Arduino Embedded Accident Prevention System for vehicles during low visibility in extreme weather conditions (dust storms & foggy weather) in the desert & hilly region

Arya Ajay Gavande,
Student of 12th Grade at Woodridge High School, Aurangabad, Maharashtra, India.

Abstract - Road accidents due to poor visibility are always a major reason in hilly & desert regions. Extreme weather condition leads to poor visibility for drivers. Typically, heavy dust storms and dense foggy weather are considered extreme weather conditions.

Extreme weather conditions as discussed above are very common in the desert region of Kuwait and the hilly region of India, this causes low visibility and eventually lots of road accidents. The vehicles installed with subjected Arduino embedded system, warn the driver about the vehicles ahead by a buzzer and flashing of the LED light or any vehicle is approaching from the back.
According to Gulf news1 and Arab news2 in Kuwait, 323 people were killed in the year 2021 and 352 in the previous year due to road accidents caused by the dust storm or foggy weather. Likewise, Time of India3 news in India, as per state transport department data almost 1800+deaths were reported in the year 2019 due to Fog. Mountain u-turns and hairpin bend crashes are one of the world's largest public health and injury prevention problems. The government data published in the Hindusthan Times4 in the first five months of 2019 about 1,170 people died in road accidents in only three hill states of India, they are Himachal Pradesh, Jammu and Kashmir, and Uttarakhand. Experts blame over-speeding, overcrowding of public transport vehicles, drunk driving, and the absence of adequate road signs as the major factors for the high number of accidents in the hill states.
The main objective of this project is to develop an Arduino-based system that will ensure driver and passengers' safety during heavy dust storms and foggy weather also in mountain u-turns, and hairpin bends. During dust storms or foggy weather, the visibility reduces to 1 or 2 miles or even less. The motivation behind this effort is to design a cost-effective Arduino-based embedded system that makes the driver and passengers' journey safer and more secure. This paper explains the vehicle alerts system during heavy dust storms and foggy weather also in mountain u-turns, and hairpin bends.

Keywords: # Road Safety # Arduino embedded system # Vehicle detection # Dust storms # foggy weather # Mountain U-turns # hairpin bends

1. INTRODUCTION

Most of the time dust storm / foggy weather arrives all of a sudden in the form of a progressing wall of dust/mist, which may be miles long and thousands of feet high vertically. This makes driving conditions hazardous. The dust/mist reduces visibility causing accidents that may involve chain collisions, creating a total mess-up. Dust storms/mist usually last a few minutes to hours or even a day, but the accidents that happened during this storm/mist may be impacted for a long.

Lack of Visibility, the tendency of not knowing about the vehicles coming side or overtaking from the other side of the road in dust storm/mist/hairpin bends are among the major factors contributing to deaths from road crashes, currently, most of the vehicles in Kuwait or interior regions of Kuwait[5] do not have any safety system to alert the people about the vehicles coming from the other side of the or overtaking in poor visibility.

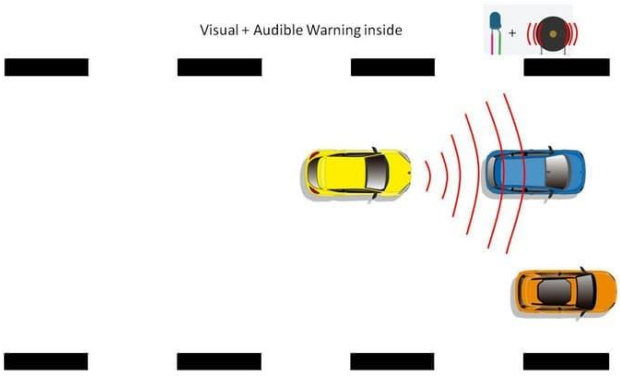

Figure 1 Conceptual

Similarly, currently most of the u-turns, hairpin bends in the mountainous regions of India do not have any safety system to alert the people about the vehicles coming from the other side of the turn. While some of the turns have cones mirrors installed but due to extreme weather conditions and lack of

visibility it's not effective. Eventhough Vehicles have side mirrors but due to lack of visibility in such scenarios they cannot be trusted with the life of the passengers.

The motivation behind the project is an attempt to make an embedded system to bring a positive difference in the field of road safety during dust storms/mist/hairpin bends. The project tackles some major causes of the road accidents such as lack of visibility and the inability to see the vehicles overtaking intern causing disastrous accidents.

This unconventional prevention system making riders alert about the vehicles ahead by a buzzer and flashing of the LED light.

In this work, the modules used are- The transmitter module, receiver module, Sonar ultrasonic sensor, Arduino UNO, 5v Buzzer, and 3v Led light.

2. SYSTEM ARCHITECTURE

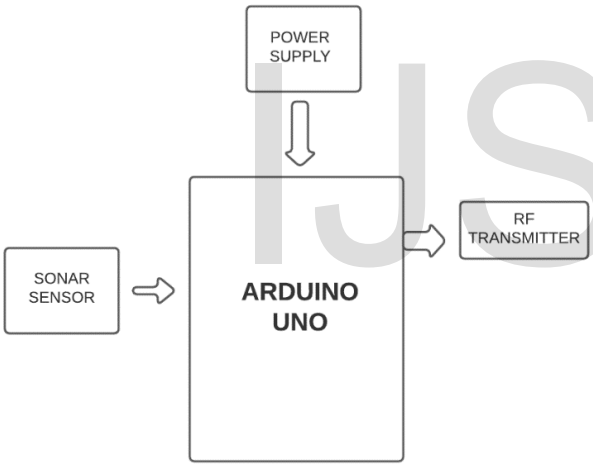

Figure 2TRANSMITTER

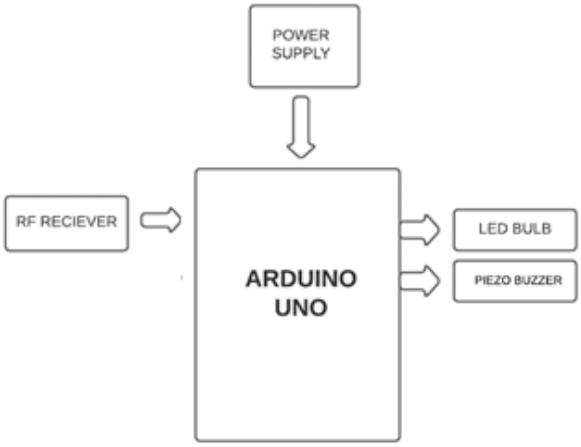

Figure 3 RECEIVER

2.1. BLOCK DIAGRAM

1. RF TX/RX Module: The transmitter/receiver (TX/RX) pair operates at a frequency of 433 MHz. The transmitter transmits at the rate of 1Kbps - 10Kbps. The transmitted information is received by an RF receiver working at an identical frequency as that of the transmitter.
2. Ultrasonic sonar sensor HC-SR04 - The ultrasonic sensor operates on the principle of the SONAR and RADAR system which is applied to determine the distance to an object. An ultrasonic sensor produces high-frequency sound waves that are ultrasound waves. When this ultrasound hits the object, it reproduces as an echo which is then detected by the receiver[6].
3. Piezo buzzer - A "piezo buzzer" is a small speaker which is connected straight to an Arduino. "Piezoelectricity" is an effect where definite crystals will alter shape when electricity is applied to them. On the occasion an electric signal at the precise frequency is applied, the crystal can make a sound[7].

3. DESIGN DETAILS

This model is the combination of two modules the Transmitter and Receiver modules. The receiver module will be placed on the charging port of the vehicle and the Transmitter module can be fitted on a vehicle trunk.

Following are the circuit diagram details:

3.1. TRANSMITTER MODULE:

To transmit the information, the RX TX module is necessary.

In this circuit, 433 Mega Hertz frequency transmitters are being utilized. Parameters: ASK modulation and transmission range is 100-300 square feet (10-15 feet).

It has 4 pins:

1. Antenna: there is an in-built helical antenna.
2. Data Pin - to collect Data for transmission
3. Ground pin - Connected to the ground
4. VCC - 3 Volts Power Supply

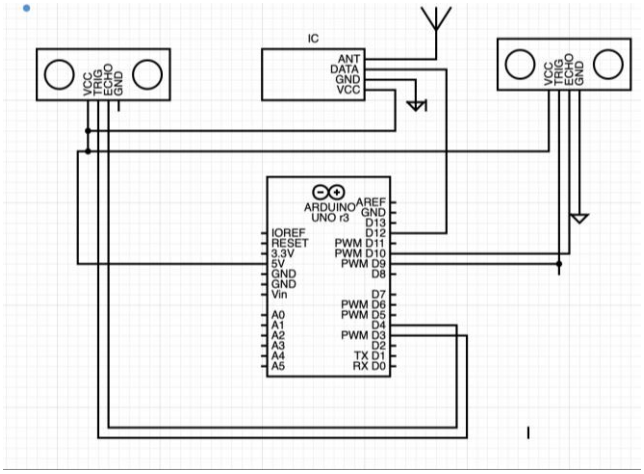

Figure 4 Transmitter Module:

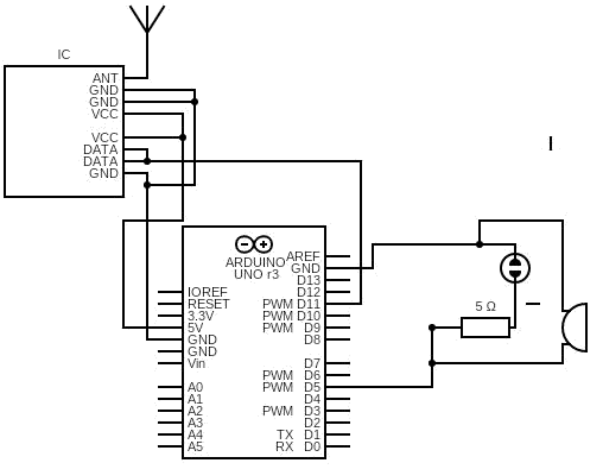

Figure 6 Receiver Module

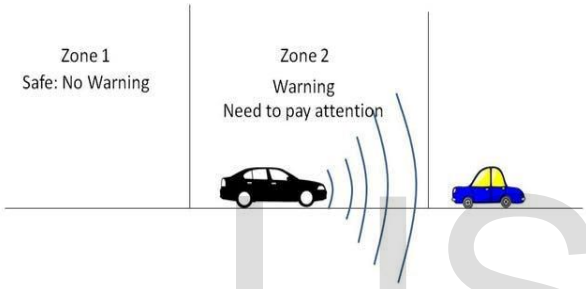

Figure 5 Schematic 1

3.2. RECEIVER MODULE:

The receiver has 32 KB (with 0.5 KB designed for the boot loader). Moreover, It has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

The Arduino Uno has several provisions for interacting with a computer, another Arduino, or other microcontrollers [10]. The receiver provides UART TTL (5V) serial communication, which is offered on digital pins 0 (RX) and 1 (TX).

To receive the data from the transmitter placed on the trunk of the other vehicle, RF Receiver is required. RX will have 4 pins just like the Transmitter.

3.3. ARDUINO SOFTWARE

THE UNO board likely gets programmed using Arduino software.

Which let you upload new code without using any external hardware programmer. The Arduino Software (IDE) uses this function to permit you to upload code by just pressing the upload button in the Arduino environment. In addition to Library was used to program the ultrasonic sonar sensor for receiving the data.

4. RESULTS

A. Environment: Transmitter circuit placed in a case, the transmitter with a range of 10 feet for implementing different features of the project.

B. Location of Receiver - In the vehicle, the receiver can be powered by means of the charging port and in the area where the buzzer is clearly audible to the driver.

C. Highly cost-effective product designed with a shoestring budget. This device doesn't even add any extra dollar to the vehicle cost.

5. CONSTRAINTS

A. Very high Extreme weather conditions affect RF Reception:
Rain fade mainly talks about the absorption of a microwave radio frequency (RF) signal by atmospheric rain, snow, or ice, and losses which are particularly prevalent at frequencies above 11 GHz. It is also called the degradation of a signal caused by the electromagnetic interference of the leading edge of a storm front[8].
Rain fade generally does not last long. Once a heavy shower or squall has passed, regular communications resume. However, during tropical storms or severe winter storms at northern latitudes, fadeouts can persist for hours at a time.

B. Reliance on the ultrasonic sensor - As it cannot tell about the type of vehicle or thing approaching there are chances of false alarm

6. CONCLUSION

Since there is the vulnerability to accidents in the desert and hilly region where the sole technique of detection of vehicles relies upon guesswork. This project would bring a massive change in the life of people as they are vulnerable to accidents that could cost them their lives.

The value of each device is less than Rs 500/- (i.e. $6) which can be afforded by the maximum number of people which makes this more accessible.

7. FUTURE SCOPE

Using AI-based tracking of objects the vehicles can be specifically told about the object approaching rather which would reduce the probabilities of false alarms.

8. REFERENCE

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