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Household Security System Based on Ultrasonic Sensor Technology with SMS Notification

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Abstract: Traditional Household Security Systems often require installation and detect on the based of opening doors and windows. In the cases where installation is not possible and/or the area of interest has no door our ultrasonic security system will come in handy because it requires no installation, and detects intruders based on their physical presence. Security is an important part of home, especially if we are going to share our house with prior strangers without lock on our room door. And we anticipate that many college students could face similar problem. What is not to love about a device that looks like WALL-E scans around for possible intruders? In case of intruders, it sends off sound alarm and alerts the owner via message. It is also password protected and could be disabled via the correct password.

In this paper, a highly advanced ultrasonic and an At89c51microcontroller are used to alert the security personals. Ultrasonic sensor is sensitive to any human movement. It detects infrared radiation coming from any alive body. At89c51 microcontroller is used for main module. In activated condition, when an intruder enters the prohibited area, sensor trigger main module zones, which in turn sends the message to the central camp and a visual and audible alert is produced. Security is an important part of home, especially if we are going to share a house with prior strangers without a lock on our room door. Here GSM Modem is used to send the message to owners mobile when the unwanted person crosses the in the prohibited area. It is also password protected and could be disabled via the correct password.

Keywords: Sensor, GSM modem, stepper motor.

1. Introduction

Ultrasound is acoustic (sound) energy in the form of waves having a frequency above the human hearing range. The highest frequency that the human ear can detect is approximately 20 thousand cycles per second (20,000 Hz). This is where the sonic range ends, and where the ultrasonic range begins. Ultrasound is used in electronic, navigational, industrial, and security applications. It is also used in medicine to view internal organs of the body.

Ultrasound can be used to locate objects by means similar to the principle by which radar works. High frequency acoustic waves reflect from objects, even comparatively small ones, because of the short wavelength. The distance to an object can be determined by measuring the delay between the transmission of an ultra-sound pulse and the return of the echo. This is the well-known means by which bats navigate in darkness. It is also believed to be used underwater by cetaceans such as dolphins and whales. Ultrasound can be used in sonar systems to determine the depth of the water in a location, to find schools of fish, to locate submarines, and to detect the presence of SCUBA divers. [1]

In this paper, a highly advanced ultrasonic and an At89c51microcontroller are used to alert the security personals. Ultrasonic sensor is sensitive to any human movement. It detects infrared radiation coming from any alive body. At89c51 microcontroller is used for main module. In activated condition, when an intruder enters the prohibited area, sensor trigger main module zones, which in turn sends the message to the central camp and a visual and audible alert is produced.[2] Security is an important part of home, especially if we are going to share a house with prior strangers without a lock on our room door. Here GSM Modem is used to send the information
to the camp when the unwanted person crosses the in the prohibited area.

2. Literature Survey

A **security alarm** is a system designed to detect intrusion – unauthorized entry – into a building or area. Security alarms are used in residential, commercial, industrial, and military properties for protection against burglary (theft) or property damage, as well as personal protection against intruders. Car alarms likewise protect vehicles and their contents. Prisons also use security systems for control of inmates.

Ultrasonic signals are like audible sound waves, except the frequencies are much higher. The ultrasonic transducers have piezoelectric crystals which resonate to a preferred frequency and convert electric energy into acoustic energy and vice versa. [3]

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Figure 1: Ultrasonic Smart sensor

The illustration in Figure 2 shows how sound waves, transmitted in the shape of a cone, are reflected from a target back to the transducer. An output signal is produced to perform some kind of indicating or control function. A minimum distance from the sensor is required to provide a time delay so that the "echoes" can be interpreted.

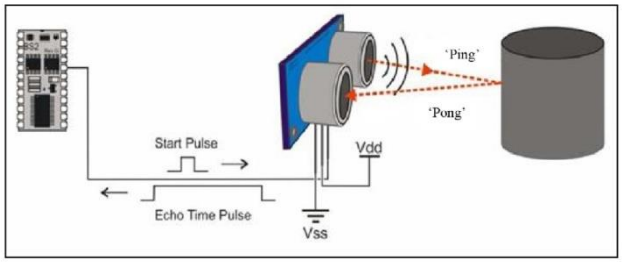

Figure 2: Basic ultrasonic sensor working

Variables which can affect the operation of ultrasonic sensing include: target surface angle, reflective surface roughness or changes in temperature or humidity. The targets can have any kind of reflective form - even round objects. Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively.[4] Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. This technology can be used for measuring: wind speed and direction (anemometer), tank or channel level, and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure tank or channel level, the sensor measures the distance to the surface of the fluid. Further applications include: humidifiers, sonar, medical ultrasonography, burglar alarms and non-destructive testing.

Systems typically use a transducer which generates sound waves in the ultrasonic range, above 18,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed. The technology is limited by the shapes of surfaces and the density or consistency of the material. Foam, in particular, can distort surface level readings. [5]

The history dates back to 1790, when Lazzaro Spallanzani first discovered that bats manoeuvred in flight using their hearing rather than sight. Jean-Daniel Col-Ultrasonic Security System lad on in 1826 discovered sonography using an underwater bell, successfully and accurately determining the speed of sound in water. Thereafter, the study and re-search work in this field went on slowly until 1881 when Pierre Curie's discovery set the stage for modern ultrasound transducers. He found out the relationship between electrical voltage and pressure on crystalline material. The unfortunate Titanic accident spurred rigorous interest into this field as a result of which Paul Langevin invented the hydrophone to detect icebergs. It was the first ultrasonic transducer. The hydrophone could send and receive low frequency sound waves and was later used in the detection of submarines in the World War 1. [6]

3. Methodology

The system uses ultrasonic sensor that has a transmitter part and a receiver part. The ultrasonic transmitter periodically emits ultrasonic signals into an open area in front of it. To cover a wide range, a rotating Stepper Motor is used to allow the sensor (transmitter and receiver pair) to cover roughly 180 degrees. If the signal ever hits a physical object, it will be reflected back and, the receiver part of the sensor will then capture it with the object considered detected as its position (distance from the device and angle relative to the device) is now known.

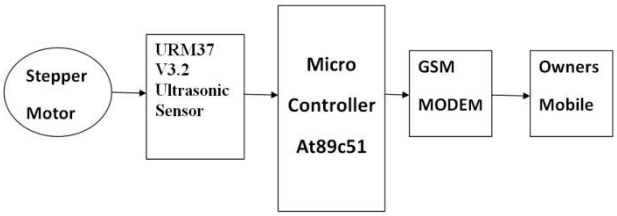

Figure 3: Block diagram of security system

As the security system sends off a signal to GSM Modem that object detected using At89c51 Microcontroller. Then SMS is sent to an owner's Mobile in advance. From the user's perspective, here is the flow of the system: when any unauthorized person enters in range of sensor then security system becomes active: motor starts rotating, sensor is scanning for potential intruders within a distance (15 cm for our demo, but could be anything realistically. It is only constrained by the sensor range, which is 5 meters theoretically), and in the case that an object is detected; the system beeps and triggers At89c51 to send a Message containing the time of detection to the user. [7]

This system consists of a GSM modem for sending and receiving the SMS, At89C51 microcontroller which is controlling the entire system, LCD for the display purpose. It can be installed at any desired location e.g., office (to protect important files and document), banks (to protect cash in locker) etc. In this system, the authorized person will have the entire control and he will decide which people will be allowed in that restricted area. Depending upon the response from the authorized person, microcontroller will decide whether to permit or not open. The GSM modem provides the communication mechanism between the user and the microcontroller system by means of SMS messages. [8]

4. Hardware Design

Stepper Motor Interfacing

Stepper motors can be driven in two different patterns or sequences. Namely

- Full Step Sequence
- Half Step Sequence

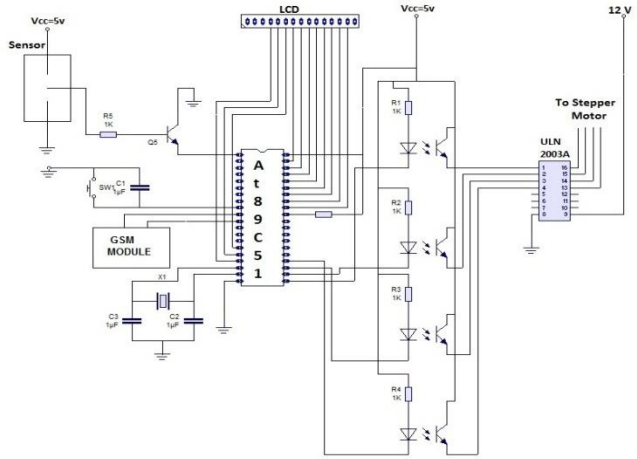

Figure 4: Circuit diagram

Step angle of the stepper motor is defined as the angle traversed by the motor in one step. To calculate step angle, simply divide 360 by number of steps a motor takes to complete one revolution. [9]

Table 1: Full Step Sequence

Step	*Winding A*	*Winding B*	*Winding C*	*Winding D*
0	1	1	0	0
1	0	1	1	0
2	0	0	1	1
3	1	0	0	1

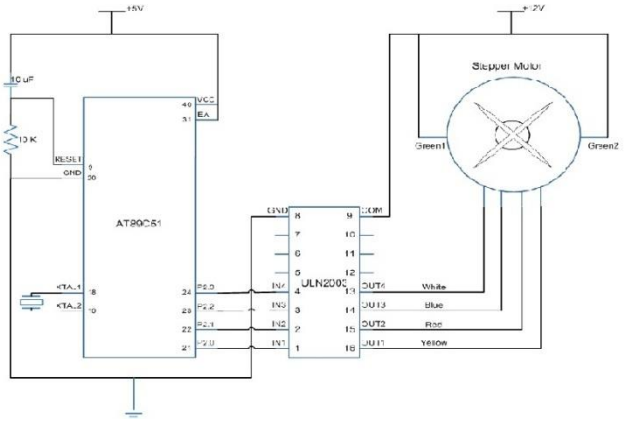

Figure 5: Stepper Motor Interfacing

To work with the unipolar stepper motor, the common points are connected to either Ground or Vcc and the end points of both the phases are usually connected through the port pins of a microcontroller. Unipolar Stepper Motor is rotated by energizing the stator coils in a sequence. [10]

5. Advantages

5.1 Distance measurement accuracy

Our sensor calibration and utilization gave us a distance measurement with roughly 1.5 cm accuracy. Provided that we are using the sensor to detect presence of an object more so than the exact distance, this accuracy is tolerable.

5.2 Speed of detection

It takes a maximum of three seconds for the system to detect a newly present object, and to turn on the alarm. This is because the servomotor is set to cover 180 degree range, and thus it takes roughly 3 seconds for it to start from one angle and back. However, a user can easily configure the servo to a narrower angle to focus at specific area (such as doorway), in which case the sensor will detect newly present object in less than a second.

5.3 Detection accuracy

Through our tests, we believe our system is capable of detecting intruders 95% of the time, provided that sensor was placed at appropriate position. The few times that intruder get away are when they are capable of crossing past the sensor quicker than 200 msec, which is our measurement interval hard-coded into our code.

5.4 Message Notification

Upon object detection, we successfully receive emails that contain the exact time when the security was triggered. This is a standard email delivery, and therefore it could take a minute or two for it to reach your inbox. When the object continues to be in the way, the system does continue to send emails. So far, we have not seen any false positive alerts.

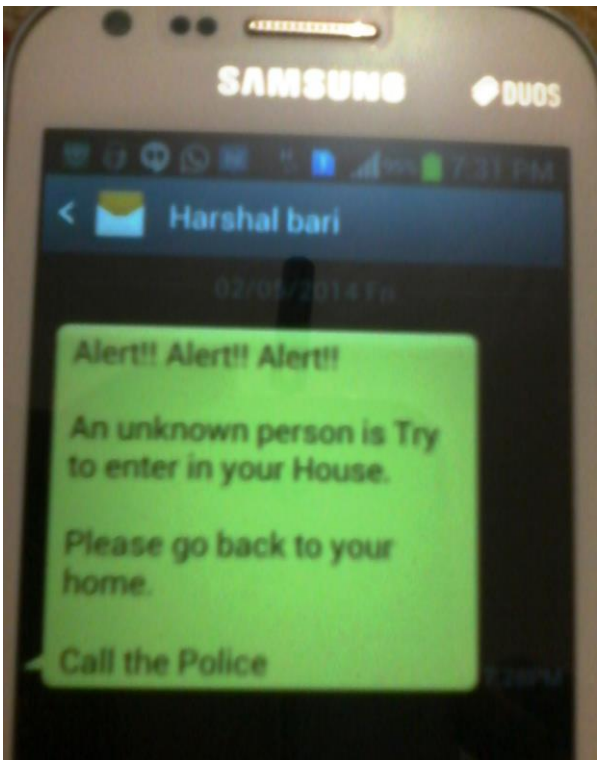

Figure 6: SMS delivered to Mobile number

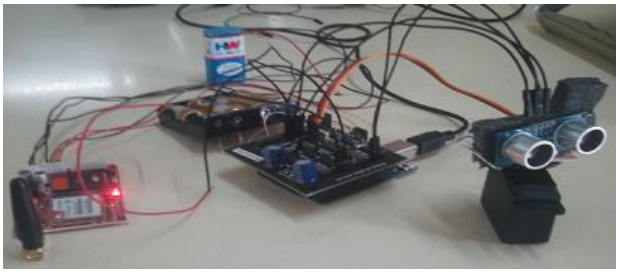

Figure 7: Actual device

6. Conclusion

It can be concluded here that the system has been successfully implemented and the aim is achieved without any deviations. The results achieved in this project are genuine and are a product of sincerity and hard work. All the devices communicate well, especially the Ultrasonic Sensor communicates well with the GSM modem and the SMS is sent successfully. There is a lot of future scope for the project, because a security system helps you protect your property and your privacy. The product can also be developed or modified according to the rising needs or demands.

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