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ADVANCED RAILWAY MANAGEMENT SYSTEM USING IOT FOR SAFETY AND EFFICIENCY

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ABSTRACT

Even with greatest of ideas to avoid railway accidents, many trains accidents still happen worldwide.The railway system is one of the most widely used modes of transportation due to its low cost. To keep the railway system running smoothly, continuous track monitoring is needed. These days, the railway system is manually supervised. As a result, there is a greater risk of disasters, such as fatalities, occurring as a result of human error while monitoring. The main problem with manual system monitoring is that it takes a long time to process all of the necessary data. Since railway tracks are built over thousands of miles, it is virtually impossible to manually control the device over such a long distance. At railway crossings, a lot of accidents happen. Crossing gates are usually opened and closed after receiving direct input from the station. We've seen on multiple occasions that people tend to rush and disobey the railway rules which causes something serious and sometimes fatal accidents. To avoid these scenarios, I and my team have come up with this automation technique. Sometimes it's also happened that the person who is at the duty of railway gate has a sudden health issue or some other reason. In these cases, the railway gate is not closed or opened at the proper time. So there is a time gap that sometimes leads people to death.If there is a delay in obtaining information from the station, there is a risk of swearing incidents. The main goal of this research is to simplify and protect the railway system. The proposed system employs Force Sensitive Resistor (FSR) detectors for automatic side road crossing protection. Any type of breakage, as well as vibration, can be efficiently detected with a higher degree of precision using Light Dependent Resistor (LRR) and laser detectors. In the event of an unexpected situation, such as an accident, the GSM module will begin communicating via message with the nearest control room for assistance. Sonar sensors are often used for obstacle avoidance when something unexpectedly appears in front of the train. The Internet of Things (IoT) has been added to the system to allow it to be monitored from anywhere in the sphere. The Arduino UNO is a microcontroller that serves as the system's backbone. The framework has the potential to be extremely beneficial to our country's railway economic growth.

Keywords: Railway track inspection, object avoidance, automated gate controlling, camera, IOT, Microcontroller, sensors, dc motor, etc.

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I. INTRODUCTION

1.1 INTRODUCTION

Microcontroller are widely used in Embedded Systems products. An Embedded product uses the microprocessor (or microcontroller) to do one task & one task only. A printer is an example of Embedded system since the processor inside it perform one task only namely getting the data and printing it. Although microcontroller is preferred choice for many Embedded systems, there are times that a microcontroller is inadequate for the task. For this reason, in recent years many manufactures of general-purpose microprocessors such as INTEL, Motorola, AMD & Cyrix have targeted their microprocessors for the high end of Embedded market. One of the most critical needs of the embedded system is to decrease power consumptions and space. This can be achieved by integrating more functions into the CPU chips. All the embedded processors have low power consumptions in additions to some forms of I/O, ROM all on a single chip. In higher performance Embedded system, the trend is to integrate more & more function on the CPU chip & let the designer decide which feature he/she wants to use.

1.2 EMBEDDED SYSTEM

Physically, embedded systems range from portable devices such as digital watches and MP3 players to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants. Complexity varies from low, with a single microcontroller chip, to very high with multiple units, peripherals and networks mounted inside a large chassis or enclosure

In general, "embedded system" is not an exactly defined term, as many systems have some element of programmability. For example, Handheld computers share some elements with embedded systems such as the operating systems and microprocessors which power them but are not truly embedded systems, because they allow different applications to be loaded and peripherals to be connected. Embedded systems span all aspects of modern life and there are many examples of their use. Telecommunications systems employ numerous embedded systems from telephone switches for the network to mobile phones at the end-user. Computer networking uses dedicated routers and network bridges to route data.

EXAMPLES OF EMBEDDED SYSTEM:

Automated teller. machines (ATMS). Integrated system in aircraft and missile. Cellular telephones and telephonic switches. Computer network equipment, including routers timeservers and firewalls. Computer printers, Copiers. Disk drives (floppy disk drive and hard disk drive). Engine controllers and antilock brake controllers for automobiles. Home automation products like thermostat, air

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conditioners sprinkles and security monitoring system. House hold appliances including microwave ovens, washing machines, TV sets DVD layers/recorders. Medical equipment. Measurement equipment such as digital storage oscilloscopes, logic analysers and spectrum analysers. Multimedia appliances: internet radio receivers, TV set top boxes.Small hand-held computer with P1M5 and other applications. Programmable logic controllers (PLC's) for industrial automation and monitoring. Stationary video game controllers.

1.3 CHARACTERISTICS:

Embedded systems are designed to do some specific tasks, rather than be a general-purpose computer for multiple tasks. Some also have real-time performance constraints that must be met, for reasons such as safety and usability; others may have low or no performance requirements, allowing the system hardware to be simplified to reduce costs. Embedded systems are not always standalone devices. Many embedded systems consist of small, computerized parts within a larger device that serves a more general purpose. For example, the Gibson Robot Guitar features an embedded system for tuning the strings, but the overall purpose of the Robot Guitar is, of course, to play music. Similarly, an embedded system in an automobile provides a specific function as a subsystem of the car itself.

The software written for embedded systems is often called firmware, and is usually stored in read- only memory or Flash memory chips rather than a disk drive. It often runs with limited computer hardware resources: small or no keyboard, screen, and little memory.

1.4 MICROPROCESSOR (MP):

A microprocessor is a general-purpose digital computer central processing unit (CPU). Although popularly known as a "computer on a chip" is in no sense a complete digital computer. The block diagram of a microprocessor CPU is shown, which contains an arithmetic and logical unit (ALU), a program counter (PC), a stack pointer (SP), some working registers, a clock timing circuit, and interrupt circuits.

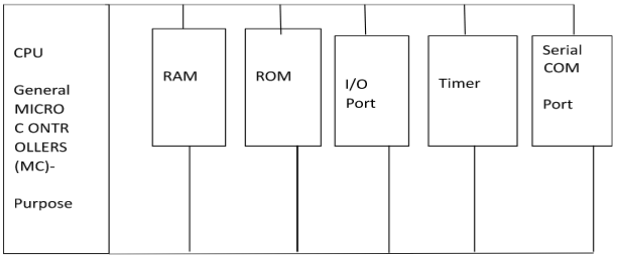

Fig 1.1 Block diagram of microprocessor

1.5 MICROCONTROLLER (MC):

Figure shows the block diagram of a typical microcontroller. The design incorporates all of the features found in micro-processor CPU: ALU, PC, SP, and registers. It also added the other features needed to make a complete computer: ROM, RAM, parallel I/O, serial I/O, counters, and clock circuit.

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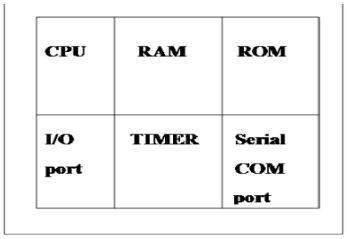

Fig 1.2 Microcontroller

1.6 COMPARISION BETWEEN MICROPROCESSOR AND MICROCONTROLLER

The microprocessor must have many additional parts to be operational as a computer whereas microcontroller requires no additional external digital parts. The prime use of microprocessor is to read data, perform extensive calculations on that data and store them in the mass storage device or display it. The prime functions of microcontroller is to read data, perform limited calculations on it, control its environment based on these data. Thus the microprocessor is said to be general-purpose digital computers whereas the microcontroller are intend to be special purpose digital controller. Microprocessor need many opcodes for moving data from the external memory to the CPU, microcontroller may require just one or two, also microprocessor may have one or two types of bit handling instructions whereas microcontrollers have many.

II. LITERATURE SURVEY

2.1 INTRODUCTION

The World Health Organization (WHO) says that every year millions of people demise due to vehicle accidents. To prevent this, the car black box system is introduced. Like black box in flight, the car black box technology can play a vital role in vehicle crash investigations. Hence it is significant to have recorders which will track all the activity in vehicles during and after accident or crash. This car black box system is mainly classified into two sections. First section detects and collects the information from the vehicle, and it is implemented using various type of sensors. Second section presents the data to the user in simplified way, and it is implemented by using the Node microcontroller (MCU) which is programmed to record the data and to retrieve the data from the Node MCU. If any vehicle crashes, the geographical co-ordinates or location is sent to the pre-stored mobile number to seek help. The investigators can use this recorded data obtained from the car black box to identify the actual reason of the accident. The black box will give the input about soundness of vehicle and accidents/mishaps and information including the vehicles mechanical and electrical status.

The black box will give the moment criticism for any physical oddities and will provide the war room access to the information on the black box. The black box can be utilized by Field Technician Soldiers, and Command Centre specialist to analyse and fix any issues that may emerge while out on the field or at command post. A data investigator can utilize the black box to decide the reason for the mishap and

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give approaches to forestall a future mishap. Field professionals and travellers in the vehicle can utilize the black box on the field to decide vehicle status. At the command centre, mechanics and investigators will utilize the black box to recognize any irregularities with the vehicle, to record ordinary activity information, and to decide the reasons for mishaps if any ought to happen.

2.2 LITERATURE SURVEY

Pakistan Railways was also Called the Pakistan Western Railway from Railways provide the lowest priced and many Convenient manners of passengers for space and suburban visitors. It also plays a significant part in the maturation and growth of businesses. Railways Assist in providing raw materials and other amenities to the mill sites and Finished products to the marketplace. So, safety and reliability should be highly considered in the case of a railway. As it is playing a vital role in the growth of the economy, so the importance of having a modern and improved railway system is increasing day by day. However, the present scenario of the railway is quite different. Railway mishap has become a common issue nowadays. This becomes daily news losing many lives by train accidents. In today's world, transport, being among the drivers of electricity, its sustainability and safety are issues of major significance. Railways offer the least expensive and most convenient way of passengers for the local and distance visitors. Additionally, it has a vital part in the maturation and growth of businesses. Railways aid in providing raw materials and other amenities to the mill websites and finished products to the marketplace. So, safety and reliability should be highly considered in the case of a railway. As it is playing a vital role in the growth of the economy, so the importance of having a modern and improved railway system is increasing day by day. However, the present scenario of the railway is quite different. Railway mishap has become a common issue nowadays.

III. PROBLEM STATEMENT

The existing system for railway safety and management primarily relies on conventional monitoring and signaling technologies, which have limitations in real-time data collection, fault detection, and efficient coordination. These systems often operate in silos and lack integration with modern sensor networks and smart data processing. Traditional railway systems depend on human intervention and fixed-time schedules, making them less responsive to dynamic conditions such as unexpected obstacles on tracks, track damage, or unauthorized access. Recent advancements incorporate basic IoT components to improve efficiency; however, they are typically limited in scope and not fully automated. Existing IoT implementations may use sensors for train detection, GPS for location tracking, and cameras for monitoring, but lack centralized intelligence for decision-making and real-time.

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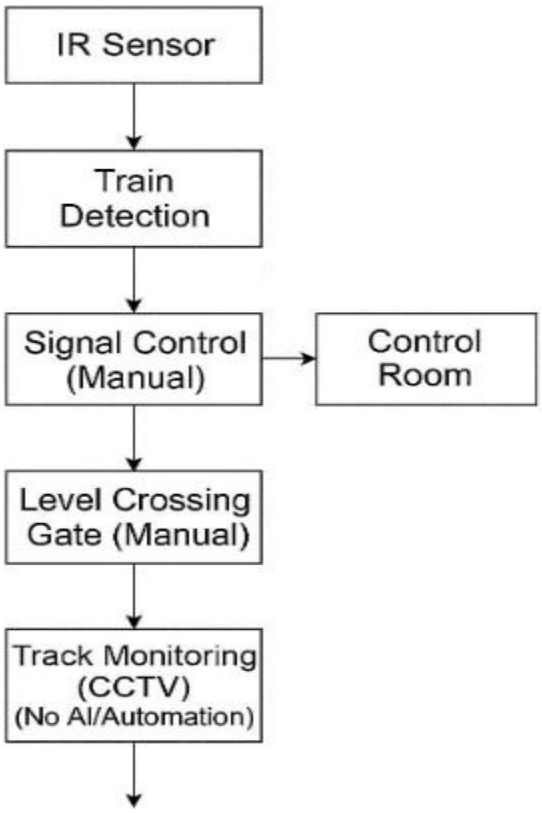
3.1 BLOCK DIAGRAM OF EXISTING SYSTEM

The below figure 2.1 shows block diagram of existing system



Block diagram of Existing System

3.2 DISADVANTAGES OF EXISTING SYSTEM

High Risk of Accidents: Due to human error and delayed responses.

Inefficiency: Manual monitoring is time-consuming and less efficient.

Limited Coverage: Difficult to manually monitor thousands of miles of railway tracks.

IV. PROPOSED SYSTEM

The proposed system architecture is centered around the Arduino UNO microcontroller, which serves as the main processing unit. Various input sensors are connected to it, including an IR sensor for train detection, an ultrasonic sensor for obstacle detection, a RPS for real-time location tracking, and an IR sensor-based module for track crack detection. An ESP32-CAM module is integrated for live video monitoring of the tracks, helping to ensure safety and surveillance.

4.1 BLOCK DIAGRAM OF PROPOSED SYSTEM

The system uses IR sensors placed along the railway track to detect the presence of an approaching train and monitor critical areas such as crossings. An ultrasonic sensor is used to detect obstacles on the track, while another IR sensor module checks for possible cracks or damage on the rails. An ESP32-CAM module is integrated to provide live video feed of the railway environment, which enhances safety by visually monitoring the track. All sensor data is processed by the Arduino UNO, which acts as the central controller. When a train is detected, the system activates a servo motor to automatically lower the level crossing gate, preventing accidents. At the same time, alerts are generated through a buzzer and important information is displayed on an LCD screen for on-site monitoring. A Wi-Fi module enables communication with an IoT cloud platform such as SMTP, allowing the collected data and video feed to be monitored remotely. Notifications are also sent through email to the concerned authorities for timely response to any abnormal conditions.

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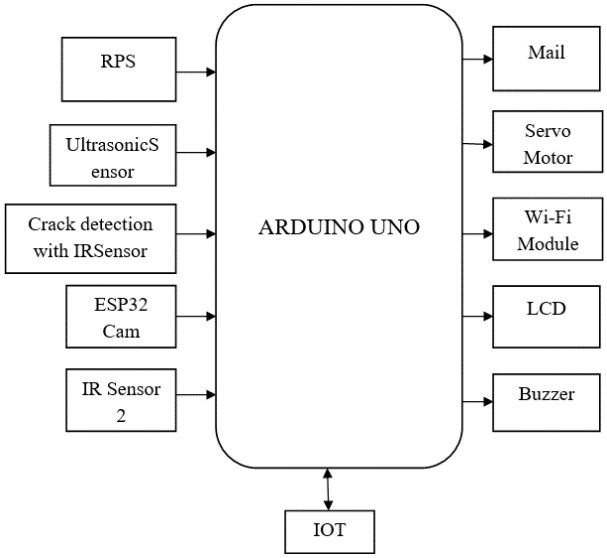
the block diagram of proposed system. The proposed system contains different modules consisting of both hardware and software components



V. BLOCK DIAGRAM OF PROPOSED SYSTEM

HARDWARE COMPONENTS

The following hardware tools used in the proposed system

Power Supply, Arduino UNO, Ultrasonic Sensor, IR Sensor, ESP32 Cam, Mail (SMTP Protocol), Servo Motor, Wi-Fi Module, LCD, Buzzer

SOFTWARE COMPONENTS

The following software tools used in the proposed system: Arduino IDE, Proteus Design Tool

TECHNOLOGY USED

IOT

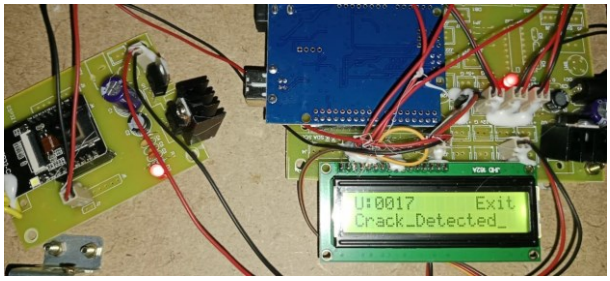
VI. RESULT AND DISCUSSION

PROTOTYPE

the prototype of the project

Prototype of the Project

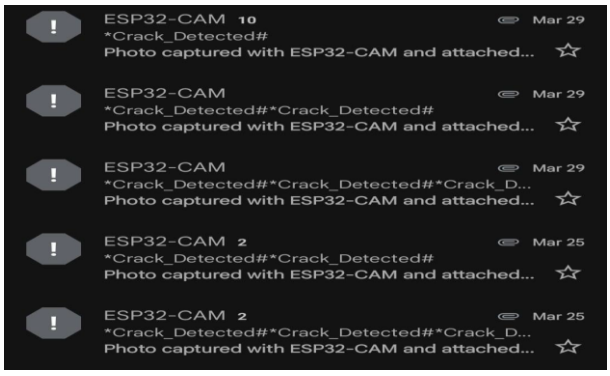
the Crack detected, Object avoidance and gate control on LCD



Showing the data on LCD

EXPERIMENTAL RESULTS

the real-time monitoring of the ESP32 camera



Realtime monitoring

VII. CONCLUSION

Before summing up, we can say accidents occurring in the railway transportation system

cost a huge number of lives. So, an advanced and dependable system is needed to avert these types of accidents and also find out the possibilities of their occurrence. The proposed model is a simple prototype that will work as an independent inspector for the railway network. This system is highly reliable and cost-effective in any traffic area, sub urban area, and the routes. Furthermore, this is small in size and low power consumption, which is, in fact, a simple solution to all the problems of a railway mishap in one system. This system will work all the modules at a time to reduce accidents.

VIII. FUTURE SCOPE

The output from a piezo vibration sensor was fluctuating, and it was giving a small value against very high vibration. The overall demonstration gives expected outcomes through the vibration of the train was insufficient so that it cannot detect from a desired distance by the vibration sensor. On the other hand, the FSR, Servo Motor, HC-SR04Sonar, was very much compatible. In a demonstration, GPS could not be able to distinguish the different locations of trains as it was a minimal setup. Therefore, it was ignored to use GPS and work with IR to stop the train and sent massage through the internet only to the control room, which was working well.

REFERENCE

1. Tanveer, M., Kashmiri, F.A., Abbas Rizvi, S.M., Ahmad, M., Sun, Y. and Lu, H., How Can the ML1 Revitalize the Pakistan Railway System. In CICTP 2020 (pp. 2483-2494).

2.Fatma, S. and Nath, V., 2019. Study and design of smart embedded system for train track monitoring using IoTs. In Nanoelectronics, Circuits and Communication Systems (pp. 383-395). Springer, Singapore.

3.Karthick, S., Patil, A., Ullas, S.U. and Saravanakumar, K., 2017. Obstacle Detection System for Railways. International Journal of Trend in Research and Development (IJTRD).

4. Zhao, Y., Yu, X., Chen, M., Zhang, M., Chen, Y., Niu, X., Sha, X., Zhan, Z. and Li, W.J., 2020. Continuous Monitoring of Train Parameters Using IoT Sensor and Edge Computing. IEEE Sensors Journal.

5. Abduvaytov, A., Kayumbek, R.M.A., Jeon, H.S. and Oh, R., 2020, November. The Real Time Railway Monitoring System suitable for Multi-View Object based on Sensor Stream Data Tracking. In 2020 International Conference on Information Science and Communications Technologies (ICISCT) (pp. 1-4). IEEE.

6. Abdel-Aty, M.A., Abdel-Rahim, A., Abdulla, S., Abdullah, N.F., Abolfazli Esfahani, M., Abolhasan, M., Abosekeen, A., Achar, A., Ahmed, S.A., Ahn, C. and Ahn, S., 2020. 2020 Index IEEE Transactions on Intelligent Transportation Systems Vol. 21. IEEE Transactions on Intelligent Transportation Systems, 21(12).

7. Al-Turjman, F. and Zahmatkesh, H., 2020. A Comprehensive Review on the Use of AI in UAV Communications: Enabling Technologies, Applications, and Challenges.

ISSN 2347–3657
Volume 13, Issue 2, 2025

Unmanned Aerial Vehicles in Smart Cities, pp.1-26.

8. Singh, S., Sabde, K., Jais, R., Ukudde, A., Kshirsagar, P. and Mohod, A., 2020. IoT Based Automatic Vehicle Detection for Railway Gates. International Journal of Research in Engineering, Science and Management, 3(7), pp.235-238.

9. Gorobetz, M., Alps, I., Potapov, A. and Levchenkov, A., 2017, October. Reliability improvement of embedded train anti-collision system by multi-processor technology. In 2017 IEEE 58th International Scientific Conference on Power and Electrical Engineering of Riga Technical University (RTUCON) (pp. 1-5). IEEE.

10. Mir, A. and Swarnalatha, R., 2018. Implementation of an industrial automation system model using an Arduino. Journal of Engineering Science and Technology, 13(12), pp.