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IOT BASED RAILWAY ACCIDENT PREVENTION AND MONITORING SYSTEM

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Abstract— **The railways are the most common and flexible mode of transportation in the majority of the world's urban areas. The railway is a popular, inexpensive, and pleasurable mode of transportation. It is accessible to people from all walks of life. The rail transportation infrastructure is essential for travel in the modern day; nonetheless, numerous accidents occur on railway lines as a result of reckless driving, particularly during morning and evening rush hours, and pedestrians crossing while using mobile phones. To prevent railway accidents, a better technique must be invented, thus we created this project to tell pedestrians when a train is coming within a specific distance, so ensuring their safety and providing the security department with an alarm signal. The project entitled "IOT based Railway Accident Prevention and Monitoring System" is based on the Internet of Things and a live sensor database, which offers a method for preventing railway accidents. Its objective is to keep people safe by employing sirens to inform them of potential accidents at railroad grade crossings, to monitor any potentially hazardous conduct that might cause an accident at a railway grade crossing, and to provide the department and a person with an alert signal.**

Keywords— **Node MCU, IR Sensor, IOT Platform, Sensors, Accident Prevention.**

I. INTRODUCTION

After the United States, Russia, and China, Indian Railways rank’s the world's fourth biggest railway network. Every day, the railroads transport nearly 20 million people and 2 million tonnes of freight around the nation. With over 1.6 million workers, it is one of the world's biggest commercial or utility employers. [1] A minor defect in the 64,600 route kilometres of track that traverse the country, a defect in the more than 9,500 locomotives, 55,000 coaches, and 2.39 lakh waggons that transport approximately 23 million passengers and nearly 2.7 million tonnes of freight every day, an incorrect indication on one of the 1000 of signals that dot the rail landscape, a mistake or act of negligence by one of the thousands of signal operators, and a hasty act by one of the millions of road users that daily make. In other nations, train accident rates are substantially higher. In 2014, for example, 25,006 persons were killed and 3,882 were wounded in 28,360 train accidents in India alone. When the number of fatalities is so high, it is imperative that accurate and safe collision detection and prevention technologies be created in order to avert these tragedies.

Railway safety is a critical part of rail operations all around the globe. Malfunctions that result in accidents generally get extensive media attention, even when the railway is not at fault, and give rail travel an unfair image of inefficiency among the uneducated public, often spurring requests for quick improvements. Numerous train catastrophes have happened throughout history as a result of track breakdown, the most recent being in 2005, when seven bogies of an express derailed over a hill and many people were killed. [2] With its expanded sophisticated technology inputs, India is in a position to counteract this scenario. Our sophisticated technology, in particular, by emulating the old human-based faults and procedural system where track monitoring system is done three times a year and will make it possible for the trains to operate safely and without incident.

The existing system only had track monitoring capabilities and did not provide for dynamic data translation in real time, but this study validates its value by providing solutions. When implemented, these systems may provide exceptional and remarkable outcomes since they are low cost and high value solutions. With the use of Internet of Things, in this project we integrated various sensors with the hardware and linked it with the software so that the live tracking of each sensor and data can be traced, analysed, actioned as well as warnings are been initiated by the system itself and the accident can be avoided.

II. LITERATURE SURVEY

C. Sharath, et.al [3] The railway has become one of the most popular ways of transportation as ticket rates have risen. The system was constructed manually, which requires time and effort and is inefficient due to the high probability of human error. In addition, inspection and testing are not possible. Humans constantly check the track, resulting in increased system condition monitoring expansion. Sensors are used to monitor structures, vehicles, and equipment. Today's top wireless networking technologies, such as Wi-Fi Ad hoc communication and mobile networking, are important key elements in railway track monitoring systems, as is the technology to integrate devices.

A. Abid, et.al [4] There are two separate new technologies that are becoming part of our everyday lives: cloud computing and the Internet of Things (IoT). It is projected that they will be more effective in their adaptation and application. Rail transit is a green method of transportation. The RaspberryPi2.0, LM393 sensor signal conditioning units, and Piezo electric buzzer components were used to develop and build the cloud computing paradigm. We were able to access the cloud, Python, and the 'smartliving.io' IoT platform over the internet. As soon as a section of track is found to be damaged, our system notifies the cloud, which immediately sends an SMS to the appropriate railway authorities' mobile phones.

T. Thusleem, et.al [5] Trains are popular modes of transportation, because they can convey a huge number of passengers at once. Railways are a major mode of transportation in India because of the country's rapidly expanding population, which necessitates more trains for safe transit. As a result, the security of passengers must be ensured. Arduino, an ultrasonic sensor, and a Node-MCU IOT module are all included in the system's fully automated design. IoT module. If an obstruction is encountered, the motor stops, and the sensor data is continuously monitored in a website using the Node-MCU microcontroller. The distance between the barrier and the display is also shown on the LCD and on the internet.

A. Haja, et.al [6] Fog computing is a novel distributed computing platform that delivers processing close to its data sources, decreasing latency and costs associated with data transportation to a distant cloud. Adding sensors and actuators to the Internet of Objects makes it feasible to detect and operate things remotely using existing networks, making it easier to integrate the physical world into PC-based frameworks and bringing about greater system accuracy as well as economic benefits. An accident-prevention system based on the Internet of Things and fog computing is proposed in this study.

III. SYSTEM REQUIRMNETS AND ANALYSIS

The IOT-based railway accident prevention and monitoring system initiatives aim to discover any defects or potentially risky actions that might lead to a train disaster.[7] It uses a range of sensors coupled with current microcontroller units like as the Esp8266 to broadcast data to a server constructed using software tools, triggering an alert in the case of an emergency.

A. ESP8266

There is an ESP8266 chip in the ESP-12E module, which is operated by a 32-bit RISC CPU in the Tensilica Xtensa LX106 on the Node-MCU ESP8266 development board. [8] This MCU supports RTOS and works between 80MHz and 160MHz in clock frequency. For storing data and programmes, the Node-MCU contains 128 KB of RAM and 4 MB of Flash memory. Because to its high computing power, integrated Wi-Fi/Bluetooth, and Deep Sleep Operating features, it is well-suited for Internet of Things (IoT) applications. The board is shown in Figure 1.

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Fig. 1. ESP8266

B. PIR SENSOR

PIR sensors detect motion and identify whether a person is in or out of range. PIRs feature a pyroelectric sensor that detects infrared radiation. [9] They're small, inexpensive, low-powered, easy to use, and durable. Residential and commercial devices use them. PIR, PIRC, or IR motion sensors. The PIR sensor is shown in below figure 2.

Fig. 2. PIR Sensor

C. WATER LEVEL SENSOR

The Water Level Depth Detection Sensor operates at DC3-5V and 20mA. The 40x16mm Analog Sensor generates pressure-based analogue output signals. The exposed parallel wires act as a variable resistor, whose resistance changes with water level. Sensor height correlates to resistance change. The water level is tested for resistance. Figure 3 depicts the Water Level Sensor.

Fig. 3. Water Level Sensor

D. RAINFALL SENSOR

A switch-like sensor detects precipitation. Sensor pad and module. When rain falls on a sensing pad, the sensor module processes and translates the data. [10] This module features an LM393-like electrical module and PCB. PCB collects rainwater. Rain produces a parallel resistance path for the op amp. Figure 4 depicts the Rainfall Sensor.

Fig. 4. Rainfall Sensor

E. ULTRASONIC SENSOR

Ultrasonic distance sensors employ reflected sound. Sonar travels faster than ultrasound (i.e., the sound that is audible to humans). Transmitter and receiver are separate devices (when the sound comes into contact with the target after it has travelled to and from the source). Ultrasonic sensors generate chirps between 23 and 40 kHz, significantly over the 20 kHz human hearing range. By a sound's chirp, they can tell how long it bounced. Due of the ultrasonic chirp's back-and-forth motion, time may be converted to distance. The ultrasonic sensor can be seen in the Figure 5.

Fig. 5. Ultrasonic Sensor

IV. SOFTWARE

Here in our proposed work, we are utilizing a wide variety of software's and tools in order to achieve better results. For example, PyCharm is a piece of software that operates on the Python programming language. [11] In order to create a graphical user interface (GUI), we require the HTML and CSS programming languages, both of which operate on visual code studio. Arduino IDE is required for debugging the code in order to facilitate the interfacing of the microcontroller and the platform

Additionally, we are employing Notepad++ is a text and source code editor that enables users to work in a single window with numerous open files at the same time. The application programming interface (API) development tool known as Postman assists in the process of constructing, testing, and modifying APIs.

V. SYSTEM DESIGN

The following flowchart demonstrates the project's working method in a particular manner. [12] It is primarily divided into two processes, the first of which explains the microcontroller's integration with the sensors and obtaining the value from the sensors, and the second of which explains the sensor data to be measured with the threshold one and uploaded to the database, where the user and the control department can view the admin page as well as the guard page constructed with a variety of tools. The stages of each flowchart are described in full below.

F. Flowchart for ESP-8266

This flowchart depicts how the device is switched on and the sensor data is examined. To keep the project operating smoothly, the ESP-8266 connects to the wi-fi and the server and, if successful, integrates the data. [13] It modifies the raw sensor data captured on board and sent to the database, and the administrator is alerted if the sensor value exceeds a specified threshold, allowing them to take action and avoid an accident.

Fig. 6. Flowchart For ESP-8266

G. User Case diagram for Admin and Guard

To access the database of the website, the administrator must input his login information on the website's login page. The data has been evaluated internally and is provided for each sensor value in a categorized way derived from the database. The user case shows the usage of the website and its internal communication between both, and this can be done simultaneously by the admin and the guard so that any warnings that is generated would be sent to the guard and the disaster can be avoided. The user case diagram is shown in below figure 7.

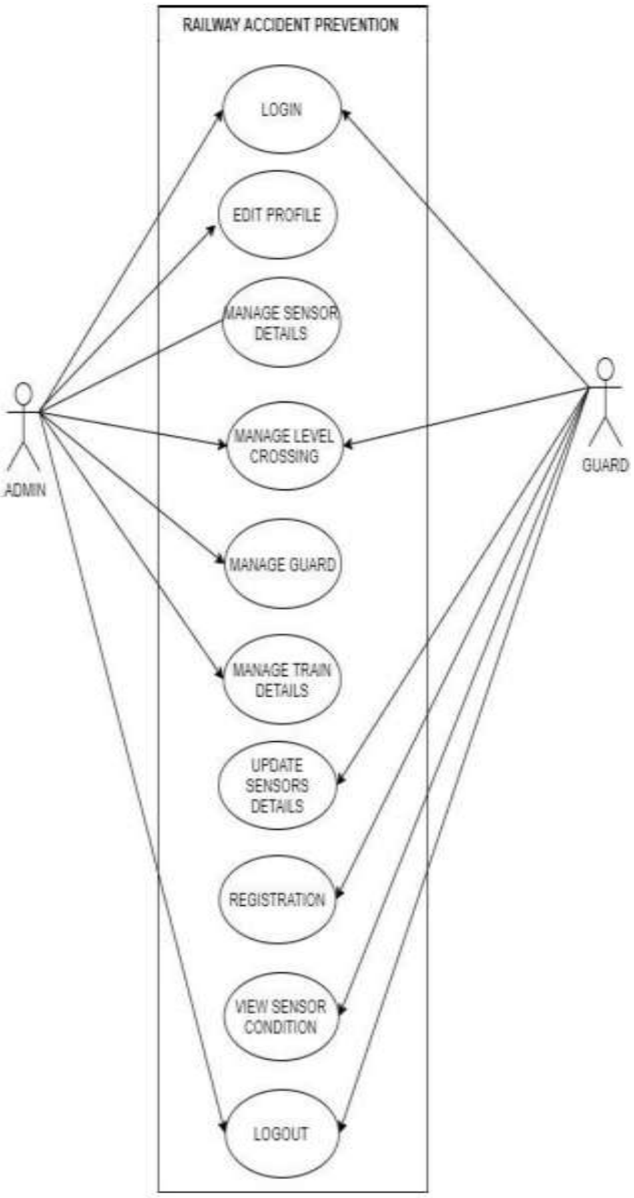

Fig. 7. User Case Diagram for Admin and Guard

VI. RESULTS AND DISCUSSION

Figure 8 depicts the total set-up for the project's equipment. ESP8266, laser diode, ultrasonic sensor, PIR sensor, water level sensor, and rain sensor along with a laser diode are included in one setup. [14] The microcontroller processes the raw settings with the sensor values and transfers the data to the database, where it is displayed on the admin page designed for that purpose. As a result, the results were almost identical to those expected.

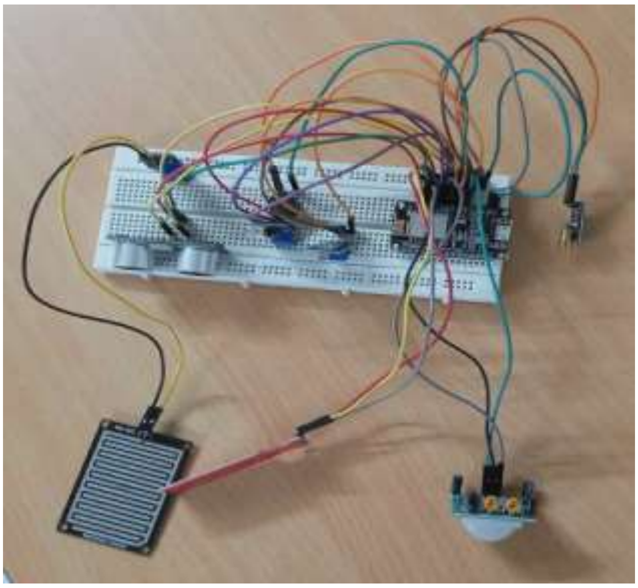

Fig. 8. Equipment Setup

Python code is used in the PyCharm programme for database interaction with other tools and modules. The Python code contains API connectivity with the database so that the live status of each sensor value can be uploaded and inferences may be drawn from the available data when making a decision. The code for the webpage is shown in Figure 9.

```
Call UserLogin(Username,password)
IF user==Admin THEN
        call populatedatatable()
        {  call human_detection()
                call level_crossing()
                call obstacle_detection()
                 call water_level()
                call rainfall_detection()
                call GenrateAlert()
                call complainstatus()
        }
IF user=Guard THEN
        call generatecomplain()
```

Fig. 9. Pseudo Code

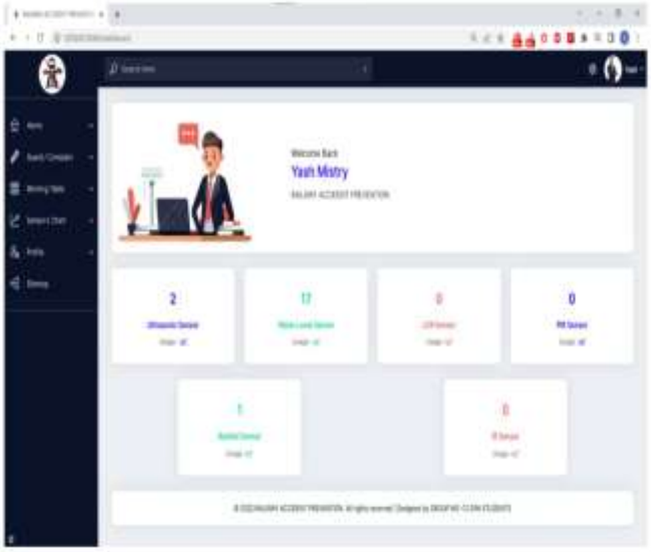

Fig. 10. Website for Each Sensor Value

When a person walks over a track, an ultrasonic sensor measures how far they are from the track, an infrared sensor detects movement of the human being, and an optical diode measures the level of crossing from the track. All of these sensors are shown in Figure 10 above.

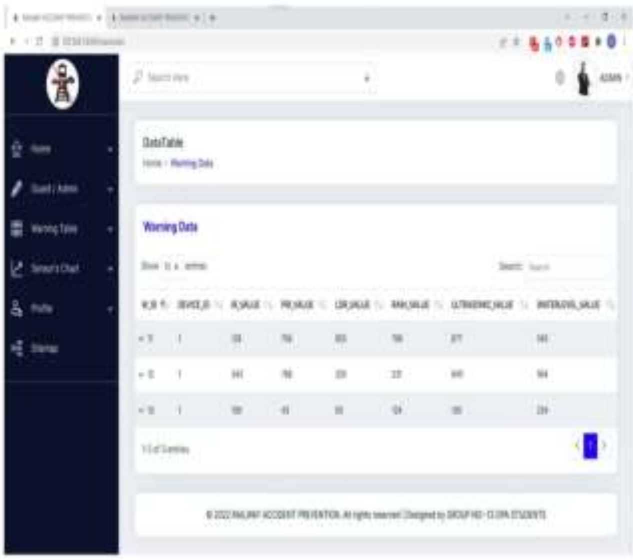

Fig. 11. Data for Each Sensor Value

Each sensor value is represented in an own database table, as shown in figure 11, which allows the website dashboard to better see sensor values and send out alerts when they go over or below a predetermined threshold. The threshold value for the sensor is given in the table 1 below which is used as a reference to throw alert signal when its value exceeds it.

SESNOR NAME	NORMAL RANGE	THRESHOLD
Ultrasonic Sensor	0 - 700	701
IR Sensor	0 - 100	101
LDR Sensor	0 - 300	301
Water Level Sensor	0 - 400	401
Rainfall Sensor	0 - 250	251
PIR Sensor	0 - 450	451

Table 1: Sensor Threshold values

VII. LIMITATION AND FUTURE WORK

Although the proposed project is reliable for the implementation of real-time applications in society due to its importance and new specifications with the most advanced hardware and software, it has some limitations, such as the sensor's potential to return erroneous values and the requirement that the internet connection for ESP8266 connectivity be maintained 24 hours a day, which leads to a constant electrical supply.

Furthermore, the established system may be improved further by including an automated emergency assistance line, via which the location of a train can be communicated to a help center with pre-recorded messages after an accident, perhaps using GPRS or a similar technology. Furthermore, train movements and speeds may be recorded in real-time on an SD card for later study, similar to the Blackbox of an aircraft for the prevention of an accident if over-speeding. Finally, the system may be coupled to the train braking system, causing the train to come to a stop if there is a chance of collision in the future at a certain time or distance.

VIII. CONCLUSION

The proposed concept aims to make trains a more reliable and secure source of transportation by replacing present systems with an IoT-based accident prevention and monitoring system. This prevents fatal accidents at grade crossings caused by human error. Among the functions are accident prevention, monitoring the water level under the tracks, and detecting human activity on the track. This not only assists in accident prevention, but also expedites assistance. Reduced human interaction, improved railroad gate management, and lower costs were all achieved. Due to human involvement, the sensors on the track can be constructed rapidly and with fewer errors. Versatile and transportable for future growth.

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