

Rochelle salt integrated PIR sensor arduino based intruder detection system (ABIDS)

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Abstract— In this paper, the Arduino based Intruder Detection System employing Rochelle Salt and Pyro-electric or Passive infrared (PIR) Sensor has been proposed. The proposed system employs Rochelle salt based sensor and PIR sensor supervised simultaneously by Arduino UNO. The Rochelle salt (Potassium Sodium Tartrate) exhibits piezoelectric properties in response to applied mechanical stress. The PIR sensor responds to Infrared (IR) radiating objects moving in its viewing range. The PIR detection is done by creating temporary electric potential whenever a change in IR radiations occurs within the viewing range of the sensor. The Rochelle salt and PIR sensor work independent of each other. The novelty of the system lies in its utilization of the Rochelle salt as sensing element for security purposes. The 20 grams of powder Rochelle salt is capable enough to generate 290mV. When the intruder enters the restricted area, the sensors sense the intruder and an alarm is triggered. In case, if one of the sensors stops working, it doesn't affect the working of the other sensor. The time variation of the buzzer helps in recognizing how far the intruder is from the restricted area.

Keywords— *Arduino UNO; PIR Sensor; Rochelle salt; Voltage regulator;*

I. INTRODUCTION

In this advanced technological era, there is a high rate of crimes under technical hands. So, it's the high time for the development of tackling tools to maintain law and order. Recently, home security systems have become mandatory as the crimes like burglary are at hike. For this accomplishment, the sensors form the foundation of the artificially intelligent devices. The PIR sensors have been employed to sense human movements in home security systems. It passively takes IR radiations as input and thereafter generates signal to be read by microcontroller [1]. The low cost, small in size, low power consumption makes it an ideal choice for use [2]. Also, it is widely used to trigger cameras owing to its working in even low light conditions [3]. By monitoring large rooms and spaces, PIR sensors are extensively used for fire detection in buildings [4]. The range of PIR sensors is about 6 meters. These are highly sensitive and hence are not recommended in areas prone to unstable environmental changes, as it can result in false alarm [1]. The Piezoelectric materials are one of the most important materials used for harvesting energies and many studies have been conducted on them [5]. The Piezoelectric effect stands for harvesting mechanical energy that can be scavenged from mere bodily movements or vibrations, into electrical energy. The first materials discovered

to exhibit the piezoelectric were potassium sodium tartrate and monopotassium phosphate. Conventionally, the ZnO, ZnS, CdS have been exploited for piezoelectric effect [6-8].

In this paper, the Rochelle salt ($\text{KNaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$) based sensor is the area of interest to explore its piezoelectric capabilities in smart security systems. The proposed work utilizes both Rochelle based sensor and PIR sensor for independent and fool proof working of intruder detection system. The section II of paper describes the design of the proposed system and the Section III deals with the calculations. The section IV illustrates the operation and working of the proposed system followed by the results in section V. The conclusion of the proposed work has been formulated in section VI.

II. DESCRIPTION OF PROPOSED SYSTEM

The circuit diagram of the proposed system is shown in figure 1 below which consist of several modules are Lead Acid rechargeable battery, Step down transformer, Schottky diodes 5819, LM7805, LM7806 Voltage regulator, Arduino UNO, PIR sensor and Rochelle salt, buzzer. The Description of the modules have been discussed in detail below.

A. LM7806 Voltage Regulator

It is a voltage regulator integrated circuit. It is also a member of 78XX series of fixed linear voltage regulator ICs. It maintains a constant output voltage of +6V without depending upon input variation and load factor. It is a three-pin device Input, GND and Output pins as shown in fig. 2.

B. 7805 Voltage Regulator

It is a three-pin device used for stabilization of DC voltage. It generates a constant output voltage regardless of any or load conditions. It is a positive voltage regulator. It belongs to series of LM78XX and can deliver over 1A output current. It also provides thermal overload protection and short circuit protection. Fig. 3 represents pin description of LM7805.

C. Rechargeable Battery

In the proposed system, a +6V battery having current rating of 4.5 Ah, with maximum charging current of 1.35A has been used. The lead acid battery has been used as power up source for the system. The lead acid rechargeable battery has the advantage that it has low self-discharge capability. The lead acid rechargeable battery employed in the proposed system is shown in fig. 4(a).

D. Step-down Transformer

It is a 9-0-9 step down transformer which converts 230V AC input to +9V DC output. It produces low voltage, high current power from high voltage, low current power. It's advantageous because it provides better control over amount of power supply. The +9V step down transformer employed in the proposed system is shown in fig. 4(b).

E. Pyro-elctric or Passive Infra-red Sensor

It is a thermal radiation detection device that detects motion for changes in infrared levels. It is a compatible 3-Pin device with all parallax micro controllers. These 3 pins are

GND, V+ and output. Its operating voltage is 3.3V to 5V with current draw less than 100µA. The PIR sensor is shown in fig. 5.

F. Rochelle Salt and Its Preparation

Potassium sodium tartrate tetra hydrate (KNaC4O6.4H2O) also known as Rochelle salt or Seignette's salt or E337 is a highly sensitive piezoelectric material. Rochelle salt exhibit the greatest amount of piezoelectric properties. The salt can be prepared using cream of tartar (potassium bitartrate) [KHC4H46] and baking soda (sodium bicarbonate)

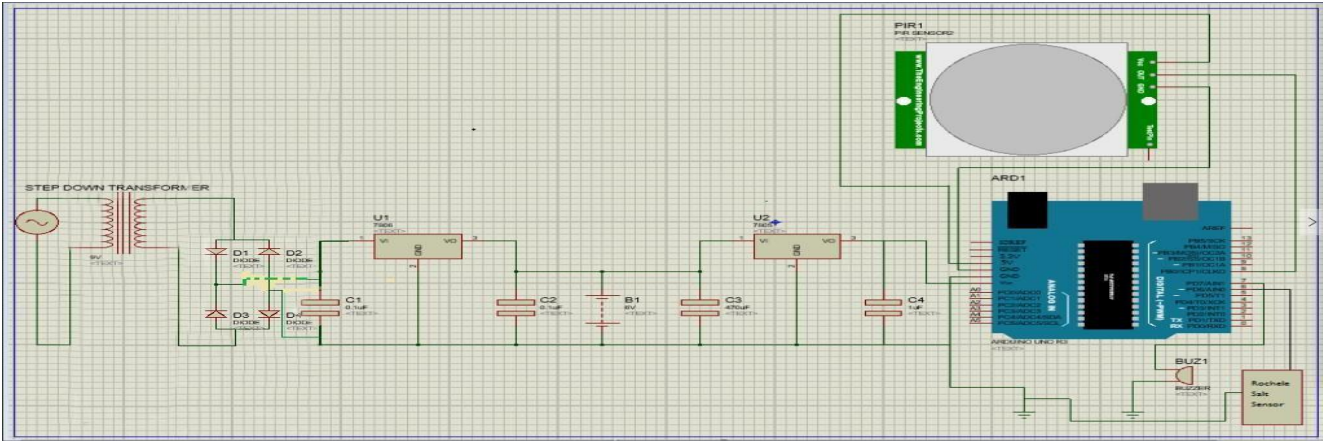


Fig.1 Circuit diagram of the proposed system variation in input

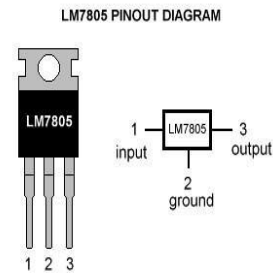


Fig.2

Fig. 2 Pin description of the LM7805 voltage regulator.

Fig. 3 Pin description of the LM7806 voltage regulator

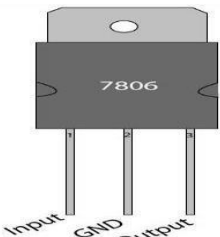


Fig.3

[NaHCO₃]. The Rochelle salt give electric output when stress is applied. The Rochelle salt is prepared by adding 10gm of Rochelle salt powder in 50 ml of distilled water kept in a water bath having stable temperature of 66°C. Further addition of Rochelle salt is done in order to produce a saturated solution. When saturation point of solution was reached, it was filtered out in borosilicate beaker. The seeding process was carried out of filtered solution. Now, the crystalline structure is converted into powder form with the help of sandpaper. The powder form of Rochelle salt is shown in fig. 6(a). The powder form of Rochelle salt is confined into small box made of cardboard. The box is of length, breadth and height 5.5cm, 3.5cm and 2.5cm, respectively. The box filled with Rochelle salt weighs 25grams. The Rochelle salt is sandwiched between two electrodes i.e. copper and aluminum. The copper act as positive terminal whereas aluminum as negative terminal of the Rochelle based sensor. The Rochelle salt sensor is shown in fig. 6(b).

G. ArdiunoUNO

Arduino UNO is an open source hardware. It has 14 digital pins and 6 analog pins. In digital pins some pins are PMW pins. It also has in built led aligned with 13th pin of the Arduino UNO. The rest button is also present on the Arduino UNO. The proposed system employs 1N5819 schottky diode as shown in fig.9. circuit board. The operating voltage of



Fig. 4(a)

Fig. 4(a) lead acid rechargeable battery employed in the proposed system.



Fig. 4(b)

Fig. 4(b) Step down transformer employed in the proposed system.

Arduino UNO is +5V [9]. The Arduino UNO is shown in fig. 7.



Fig. 5 PIR sensor employed in the proposed system.



Fig. 6(a) Powder form of Rochelle salt.
Fig. 6(b) Rochelle Sensor employed in the proposed system.



Fig. 7 Arduino UNO employed in the propose system

H. Buzzer

The Buzzer is a piezoelectric audio signalling device. Its structure comprises of ceramic disks, the disk deforms and bending diaphragms. When a recurring voltage is applied to the buzzer, it vibrates at the frequency of applied voltage. The buzzer employed in the proposed system is shown in fig. 8.

I. Diode

The Schottky diode 1N5819 have been employed in the proposed system. The schottky diode 5819 has current rating of 1A and maximum voltage +40V. The schottky diode have extremely low forward voltage. Schottky diodes have

maximum carrier conduction. In the proposed system by employing the schottky diodes bridge rectifier is formed.



Fig. 8 Buzzer produce sound when intruder enters the restricted area.

Fig. 9 1N5818 Schottky diode

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III. CALCULATIONS OF THE PROPOSED SYSTEM

The instantaneous current consumption of the proposed system = 0.01A.

Time period for which the alarm is triggered = 120 seconds.

Instantaneous power consumption of the proposed system = 0.052W.

Total current consumption of the proposed system for onetime alarm triggered

$$= \text{instantaneous current} \times \text{Total time}$$

$$= 0.02 \text{ Ampere m hour}$$

Number of times alarm can be triggered

$$= \frac{4.5}{3.3 \times 10^{-4}} = 13636 \text{ times}$$

IV. OPERATION AND WORKING OF THE PROPOSED SYSTEM

The operation of the proposed system comprises of 3 main components Arduino UNO, PIR and Rochelle sensor as shown in fig. 1. In the proposed system 230V AC is converted into +9V DC by step down (9-0-9) transformer. The output of the step-down transformer is connected to the LM7806 voltage regulator via. 0.1uF capacitor and the output of the voltage regulator is connected to the lead acid power battery of +6V having current rating 4.5Ah, which act as a power source to the proposed system as shown in fig. 11. The positive terminal of the battery is connected to +V_{in} pin and negative terminal of the battery to GND of the Arduino UNO. In the proposed system, PIR detection done by creating a temporary electric potential whenever a change in infrared (IR) radiations occur on the viewing range of the sensor. The PIR terminals, +V_{cc}, GND and output are connected to +5V, GND, and 8th pin of the Arduino UNO

respectively. The Rochelle salt based sensor having two terminals +V_{cc} and GND is connected to 6th and GND pin of the Arduino UNO respectively. The working of both the sensors in the proposed system is independent of each other. As Intruder enter the restricted premises the PIR sensor detects the motion of the intruder in the range of 6 meters, a primary alarm is triggered for 10 seconds. In case of further movement of the intruder towards the restricted door, the Rochelle salt based sensor which is placed at the door step, detects the presence of the intruder, as it exhibits piezoelectric properties in response to applied mechanical stress i.e. weight of the intruder and then the secondary alarm is triggered for 2 minutes. The execution of the proposed system works in a continuous sequence as shown in fig.10.

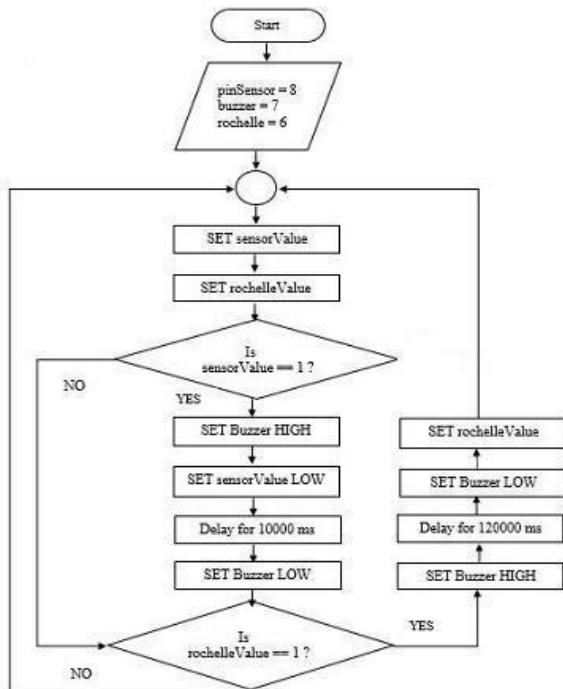


Fig. 10. Flow chart of the proposed system

Fig. 11 Current consumption of the proposed system

V. RESULT

The on load current consumption of the proposed system is 0.01A when alarm is triggered as shown in fig.11 and voltage is +5.26V as shown in fig.12. The proposed system consumes very low power 0.0526W. The cost of the proposed system is described in detail as shown in table 1 Cost of the Proposed System In proposed system, the Arduino based Rochelle salt and PIR smart sensor intruder detection system have been proposed which can efficiently replace the use of high cost security system. The designed system consumes very low power of 0.052W. The alarm system works according to the distance between the intruder and sensor. It is also advantageous because of its fool-proofing characteristics and multi stage sensing feature. It also decreases the false alarm rate. In future Rochelle based sensor application can be employed in military area, wide area sensing, organizations and for home security purpose.

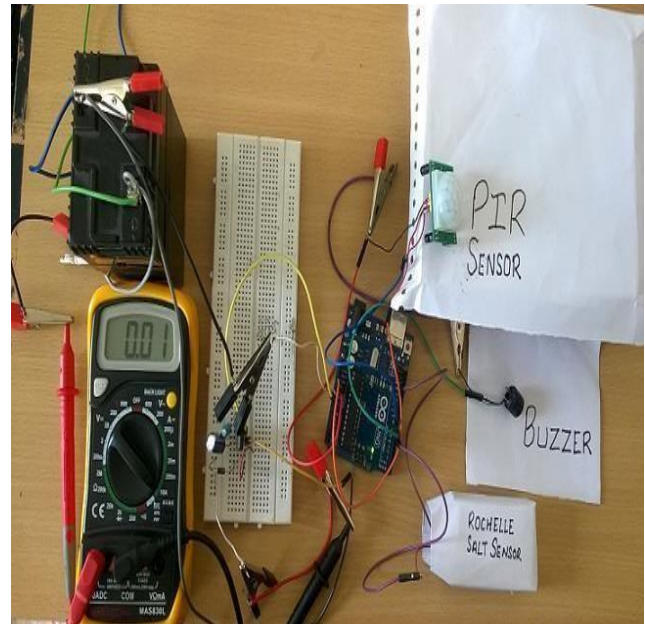
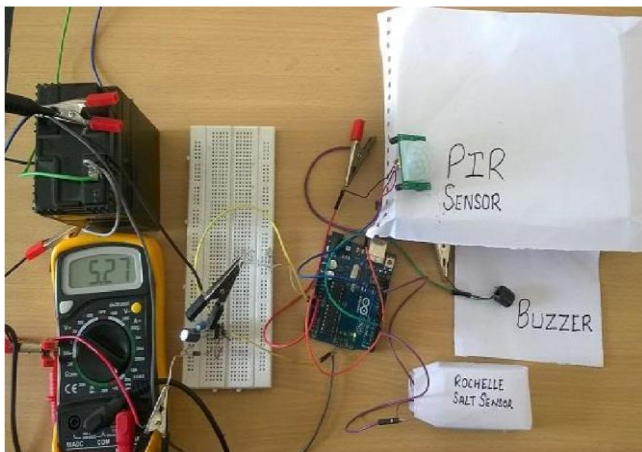


Fig. 12 Voltage consumption of the proposed system

VI. CONCLUSION

In proposed system, the Arduino based Rochelle salt and PIR smart sensor intruder detection system have been proposed which can efficiently replace the use of high cost security system. The designed system consumes very low power of 0.052W. The alarm system works according to the distance between the intruder and sensor. It is also advantageous because of its fool-proofing characteristics and multi stage sensing feature. It also decreases the false alarm rate. In future Rochelle based sensor application can be



employed in military area, wide area sensing, organizations and for home security purpose

TABLE I. 1 Cost of the Proposed System

<i>Components</i>	<i>Value</i>	<i>Price (INR)</i>
Rochelle salt	20 grams	40/-
Container matchstick box	Dimensions l=5.5cm, breadth= 3.5cm and height= 2.5cm	free
Glass Beaker	200 ml	120/-
Filter paper	-	10/-
PIR sensor module	I < 100 μ A Detection range: 6meters	120/-
Arduino_UNO + USB Cable	Operating Voltage= 5 V	480/-
Transformer	9-0-9 500 mA	85/-
Battery	+6 V	200/-
LM7805 Positive Voltage Regulator	+5V	10/-
LM7806	+6V	10/-
Capacitors	0.1uF,470uF,0.1uF,1uF	4/-
Buzzer	-	20/-
Schottky diode	1N5819	80/-
Total cost		1179(INR) 17.4(USD)

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