International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 8, Issue 3, pp 304-309, March-2024

https://doi.org/10.47001/IRJIET/2024.803046

Automatic Railway Track Crack Detection System

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***Abstract* - Railway system is the most commonly used transportation system especially in India. But due to miscommunication about the railway schedules and lack of coordination, accidents happen. According to survey, 60 % of the accidents happen either at crossings or cracks in railway tracks. To avoid these situations, it is necessary to have an accurate system for both of them. This project proposes a system which includes automated railway gates at crossings and also automatic crack detection in railway tracks. This model is implemented using sensor technique. The sensors are placed at a certain distance from the gate and they detect the approaching train and accordingly control the operation of the gate. After detecting the crack, the coordinates are tracked and sent back to control room for further actions. This system includes IR sensors, ARDUINO microcontroller along with GPS and GSM modules. This will help in detecting the cracks and functioning of gates get done without any human intervention.**

Keywords: IR sensor, GPS, GSM, Arduino and Alert message, etc.

I. INTRODUCTION

The Indian Railways has one in all the greatest rail route networks inside the world, emergencies organic interaction one, 15,000 kilometers in distance, wherever Asian country. Robotized entryway - free rail route activities are uncommon these days due the human carelessness and miscommunications which prompts mishaps and deferral in appearance of the train; the way or the region where street and rail lines meet is realized rail line crossing Gates are physically worked, blunders which may give rise while shutting and opening, the strategy proposed here, our venture presents an entirely different method of computerizing the things. In this proposed work attempts to build up a strategy which does the robotization door tasks (opening and shutting) utilizing Two IR sensor put in two ways and utilizing Motor for shutting and opening of an entryway. Track Crack recognition - ongoing investigations revealed that more than twenty fifth of the track length is in might want of substitution thanks because of the improvement of breaks on it. Manual recognition of breaks is troublesome and not completely successful which prompts a lot of time. Our work presents an undertaking that points in planning hearty rail line break location plot (RRCDS) utilizing wired association all through the track at whatever point the association between wires lost, get together framework that identifies the breaks on railroad tracks. And furthermore fit for alarming the experts as SMS. We will get the longitude and scope area where the break occurred by GPS module.

Figure 1 depicts the crack on track. The Rail transport is growing at a rapid pace in India. It is one of the major mode 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 is due to derailments, recent measurements shows that about 90% are due to cracks on the rails. Hence, it is not safer for Human Life. This needs to be at the utmost attention. These goes unnoticed and the properly maintenance of tracks is not done.

Figure 1: Railway crack on track

II. LITERATURE REVIEW

This system is mainly concerned in identifying the cracks in railway tracks and helps to prevent the accidents without manual power. It's not only concentrated on finding damaged tracks but also helpful to find out the derailment and the exact place where it is. In this technical solutions offered by many companies in the detection of cracks in rails involve periodic maintenance coupled with occasional monitoring usually once a month or in a similar time frame. But the robotics possesses the inherent advantage of facilitating monitoring of rail tracks on a daily basis during nights, when the usual train traffic is suspended. Further, that the simplicity of this idea and easy availability of the components make for implementation on a large scale with very little initial investment. The simplicity of

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this work ensures robustness of operation and also the design has been carefully modified to permit rugged operation. Another disadvantage that can be attributed to the conventional commercially available testing equipment's is that they are heavy which poses a practical limitation. This important disadvantage has been rectified in robotics project as the design is simple and sensible enabling the device to be easily portable. While designing the mechanical parts of the robot, due consideration has been given to the variable nature of the tracks and the unique challenges possessed by the deviations in the Indian scenario. For example, in areas near road crossings the outer part of the track is usually covered with cement. Also, there is always the problem of rocks obstructing the path on the inside parts of the rails.

E Amarnatha Reddy, Ilaiah Kavati, K Srinivas Rao, G Kiran Kumar have made a project to develop a prototype that control the railway gate using the microcontroller. Whenever train touches base at the sensor, caution is activated at the railway crossing so that the general population get instruction that entryway will be shut. This logic was implemented in Embedded C and dumped to the Raspberry. [1]

Dr. Velayutham.R, Sangeethavani.T, Sundaralakshmi.K have made a track and detect the arrival of the train by using GPS and not by the sensors. This way of train tracking using GPS is embedded with our mobile application. Using this application, the engine driver controls the railway gate. [2]

Miss. Sandhya Sharma, (Prof.) Dr. Neetesh Kumar Gupta have made a project a genetic algorithm is proposed that segment the image in defined part. After segmentation crack detection was done by analyzing image using TBLR threshold. Experiment is done real as well as artificial dataset. [3]

Afsana Ahmed, Kazi Rifah Noor, Tanveer Rahman have made a project, that proposed a method which is capable of controlling rail gate for level crossing which is totally automated. Couple of Sensors are connected with Wemos D1 for control autonomous rail gate with measuring distance and Thing Speak server has been used to centrally control. [4]

Marwa M. Eid, M. I. Fath Allah have made a project that is established on an Arduino UNO embedded platform to introduce automatic control crossing gates, switching train tracks and detecting line cracks with the aid of electronic sensors like IR sharp sensor, ultrasonic sensor, and gyroscopes. [5]

III. PROBLEM STATEMENT

In India railways transportation service is the cheap and the majority convenient mode of passenger transport and also for long distance and suburban traffic. The main cause of the accidents happened in railways are railway track crossing and unrevealed crack in railway tracks. Therefore, there is a need to have new technology which will be robust, efficient and stable for both crack detections in railway track as well as object detection.

This project discusses a Railway track crack detection using sensors and is a dynamic approach which combines the use of GPS tracking system to send alert messages and the geographical coordinate of location.

IV. METHODOLOGY

The system uses an Arduino UNO as the microcontroller to control all of the components. It is using software Arduino IDE as a platform to make the coding.

This system involves the design of crack finding robot for finding cracks in railway tracks. This system uses controller for interfacing the robotic vehicle and crack detection sensor. The sensing device senses the voltage variations from the crack sensor and then it gives the signal to the microcontroller. The microcontroller checks the voltage variations between measured value and threshold value and controls the robot according to it.

The robotic model is interfaced with the microcontroller with the help of SPDT relays and driver IC. If any crack occurs in the rail, the robot will be stopped and then an alarm will be raised.

This project uses regulated 5V, 750mA power supply. 7805 three terminal voltage regulator is used for voltage regulation. Bridge type full wave rectifier is used to rectify the ac output of secondary of 230/18V step down transformer.

V. SYSTEM DESIGN

The project block diagram is shown in Figure, which contains following process:

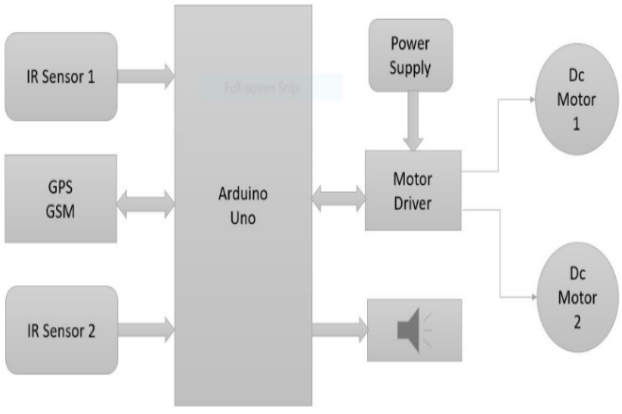

Figure 2: Block Diagram

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- Initially the tracks are being continuously monitored with the help of sensor, which is used to detect the crack in the track.
- This monitoring is done with the help of IR sensor in order to sense the minor changes also which can be quite difficult with other sensors.
- Whenever the crack gets detected with the help of IR sensor it passes the alert of crack found to the Arduino microcontroller.
- The Arduino microcontroller will perform the process assigned to it accordingly.
- The process mainly includes positioning, sending and alerting through the help of GPS module.
- As the message gets delivered to the Railway Authority, the alert is to be taken into account and important measures must be taken by them in order to avoid future incidents and miss happenings which can lead to loss of human life and also to major injuries.

Following figure shows the flowchart of the system:

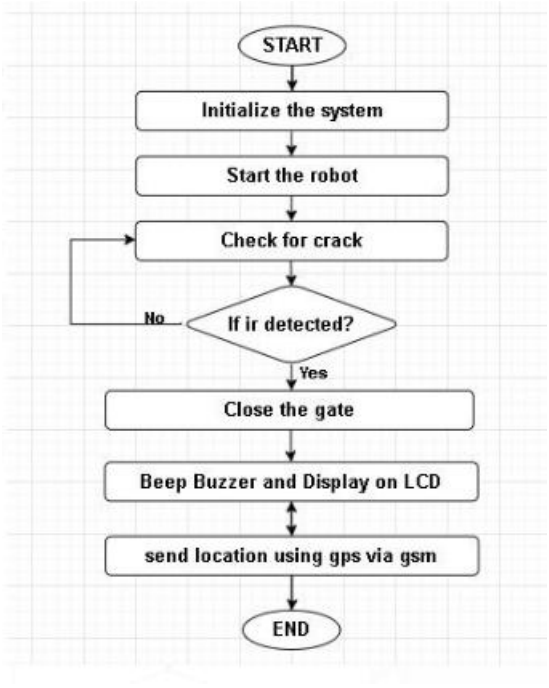

Figure 3: Flowchart of the System

VI. CNN ALGORITHM

A) Import the Given Image from Dataset

Using Keras' pre-processing picture data generator function, we must import our data set and generate the size, rescale, range, zoom range, and horizontal flip functions. Next, we use the data generator method to import our image dataset from the folder. Here, we set the parameters for the train, test, and validation phases as well as the target size, batch size, and class mode. We then use this function to train our own network by adding CNN layers.

B) To Train the Module By Given Image Dataset

With the help of a classifier, fit generator function, training steps for each epoch, the total number of epochs, validation data, and validation steps, we are able to train our dataset.

C) Working Process of Layers in CNN Model

Convolutional neural networks, or CNNs, are a type of deep learning technique that can recognize different characteristics of an input image and assign weights and biases to them based on training. Compared to alternative classification techniques, ConvNet necessitates significantly less pre-processing. Primitive techniques require hand-engineered filters, but with sufficient training, ConvNets may learn these filters and properties. The architecture of a ConvNet was impacted by the configuration of the Visual Cortex and is akin to the patterns of connections between neurons. Only alterations in the receptive Field, a very small area of the visual field, cause individual neurons to fire. Each of the four levels in their network comprises 1,024 input units, 256 in the first hidden layer, 8 in the concealed layer, and 2 output units.

Input Layer: CNN's input layer holds picture data. Three-dimensional matrices are used to represent image data. It must be rearranged into a single column. A photograph that is 28 × 28 = 784 in size needs to be transformed to 784 x 1 before it can be entered.

Convo Layer: Since the convolution layer extracts features from the image, it is often referred to as the feature extractor layer. A portion of the image is first linked to the Convo layer, which performs the convolution process described earlier and calculates the dot product between the filter and the receptive field, a local area of the input image that is the same size as the filters. The output volume of the process is represented by a single integer. Next, repeat the technique by applying a Stride filter over the subsequent receptive field of the identical input image. Until the entire image has been processed, it will carry out this process again. The output will be the input for the next layer.

Pooling Layer: A pooling layer is used to reduce the physical volume of the input image after convolution. It is used in between two convolution layers. Applying FC after the Convo layer without adding pooling or max pooling will need a lot of processing power. Therefore, using maximum pooling is the sole method to reduce the geographic volume of the input

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image. Max pooling was used in a grayscale slice with a Stride of 2. It detects that the 4 x 4 input is reducing to a 2 by 2 size.

Fully Connected Layer (FC): Within the completely linked layer are neurons, weights, and biases. It establishes connections between neurons in different layers. People have learned how to classify photos into several groups by using it.

Softmax / Logistic Layer: The last layer of CNN is called Softmax. It is located at the base of the FC layer. Softmax is used for multi-classification, while logistic is used for binary classification algorithms.

Output Layer: The output layer stores the label as one-hot encrypted data. You now comprehend CNN quite well.

D) Classification

The first step in the analysis of video streams is called Moving Object Extraction, during which the system identifies and isolates objects that are in motion. This is a crucial step since it sets up the tasks of analysis and recognition that come after. Background subtraction, a method that distinguishes moving objects from the static background by identifying regions of notable change between successive video frames, is one often used strategy in this step. The system may efficiently filter out unnecessary information and focus just on the items of interest by isolating these dynamic aspects.

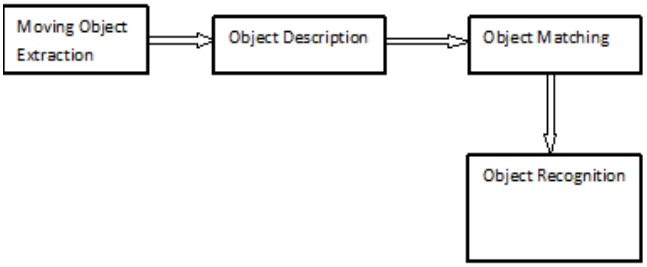

Figure 4: Classification

The system moves on to the Object Description stage after extracting the moving items. Here, each retrieved object's properties and attributes are painstakingly described by the system. Aspects like size, form, colour, and even motion patterns can be included in these attributes. The system learns a great deal about the look and behaviour of the objects by carefully examining these attributes, which helps with subsequent tasks like recognition and classification.

The retrieved objects are compared to a database of known items in the Object Matching step of the process, which comes after the Object Description stage. Determining the identity or category of each object requires this matching process. The system can determine the likely identify of the objects by comparing their attributes from the extracted objects with those stored in the database. This allows for more precise object recognition and categorization.

In the final stage, called Object Recognition, the system uses the comprehensive object descriptions and the matching results to give class labels to the objects.

VII. RESULT AND DISCUSSIONS

In this system, we use ARDUINO (ATmega328) microcontroller which acts as brain of the system, because the entire system program instruction stored in it.

We have two-IR sensors; they are used here for determining the arrival and departure of train so that opening and closing of gate can be operate automatically using servo motor.

The LED is turned to red color and buzzer makes the sound to alert the people around there.

Here we use GPS whenever crack detected on the track LED will be on and buzzer makes the sound to alert the workers and send the location to the respective department using GPS and GSM for the security alert.

Hardware Setup of the system is as shown below:

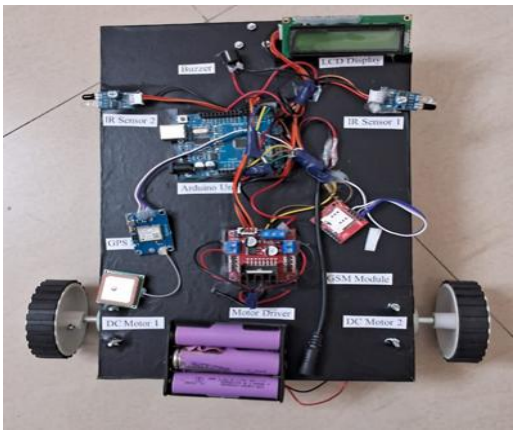

Figure 5: Hardware Setup

Figure 6: LCD Output

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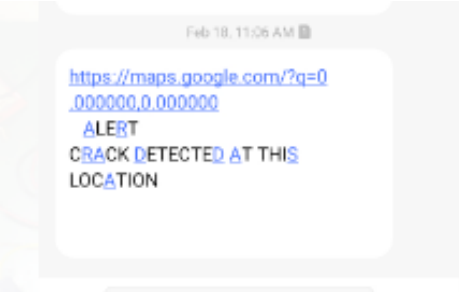

Figure 7: GSM Message

VIII. CONCLUSION

In this project, we have designed a cost effective, low-power embedded system, which facilitate better safety standards for rail tracks for preventing railway accidents due to cracks and obstacles on railway tracks. The Prototype of testing vehicle can efficiently detect cracks and obstacles on railway tracks. The result shows that this new innovative technology will increase the reliability of safety systems in railway transport. By implementing these features in real time application, we can avoid accidents up to approximately 70%.

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Citation of this Article:

Sneha Kirdat, Rohan Shinde, Tejas Khamkar, Atharva Bankhele, Prof. P. N. Todkar, "Accident Prevention and Detection Using GSM/GPS Automatic Railway Track Crack Detection System", Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 8, Issue 3, pp 304-309, March 2024. Article DOI https://doi.org/10.47001/IRJIET/2024.803046

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