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A Low Budget Touch less Door Bell with Integrated Intruder Alerting Safety System

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Abstract*: *A Door bell is a signaling device of your home which is used to indicate the Owner (host) that someone is at your door-step. The problem that is faced today is the touch contact of the Door-bell switch, wherein everyone will have to touch it, not having any other option than knocking or slamming the door. This is a critical issue condition nowadays, when by chance a Corona affected person unintentionally touches the switch, later followed by a healthy person, wherein which it now acts as a source of transmission. A touch less door bell (Buzzer) using sensors will solve this issue, wherein available solutions have Ultrasonic sensors for the same. Similarly this door bell can also produce a strong intensity of signal which can also be used as an alert system, if an intruder is trying to enter, while the host is not in the house. To implement both these together a PIR sensor would additionally be required to enable the Ultrasonic sensor and Sound sensor. The alert system can be controlled by the Host with the help of a Switch placed inside the house. The host is being alerted with a message in both scenarios with the help of a GSM module. All of these controlled by a single microcontroller, and the reuse of PIR and Buzzer, makes it cost effective.

Keywords* : *Arduino UNO Microcontroller, GSM, Ultrasonic sensor, PIR sensor, Sound Sensor.

I. INTRODUCTION

Technology plays a very important role in our daily life. Utilizing them at the right place and right moment wisely is up to the design embedded enthusiasts. Whatever be the technology used, the design should be such that it consumes lesser power and that it can be used for multiple applications, i.e. by reusing the components. The need of the day is that wherever we go, it is best we avoid skin contact anywhere due to the situation of the air born Corona virus. The main part that we would use anywhere is our fingers. This could be to give or receive product, materials or money. It could also be to touch the different button systems around us, for example like the buttons in an escalator, card swiping machine, ATM or even the Door bell of our home. All of these common contacts would act as transporting points of the virus.

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There are two possible ways to overcome the spread of the virus from the above specified conditions. The first possibility is to never use any of the above methodologies, i.e. stay locked down at home without any contact with the outside world. This may be possible only for a few days, but beyond that it is practically not possible due to its limitations as we are aware that this period would extend for a few months.

The second possibility is to avoid touch (direct contact) at the above mentioned places. This cannot be done with the existing system that is found around us. But this can be achieved with the growth in technology and availability of specific sensors. There are a few such sensors available that can sense the presence of human without requiring touch. These sensors work on the principle of Infrared rays and SONAR. The sensors namely are Passive (or) Pyroelctric Infrared sensor and Ultrasonic sensors are the most commonly used and is also being used here. Choosing the optimal controller for the system is important considering the factors of operating voltage for low power consumption and the number of I/O pins available for interfacing. In our method, only digital pins are required to interface the components to the controller. Another advantage is that only 9 digital I/O pins are required. With many options available in the market, as specified (see Table I), Arduino Uno is optimal, because other types either would have insufficient supply voltage of 3.3Volts (or) very less number of I/O pins like 7 pins only (or) the other way round having more than 20 I/O pins which is wastage of resource. Another advantage of having 14 I/O pins is that the proposed system can be expanded in the future, covering additional components and thus probably increasing the number of applications too.

Table- I: Types of Arduino Boards with the Operating voltage and Number of Digital I/O pins considered

Board	Microcontroller	Operating Voltage	Digital I/O pins
Uno	ATmega328	5	14
Leonardo	ATmega32u4	5	20
Nano	ATmega328	5	22
Due	Atmel SAM3X8E	3.3	54
Industrial 101	ATmega3u4	5	7
MKR1000	Atmel SAMD21	3.3	8

The advantage of the proposed system is that, the design not only consists of a touch less door bell design but also an alert system to enable the owner and neighbors be aware of any intruder in the house. The rest of the paper deals with the Existing System (II) explaining the already available techniques followed by, Working Principle (III) of the system,

then the Architectural Design (IV) explaining the Flow chart of both the door bell and the alert system, continued by the Schematic Diagram (V) representation of the entire module, followed by Results and Discussion (VI) and lastly concluding with the Conclusion and Future Works (VII).

II. EXISTING SYSTEM

There are a few Automated based home automation technologies available [1]. To see a few of the drawbacks, one such work requires the implementation of Speech recognition [2]. This requires computers or laptops to be used during usage which makes it not only complex but considering elderly and illiterate people; it cannot be implemented in most of the houses [3]. Another system proposes the usage of fingerprint capturing along with the current date and time [4]. The drawback of the method is that firstly, an alert system cannot be constructed using the method even as a future advancement, and secondly maintaining a database of the collected data is quite costly, covering extra space and mostly requiring additional human support for its maintenance in case of technological malfunctions. Another technique in this domain uses separate Mobile Applications [5] which increases the cost due to the additional usage of Internet need to be interfaced. In the case, a simple message is more than sufficient to alert the concerned house owner or neighbor or nearest police station, which can be implemented with a GSM module [6].

III. WORKING PRINCIPLE

In this proposed system, both the above mentioned design concerns are considered. To reduce the consumption of power by the Ultrasonic sensor, a PIR sensor is used. It works in such a way that, if there is movement in the corridor of the front door, the PIR sensor senses a signal. When the PIR sensor senses the movement, it then only activates the Ultrasonic sensor for a short duration of time, which is the actual touch less switch for the Buzzer (Door bell). The ultrasonic sensor has a Trigger Pin, which is enabled only when the PIR sensor detects a signal. This helps in reducing the unnecessary consumption of power because normally the buzzer is activated just based on the movement detected by the PIR sensor [7]. The reason why only a PIR sensor was not considered was, for examples pets of neighbors in Flats based houses will always be detected by the PIR sensor as movement. This movement when initiating the buzzer being ON, will surely be of disturbance to the owner. Another drawback of the PIR sensor is that it requires continuous movement of the human for the buzzer to be ON.

When the Ultrasonic sensor detects a signal (specific distance, < 5cm), the Buzzer goes on without the person needing to come into contact with any component. The next advantage of the proposed system is that when there is no response at the door from the inside and the ultrasonic sensor detects a signal for the second time a text message is sent to the owner of the house. This message would help the owner if he is inside the house indicating that the Buzzer (Door bell) is not working. If the ultrasonic sensor detects a signal for the third time, the Buzzer is turned OFF intentionally, assumed clearly that the owner is not at home. This is where again the main role of reducing power consumption comes into picture. Thus if a person whose character is such that he/she continuously hits the Buzzer though unaware the owner is not at home, without their knowledge the Buzzer will be OFF, thus helping unnecessary wastage of power.

The next application of the proposed system is to provide a safety system when the owner is not at home. This can be done with the help of a single SPST switch controlling the absence of the owner. For example let us consider that the SPST switch is available near the Back door but inside the house. When the owner leaves the house, he turns on this Switch. This activates a Sound Sensor placed on the inside wall of the house near the door which was turned OFF till then, thus again saving power consumed. This Sound Sensor can measure the intensity of sound from different sources like knocks, claps, loud voices, etc. Hence depending on the neighborhood the intensity can be varied by the owner through the programmer. When the Sound sensor receives a signal it activates the Buzzer of the house and sends a message via GSM module. This is the same Buzzer and GSM module [8] of the house used for the door bell application. But now the Buzzer has a higher sound intensity, which would be enough to give an alert to the neighbors and the GSM can be used to alert both the neighbor and the owner simultaneously. The duration of which the Buzzer would be ON could be programmed such that Switch from the inside is turned OFF.

In case it was the night time that the intruder was trying to come in, along with the buzzer going ON the LED would also go ON. Thus, the LED can be turned OFF depending on the duration provided by the programmer. This LED is equivalent to connecting Light bulbs to the microcontroller via Relay modules. For simplicity of working LED is considered here.

This alert system need not be applied at the doors only as it can be placed near the windows also. The difference would be that there would be individual Sound sensors at each location, whereas only a single switch and buzzer is required for the entire setup. This makes highly cost effective under such conditions.

The Algorithm followed in implementing the two applications are given below.

A. Door Bell:

Step 1: Is there a signal detected due to movement of a Human from the PIR sensor?

If NO, stay in the same Step 1, else if detected go to Step 2.

Step 2: Is there signal detected due to hand placed in front of Ultrasonic sensor, with less than 5cm distance, and duration greater than 1second (i.e. First time)?

If NO (i.e. either one of the above not satisfying), wait in same Step 2 and if hand not placed within next 30 seconds, go back to Step 1. Else if signal detected go to Step 3.

Step 3: Turn ON Buzzer for 3 seconds and go to Step 4.

Step 4: Is there signal detected again from Ultrasonic sensor, within next 30 seconds (i.e. Second time)?

If NO go back to Step 1. Else if signal detected go to Step 5.

Step 5: Is there minimum of 5cm distance, and a duration greater than 1second of hand placed in front of the ultrasonic sensor?

If NO go back to Step 4. If YES go to Step 6.

Step 6: Turn ON Buzzer for 2 seconds and then activate GSM to send a message to House owner "Someone @ Front Door".

Step 7: Is there signal detected from Ultrasonic sensor, within next 30 seconds?
If NO go directly to Step 1. If YES, go to STEP 8.

Step 8: Turn OFF the Buzzer for the Next 2 minutes and then go to Step 1 (to avoid the person pressing the bell unnecessarily).

B. Alert System:

Step 1: Is the SPST 2-pin Switch in ON or OFF Condition? If OFF, continue at this same Step. If ON, go to Step 2.

Step 2: Is the Sound Sensor value high i.e. reading a signal (sound due to human work outside)?
If NO go to Step 1. If YES, go to Step 3.

Step 3: Activate the GSM module and Send Message "Intruder @ Back door" to owner.

Step 4: Turn Buzzer ON with a high intensity compared to that of a normal Door Bell sound for next 5 minutes to alert neighbor. The Buzzer cannot be turned OFF manually. Simultaneously, Turn LED ON till the SPST switch is turned OFF manually.

IV. ARCHITECTURAL DESIGN

Implementing an idea having multiple applications is very important to make sure it is cost-effective. Based on the idea proposed earlier, two different Flow charts specified in Fig. 1 and Fig. 2 have been put up to explain the alert system and the door bell respectively.

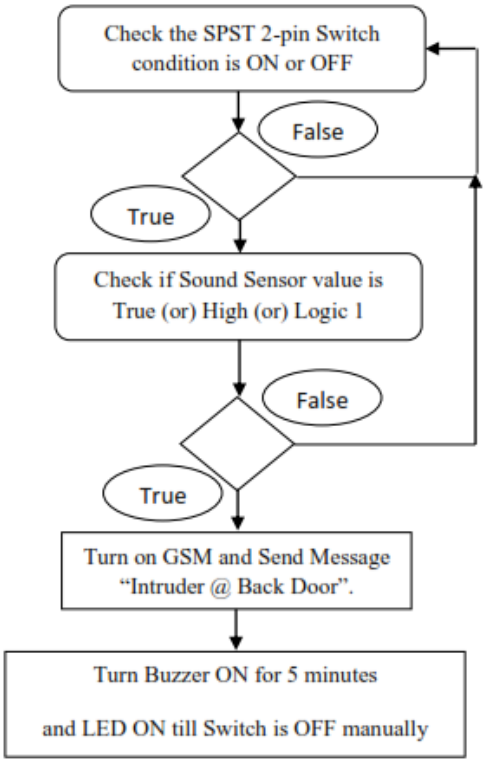

Fig. 1.Alert System (for example: Back door)

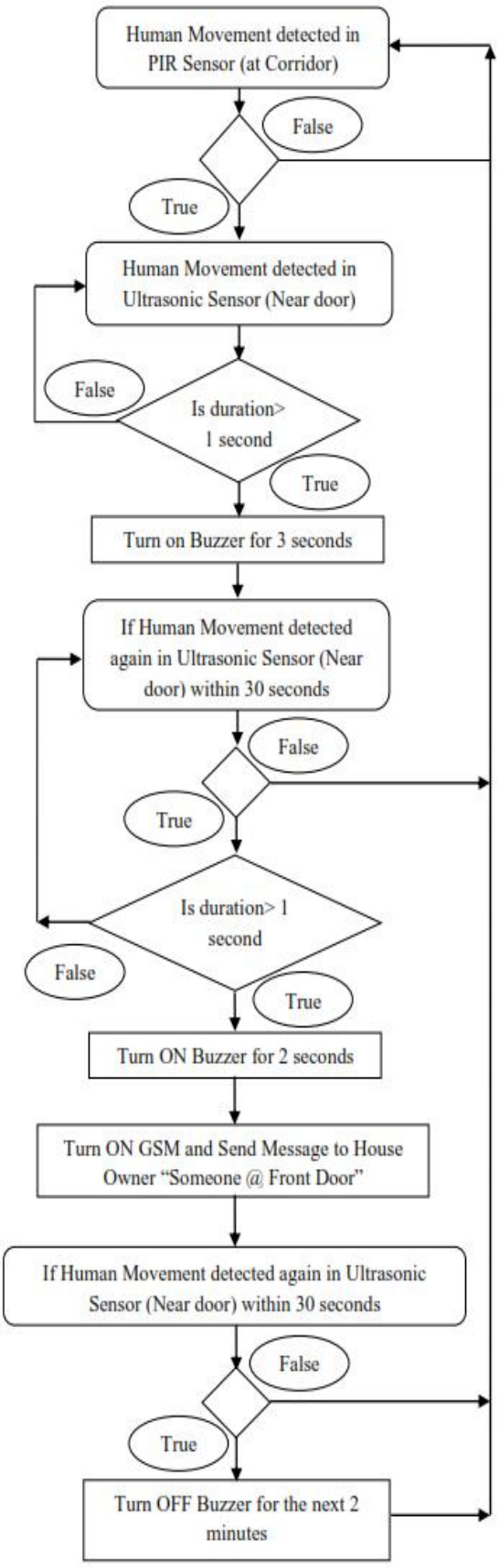

Fig. 2.Door Bell (*for example: Front door*)

V. SCHEMATIC DIAGRAM

To implement the proposed system, Arduino Uno Microcontroller has been used and its implementation was being done using Proteus tool. The Supply (V_{CC}) pin of the PIR, Ultrasonic and Sound sensor are connected to a common 5 volt power source. Similarly, the Ground (Gnd) pin of the above sensors along with the LED and Buzzer are connected to a common ground. All the pins are interfaced to the Digital pins of the microcontroller. The Output pin of the PIR and Sound sensor are connected to pins 3 and 8 of the microcontroller respectively. The Trigger and Echo pin of Ultrasonic sensor are connected to Pins 7 and 6 of microcontroller respectively. Similarly, with one end of the Buzzer, LED and SPDT Switch grounded, the other ends of them are connected to pin 13 and 12 and 10 respectively. Finally, the Transmit Data (TxD) and Receive Data (RxD) of GSM module is connected to pins 0 and 1 respectively.

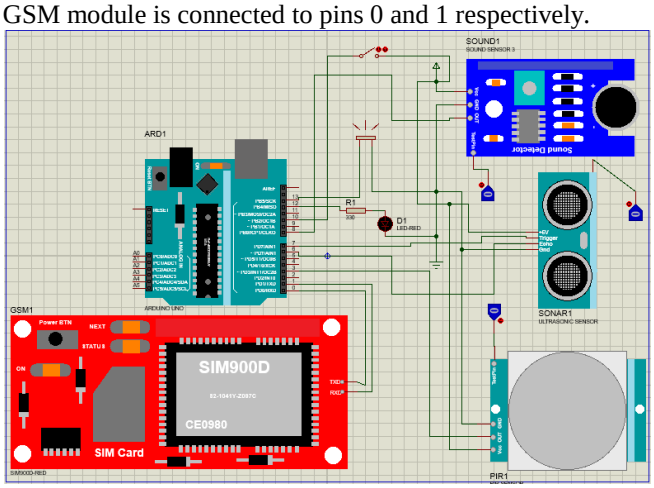

Fig. 3.Schematic Diagram of the proposed Door Bell and Alert sysytem.

As in the schematic shown above i.e. Fig. 3, the PIR sensor is the Master sensor that activates the Ultrasonic sensor for the Buzzer and the Sound sensor for the Door Bell and Alarm system respectively. When the Ultrasonic sensor is ON it checks whether the hand is placed at a distance less than 5 cm from the source and similarly whether it was placed for a duration greater than 1 second. If successful accordingly the Buzzer goes on. When the same procedure repeats, the GSM module is activated to intimate the House owner about the visit of a stranger. This is done by sending an SMS. To avoid the stranger repeatedly hitting the bell though the door is not being answered, the buzzer would be turned OFF for the next two minutes. This is expected to make him leave the place.

In the case of the Alarm system, the Master control is the SPDT Switch. When it is OFF and the PIR sensor is ON, the sound sensor is activated. If there is a signal from the sond sensor, the GSM module is first activated the alert the owner of the house about the presence of a possible intruder. Next, the Buzzer is switched ON for the next 5 minutes with a higher intensity than that of the normal door bell. This can be controlled by the "tone(piezopin, frequency, duration)" instruction. While the value of frequency is changed, the intensity of the signal varies. Thus, with a single Buzzer we can make use of it to work either as a Door Bell or an Alarm.

VI. RESULT AND DISCUSSION

The results of the system have been tabulated for better understanding of the Algorithm. To understand the working of the Door Bell (see Table II) algorithm, the experimental results are tabulated below. Similarly to understand the working of the Alarm System (see Table III) algorithm, the experimental results are given below Table II. In the table, the ON state specifies that the device is ON, and the OFF state specifies that the device is OFF. The ON / OFF state infers that the device could be in either of the ON or OFF condition. As the GSM is a module rather than a sensor or device, it is being used with the terminology of Enabled and Disabled for the Active and Inactive states respectively.

Table- II: Experimental results of the Door Bell Algorithm

Steps	1	2	3	4	5	6	7	8
PIR sensor	ON / OFF	ON	ON	ON	ON	ON	ON	ON
Ultrasonic sensor	OFF	ON / OFF	ON	ON / OFF	ON / OFF	ON	ON / OFF	ON
Buzzer	OFF	OFF	ON	OFF	OFF	ON	OFF	OFF
GSM	Disabled	Disabled	Disabled	Disabled	Disabled	Enabled	Disabled	Disabled

Table- III: Experimental results of the Alarm System Algorithm

Steps	1	2	3	4
SPDT Switch	ON / OFF	ON	ON	ON
PIR sensor	OFF	ON	ON	ON
Sound Sensor	OFF	ON / OFF	ON	ON
Buzzer	OFF	OFF	OFF	ON
LED	OFF	OFF	OFF	ON
GSM	Disabled	Disabled	Enabled	Disabled

VII. CONCLUSION

With only a few available fully automated door bell systems available, the proposed system provides the advantage of not only having a touch less system considering the COVID situation and power consumption reduction as a factor, it also considers another application of Alert system being integrated without the use of any costly components or complex circuits. The advantage of the proposed alert system is also that it is being implemented using the same microcontroller, GSM module and buzzer, as the one used in the Door Bell, thus making it very a cost effective one too.

The idea of integrating the Door Bell with the Alerting system at houses can further be taken to the next level by integrating cameras that further increase security. Also an application (apps) can be integrated to monitor the activities of the house at any time. The above two can be integrated at the cost of increasing price and complexity of the system

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