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SECURED RAILWAY-LEVEL CROSSING SYSTEM WITH SELF-SUSTAINING BY USING RACK AND PINION MECHANISM

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ABSTRACT

Railroad level crossings remain a significant problem for the Indian railways and other countries globally, causing economic losses and safety hazards. To address these challenges, the railway network must find ways to reduce power consumption and generate power using sustainable mechanisms. One solution proposed in this paper is an automated railway crossing system that leverages IoT technologies and embedded sensors, including an IR sensor, to detect train arrivals and departures and open and close the gate accordingly. The system utilizes a rack and pinion mechanism to generate electricity, reducing the burden on the railway sector while preventing level-crossing accidents. The system's performance can be monitored through the LCDS display and an ESP32 camera, enabling real-time surveillance of the railway level crossing. By implementing this innovative solution, the Indian railways and other railway networks globally can reduce accidents and power consumption while promoting sustainable practices.

Keywords: *automated railway level-crossing, the IR sensor, rack, pinion mechanism, electricity.*

I.INTRODUCTION

The railway system plays a crucial role in a country's economy, and India's railway network is ranked fourth in the world, covering over 68,000 km. Unfortunately, the country faces a significant issue with railway level crossings (RLCs), with over 31,000 such crossings, of which 13,530 are unmanned. These crossings have been responsible for thousands of fatalities in recent years, caused mainly by negligence on the part of gatemen or road users. However, the implementation of automated railway level crossings could significantly reduce the number of accidents and associated losses. India has already witnessed a high number of railway-level crossing accidents between 2000 and 2016, with varying numbers of casualties each year. Furthermore, the Indian railway network

The railway network consumes a large amount of energy, requiring over 20 billion units annually. To address this, recent research proposes a power generation method using automated sensors that convert mechanical energy into electrical energy via the rotational motion of the pinion, thereby reducing energy consumption and increasing revenue.

II. LITERATURE SURVEY

In his work, Atul Kumar Dewan Gan provides a comprehensive overview of the current railway technologies and highlights the drawbacks of relying on manual railway signals and level-crossing alerts. The focal point of the automation system for level-crossings is the train detectors [1].

In a study conducted by Green, R.J., an intelligent control system for railway level crossings with multiple tracks was proposed. The system utilizes sensors to receive information from incoming and outgoing trains, such as train direction and identity. Using this a controller device is responsible for determining when to open or close the level-crossing gates. However, the implementation of this technology [2].

Jeong Y developed a railway automation system that utilizes OSGI and JESS for estimating the state

of the crossing. However, a limitation of the system is that it cannot control the speed of the train within a range of 1 km [3].

Qiao Jian-hua developed a railway track control method that utilizes anti-collision techniques and sensors. The sensors are positioned at a certain distance, and they detect incoming trains, enabling the control of gate operations accordingly [4].

M. E. Amiryar has introduced Energy Storage Systems (ESS) as a solution to enhance the efficiency of electrical systems during imbalances between supply and demand. These systems are also crucial in improving the stability and quality of electrical networks, providing flexibility to the system by reducing supply intermittency [5].

III THE PROPOSED METHODOLOGY

A proposed Self-sustained railway crossing accident prevention system utilizes an IR sensor and voltage sensor to detect train arrival and departure and opens or closes the crossing gate via a servo motor. The system aims to reduce accidents caused by careless behavior or unmanned crossings. An ESP32 Camera can be placed to monitor crossings. The project also focuses on power generation, using a rack and pinion mechanism connected to a DC motor. The rotation of the train-fixed rack rotates the track-fixed pinion to generate power, making the system efficient and multifunctional. This is shown in fig-1.

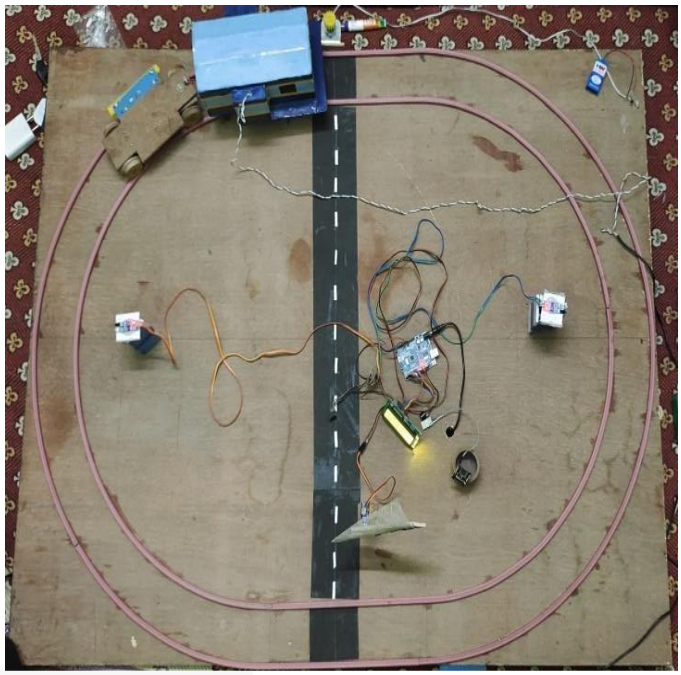

Fig.1. Prototype of the Project

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A. FLOW CHART

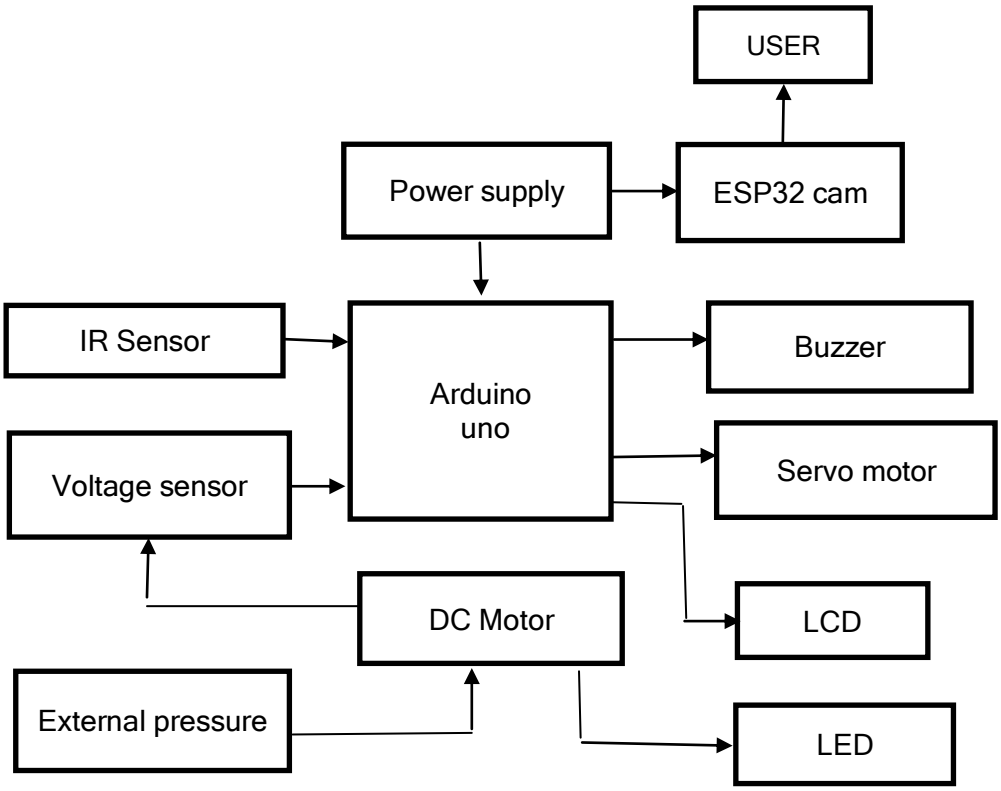

Fig. 2.. Architectural view automated level crossing and power generation

Figure 2 illustrates the block diagram of the proposed system, which comprises of two sensors - an IR sensor linked to the digital pins of the controller and a voltage sensor linked to the analog pins of the controller. Both the power supply of the Arduino Uno and the common ground node are connected to the common node of the power supply. The DC motor is indirectly connected to the LCD through the Arduino Uno and the voltage sensor.

IV OBSERVATIONS AND RESULTS

The main objective of this project is to automate level crossings and generate power. An ESP32 camera is installed to monitor the environment at a level crossing. When a train is detected by the IR sensor, an alarm is triggered to alert road users, and the servo motor opens or closes the gate according to the train's proximity. Once the gate is fully opened, the buzzer is deactivated. This prototype automates the level-crossing process and generates power using the rack and pinion mechanisms. as shown in Figs 3 and 4 respectively.

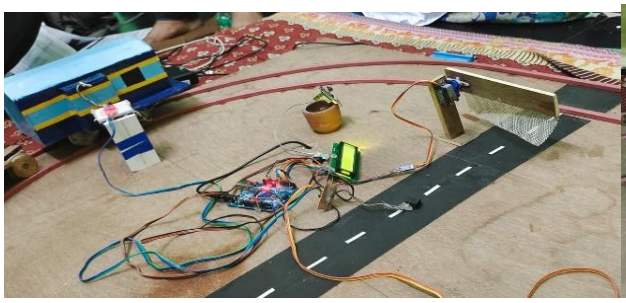

Fig.3. Power generation indication

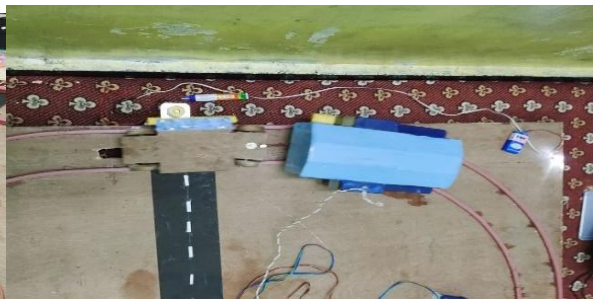

Fig. 4. Automated railway level-crossing

V. CONCLUSION

The automatic level-crossing system is considered a highly efficient and optimal solution to the problems faced by trains in India. This system provides significant benefits to road and rail utilization managers and helps prevent negative consequences as it requires no human resources. It can be installed in remote and rural areas where guardrails are not available. The proposed system uses a servo motor to lift and lower the gate to a specific angle, providing reliable and accurate results. As the demand for electricity continues to rise, engineers must seek new ideas to generate electricity. By converting energy into a usable form, we can power station equipment, lights, fans, signal lights, etc. This system can be installed at the station entrance and starting point and can be adapted for various applications. In conclusion, the proposed system is expected to offer superior performance, reliability, and lower cost compared to existing systems.

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