



# Design of a Microcontroller Based Community Security System for Developing Nations

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## Article Information

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## ABSTRACT

There can never be any time in the history of mankind that issue of community security secures the rapt attentions of all and sundries. It is believed in many security circles that the upsurge may not be unconnected from craves for materialism, ubiquitous social media technologies and a breakdown in citizen's value systems. The design uses an AtMega328P based Microcontroller to develop the security system. It uses Photosensitive and Passive Infrared devices as sensors. Codes were written and compiled. Simulation was done using Proteus while implementation was achieved on breadboard. The system operates each time an intruder is sensed; with the presence of any burglar, a buzzer sounds an alarm and security lighting system switch on for five minutes. A 16 by 2 LCD unit displays the state of the machine. It is believed undoubtedly that the loud noise from the buzzer will keep awake the domestic buildings' occupants and other security conscious neighbours thereby scaring away the unwanted guests.

*Keywords: Arduino; codes; community; intruder; microcontroller; security; sensors; simulation.*

## 1. INTRODUCTION

The needs of man are classified under five categories according to Abraham Maslow. These

needs are illustrated using Pyramid or triangle. Those important ones are at the base while the least important are located at the tip. The base of the pyramid occupies physiological needs which

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are basic ones, namely, food, water, sleep and warmth. After basic needs, are Security and Safety needs, so it shows that a man after his basic needs will crave for safety [1]. The next up the pyramid is the social needs, followed by Esteem needs and at the tip is the Self actualization [2]. Security and safety needs entails keeping oneself safe from harms which normally involve job security, health security, financial security and safe environment, law and order. Psychologically, man will prefer to migrate to a secure town, street or domain, he will want to secure the company of guard dog, get a security guard and move further to acquire security gadgets in order to meet this important need. Engineers have continued to solve man's problems; they study science and technologies in order to apply them in designing machines that work in automatic fashions [3]. The latter incorporate microcontrollers in conjunction with sensors to realise the devices. In this case an intruder must be sensed using human sensors. In the night, passive infrared sensor detects body heat and unusual movements, it reacts to any change in the infrared heat radiation that occur in an environment due to a moving person [4]. Every criminal detests being caught.

## 2. METHODOLOGY

This design work uses Arduino board incorporating ATmega328P microcontroller as the main component [5]. It was very easy to program, an open source platform having numerous users with online supports. The programming was done on its IDE downloaded from [www.arduino.cc](http://www.arduino.cc). There is no need for separate programmer, coding, compiling and debugging achieved through the platform installed on engineers' laptop.

Light dependent resistors LDR and Passive Infrared PIR sensors were electrical input transducers used while Buzzer, Security lighting devices used as the output units (Fig 1). Simple algorithms spelt out with corresponding Arduino codes written. Also, simulation was done on Proteus 8.0 while implementation realised on the breadboard. Input from the LDR was analog, hence usage of analog Read function. Human presence produced a HIGH (+5V), that is, a transition from LOW (0V) a state, the latter encouraged invocation of digitalRead function. The two outputs were ANDed using AND operator &&. If - Else statements deployed to switch ON the security lighting system and a buzzer by adopting digitalWrite functions and delay() functions. lcd.print() together with other print functions. The system flowchart in Fig 2. shows representation of flow process. It was used to in writing the codes in section 2.2 after successfully listing out the algorithms that explain the sequence of operations [3].

### 2.1 Sensors: Light Dependent Resistor (LDR) and Passive Infrared Radiation (PIR)

Light dependent resistors (LDR) (Fig 3.0a) are photoconductive cells or Photoresistors that vary their resistances with light intensity [6]. A well illuminated environment is capable of reducing its resistance to about 100Ω while at darkness can be as high as 10MΩ [7]. Those devices which emit and modify lights are considered as Optoelectronic devices. By connecting a resistor in series with it, a potential divider can be formed. Another potential divider realize from a potentiometer can be formed with its wiper terminal serving as an output thus providing reference voltage,  $V_{REF}$ .

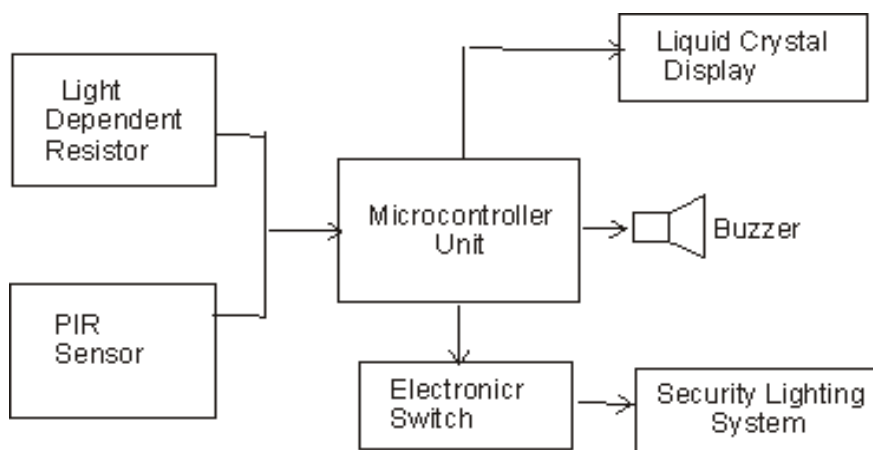
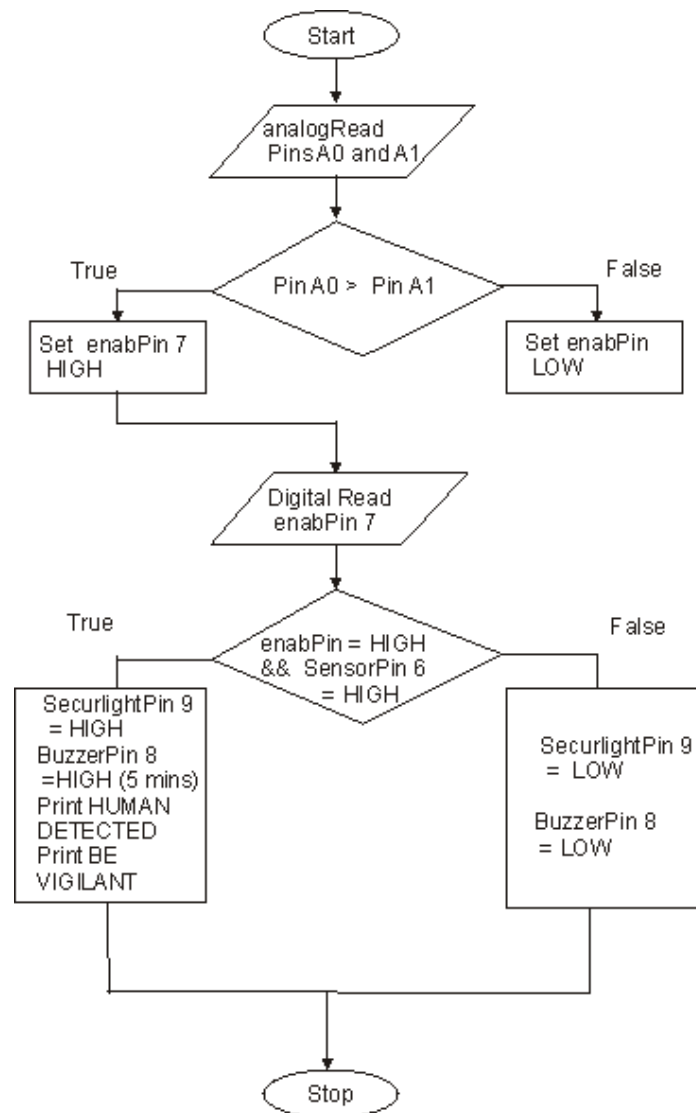


Fig. 1. The security system's block diagram



**Fig. 2. The security system's flow chart**



**Fig. 3. The security system's flow chart**

The two outputs can be fed into the microcontroller and compared. With the pot, a reference point is set so that a threshold of darkness sensing can be set. At darkness  $V_{LDR} > V_{REF}$ . The output pin enabPin 7 becomes HIGH (+5V) thus biasing the device to operate if

an intruder is sensed by a Passive Infrared Radiation sensor (Fig. 3.0b). Heat energy is radiated into medium by a body which is warmer than the medium surrounding it, so, hot bodies tend to emit heat as well as light energy having a velocity of  $3.0 \times 10^8$  m/s [4]. A change in

Infrared radiation radiated from heat within moving human body is sensed by passive infrared radiation sensor. The warmer human body must be within the detection range of the sensor [8]. The output terminal of the device goes HIGH +5V when a moving human body is sensed; sensor also provides means of setting its sensitivity.

## 2.2 Security System's Codes

The codes were written and compiled on Arduino's Integrated Development Environment (IDE). Liquid Crystal Display (LCD) unit adopted a 4-bit mode for data transfer from the microcontroller to the 16 x 2 LCD display. The syntax was LiquidCrystal lcd(RS, EN, D4,D5, D6, D7) corresponding to LiquidCrystal lcd(4, 5, 10,11, 12, 13) [9].

//Codes for PIR Sensor triggered, LDR controlled night time Security System for Community.

```
#include <LiquidCrystal.h>
#include <Wire.h>
LiquidCrystal lcd(4,5,10,11,12,13);
```

```
int Buzzer=8; // buzzer was connected to pin 8
int SecuLight=9; // Seculight was connected to pin 9
int humanSensor=6; // humanSensor was connected to pin 6
int enabPin=7; // enab pin was connected to pin 6
int valPin1=0; // initialize location content to 0
int valPin2=0; //initialize location content to 0
int vald=0; // initialize location content to 0
int valen=0; // initialize location content to 0
```

```
void setup()
{
  lcd.begin(16,2); // for 16 X 2 LCD module
  lcd.setCursor(0,0); // set cursor at col 0 and row 0
  lcd.print("SECURITY SYSTEM"); // print SECURITY SYSTEM
  lcd.setCursor(0,1); // set cursor at col 0 and row 1
  lcd.print(" ** KEEP SAFE**"); // pint **KEEP SAFE**
  delay(1000); // wait for 1s
  pinMode(Buzzer,OUTPUT); // set Buzzer pin as an Output pin
  pinMode(SecuLight,OUTPUT); // set Seculight pin as an Output pin
  pinMode(humanSensor,INPUT); // set humansensor pin as an input pin
```

```
pinMode(enabPin,OUTPUT); //// set enbpin as an Output pin
}
void loop()
{
  valPin1=analogRead(0); // read analog input A0 and store the value in location valPin1
  valPin2=analogRead(1); // read analog input A1 and store the value in location valPin2
  if(valPin1>valPin2) // check if valPin1 is greater than valPin2
  {
    digitalWrite(enabPin,HIGH); // if true, raise the level of enabPin , i.e. 7 HIGH (+5V)
  }
  else
  {
    digitalWrite(enabPin,LOW); // if not enabPin to remain LOW
  }
  vald=digitalRead(humanSensor); // read digital level at pin6 (human sensor) and store the value at vald
  valen=digitalRead(enabPin); // read digital level at pin7 (enabPin) and store the value at valen

  if((valen==HIGH)&&(vald==HIGH)){ // chech if valen and vald are HIGH
    digitalWrite(SecuLight, HIGH); // if true raise the level of pin 9 (secuLight) HIGH (+5V)
    digitalWrite(Buzzer, HIGH); // if true raise the level of pin 8 (Buzzer) HIGH (+5V)
    delay(300000); // wait for 5 minutes, that is, buzzer and secuLight will remain HIGH for 60 X 5 X 1000 =300000mS
    lcd.clear(); // LCD to clear its display
    lcd.setCursor(0,0); // place cursor at col 0 and row 0 of the 16 X 2 LCD screen
    lcd.print("HUMAN DETECTED");// print HUMAN DETECTED
    delay(1000); // wait for 1s
    lcd.setCursor(0,1); // set cursor at col 0 and row 1
    lcd.print("ACTIVATED"); // print ACTIVATED
    lcd.clear(); // clear LCD display
    lcd.setCursor(0,0); // place cursor at col 0 and row 0 of the screen
    lcd.print("BE VIGILANT"); // print BE VIGILANT
  }
  else digitalWrite(SecuLight, LOW); // if valen AND vald not true, LOW secuLight pin
  digitalWrite(Buzzer, LOW); // if valen AND vald not true, LOW Buzzer pin delay(100); // wait for 100mS
}
```

### 2.3 Simulation and Implementation

The simulation was done on Proteus 8. [10]. after compilation of the codes in the Arduino's Integrated Development Environment (IDE), the hex file address location(C:\Users\OYEWOL~1.AKI\AppData\Local\Temp\arduino\_build\_725967/security\_auchi.ino.hex) was copied and inserted into the microcontroller board in the Proteus platform. The result was as shown in Fig 4.0a; when the RUN button was engaged. LEDs representing the enabPin 7, and Security lighting system were lit while the buzzer was activated to produce audible sound when a motion of a body in the detecting range of PIR was detected. Human body detection was simulated with an operation of a pull down momentary switch that presented a HIGH (+5V) to the Arduino's pin 6. The implementation was done on the breadboard as shown in Fig 4.0b.

### 4. RESULTS AND DISCUSSION

The PIR sensor tends to be unstable when the system was initially switched ON. This is normal; it normally stabilizes after one second of switching on or engaging the system. The system schematic diagram is shown in Fig 5. The security system was designed to operate in the night time hence the usage of a Light Dependent

Resistor which senses darkness; with darkness, its resistance rose thus increasing proportionately the  $V_{LDR}$ .

This voltage was compared with the  $V_{REF}$  obtained from the wiper of the potentiometer having its maximum resistance and lowest points connected to +5V power rail and GND respectively [7]. During night time,  $V_{LDR} > V_{REF}$  hence enabPin 7 became HIGH, (+5V). In the day time, the reverse was the case, that is, enabPin 7 went down to LOW (0V). It was coded to sense human presence during night time, whenever enabPin 7 is HIGH. When an intruder was sensed, Pin 9 switched ON the security lighting system (Fig. 4b) and Pin 8 also activated the buzzer (Fig. 4b) when it rose to a HIGH (+5V) level. When PIR sensor detected moving warm bodies, its output pin which was connected to Arduino's pin 6 rose to an HIGH (+5V) level. This device was connected in non-retriggering mode, its output was set to be HIGH for about a second. A departure from retriggering mode that remains HIGH as long as the moving body remains in its detecting range. The Buzzer used was SFM-27 operated from 3-24VDC, being an active buzzer generated its audible note at 400Hz each time a HIGH voltage was applied to its terminal. This buzzer comprises an inbuilt oscillator, it needs a DC voltage to work. A common emitter transistor switch having a relay

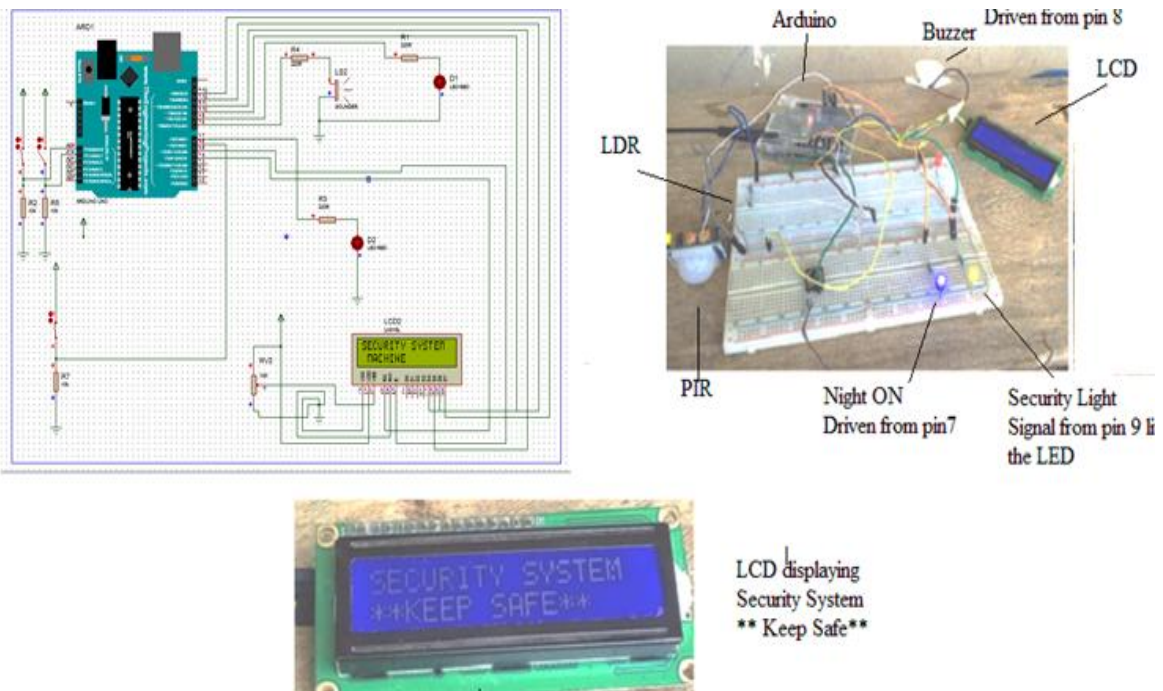
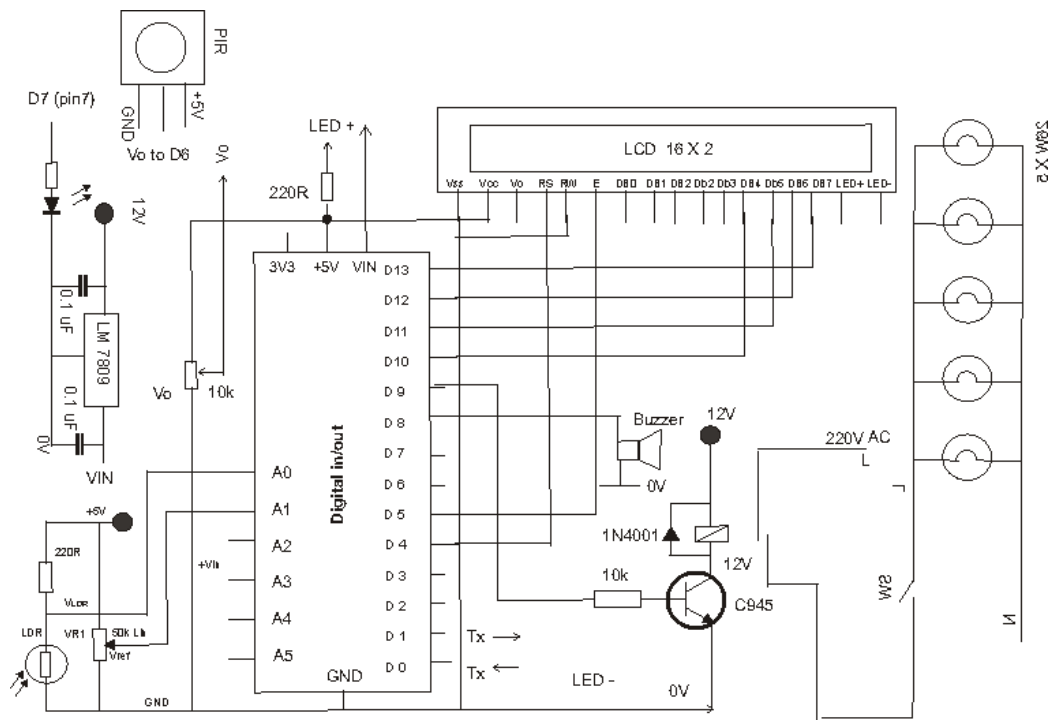


Fig. 4. (a) Simulation in Proteus 8 (b) Implementation on the Breadboard



**Fig. 5. System's circuit diagram**

as its load was used to drive the lighting circuits. In this case, pin 9 activated the switch, a HIGH level from pin 9 saturated the C945 transistor thus making its collector becoming LOW [11]. Now, a 12V was effectively across the relay load, In order to power the lighting circuit, a 220V AC power line was connected to the lighting circuits through the normally open contact set of the relay.

## 5. CONCLUSION

Everyone in every place globally knows that criminals in which burglars or intruders belong will not want to be caught in their nefarious activities. So any device that draws attention to them will help in preventing their onslaught on the community or home. This project has demonstrated how to use a PIR sensor along with a microcontroller to sense unwanted persons. Also, the application of a LDR allows the system to function at night time which is the common period for criminal activities. To further increase the loudness of the sound produced, a 12V loud, high decibel car horn can be used along with the buzzer. So, when the security light is switched on, the horn also comes on. It will have an advantage of generation of loud sound capable of waking up any property owner and neighbours alike thereby scaring away criminals, with a resultant of a secured environment.

Improvements can be in the area of incorporation of a sound sensor and a motion camera that pick strange noise and criminals' footage.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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