

Rockfall Alarm

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Abstract—The project Rockfall Alarm aims to make the life of people in mountain regions more safe and threat free from rockfall . Rockfall alarm gives an instant alarm to the passing by vehicles and people as soon as there is slight movement in the rock, Hence giving people 10 to 15 seconds to take quick actions to save their life. Keeping in mind that the roads on mountains are in form of spiral, the RockFall Alarm also warns the following roads when the rock continues to topple from one road to another. After learning that Rockfall is common means of accidents and death in Mandi , We plan to install this project at Gharpa Guest House for testing and further improvements.

Index Terms—Photo interrupter, Rf Module, Ultrasonic sensor

I. INTRODUCTION

THE Rockfall alarm is designed to operate two important tasks

- 1) Sense the movement of rock and set alarm.
- 2) Warn the following roads over which the rock topples.

A. The Components

- 1) Arduino: Arduino is a hardware and software platform which can be used to implement small electronics project easily. It can give instructions to the sensors connected to it like taking data from them as well as processing the data. Arduino comes in various sizes and features like UNO, nano and mega. Arduino UNO contains Atmega328P chip as its microcontroller.



Fig. 1. An arduino Uno board [1]

- 2) Photo interrupter sensor: It is small U-shaped device that has IR(Infrared emitter on one side and IR receiver on the other. The sensor gives LOW signal when there is obstacle between the transmitter and receiver and HIGH when the path is clear, hence it acting as a switch [7].



Fig. 2. A photo interrupter sensor [2]

- 3) Ultra-Sonic Distance Sensor: Ultra-sonic distance sensor is also popularly known as SONAR .It has a UV emitter and Receiver on same side of the module. It measures the distance between the obstacle and itself by calculating the time taken for the emitted rays to reach the receiver. As speed of UV rays is known , the distance is calculated using simple formula distance=speed X time. The module does all the calculation , hence giving us the distance.



Fig. 3. An ultrasonic distance sensor [3]

- 4) RF Module: RF(radio Frequency) module is a wireless communication device consisting of a transmitter and a receiver .Radio Frequencies are transmitted by Transmitter and received by the receiver placed at other end. The RF 433 Mhz module operates over a good range about 100m.

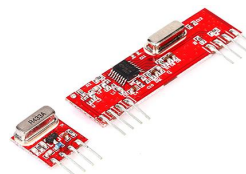


Fig. 4. A RF module [4]

- 5) Piezo Buzzer- It is a sound signalling device . Its is also known as a beeper. It produces sound depending upon the frequency sent to it by the arduino. It is widely used to produce alarming sound in academic projects [8].



Fig. 5. A Piezo buzzer [5]

- 6) Ball bearing- Ball bearings are widely used to reduce the friction during rotation. These consists of many small balls inside them, thus reducing the contact surface. These small balls individually rotate resulting in free rotation of the Ball bearing [9].



Fig. 6. A Ball Bearing [6]

B. Motivation behind the project

For years, Rockfall has been a constant threat to people living in mountain areas like Mandi. It has led to many accidents and severe injuries. As, IIT Mandi is located in such place, it brings the lives of students and teachers at risks. In order to make them feel more safe and secure, we chose to work on Rockfall Alarm.

Improving the conditions of mountain regions results in achieving the following :

- 1) Easy transportation: Drivers can drive without any fear of losing their life .Thus increasing transportation.
- 2) Development: More transportation and migration of people results in development of the area.

II. IMPLEMENTATION

A. The making of the device

- 1) A wooden box of dimension 20 X 20 cm was made upon which a Galvanized Iron sheet was attached to protect the box from rain.
- 2) On two opposite faces circular holes of diameter 7 cm were made into which the ball bearings were fixed.
- 3) A slotted plastic disc with a 4 cm diameter hole was taken and inserted on a cylindrical PVC pipe. A long nylon rope was then fastened on one end to the pipe while the rest of the rope was winded over the pipe. This cylindrical pipe setup was then inserted between the ball bearings.
- 4) A small hole was drilled on the front face of the box so that the other end of the rope could come out.

- 5) Using a bread board and arduino all the circuit connections were made for the transmitter circuit as shown in the figure 7. An external 9V battery was connected to arduino to give it power. This bread board was fixed inside the wooden box such that the slotted disc was exactly in the middle of photo interrupter.

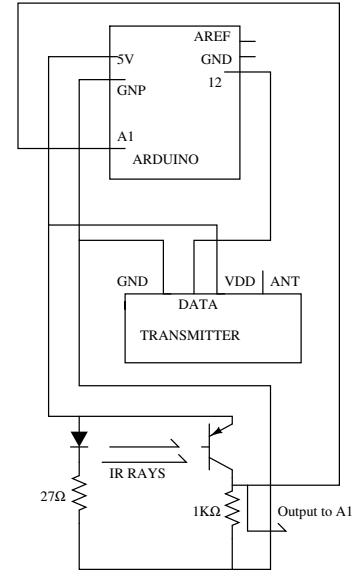


Fig. 7. Circuit to implement on the transmitter part of the rockfall alarm device

- 6) Similarly, the receiver circuit was assembled as shown in the figure 8 using a bread board. This was kept inside a cardboard box.

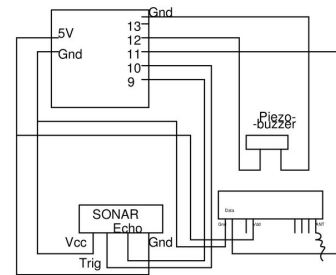


Fig. 8. Circuit to implement on the receiver part of the rockfall alarm device

- 7) The code was then fed into the arduino boards. The pseudo code is as shown in figures 9 and 10.

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Setup:
  A1=input from photo interrupter
Loop:
  Read input A1
  if A1==HIGH:
    Send HIGH to Transmitter
  else:
    continue

```

Fig. 9. Pseudo code for transmitter circuit

```

1 Setup:
2   output 1=output to buzzer
3   input 1=input to receiver
4   output 2=trig pin of ultrasonic sensor
5   input 2=echo pin of ultrasonic sensor
6   input 3=receiver input
7
8 Loop:
9   flag=0
10  Receive input 3
11  if input3==HIGH:
12    flag++
13
14    send HIGH to output 2
15    delay for 10 milli seconds
16    send LOW to output 2
17    duration=pulsein(input 2) // a special function defined in
18                                arduino to get the time between
19                                sending and receiving a wave
20    distance = (duration)/58.2 //converting into cm
21    if duration<1000 and flag==1 //1000 taken to detect for a large distance
22      flag++
23
24    if flag==1
25      send frequency 1000 to output 1
26
27    else if flag==2
28      send frequency 2000 to output 1
29
30

```

Fig. 10. Pseudo code for receiver circuit

B. Working Principle

One end of the nylon rope is tied onto the rock which is in hazardous zone. When the rock starts to move during a rockfall, the rope starts to unwind which rotates the cylindrical pipe, thereby rotating the slotted disc. Because of rotation, the slotted part and the unslotted part of the disc keeps interchanging between the photo interrupter. Hence, we get a continuous low and high value from the sensor for slotted and unslotted part respectively. If this change occurs, the rf transmitter is asked to send a HIGH signal signifying the rockfall is occurring. The rf receiver then receives this HIGH signal. Subsequently, the piezo buzzer is given the necessary voltage which then makes the sound signifying alarming condition.

Whenever the rock passes in front of the ultrasonic sensor a signal is sent to arduino which then asks the piezo buzzer to operate at a different frequency thereby alarming the people on roads at a lower altitude that the rock has crossed the upper roads.

III. RESULTS AND DISCUSSIONS

TABLE I
EFFECTIVE COST

Sr.No.	Components	Total Cost(INR)
1	Arduino UNO x 2	900
2	Piezo Buzzer x 1	25
3	Battery(9V) x 2	40
4	Jumper Wires	90
5	RF 433Mhz module x 1	190
6	SONAR x 1	100
7	Photo interuppter x 1	35
8	Ball bearing x 2	420
	Total Cost	1800

This implementation costs about Rs 1800 which is a very small amount. With further improvements and increasing the scalability of this project the price still wont go above Rs 10,000. This amount is very small as compared to already existing methods of rockfall detection which uses sensors like extensometer which costs around 12 lakhs.

IV. CONCLUSION

A. Advantages

- 1) Low Cost Installment-The installment cost is low and once installed it can be used again and again, only the wire or rope has to be re-winded.
- 2) Can be used all weather as we have insulated it with galvanized iron sheet.
- 3) Gives 10-15 seconds to people to save themselves by taking quick actions.
- 4) The change of frequency if ultrasonic distance sensor gives high output, warns the following roads on lower altitude over which the rock may topple.

B. Future Implementations

- 1) Since the use of a single rope for each rock is not feasible, we can use a wire mesh for a cluster of rocks. The device will then sense the movement of this mesh instead of a single rope. This way we can detect movement in multiple rocks using a single rockfall alarm device instead of using multiple devices for multiple rocks.
- 2) We currently used 9V battery for power arduino. Since arduino has to be provided with power all the time as rockfall can occur any time, even after 10-15 years. So, we intend to use solar cells which regularly recharge themselves and can be used for years. Also it is a clean and renewable source of energy and hence does not harm the nature in anyway.
- 3) Since Nylon wire is not feasible to use in practical conditions. We can use copper wire which has high tensile strength and can be used multiple times due to its resistance to fatigue.
- 4) We can use some LEDs along with alarm to notify people when rockfall occurs. Since, the disc rotates with speed proportional to rocks falling speed we can use led colors correspondingly. For example, Green for very slow movement like sliding, Yellow for moderate and Red for extremely fast movement.
- 5) We can also use GSM module to send alarming messages to the people residing nearby.

Remark-In this paper, the implementation and working of rockfall alarm was discussed. The project is in nurturing stage and can be used practically after implementing the discussed future prospects and after various testing.

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