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Railway Track Inspection Using Arduino and Image Processing

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ABSTRACT: In India, most of the commercial transport is being carried out by the railway network and therefore, any problems in the same has the capacity to induce major damage to the economy-notwithstanding the societal impact of loss of life or serious injury to people. This project proposes a cost effective yet robust solution to the problem of railway crack detection utilizing a method that is unique in the sense that while it is simple, the idea is completely novel and produces efficient results. Most of the time trolley is run on the track before running of rail to ensure the safety of track. This method will consume a lot of time and energy. Railway track inspection can also be done using image processing. A camera will be mounted on the device which will run on the railway track. Camera will capture the image of track of specified length this image will be compared with the initially loaded image then accordingly it detects the crack in the track if any. If any fault seen then computer will warn otherwise if there are no fault, then it proceed.

KEYWORDS: Cracks, Arduino, Infrared, Camera.

I. INTRODUCTION

In today's world, transport is a key necessity because in its absence it would be impossible for products to be consumed in areas which are not in the immediate vicinity of the production centers. The rail network traverses every length and breadth of India and is known to carry over 30 million passengers and 2.8 million tons of freight daily. Our facilities are inadequate compared to the international standards and as a result, there have been frequent derailments that have resulted in severe loss of valuable human lives and property as well. Owing to the crucial repercussions of this problem, this project presents an implementation of an efficient and cost effective solution suitable for large scale application.

The problem inherent in all various other techniques is that the cost incurred is high. Hence this project proposes a cheap, novel yet simple scheme with sufficient ruggedness suitable to the Indian scenario that uses an infrared module to detect the crack in railway lines, which proves to be cost effective as compared to the existing methods. Camera will capture the image of track of specified length this image will be compared with the initially loaded image then accordingly it detects the crack in the track if any.

II. RELATED WORK

With the advent of powerful digital signal processors, Image Processing techniques [1] have been explored to formulate solutions to the problem of railway crack detection. Though it provides good accuracy, this method uses techniques like image segmentation, morphology and edge detection all of which take a lot of processing power and an extreme amount of time rendering the robot slow and thereby unsuitable. Recent research has investigated the use of microwave horn antennas for crack detection [2]. This technique was found to produce very accurate results in lab based testing. But, unfortunately it requires spectrum analyzers which are both costly and also can't be placed on-board a moving robot because of their delicacy. Eddy current based methods ([3], [4] and [5]) are used to tide over limitations associated with ultrasonics and microwave techniques. However they have the problem of very slow overall speed which reduces the usability of the same. A vast majority of the work done in the field of crack detection

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uses the infrared sensing technique ([6], [7] and [8]). It is a well understood technique so much so that it was initially thought to be the best solution to the problem of crack detection, but later it was found to be prone to external disturbances and hence came to be considered inaccurate. Techniques that employ ultrasonics ([9], [10] and [11]) tide over some of the problems mentioned earlier, but they can only inspect the core of the track; that is, it cannot check for surface and near- surface cracking where most faults are usually located. Several other miscellaneous techniques like observation and analysis of wave propagation via model impacts and piezo actuation have also been developed.

The problem inherent in all these techniques is that the cost incurred is high. Hence this project proposes a cheap, novel yet simple scheme with sufficient ruggedness suitable to the Indian scenario that uses an infrared module to detect the crack in railway lines, which proves to be cost effective as compared to the existing methods. The important role played by transport in the development of an economy has been studied. In addition, statistics of the number of rail accidents and their corresponding causes have also been studied.

III. PROPOSED ALGORITHM

A. *Design Considerations:*

- Infrared sensors
- DC motors
- Camera
- Arduino Uno
- MATLAB software

B. *Description of the Proposed Algorithm:*

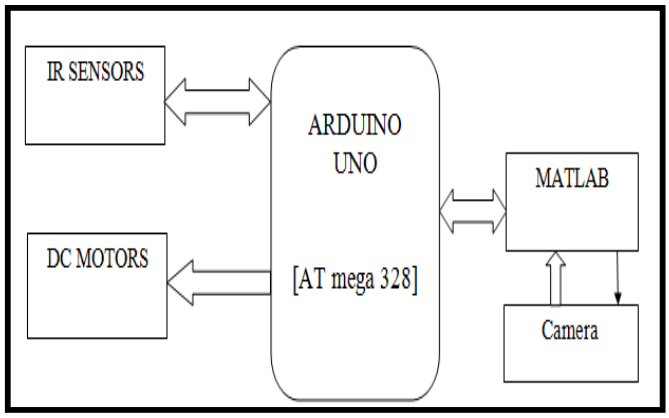

Figure 1: Block diagram of proposed model

The block diagram of the proposed scheme is illustrated in Figure 1. To ensure robustness, repeatability and easy implementation, the principle idea has been kept very simple yet effective. The model consists of the following components: The input is DC voltage of 9V and the output expected is 5V DC. This voltage is given as input to the Arduino UNO board. The Arduino board is mounted on an inspection vehicle. This inspection vehicle runs on the tracks. Two DC motors are fixed to the wheels of the vehicle. These wheels ensure the movement of the vehicle on the tracks.

Two IR sensors are used. These IR sensors are placed on either side of the vehicle. If both the IR sensors sense the track, the DC motor rotates. If any one of the IR sensors does not sense the track, the vehicle stops. These IR sensors are placed such that they can detect the crack on the railway track. If any crack is detected on the track then the vehicle stops. As soon as the vehicle stops, Arduino generates a signal to the MATLAB. On the reception of this signal MATLAB is coded to capture the image of the track. The image is captured and processed.

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Edge detection technique is used for image processing. Initially a dataset of images of the track is collected. This comprises of track with join, crack as well as a proper track. Image of a proper track is compared with the image of a track having defects. Percentage of uniqueness is used to identify if there is a crack or no. In the case if a crack is detected an alarm is sent as an output. In the case if no crack is detected or if it is a join between two tracks then MATLAB sends a signal to the Arduino to continue the inspection process.

IV. PSEUDO CODE

Step 1: Device runs on the track
Step 2: Infrared sensor continuously senses for the crack on the track.
Step 3: Check the below condition
if (crack is detected)
Go to Step 4
else
Continue with Step 1
end
Step 4: Click the image
Step 5: Process the image and check for a crack
if (actual crack)
Alert message to be sent
else
Continue with Step 1
end
Step 6: End.

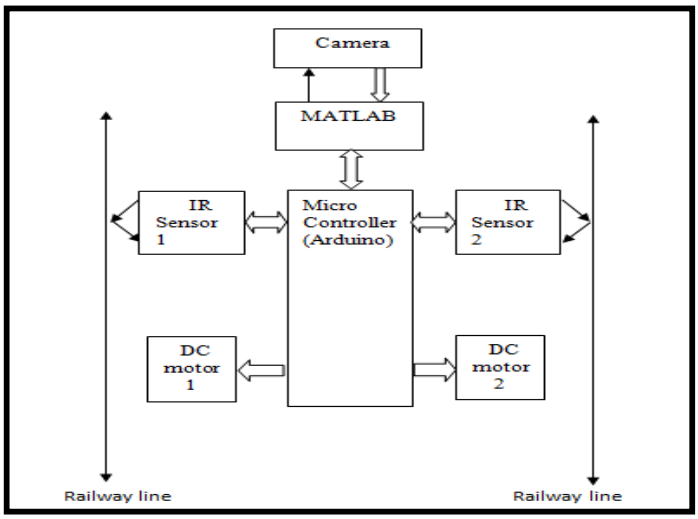

Figure 2: Technical block diagram of railway track inspection

In the Current System the principle involved in crack detection is the concept of IR sensors and image processing Technique. The Technical block diagram of railway track inspection is shown in Figure 2. In the proposed design, the IR (Infrared) transreceiver will be attached to one side of the rails. During normal operation, when there are no cracks, the IR light will reflect back and it received by the IR receiver. As a consequence, when IR light not reflect back to IR

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receiver due to the presence of a crack or a break, microcontroller will stop the motors in order to stop the proposed model at that point where it does not receive reflected IR light. Then camera will take the image of the track where it was stopped. Then captured image is processed in MATLAB such as edge detection and compare with stored images.

V. SIMULATION RESULTS

The implementation of the device is done as shown in the Figure 3. The device consists of an Arduino board. It also consists of two IR sensors. These IR sensors are to detect the cracks on the railway track. The Arduino board is programmed to receive the inputs from the IR sensor. When the IR sensor detects the normal track it gives the input to the DC motor to rotate. Four DC motors are connected to the four wheels of the device.

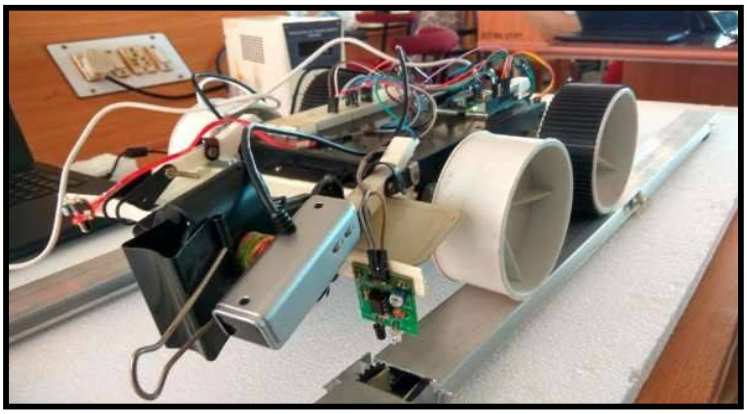

Figure 3: Implementation of the device

Generally the major condition for a gap between two tracks is either a crack or a rivet that joins the two tracks. The device is tested to detect both the cases cracks as shown in figure 4 and rivets as shown in Figure 5.

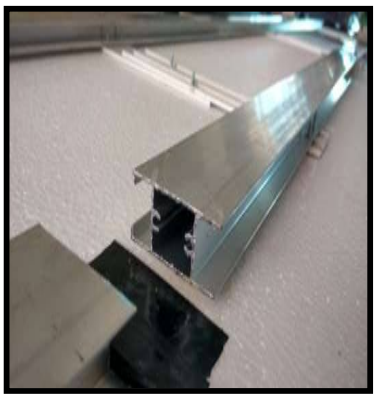

Figure 4: Crack in a track

Figure 5: Rivets in a track

The device is made to run on the track. When the device encounters a crack, the IR sensor senses the crack. Thus, the device stops and captures an image to be sent to the MATLAB software for further processing. In MATLAB testing is done to check if the detected crack is a crack or a rivet.

The captures image is as shown in Figure 6. This image is given for further processing to MATLAB software. Edge detection technique is used to compare the images. The captured image is compared with a proper track. Based on the percentage of difference between the two images the result is displayed. The snapshot of the result is as shown in Figure 7.

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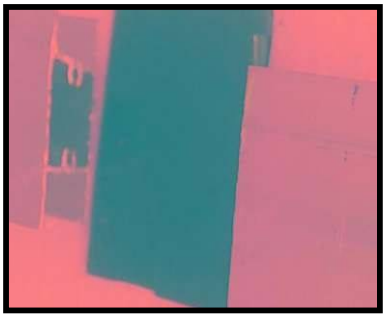

Figure 6: Captured Image

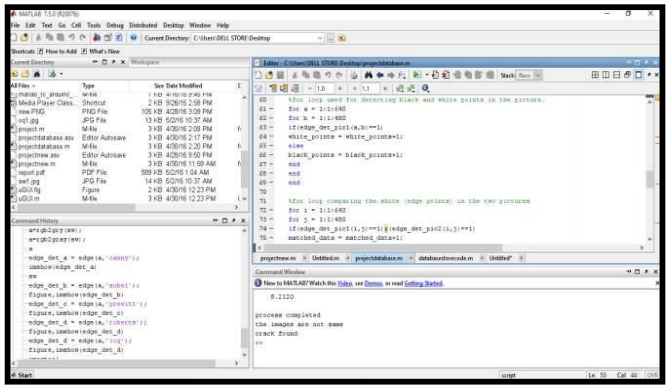

Figure 7: Screenshot of output

VI. CONCLUSION AND FUTURE WORK

The Indian railways are the largest rail passenger transport in today's world and it is the back bone of the countrys' transport infrastructure. The main problem about a railway analysis is detection of cracks in the structure. If these deficiencies are not controlled at early stages they might lead to a number of derailments resulting in a heavy loss of life and property.

The proposed broken rail detection system automatically detects the faulty rail track without any human intervention. There are many advantages with the proposed system when compared with the traditional detection techniques. The advantages include less cost, low power consumption and less analysis time. The method can be implemented in large scale in the long run to facilitate better safety standards for rail tracks and provide effective testing infrastructure for achieving better results in the future.

In future work we intend to incorporate GPS facility to the system to detect the exact position where the crack is present on the track. This facility will provide more accurate position, so we can take further action in order to repair the track quickly. In future a wireless communication between MATLAB and Arduino can be implemented.

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