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Smart Surveillance System for Railway Track Safety Using Esp32-Cam

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ABSTRACT:

Railway safety is a critical concern, requiring continuous monitoring of track integrity to prevent derailments and accidents. This project proposes an AI-Based Railway Track Detection System that utilizes Arduino Uno and ESP32-CAM as the primary controllers, along with GSM and GPS modules for real-time communication[1][4].The system employs two IR sensors (IR1 & IR2), positioned on either side of the railway track, to monitor track alignment. In the event of track displacement or breakage, the system triggers the ESP32-CAM[4], which captures and transmits real-time footage of the affected area. Simultaneously, an alert message containing the precise GPS coordinates is sent via the GSM module to an authorized mobile device[2], enabling immediate response and inspection.

KEYWORDS-

IR Sensors, Arduino Uno, GPS, GSM, ESP32CAM, motor driver.

I.INTRODUCTION

Railway is one of the most significant transportation modes of our country but it is a matter of great sorrow that, railway tracks of our country are very prone.
That's why, a vast number of accidents are occurred every year due to this primitive type of railway tracks and as the consequences of those accidents we lose huge number of lives every year[1].

These types of incidents motivate us to think over the above-mentioned issue and take necessary steps to protect those lives. Through our proposed system, we need to establish more modern and secure railway system. Besides this, there is no such type of technology or system in our country which can stop the collision between two trains coming from the opposite direction of each other on the same track[4]. We actually think over this matter and motivated to do so. Moreover, natural disaster can throw any object on the rail track which cannot be removed very quickly in the remote area. We thought if our system can detect those object or barrier and inform to the control room then they can take necessary steps 3 to avoid accident. Figure1 depicts the crack on track. The Rail transport is growing at a rapid pace in India. It is one of the major modes of transport but still our facilities are not that accurate, safer as compared to international standards. A survey on the internet states that about 60% of all the railway accidents[4].

II. PROBLEM STATEMENT

Developing advanced railway fault detection and reporting system leveraging iot presence a critical Challenge in enhancing railway safety and efficiency the system AIIMS to integrated network of sense of deployed along the railway tracks and on trains continuously monitoring various parameters as temperature vibration speed and track conditions these sense transmitter real time data to centralized server or cloud platform through IOT gateways, employing wireless communication technologies like GSM, LTE[4][2].

Ultimately by leveraging iot technology for advanced fault detection and reporting railway operators can optimize maintenance effort improve safety and deliver a more reliable transportation service.

III. METHODOLOGY:

The methodology for implementing and advanced railway fault detection and reporting system over iot involves several key steps in Sheela comprehensive assessment of the railway network infrastructure and operational[3] requirement is conducted to determine the requirements is conducted to determine placement of sensors and I would get ways next robot a robot to communication infrastructure utilized wireless technologies such as GSM[2], LTE is established to ensure seamless data transmission between sensors, gateways, central server or cloud platform.

IV. BLOCK DIAGRAM

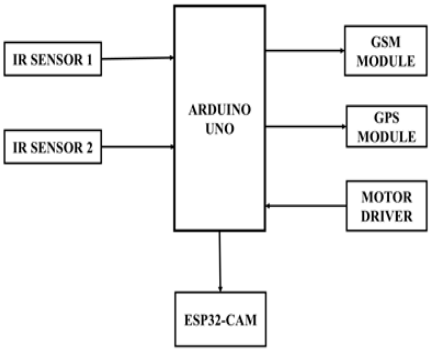


Fig: Block Diagram

V. COMPONENTS USED

1. ARDUINO UNO

The Arduino UNO is a widely used open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino [5]. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts [4].

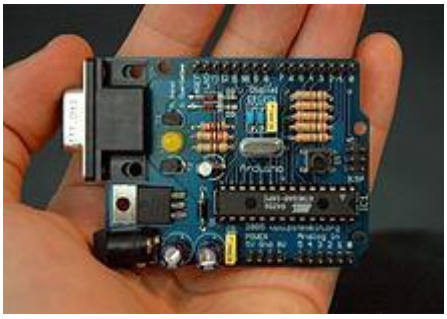


Fig**: ARDUINO UNO**

PINS:-

Fig**: PIN DIAGRAM OF ARDUINOUNO**

2. IR SENSORS:

An infrared (IR) sensor is an electronic device that detects and measures infrared radiation, which is invisible to the human eye and falls within the electromagnetic spectrum beyond red light[2]. IR sensors detect the presence of objects or changes in the environment by measuring the level and magnitude of infrared energy emitted or reflected by those objects[3].

Fig**: IR SENSORS**

3. ESP32-CAM

ESP32-CAM is a Wi-Fi-enabled camera module used to capture images of illegal sand mining activities. When unauthorized mining is detected, it automatically takes a photo of the site and sends it to the Telegram app for remote monitoring [4].

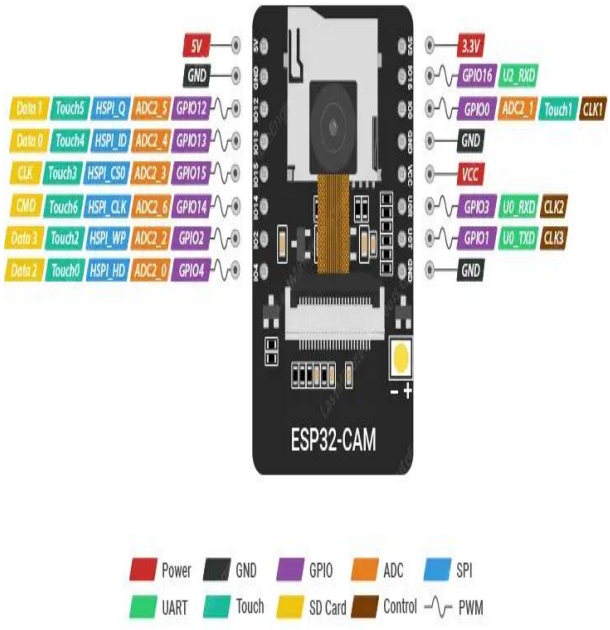


Fig: **ESP32-CAM**

4. GSM MODULE

The Global System for Mobile Communications (GSM) is a family of standards to describe the protocols for second-generation (2G) digital cellular networks as used by mobile devices such as mobile phones and mobile broadband modems GSM is also a used in GSM[3].

Fig: **GSM MODULE**

The specifications and maintenance of GSM passed over to the 3GPP body in 2000, which at the time developed third-generation 3G UMTS standards, followed by the fourth-generation 4G LTE Advanced and the fifth-generation 5G standards, which do not form part of the GSM standard. Beginning in the late 2010s, various carriers worldwide started to shut down their GSM networks[5];

nevertheless, as a result of the network's widespread use, the acronym "GSM" is still used as a generic term for the plethora of *G* mobile phone technologies evolved from it or mobile phones itself.

5. GPS MODULE

The Global Positioning System (GPS) is the only fully functional Global Navigation Satellite System (GNSS)[6]. The GPS uses a constellation of between 24 and 32 Medium Earth Orbit satellites that transmit precise microwave signals, which enable GPS receivers to determine their location, speed, GPS was developed by the United States Department of Defense. Its official name is NAVSTAR-GPS. Although NAVSTAR-GPS is not an acronym, a few backronyms have been created for it. The GPS satellite constellation is managed by the United States Air Force 50th Space Wing[4].

Fig**: GPS MODULE**

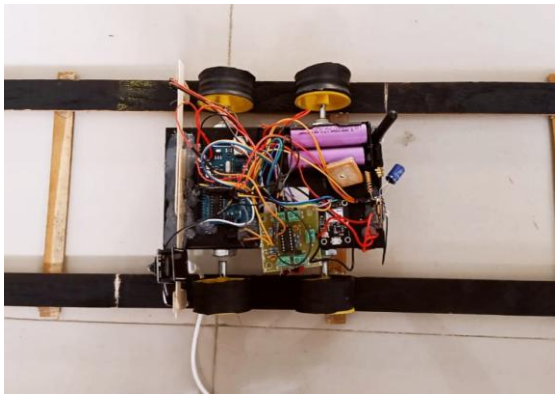
6.MOTOR DRIVER

A motor driver is an electronic circuit or module that controls the power supplied to an electric motor. Since microcontrollers or processors usually cannot supply the high current required by motors, a motor driver acts as an intermediary, amplifying the low-power control signals into high-power signals suitable for motor operation[5].

Fig: **MOTOR DRIVER**

Motor drivers receive control signals from a microcontroller, then adjust voltage and current to regulate the motor's speed and direction. Most motor drivers use transistors, MOSFETs, or H-Bridge circuits to achieve this.

RESULT: -



CONCLUSION:

The smart surveillance system for railway track safety using ESP32-CAM System is a cost-effective, reliable, and scalable solution for railway infrastructure monitoring[2]. By integrating IR sensors, ESP32-CAM, and AI-powered image analysis[3] the system ensures real-time crack detection and predictive maintenance, significantly reducing the risk of train accidents[1]. The wireless communication module provides instant alerts, allowing railway authorities to take immediate action to repair damaged tracks.

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