upload the same in cloud when the motion ends. The link of the uploaded video is sent to user through email.

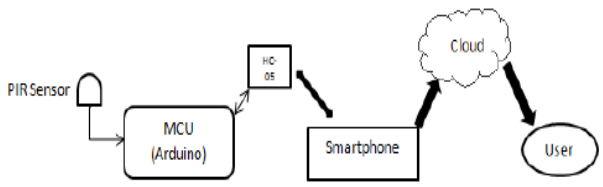

Figure1: Architecture of proposed system

The Bellow figure shows the detailed architecture of the overall system. Hardware module consists of a smartphone which acts as the controlling and computation point. The MCU activates the smartphone application module on getting trigger from the PIR sensor. The Bluetooth module mediates the communication between MCU and the smartphone.

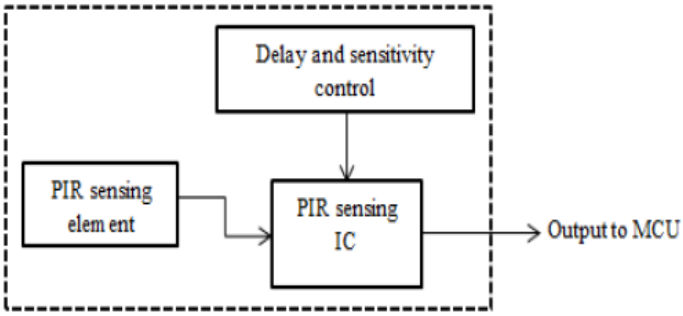

Figure2: Block Diagram of PIR sensor module

The smartphone starts video capturing and simultaneously sends SMS alert to the user on receiving motion detection signal from MCU. On receiving motion end signal the smartphone stops the video capturing and upload it in cloud and then executes the notification module. Storing surveillance video in cloud improves security of the surveillance records. The uploaded videos are safe in remote location which can be later retrieved and verified though the surveillance system is damaged or seized. The notification module is responsible for notifying the user about the intrusion. It sends email to user with the uploaded video URL.

The proposed Smartphone enabled Intelligent Surveillance System uses Arduino microcontroller board as the MCU. It is easy to program Ardunio board also it consumes less amount of energy. The software and hardware module of the proposed system is explained below.

Software Usage

The MCU software module processes the signal from the PIR sensor and forwards it to the smartphone. When an intrusion is detected by the PIR it activates the MCU and MCU notifies the application running inside the smartphone through a Bluetooth. The application activates the camera of smartphone for video capturing. Simultaneously the SMS is sent to the registered phone numbers. The video is captured until the application gets a motion end signal from the MCU. The video is saved locally then uploaded to the cloud storage.

In this design we are using Google drive for saving the video. After saving the video the user is notified through an email with the path of uploaded video. Fig 4 shows the flowchart of the software module.

Hardware Usage

To detect the motion we use PIR motion sensor in our design. The above figure PIR shows the block diagram of a general PIR motion sensor. The PIR sensing element senses the change in infrared radiation and is fed to the sensing IC which amplifies the signal. The delay and sensitivity control circuit is used to adjust the delay and the sensitivity of the sensor. The output is directly fed to the MCU digital input pins. The output of the sensor will be either 0 or 1. 1 represents the motion detection and 0 represents the normal idle state.

Sensor Input Locking Technique

PIR motion sensor senses the change in Infra-red radiation in its vicinity. The input pin of PIR is HIGH on motion detection and it changes to LOW when the motion subsides. A continuous stream of HIGH value is sent to the MCU when there is a motion and a continuous stream of LOW value is sent to the MCU when the motion is stopped. To get an exact time slot of the motion a simple input locking mechanism is implemented using a lock variable. If motion is detected the output state of the sensor changes from LOW to HIGH and the lock variable is made TRUE. When the motion subsides the state changes from HIGH to LOW and the lock variable is changed to FALSE. The slot can be determined as the time the lock variables became FALSE from TRUE to TRUE from FALSE.

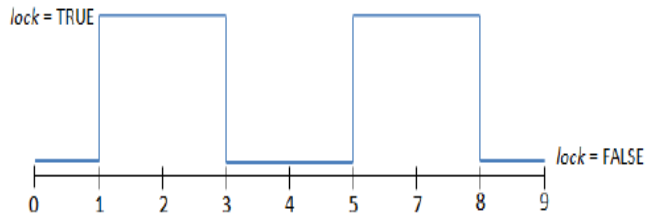

Figure3: Shows the graph of the detected timeslot using the lock variable.

The lock variable helps in starting and stopping of recording. The smartphone captures the video when "MOTIONSTARTS" command is received from the MCU and stops recording on receiving "MOTIONEND" command from the MCU. Along with the recording the smartphone simultaneously take necessary steps to notify the user. So it is very important to get the exact time slot. The MCU sends "MOTIONSTARTS" command when the lock variable changes to TRUE from FALSE and sends "MOTIONEND" command when lock changes to FALSE from TRUE. The locking mechanism helps to get the exact time slot of the motion.

Results Analysis

The PIR sensor and the Smartphone camera is placed in line so that it can capture the exact visuals when triggered by PIR sensor. The sensor is placed anywhere around the Bluetooth range. For wide range of vicinity the surveillance system is fixed on ceiling of the room or at the door.

The PIR sensor needs some time to calibrate itself to the environment. In this design it takes 30 seconds to finish the calibration. Once the sensor finished its calibration it is in active mode checking for the movements. If the output of the PIR sensor is 3.3v it is read as a HIGH by the MCU's digital pin. The HIGH value is triggered when the movement is observed by the PIR.

Notification

An SMS notification is sent to the registered phone number once motion is detected by the PIR sensor. The smartphone starts recording its vicinity on receiving motion detection signal. On receiving motion end signal the smartphone verifies the video timer tv, if it is more than 5 seconds the system is in safe state and stops recording otherwise the video is recorded for 5 seconds. If the video timer is more than 5 seconds the video is uploaded on cloud. Then mail notification is sent to the registered Email along with the URL of the uploaded video.

Conclusion

This paper presents a new method for intelligent surveillance utilizing the capabilities of a smartphone along with PIR sensor. The network and computational powers of the smartphone is utilized for surveillance. The energy usage is reduced by activating the camera only when the movement detected by the PIR sensor. The captured video footage is uploaded in cloud to enhance the security. A real time notification feature notifies the user about the intrusion through SMS and email. This design offers cost effective and energy efficient intelligent surveillance.

Future work

As a future work, the efficiency of our design can be further improved by adding more sensors to it. Also, adding a wifi module to the MCU will improve the connectivity and remote access of smartphone live stream using web services. To increase the quality of the video during nights, the lights may be turned on automatically when the intrusion is detected. The digital image processing algorithm may be implemented in the application module of smartphone to differentiate radiation changes between human and animal species.

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