Space Security System using Motion Sensor and Notification of Short Message Service with Arduino-Based Fuzzy Logic Algorithm

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Abstract : Security system is a store generally still use a conventional security system. Conventional security devices used include padlock and Close Circuit Television (CCTV). CCTV devices have a function to record any activity or event as long as the store is active or outside of its activity hours. However, CCTV has disadvantages because CCTV only records without giving a notification if there is human movement in the room after the store's operating hours end. Therefore we need a security system that can provide up-to-date information in real time to detect human movements within the store when it is outside its operating hours. The system was built using Passive InfraRed Sensors (PIR) which are connected to the microcontroller as the central control system to detect human movements outside the store's operating hours based on the results of design and testing, this system can be used properly and provides real time notifications to users. When the sensor detects human movement outside the store's operating hours, the system will send an SMS notification to the shop owner's mobile number.

1. Introduction

Advances in electronic and informatics technology have also helped in the development of reliable security systems. Many electronic devices are used for shop security systems. Therefore a security system is needed to maintain security at all times in order to protect the asset owned. By utilizing this system, it is expected to protect from theft or intruder, which lately are rife, causing security every time.This system is used to detect security conditions in a store using an alarm as a warning sign and notification via short message to the shop owner itself. This security system is made to know the motion of a human object when the store is out of operating hours. This system has the advantage of using Passive Infra Red (PIR) sensor that can detect infrared radiation emitted by the human body so that it can detect even dark conditions.

Passive infrared sensor has been used extensively in many applications, including motion detectors for alarms, lighting systems and hand dryers. The combination of several PIR sensor has also been used to count the number of human passing through the door [1]. Passive infra Red sensor work by detecting electromagnetic radiation emitted from objects. a medium which is irradiated by electromagnetic radiation which determines the amount of radiation that reaches the sensor. no energy lost in a vacuum and the sensor receives all the radiation emitted. However, not all wavelengths spread equally in the Earth's atmosphere because electromagnetic radiation is absorbed by several molecules [2]. PIR sensors are also commonly used with various sensors in a variety of applications to build a smart environment, the other for a security system. Han et al. presents a residential quality and indoor sensing method based on a series of sensors, including PIR sensors, CO2 sensors, humidity sensors and concentration sensors [3]. Tsai et al. presents how to reduce the standby power consumption of lighting devices based on PIR sensors, ambient light sensors and lighting duration modules [4]. They also provide a way to reduce standby power consumption from personal computer monitors in sleep status [5]. Erickson et al. presents an energy-efficient occupancy-based energy management system based on camera-based and PIR-based wireless sensor sensors for opportunistically controlled HVAC systems and, thus, improves energy efficiency, while maintaining the effectiveness of conditioning [6]. The occupant's ability and sensor-based PIR motion detection for a variety of application domains provide motivation for this research in establishing a space security system where this application works by sending a warning message in the form of Short Message Service (SMS) to the shop owner. Whereas for the exit indicator using buzzer and SMS notification by applying fuzzy logic algorithm.

2. Literature Survey

The sensor according to [7] is "a component used to input value data to Arduino for later processing." There are many types of sensors including motion sensors, gas sensors, light sensors, sound sensors, temperature sensors, humidity sensors, water sensor, water / air / wind discharge sensor, touch sensor, infrared sensor and so on.

Passive Infra Red Sensors (PIR) according to [7] are "electronic components in the form of infrared-based sensors". The PIR sensor only responds to Passive Infra Red bean energy that every object or object has detected. Objects that can be detected by these sensors are usually living things, especially humans whose volume is quite large.

PIR sensors work by capturing heat energy produced from passive infrared rays that are possessed by each object with an object temperature above 0 degrees. Explanation of the PIR sensor parts: *Fresnel Lens, IR Filter, Pyroelectric Sensor, Amplifier,* An existing amplifier circuit amplifies the current entering the pyroelectric material , and *Comparator*

After being amplified by an amplifier then the current is compared by the comparator so that it can produce output. The range of the PIR sensor itself can be adjusted as needed. The maximum distance is + 10 meters and a minimum of + 30 cm.

The microcontroller according to [7] is "a chip or IC (Integrated Circuit) that can be programmed using a computer." The recorded program aims to enable the electronic circuit to read input, process, and then produce output as desired. The output can be a signal, voltage, light, sound, vibration, movement and so on. [8] Arduino is a hardware and software that allows anyone to make a prototype of an electronic circuit based on a microcontroller easily and quickly.

Arduino uno according to [9] is "one of the actual Arduino labeled product is an electronic board containing an ATMega328 microcontroller (a machine that functionally acts like a computer). "

This tool can be used to realize electronic circuits from simple to complex. Control of Light Emitting Diode (LED) to control robots can be implemented using this relatively small sized board. Even with the addition of certain components, this device can be used for remote monitoring via the internet or SMS. For example in controlling home appliances, or motion sensor notifications on security. Arduino

uno contains a microcontroller and a number of inputs / outputs (I / O) that make it easy for users to create a variety of electronics projects that are devoted to dealing with specific goals.

The GSM SIM900A module is the SIM module used in this study. SIM900A Module GSM / GPRS is the part that serves to communicate between the main monitor with the Mobile. The GSM SIM900A module communicates via ATCommand commands. ATCommand is a command that can be given a GSM / CDMA modem such as to send and receive GSM / GPRS based data, or send and receive SMS. SIM900A GSM / GPRS is controlled through AT commands (GSM 07.07, 07.05, and SIMCOM).

According to [9] Breadboard is "a board equipped with holes that can be used to conduct electronic circuit experiments without requiring a soldering process. By using this board, the components used can be recycled. "

Buzzer is an electronic component that functions to convert electrical vibrations into sound vibrations. Basically the working principle of the buzzer is almost the same as the loud speaker, so the buzzer also consists of a coil that is attached to the diaphragm and then the coil is flowed so that it becomes an electromagnet, the coil will be pulled in or out, depending on the direction of direction and magnetic polarity, because the coil mounted on the diaphragm, each movement of the coil will move the diaphragm back and forth so as to make the air vibrate which will produce sound. Buzzer is usually used as an indicator that the process has been completed or an error has occurred in a device (alarm)

3. Design
In this study, a security system was designed which functions to detect human movements in shops, when they are outside the store's operating hours. In general, the system built is shown in figure 1.

Figure 1. Space Security System uses a motion sensor with Arduino based SMS notification

The hardware needed to develop the system includes:Arduino UNO, GSM SIM900A module, Realtime Clock (RTC) Module, Passive Infrared Sensor (PIR), Magnetic Switch, 3x4 Matrix, 2x16 LCD Keypad, Breadboard, and Buzzer. Figure 2 is the design of the flowchart system that is being developed
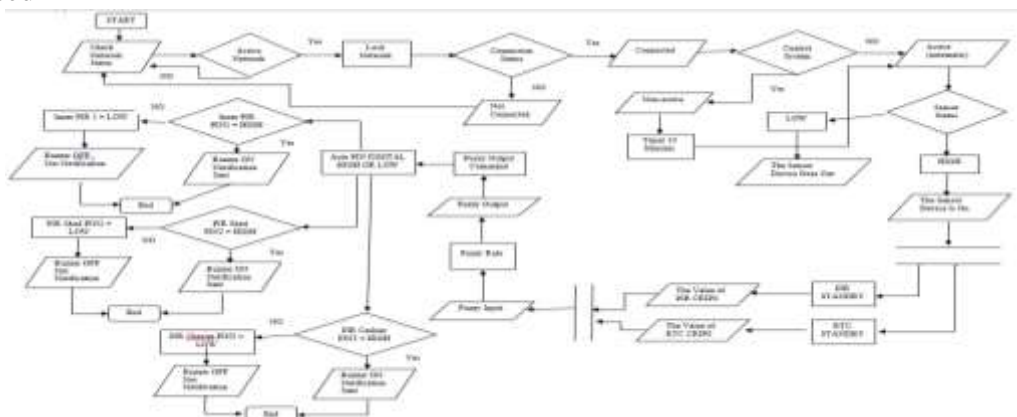

Figure 2. Flowchart System developed

The following are described the steps or functions of the system made:

1) The assembled microcontroller is then input into the program so that it has a function to detect human movement from the PIR sensor. The device will run with a predetermined time according to the operational condition of the poet's shop that is the location of the study.

2) The process of reading the conditions of space and time. The space condition in question is the process of reading human movements by sensors, while the condition of time is a predetermined real time clock state. This process starts when the device operates, a device that is active will detect human movement in the room.

3) The process of sending notifications, If the sensor detects a movement around the sensor using the fuzzy logic algorithm. The process of sending notifications is the result of reading the sensor and the time specified. If there is movement in the room, the system will emit a sound through the buzzer and send an SMS notification to the shop owner's number

4. Discussion And Result

The Arduino Uno microcontroller that has been assembled is then inputted in such a way that it has a function to detect human movement from the PIR sensor. The device will run with a predetermined time according to the operational condition of the shop that is the location of the study.

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The process of sending notifications, If the sensor detect a movement around the sensor using the fuzzy logic algorithm. The process of sending notifications is the result of reading the sensor and the time specified. If there is movement in the room, the system will emit a sound through the buzzer and send an SMS notification to the shop owner's number.

In this study the problem solving method applied is fuzzy logic. The stage of application of fuzzy logic in this study is the withdrawal of the value from the Passive Infra Red (PIR) sensor, which later results in a value of the distance between human objects and sensors. The value of distance between humans and sensors is an input for fuzzy logic processes. The function of these devices is to detect human movements in the shop when outside of their operating hours. The fuzzy logic process is fuzzyfication, inference, and defuzzification

4.1. Fuzzyfication

The step of the fuzzyfication process is to convert the input values of the correctness of the sensor device into linguistic or fuzzy input values.

4.1.1. The design of the PIR sensor membership function is data in the form of a crisp value or the initial value of a PIR sensor that is converted to fuzzy input

Table 1. Design of the PIR sensor membership function

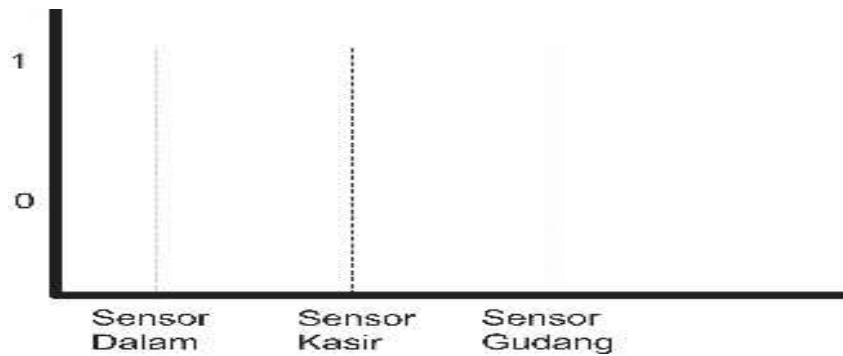| NO	Crisp value	Linguistic Value
1	Internal Sensor	0 = There is no
2	Warehouse Sensor	movement
3	Cashier Sensor	1 = Movement

Figure 3. *Sensor membership Function PIR*

a. The design of the Real Time Clock (RTC) membership function is data that is also in the form of a crisp value or the initial value of the RTC module. The initial value of the RTC takes the form of store operating hours data which is converted to fuzzy input

Table 2. Design of the Real Time Clock membership function

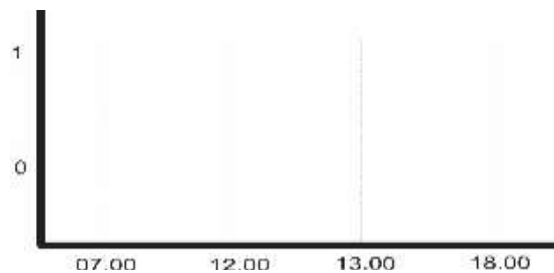| No	Crisp Value	Linguistic Value
1	07.00 – 11.59	Morning (P)
2	12.00 – 12.59	Afternoon Break (JIS)
3	13.00 – 17.59	Afternoon (S)
4	18.00 – 06.59	Night (M)

Figure 4. Real Time Clock membership function

4.1.2.   Inference

Based on the existing sensor fuzzyfication process, rules will be made from the values read from the sensor. Where the rules here are made to operate buzzer alarms and SMS notifications. The rules are as follows:

Table 3. The results of fuzzy rules are based on the values read from the sensor

S PIR \ RTC	Morning (P) 07.00 – 11.59	Afternoon Break (JIS) 12.00 – 12.59	Afternoon (S) 13.00 – 17.59	Night (M) 17.59 – 06.59
Sensor 1 (Internal)	BMTN	BNTN	BMTN	BNSK
Sensor 2 (WarerHouse/Shed)	BMTN	BNTN	BMTN	BNSK
Sensor 3 (Cashier)	BMTN	BNSK	BMTN	BNSK

Keterangan :

BNSK = Buzzer On SMS Send

BNTN = Buzzer On There is no SMS Notification

BMTN = Buzzer Off No SMS Notification

From the description of fuzzy rules / rule inferences from the 3 sensor columns and 4 RTC columns, the 12 rules of the rule are as follows:

IF S-PIR = Cashier AND RTC = P THEN BMTN   IF S-PIR = In AND RTC = JIS THEN BNTN

IF S-PIR = Cashier AND RTC = M THEN BNSK   IF S-PIR = In AND RTC = M THEN BNSK

IF S-PIR = Cashier AND RTC = JIS THEN BNSK   IF S-PIR = In AND RTC = P THEN BMTN

S-PIR = Warehouse AND RTC = JIS THEN BNTN   IF S-PIR = In AND RTC = S THEN BMTN

IF S-PIR = Warehouse AND RTC = S THEN BMTN

IF S-PIR = Warehouse AND RTC = M THEN BNSK

IF S-PIR = Warehouse AND RTC = P THEN BMTN

4.1.3. Defuzzification

The defuzzification process in this system is used to change fuzzy rules or rule inferences to be crisp output values that are used as a follow-up to movement readings by the PIR sensor and the timing of the RTC:

1. BNSK (Buzzer On SMS Send)
   Sensor In = PIN A0 (HIGH)
   Warehouse Sensor = PIN A1 (HIGH)
   Cashier Sensor = PIN A2 (HIGH)
2. BNTN (Buzzer On No SMS Notification)
   Sensor In = PIN A0 (LOW)
   Warehouse Sensor = PIN A1 (LOW)
   Cashier Sensor = PIN A2 (HIGH)
3. BMTN (Buzzer Off No SMS Notification)
   Sensor In = PIN A0 (LOW)
   Warehouse Sensor = PIN A1 (LOW)
       Cashier Sensor = PIN A2 (LOW)

5. Conclusion

Testing this system uses Arduino Uno with Fuzzy Logic algorithm and Android smartphone as recipients of SMS notifications. The implementation is focused on the sensor's performance and its notifications according to the store's operating hours that have been arranged and stored on Arduino. Each installed PIR sensor can send a signal to the microcontroller, then the system will send a notification via a short message to the user's mobile number in accordance with the reading from the PIR sensor and the time rule on the RTC module. Fuzzy Logic in the security system functions to process input data from the PIR and RTC sensors used to produce the final decision in the form of notification. When the system is active, if a human movement occurs in the store, the system will send a notification in the form of an SMS to the shop owner's number.

6. Reference

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