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Smart Interlocking Detection System

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ABSTRACT: This paper proposes a "SMART INTERLOCKING DETECTION SYSTEM" which has been designed to control railway track devices including railway switches and signals within a given area from a single point. Such control is exercised through the use of various track circuits which detect the presence of trains on a particular track and monitor the train's safety from a central room. The system secures the safety standards as well as economical and beneficial switch and signal control within a distance maintaining reliability, sensibility, and precision. This research is based on microcontrollers to reduce the complexity and cost. A low-power DC motor is used as a track-switching device. In the sensing unit photodiode is used for detecting IR radiation which ensures a reliable detection of trains' entrances. A communication line communicates between the track-switching device and the main monitoring room. The total system can be monitored and visualized by software that shows the train's position, operation mode, and safety status. This system can work both automatically and manually and also can be controlled by the software from the main control room which gives the system more flexibility in operation.With the help of IoT technology we can easily get the feedback of interlocking of the railway tracks. This technology will help to prevent major accidents of trains due to the interlocking failure. The software will monitor and maintain the whole process to secure the safety of the train. By analyzing cost, efficiency, and reliability the system is found better than the existing system. The software will monitor and maintain the whole process to secure the safety of the train. By analyzing cost, efficiency, and reliability the system is found better than the existing system.

KEYWORDS: Interlocking, Smart Interlocking Detection System, System Security.

I.INTRODUCTION

As the major part of the public transport system railway serves millions of passengers and carries tons of goods every day. Railways provide a better alternative to other modes of transport by being energy efficient since they can carry large numbers of people and goods at the same time. As a result, the railways have grown over the years, and also the number of people using it. It contributes a lot to our economy. It is their responsibility to have a good management system for good customer service. Therefore, the management must make the train journey safe & reliable. But the recent train accidents especially head-on collisions make the passengers think otherwise. The old signalling and operating systems sometimes make wrong operations which causes severe train accidents with a huge number of casualties as well as colossal financial losses. In our research, the sole idea was to design a system to avoid head-on collisions of trains due to either desperation or maliciousness. The system will work automatically and send the information to the central control authorities for further processing. Some sensors have been used to detect the train position and communication line to communicate from the rail track to the main control room. The development in the railroad area has brought about an expansion in the train activity thickness over the world. This has brought about the expansion in the number of mischance including trains.

II.SYSTEM MODEL AND ASSUMPTIONS

India's railways take numerous measures to prevent accidents, but they still have to face the loss of problems and the waste of money. During this period, we plan to work on a project that can help solve some real problems. Then, we discovered some problems such as detecting faults in the railroad to avoid accidents and we also tracked down the location of such faults. The current railway interlocking system faces challenges in ensuring optimal safety and efficiency. The need for a SMART INTERLOCKING DETECTION SYSTEM arises to address these concerns by integrating advanced sensors and AI algorithms for real-time monitoring, reducing incidents, and enhancing overall railway operations.

This project proposes a "SMART INTERLOCKING DETECTION SYSTEM" which has been designed to control railway track devices including railway switches and signals within a given area from a single point. Such control is exercised through the use of various track circuits which detect the presence of trains on a particular track and monitor the train's safety from a central room. The system secures the safety standards as well as economical and beneficial

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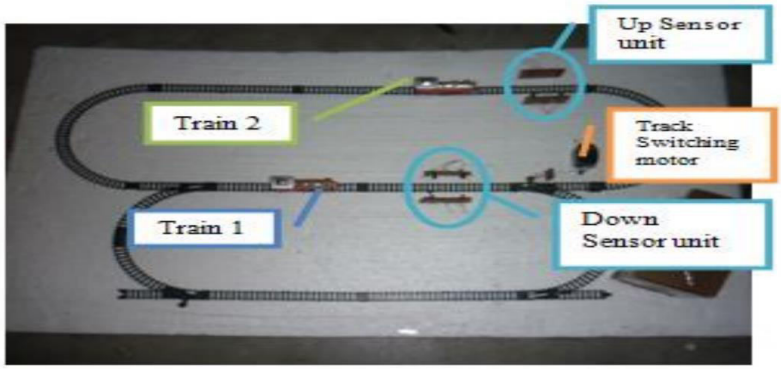
III. METHODOLOGY

In India, the railway is the main source of transport and, therefore, as with any problem during transport, the main damage to the economy occurred despite the social life. At present, railways use manual methods of detecting cracks through human inspectors. Taking all this into consideration, it will be necessary to develop an automatic obstacle detection system, which is also used to detect railway breakage. Rail transport always depends only on the train tracks. If there is a crack in these tracks, it creates a big problem. Most of the train accidents are due to cracks in the train tracks, which cannot easily be identified. It also takes more time to solve this problem. Most of the commercial transport is carried out by the railway network and, therefore, any problem in the railway can cause significant damage to the economy, despite the social impact of loss of life or physical integrity. This project presents an economic solution but robust to the problem of the detection of railway cracks using a unique method in the sense that, while it is simple, the idea is completely profitable. The project analyzes in detail the technical and design features and also provides the robust cracks detection algorithm proposed. The project also presents details of the implementation results of the use of simple components that include the IR-LED-PHOTODIODE-based crack detector assembly.

IV. METHOD

When a train passes the up-sensing unit then the entrance information is stored in the microcontroller. If the train is outgoing (out of the junction) the procedure is repeated. If the train is incoming (into the junction) then the down-sensing unit status is checked. If the train is outgoing at the down sensing unit, then the operation is again repeated. Otherwise, if the train is incoming, while it ensures that two trains are on the way in a face-to-face direction, the microcontroller sends the information to the PC. If the PC control software is configured as automatic then the microcontroller sends a signal to the track switching motor to switch track. If the PC control software is configured as manual then the microcontroller waits for the controller personnel's response and operates accordingly. The overall flow chart of the system is shown in the following. A prototype implemented model has two sensing units: An up sensor unit and a down sensor unit and also has a track switching unit. Two units separately sense the train's position on a particular track at a particular time. If both sensors sense that the two trains are on the same track then the control software sends a signal to the track-changing motor to bypass one train from another. Here, track switching should consider the single track, if the train line is a single track then how train be bypassed? In that case, we have to find the nearest train station that has two lines and the sensor arrangement & software algorithm should make a way so that in a particular distance finding that station the trains bypass each other.



Theoretical Background: This Section aims to explain the paradigm and predictive maintenance. Furthermore, the main railway areas, the DT enabling technologies, and AI categories and subareas are explained to better understand the Sections that follow

Digital twin: It describes that DTs concentrate on bilateral interdependency between physical and virtual assets. The interdependency brings advantages, such as the physical asset can adapt its behavior according to the feedback

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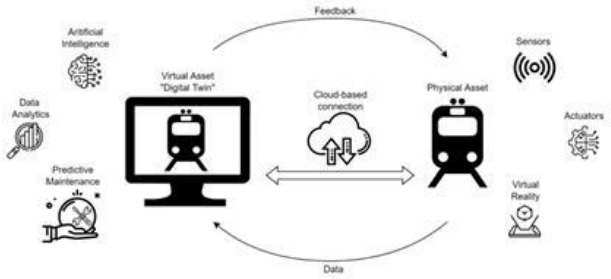
generated by the DTinreal-time. Interconnection also enables one to mirror the real-world condition of the physical asset in a simulation. The interconnection can be realized with IoT sensors that collect data and send them to the cloud. These data can, in turn, be analyzed in the digital space by applying, among others, AI techniques (e.g., ML algorithms) and/or big data analytics. Based on the results from the analysis, possible critical faults can be detected. These features of a DT are shown in the figure



Digital Twin Enablers: This part discusses the enabling technologies, here called enablers, and barriers of DTs in the process industry. The authors categorize the DT enablers into a list of categories, where some of the most important enablers for this thesis work are discussed as follows.

IoT/IIoT is another category of enablers, such as the IoT, Industrial IoT (IIoT), Sensors, RFID, NFC, actuators, and others. These technologies make communication among devices possible. Sensors can collect massive amounts of data that can be further analyzed to detect faults for predictive maintenance, so maintenance operations are performed only when needed.

VR/AR category stands for the enablers of virtual and augmented reality. discuss that AR and VR allow the user to understand better, e.g., a manufacturing process or enable the user to train and run simulations in a virtual environment. Intelligent sensor data integration by Jiang discusses the railway industry's demand for on-site data collection, control and management. The authors propose a monitoring platform design and architecture for intelligent high-speed railways. Jiang et al. also discuss the DT architecture, from collecting real-time data from the sensors, and integrating sensor monitoring data, to providing optimal solutions for failure handling. The aim of the DT is to develop a high-intelligence stage to intervene during abnormal working conditions through automatic monitoring and to prevent accidents. Errandonea propose an IoT approach for intelligent data acquisition for generating DTs in the railway industry, with the goal to create an onboard system for maintenance prediction in trains. The authors detail the architecture of the approach in three aspects: The communication module for near-real-time communication and batch information transfer. The functional design of the system, where the processing and integration of the sensor data are done in modules so that the system remains independent. Data ingestion technologies, where the authors make use of Apache NIFI since it allows different data sources and parallel executions. Thus, the presented approach offers a valid solution for managing the transmission of data.

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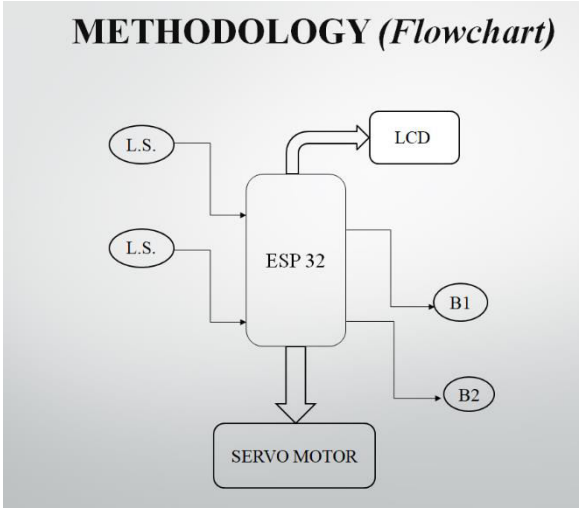

V. RESULT AND DISCUSSION

As a result, the advanced interlocking system not only prioritizes passenger safety but also contributes to the reliability and punctuality of rail services, ultimately shaping a safer and more efficient future for railway transportation. And with IOT technology we can get double feedback about the interlocking, which will help to neglect rail accidents because of interlocking failure. The project successfully achieves its objectives of Interlocking in Railway tracks.

VI.CONCLUSION

In conclusion, the implementation of the advanced interlocking system for railway tracks marks a significant leap forward in ensuring the safety of passengers and the efficiency of rail transportation. This innovative system seamlessly integrates cutting-edge technology to monitor, control, and optimize the intricate network of railway tracks. By employing state-of-the-art sensors, automated signalling, and real-time data analysis, the system minimizes the risk of accidents and enhances overall operational safety. The project's success lies in its ability to mitigate human error, reduce response time during emergencies, and facilitate smoother coordination between different sections of the railway network.

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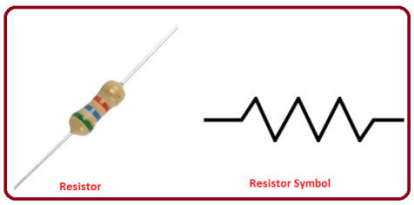
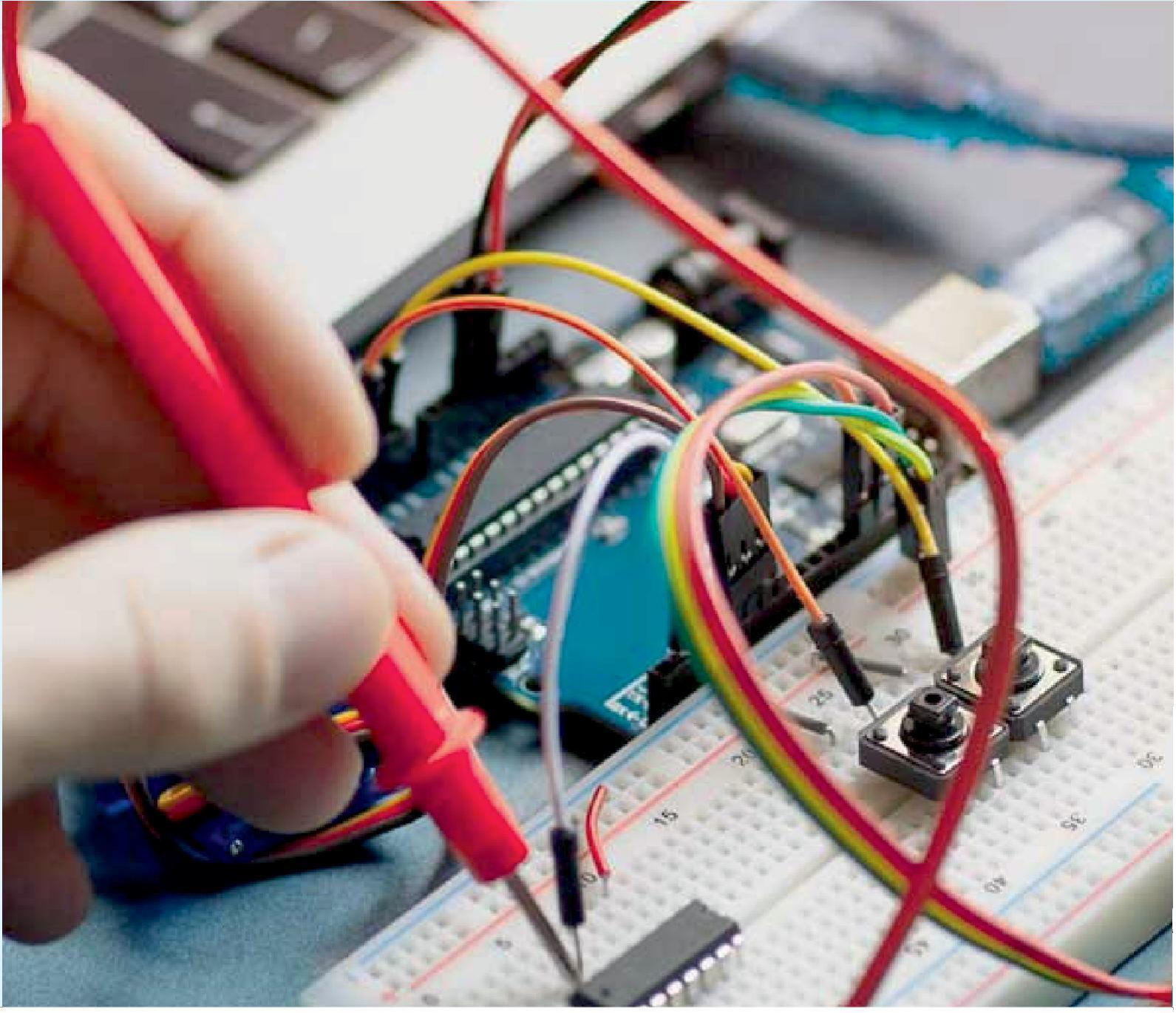
APPENDICES:

ESP 32 MICROCONTROLLER	
DC SERVO MOTOR	
RESISTOR & LIMIT SWITCH	



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