Smart Security System using Arduino and Wireless Communication

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Abstract – **The development of technology in the field of Electronics has brought a drastic change in everyday life. With the leveraging of new technology, we have entered the fields like industry, medicine, telecommunication, automation and also security. This paper introduces the implementation of a low cost, low power consumption wireless security system. We proposed an intelligent security system which is developed using password based digital lock and vibration sensor for theft detection and the RF wireless communication technology to send signals for the indication of theft. If entered password is wrong for more than 3 times or any person tries to break the system, then the system gets locked and it will transmit a signal to the neighboring houses so that the people can gather together and catch the thief. The system gives the overall framework of hardware and software design, and describes ways to implement the system.**

Keywords – **Arduino, Vibration Sensor, RF Module, RF Encoder, Decoder.**

I. INTRODUCTION

With the emergence of developed technology security system has become one of the upcoming field. Home security system introduces many technologies for making the system installation easy and secure. Most of the system makes use of mobile communication like GSM [3] and Wi-Fi [2] for security systems. Now a days Radio Frequency is widely used wireless communications technology, with low power, low cost and more reliable. The Central Processing Unit for the proposed system is developed using the Arduino microcontroller which is a low cost and efficient controller used in many applications.

Here the embedded system technology is combined with the wireless technology. In this we used a password based digital lock [1] which is an access control system that allows only authorized persons to access a restricted area and the RF wireless communication technology for transmitting theft indication signals. If entered password is wrong for more than 3 times then the system gets locked and output is extended such that it will also transmit a signal to the neighboring houses so that the people can gather together and catch the thief. This system can also be used in multiple ways as we can protect our houses, banks, vehicles and lockers etc., [11]-[13].

Fig.1.1: Overview

A. Block Diagram:

The system consists of two sections, the transmitter section and the receiver section. The transmitter section consists of Hex keypad, RF encoder, RF transmitter and vibration sensor interfaced to the microcontroller. The receiver section consists of RF receiver, RF decoder, signaling element (LED or buzzer).
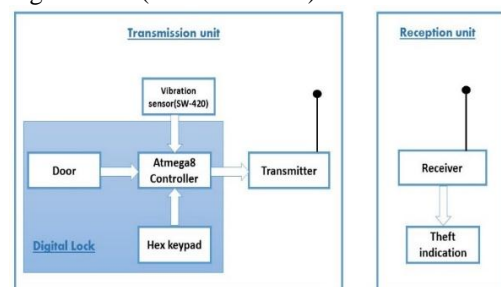

Fig.1.2: Block Diagram

- Digital code lock [1] is a type of digital locks where a combination of digits/characters or both are used for unlocking the lock.
- Vibration detection is curial in security, normally being placed at window grill or door. It has vibration switch digital output module. In combination with microcontroller board such as Arduino, SK40C, SK18B, SKds40A, and other, sensing magnet will be simple.
- The RF module [4], as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. This RF module comprises of an RF Transmitter and an RF Receiver. This wireless data is the easiest to use, lowest cost RF link we have ever seen! The RF module is often used along with a pair of encoder/decoder. HT12E-HT12D [4], HT640-HT648, etc. are some commonly used encoder/decoder pair ICs.

II. HARDWARE REQUIREMENTS

The transmission unit consists of Hex keypad (4x4 matrix) as input, Arduino (Atmega controller), RF encoder and RF Transmitter for transmission.

A. Digital Code Lock:

This kind of lock [8] can avoid the problems caused by the duplicating of keys. The system comprises a number keypad which is connected to the Arduino Board. The microcontroller continuously monitors the keypad and if some person enters the password then it crosschecks with the already stored password. If they are same then the microcontroller will switch on the corresponding device. The system gets locked if more than three attempts are made with wrong password.

Fig.2.1: Hex Keypad

B. Arduino Board:

Arduino [6] is a tool for making computers that can sense and control more of the physical world than your desktop computer. It's an open-source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer (e.g. Flash, Processing, and MaxMSP.) The boards can be assembled by hand or purchased preassembled. Arduino simplifies the process of working with microcontrollers, and also it offers some advantage for teachers, students, and interested amateurs over other systems:

- Inexpensive
- Cross-platform
- Simple clear programming environment
- Open source and extensible software
- Open source and extensible hardware

C. Vibration Sensor:

The Vibration module is based on the vibration sensor SW-420 and Comparator LM393 to detect if there is any vibration beyond the threshold. The threshold can be adjusted by the on-board potentiometer [9].
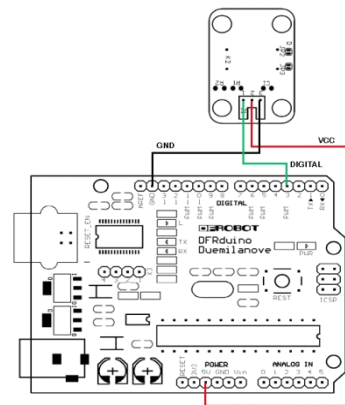

Fig.2.2: Interfacing of vibration sensor to Arduino

When there is no vibration, the output of this module is logic LOW, This is indicated by an LED placed in vibration sensor module as shown in Fig2.2.

Performance:

- The conductive pin will make an instant turn-on (ON) state when touched by the outside force to achieve the proper vibration force, or an appropriate speed from the (partial) energy.
- No direction i.e., any angle may trigger the output.
- The switch is suitable for small-current circuit (secondary circuit) or (IC) of the trigger.
- At room temperature and normal use the next switch service life is up to 10 million times (times/1sec).

D. Encoder:

The encoder [4] has four input lines. These lines are used to give input which we want to encode. The encoded data is transmitted out from the 'Data out' pin. The transmission medium could be our regular wire, or wireless. The input given to data pin is in parallel form which is being transmitted into serial form from the data output pin.
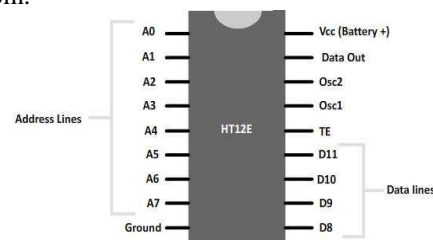

Fig.2.3: RF Encoder (HT12E)

E. Transmitter:

An RF transmitter [4] receives serial data and transmits it wirelessly through RF by an antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps.

The 434MHz transmitter work with the RF Links at 434MHz at either baud rate. Only one 434MHz transmitter will work within the same location. These modules have up to 500 ft. range in open space. The transmitter operates from 2-12V. The higher the voltage, greater will be the range. We can use these components to transmit position data, temperature data, and even current program register values wirelessly to the receiver.
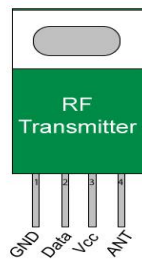
Fig.2.4: RF Transmitter (A-434)

F. Reception Unit:

This unit consists of RF Receiver [4], RF Decoder [4] and output elements like buzzer as alert.

The encoded data which is coming from the transmitter side goes into the Data in (Din) pin. The data which was in serial order gets decoded and the output is generated at the data line pins in same order as that on transmitter pin. When there is no input at the data in pin, the output pins i.e. data lines remains high both in transmitter and receiver.
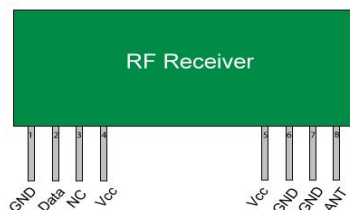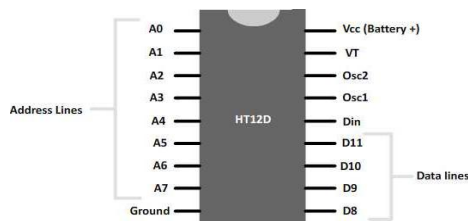

Fig.2.5: RF Receiver (A-434)

Fig.2.6: RF Decoder (HT12D)

III. SOFTWARE REQUIREMENTS

The Arduino programming language [7] is an implementation of Wiring, a similar physical computing platform, which is based on the Processing Multimedia Programming environment.

Arduino programs [7] are written in C, C++ and JAVA. The Arduino IDE comes with software library called "wiring" from the original wiring project, which makes many common input/output operations much easier. Users only need to define two functions to make a runnable cyclic executive program:

Fig.3.1: Arduino (Software)

- Setup (): a function run once at the start of a program that can initialize settings.
- Loop (): a function called repeatedly until the board powers off.

IV. IMPLEMENTATION

A. Transmission Unit:

The program is initialized whenever the power is ON. As the program starts, it will ask to input 5 digits as password at the initial boot/reset of the device. After the five digits are entered, the user is prompted to confirm password. If the password does not match for the conditions given, a message is displayed to indicate the Invalid Keys. Again the keypad is scanned for pressed keys and corresponding digits are identified. If all the five digits match the set password, the lock output pin goes high. Hence the device is LOCKED after setting the PASSWORD [8]. The controller continuously scan the data from the keypad and whenever the password is entered through the digital keypad interfaced to the controller, the RF encoder which is a parallel to serial convertor encodes the data and is given to the RF transmitter. The RF transmitter modulates the signal using ASK technique and transmits the data signal into the free space [4]. The RF receiver at the receiver section receives the signal that is transmitted from the transmitter and the received signal is demodulated to recover the transmitted data. The data from the RF receiver is given to the RF decoder where it decodes the data and if the code matches with the predefined code, then necessary action will be performed by using the micro controller [4].
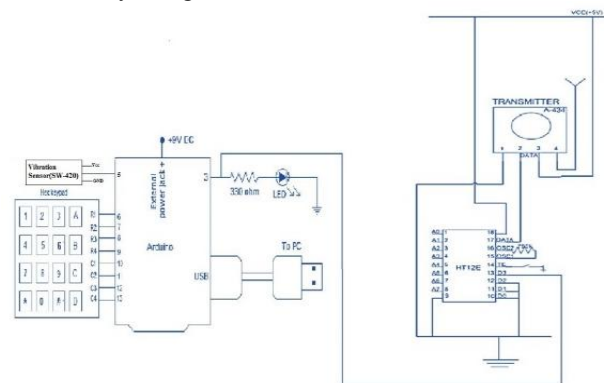

Fig.4.1: Circuit Diagram (Transmission Side)

- Key A - for unlocking the device. Input correct password and press A for Unlocking.
- Key B - for locking any time. Just press B and you will see the LOCKED message.
- Key C - for changing the password. Input the correct password and Press C. It will show message asking to ENTER NEW PASSWORD. The first entered 5 digits will be SAVED as new password.

Flow chart for the sample code is shown in Fig 4.2.

Stored Password   - - - - ➤   'C'
Entered Password   - - - - ➤   'P'
Output of Vibration Sensor - ➤   'V'
Output of Arduino Board   - ➤   'S'

The system gets locked when
1) An unknown person tries to break the system the output pin of vibration sensor (V) goes HIGH.
2) Entered password (C) does not match with the stored password (P).

Whenever the system gets locked it also excites the output pin of microcontroller (variable 'S') which is given to one of the data lines (D0, D1, D2, D3) of encoder and this transmits theft indication signals to neighboring houses using RF transmitter.
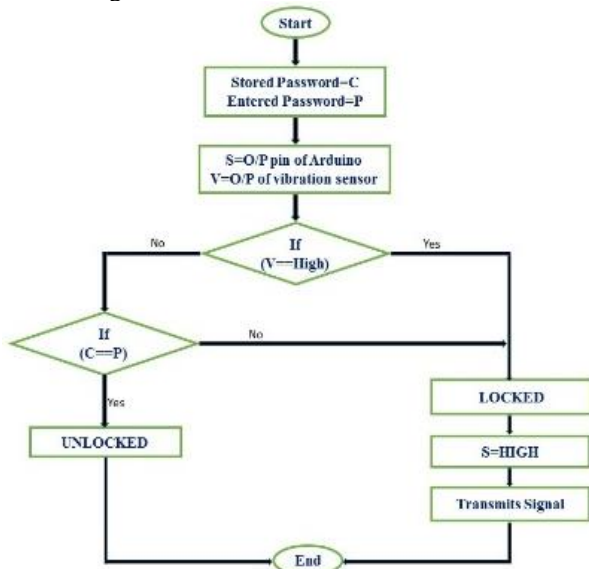

Fig.4.2: Flowchart for the sample code

B. Reception Unit:

The RF receiver [4] receives the data coming from the transmitter and gives to Din pin of decoder serially. The decoder decodes it and gives output at the data line pins (D0, D1, D2, D3) in same order as that on transmitter pin.
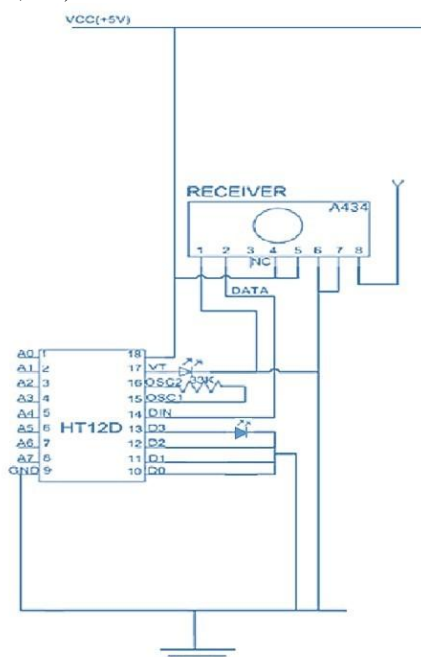

Fig.4.3: Circuit Diagram (Receiver Side)

In the Fig.4.3 we have used LED as indicating element, also any type of signaling elements like buzzer can be used for indication of theft.

V. RESULT AND DISCUSSIONS

We implemented an intelligent, low cost, low power consumption wireless security system by using password based digital lock and vibration sensor for theft detection and the RF wireless communication technology which is to send signals for the indication of theft. If entered password is wrong for more than 3 times or any person tries to break system, then the system gets locked and it will transmit a signal to the neighboring houses so that the people can gather together and catch the thief.

In this paper we showed only one reception unit but we can use any number of reception units for one transmission unit depending on the frequency range, so that whenever theft occurs at one house, the theft indication signals will be transmitted to neighboring houses where we have already placed the receivers.

A. Transmitter side:

The experimental prototype of the transmitter module will be as shown in the Fig. 5.1, 5.2 and 5.3.
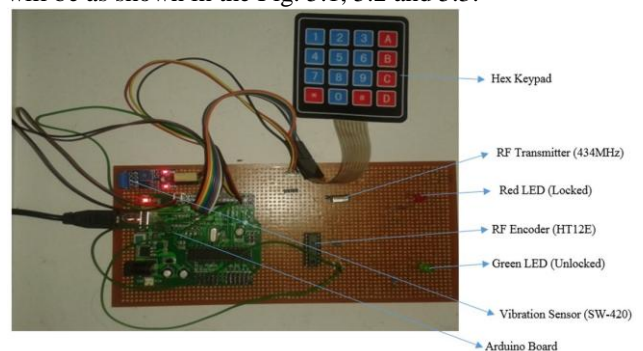

Fig.5.1: Prototype of Transmission side

• The hex keypad and vibration sensor are interfaced to the Arduino board (Atmega8) and the output pin of microcontroller is given to the RF Encoder.
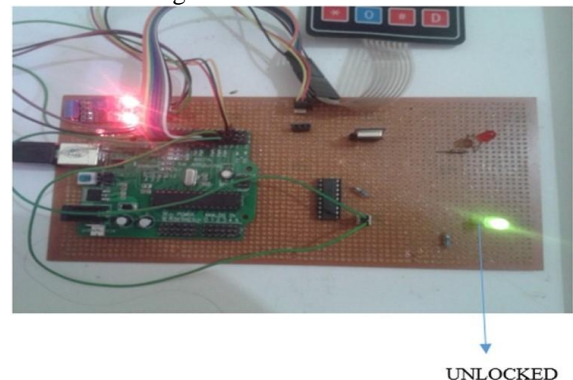

Fig.5.2: Indication for unlocking the door

• When the entered password matches with the already stored password then the system gets unlocked. This is indicated by a green LED in Fig.5.2.
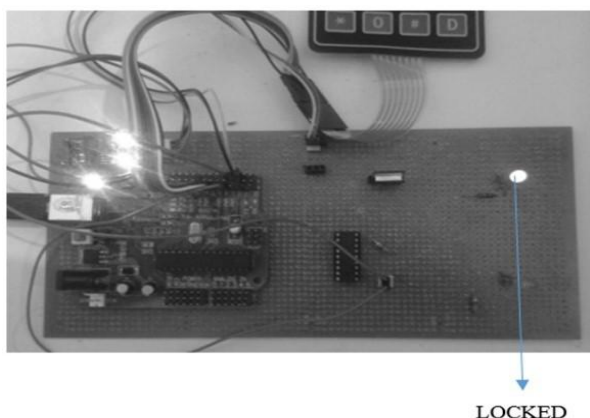
Fig.5.3: Indication for locking the door

• The system gets locked whenever the thief tries to break the system or more than 3 attempts are made with the wrong password. This is indicated by red LED in Fig.5.3, and this output is extended to RF Encoder for transmitting theft indication signals to neighboring houses.

B. Receiver side:

The prototype of the receiver module will be as shown in the Fig5.4 and 5.5.
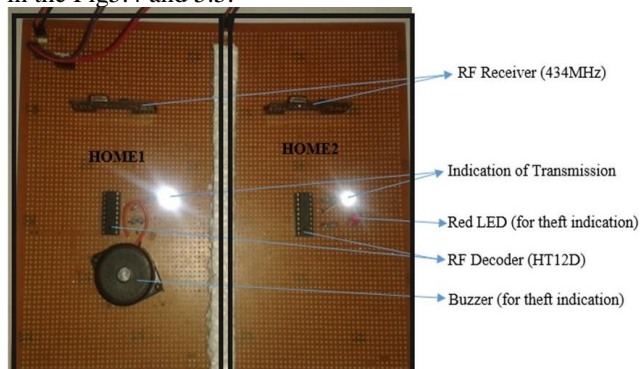

Fig.5.4: Prototype of Reception side

• In Fig.5.4 we showed two homes where we placed receivers. In HOME1 buzzer is used for theft indication and in HOME2 red LED is used. We can extend it to 5 or 6 homes which are under the frequency range of RF module.
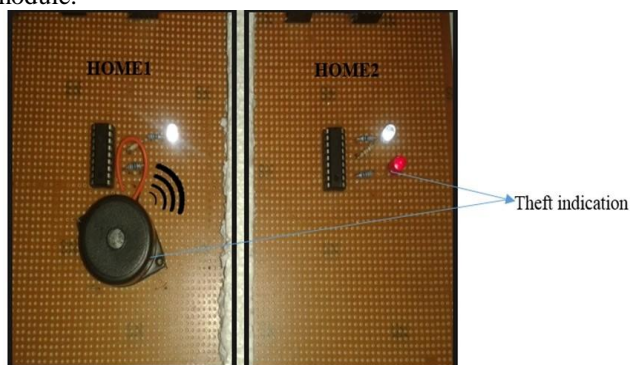

Figure.5.5: Theft indication in homes

• The theft indication signals in different homes are shown in Fig.5.5.

Table 1: Overall Result

House1	House2	House3	House4	House5	House6
✓	✓	✓	✓	✓	Thief
✓	✓	✓	✓	✓	
✓	✓	✓	✓	Thief	✓
✓	✓	✓	Thief	✓	✓
✓	✓	Thief	✓	✓	✓
✓	Thief	✓	✓	✓	✓
Thief	✓	✓	✓	✓	✓

✓ -Theft indication

VI. CONCLUSION

This paper presents the design and the implementation of a Smart Security System for homes using Arduino and the Wireless RF. Arduino and RF modules are adopted. The system has a friendly user interface so the community can use wherever they need high security. Communication of the system is completely wireless, which makes the system easy to install and use. The system is low cost, low power consumption and easily operable. In addition, the wireless RF modules enable the system to transfer other information such as voice and picture rather than just alarm signals.

FUTURE WORK

In future the Smart Security can include an image processing tool at the entrance of the house. This system scans the photo of the person entering the password, scanned photo gets compared with the predefined image of the authorized user in the system. If the both images match, then the system operation takes place or else the access will be denied. This future design will still enhance the security of the system because only authorized persons should enter the password so that intruder cannot access the system even though he knows the password and also the wireless transceiver modules enable the system to transfer other information such as voice and picture rather than just alarm signal[5].

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