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Train Accident Prevention System (T.A.P.S)

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Abstract-The train accident prevention system designed by us is one of the subsystems for the highly integrated railway lines of India and is an essential equipment to ensure the transportation safety of the high-speed railway. Particularly against the disasters and accidents caused by the natural hazards in hilly areas like landslides and sometimes earthquakes or sudden event and intruding obstacles on the track which cost them their life, this paper proposes a framework structure, and overall functions, and data transmission of integrated monitoring system for disaster and accident prevention due to obstacles on the track , which is specifically suitable for the operation model and geographical environment of Indian railways. This train accident prevention system, TAPS, is capable of automatically detecting, collecting, and widely sharing of obstacle information or disaster information which can block the railway lines and data related to it with nearby stations. Besides, a simulation system has been developed. It is no doubtful that the research of the TAPS system will serve as a reference for the accident free construction of Indian Railways.

Keywords: - TAPS, Railway, Sensors, IoT, Connectivity

I. INTRODUCTION

We are working on a system that can prevent train accidents that occur every year due to various reasons like landslides or obstacles such as animals or boulders present on the tracks. Looking into the insights, we find, Indian Railways said that about 35,732 animals died on the railway tracks in the last four years. Out of the total, 65 were elephants. All in all, every day, 31 animals had lost their lives on the tracks for the last three years. According to the official data, the number has been continuously increasing every year. Train accidents killed 3,479 animals until June this year. Last year, the number stood at 12,625. The animal deaths were no more than 3,000-4,000 in 2014-15. Animals present on the track not only risk their life but also put the lives of the passengers at stake as it could lead to accidents. Noticeably, these accidents took place mostly on railway tracks passing through forest areas and wildlife sanctuaries and at some particular passes. According to the Railway surveys in India, these accidents majorly involve elephants and occur mainly in the eastern parts of the country, where the northern parts of West Bengal are at the top. The reason for this is that the rail lines pass mostly through crop fields and forests. Accidents are common during the night. A rule is to drive the train slowly during the night while passing through this area but hardly followed.

Year	Number of deaths
2016-2018	32000
2019-2020	38000
2020-2021	27000

Fig:-Number of deaths of animals in last 5 years

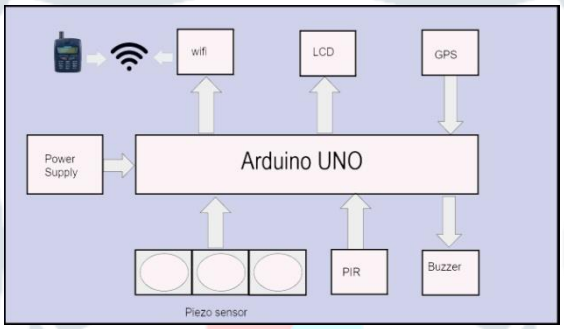
Another reason for train accidents is landslides in hilly areas. It is a common reason for the halt in train transportation as it blocks the railway tracks and sometimes also causes accidents. The solutions of the above problems are of great and practical significance to ensure the train operation safety and security for railway passenger dedicated lines.

When we looked at these problems, we thought of working upon a system that can pre-inform the train driver or loco pilot about the presence of obstacles on the track, whether it is animal or boulder.

All in All, under this project, we will make an IOT and sensor based accident detection system for the railways where, if an animal comes on the railway track, the train driver will be alerted via a message from the nearby station. The coordinates of the obstacle will be shared with the nearby station that will be further shared with the loco pilot so that he can slow the train speed. If successful, this project can save the lives of thousands of animals and prevent rail accidents every year. It is simple and easy to implement project.

II. TAPS System Architecture

The proposed project is planned to be designed with the IoT concepts using sensors and microcontrollers. The project consists of various subsystems with each system having their own unique functionality.



Selection of Components

The Arduino UNO microcontroller with Node MCU is used to connect the relevant sensors and actuators. Since multiple sensors are being used, therefore, we used UNO for easy connectivity and Node MCU to connect with servers via Wi-Fi. We are using sensors like piezoelectric sensors and PIR sensors for detection.

The Various Sub-units of thee project are described below:

1. Power and Control Unit

This unit consists of power source like batteries and microcontrollers to connect with various sensors present in the project. The role of major microcontroller is played by Arduino UNO since all the sensors are connected with it. The role of node MCU in the project is to provide connectivity with the servers via Wi-Fi.

2. Connectivity Unit

This unit consists of connectivity sources like Node MCU with ESP8266 mounted on it to connect with the nearby station. As the location co-ordinates of the obstacle or disaster site has to shared with the authorities and loco pilot, so internet connection is required which is fulfilled by ESP8266 module present on Node MCU. The GPS module present in the system is used to fetch the coordinates of the particular location on the track which is then shared to the servers for further transfer.

3. Sensor Unit

The most important part of TAPS is its sensors. This unit consists of all the sensors required for the proper functioning of the system. The major sensors used are piezoelectric sensors and P I R sensors. Piezoelectric sensors are used for obstacle detection by sensing pressure changes and P I R sensor is used for obstacle detection using infrared within a range of 10 meters. This unit also consists of all the complimentary electronic components like resistors, capacitors and transistors which are required by the sensors and microcontrollers.

4. Alarm Unit

This unit is responsible for producing an alarming noise using buzzers on sensing obstacles as well as alarming the station units. Alarm system also helps to keep the animals away from the track as it produces a loud noise.

5. Data Sharing Unit

This part is basically a combination of connectivity unit and the software required for data sharing with the stations and lo co pilot. For the purpose of presentation, we used Blynk Mobile app for its remote features and accurate data transfer. When implemented Blynk can be continued as it provides alerts on multiple devices at the same time via Wi-Fi and is also good for data visualization which is the coordinates in our case, on Google Maps. We also installed a LCD (16X2) on the project for the purpose of presentation.

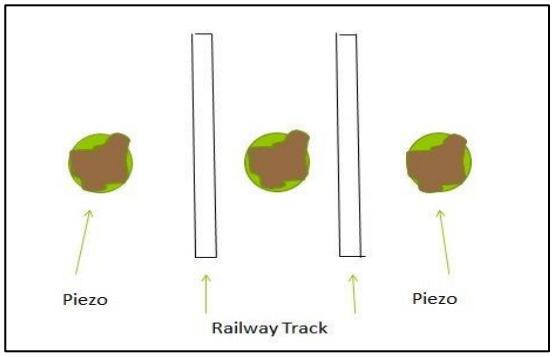
III. Overall Functionality

The project uses a set of 3 piezoelectric wafer sensors along with 1 PIR sensor for the detection of animals, objects and landslides. Arduino UNO is

used to control the functioning of the project along with GPS module to provide GPS coordinate of that place. Piezo wafers are preferable over pressure sensors as pressure sensors may provide false triggers, causing unnecessary alarm.

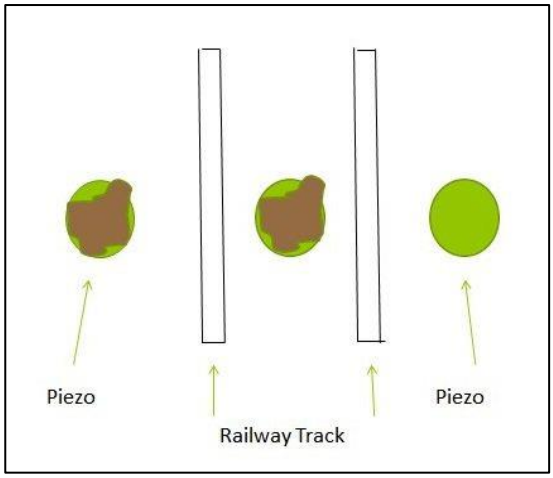
The data/GPS coordinate are passed to the nearby stations and upcoming trains using ESP8266 Wi-Fi module via a local server to take necessary actions to prevent accident. The working of this project can be understood by taking three different scenarios:

Case 1: Landslide: boulders on all the 3 pressure sensors



During this condition, all the sensors will give a high and there will be very less or no delay between them giving a high. The microcontroller senses this and sends the GPS co-ordinates of the sensor along with a message – "Landslide", to the database on the local server.

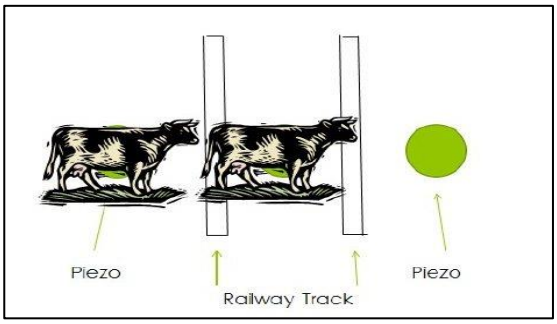
Case 2: Landslide: boulders on either of the 2 sensors



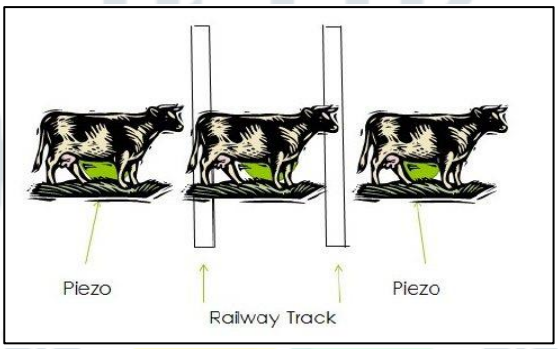
In this case also, any 2 sensors will give a high (including the middle one) and the most important thing is that there will be very less or no delay between them. So, the Wi-Fi module will send the GPS co-ordinates as well as a message – "Landslide" to the database.

Case 3: Presence of an animal on the tracks

In this case, 2 of the sensors will give a high but there will be a considerable delay between them and thus, the micro-controller will distinguish it from the landslide resulting in the Wi-Fi module sending the GPS co-ordinates of that place to the database along with a message – "Animal Present".



Case 4: An animal passing over tracks

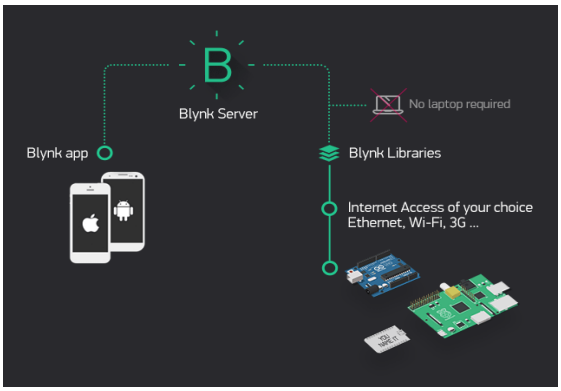


In this case, all the 3 sensors will give a high but there will be considerable delay between the High given by the sensors. The micro-controller will sense this and the Wi-Fi module will send the GPS co-ordinates and a message – "Animal Passed" to the database.

IV. Data Transfer Techniques

Data from the microprocessor is passed to the database via Wi-Fi module which is then provided to the nearby Railway stations and the upcoming trains. Here we have used the Blynk platform for the various functionality of our project.

The Blynk app has 4 major components which are used for all the data transfer. They are:-



1. Blynk App – It provides us various widgets to visualize the data send by the microprocessor. Here we have used the Google map view to display the GPS coordinate of the place where landslide or Animal is detected.

2. Blynk Server –It is responsible for all the reception and transmission of data between server and microprocessor. Its open-source could easily handle thousands of devices and can launch on an Arduino.

3. Blynk Libraries –It makes our project simpler and used to enable communication with the server and process all the incoming and outgoing commands.

4. Blynk Cloud – It provides us the functionality to store the data for the further processing of it in the future. The below part shows the code in the ESP8266 code where blynk libraries are used to connect ESP8266 present on Node MCU with blynk app and after connecting them, imposing all the conditions.

```
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

char auth[] = "duuTskTch4WiCYE-u7GWGBcRKBMn9x04";
char ssid[] = "AndroidAP";
char pass[] = "*******";
```

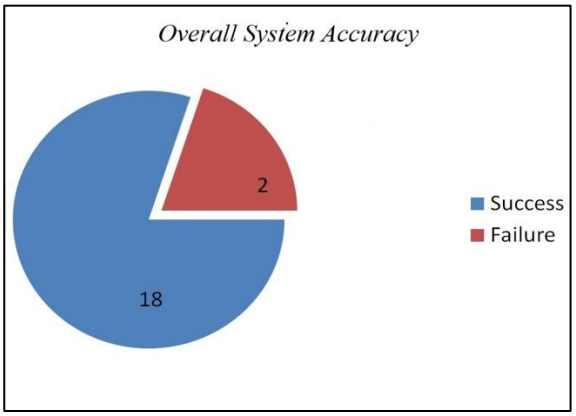
```
BLYNK_CONNECTED()
{
  digitalWrite(2, LOW);
}
//******************************************************
void setup()
{
  Serial.begin(9600);
  pinMode(2, OUTPUT);digitalWrite(2, HIGH);
  Blynk.begin(auth, ssid, pass);
}
//*************************************************

void loop()
{

  if(!Blynk.connected())
  {
    Serial.println("Reconnecting ... ");
    digitalWrite(2, LOW);
    Blynk.connect();
  }
  Blynk.run();
  serial_get_command();

}
```

V. System accuracy of the project



Case 1: Error in pressure generation

The detection of animal over the tracks with its direction and coordinates is measured correctly with the accuracy of ~90%, and its slips to ~10% due to the light weighted obstacles/animals over the piezoelectric sensors which can't produce the exact pressure. The detection results are shown with the help of pie chart in figure

Case 2: Weighted animals and landslides

In this case, piezoelectric sensor works accurately without any error in the generation of pressure which means that the detection of animal over the tracks with its direction and coordinates is measured correctly with the accuracy of ~100%

Case 3: Cause due to sunlight

In this case, sometimes due to the sunlight the PIR sensor does not work properly and can also result in faulty detection of obstacles due to which the accuracy we get is ~95% and its slips to ~5%.

VI. CONCLUSION

The automation project is started by considering the pitfalls of the existing systems and also by directly witnessed some serious scenarios at the railway track. According to the statistics reviewed, it is evident that the train accident prevention system should be regulated over every railway track of our country. With the help of existing IoT technologies, an ace system is designed to avoid animal deaths and train accidents due to disasters like landslides and presence of obstacles on the track.

Hence, the system is tested with many test cases and confirmed that it gives around 95% accuracy with the available dataset.

Further, this is a low-cost model without any human intervention in the system. The train accident prevention system will ensure the safety of passengers, animals, and will reduce the number of accidents. In the future, it can be further tested with the vast number of real datasets and improved with more accuracy. For preventing the PIR sensor from the sunlight, it can be covered from the top for proper working of the system. In the future, the system can be expanded into the wider area by using the cameras near the railway track by using the image processing technologies for tracking the animals or any landslides near the tracks. Also, in order to increase the effective pressure sensing area, an array of multiple piezoelectric sensors can also be used.

Eventually, this system will save the lives of animals which are continuously increasing year by year and also it will work like a boon for the Indian railways for controlling the death rates of animals which is caused by them and also monitoring the landslides.

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