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Crack Detection in Concrete Railway Sleeper

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***Abstract*—** In India, railway transport occupies an important position in providing the needful transport infrastructure to assist needs of a rapidly growing economy. Even though India has one of the largest rail networks in the world, it has not reached the global level in terms of safety and reliability. The major problems which affect safety and reliability are the crack detection done of the structures. These cracks lead to derailments of the tracks which may cause damage to life and property. This paper proposes a solution to the problem of railway sleeper crack detection using various image processing techniques.

***Keywords*—**Crack Detection, Image Processing, Concrete Sleepers

I. INTRODUCTION

Transportation is an act of moving people or goods from one place to another. In today's world, travelling is not that strenuous activity as it used to be in prehistorical days. Nowadays, travelling has become an important activity of person's day to day life. Without transportation there would be no trade. Transportation is a key factor because its absence would have a great impact on economy. Railways are the most important means of transportation in present day India. Rail transportation has accelerated industrial and agricultural growth in India. The Indian Railways have made impressive progress in the 148 years of its existence. It has played a vital role in the economic, industrial and social development of the country. The Indian Railways are now Asia's largest and world's second largest railway system under a single management, Government of India through the Ministry of Railways.

The Indian Railway network these days has a track length of 115,000 km (71,000 mi) over a route of 65,808 km (40,891 mi) and 7,112 stations [1]. In 2014-15, Indian Railways carried 8.397 billion passengers annually or over 23 million passengers on a daily basis (roughly half of whom were suburban passengers) and 1058.81 million heaps of freight within the year [1]. In 2014–2015, Indian Railways had revenues of □1634.50 billion (US$24 billion) which consists of □1069.27 billion (US$16 billion) from freight and □402.80 billion (US$6.0 billion) from passengers' tickets [2]. Though Indian Railway network is growing at a rapid pace, it is still lagging behind in terms of safety issues. India still has to meet the global security standard as they are inadequate compared to international facilities as a result of which there have been frequent cases of railway accident every year. The review of train accidents of the last 5 years (2009-10 to 2013-14) for which the data is available indicates that a large number of accidents happen because of derailments & at level crossing ([5] and [6]).

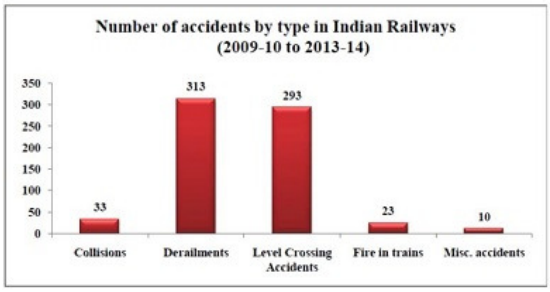


Figure 1. Statistics for accidents. [6]

Above analysis of last five year shows that, out of 672 accidents 313 were because of derailment ([5] and [6]). The major cause of derailment is the cracks present in railway sleepers, which mainly occurs due to natural causes (like excessive expansion due to heat) [3]. This problem needs to be handled as early as possible since Railways is a major mode of transportation in India. The cracks and other problems occur due to poor maintenance of tracks or faults in traditional system of manually checking the tracks that is being used nowadays. To prevent such human errors it is necessary to automate this process of identifying cracks in Railway sleepers.

II. EXISTING SYSTEM

There have been various techniques proposed for identifying cracks in railway sleepers. Researchers are trying to use microwave horn antennas for detecting cracks present in railway sleepers. This technique uses spectrum analyzer for crack detection. Spectrum analyzer is very costly and it needs to be handled with care because of its delicacy, due to which it can't be implemented on moving robot [3]. To overcome the problems associated with microwave and ultrasonic, Eddy current based methods were proposed. Eddy current based methods do not give faster results which reduces the throughput of the system [3]. Most of the mechanisms developed for detecting cracks are using

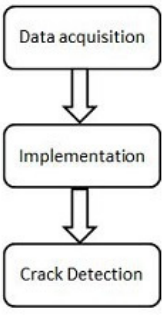
infrared sensing techniques. Results of these techniques are not accurate since they get affected by external disturbances. Ultrasonic sound technology is also used for detecting cracks. Ultrasonic is useful for overcoming some of the problems mentioned above, but ultrasonic cannot check for surface and near surface cracking where most of the time cracks are located. It only checks for core surface of the sleeper [3]. LED-LDR based design is using infrared sensors which are not suitable for external disturbances [4]. LED-LDR technique causes interruption in tunnels. It is very costly and does not give accurate results. The information being transmitted is also delayed, hence reduces the overall speed of the system.

III. PROPOSED SYSTEM

The existing image processing method uses techniques like segmentation of image, morphological approach and edge detection. This method gives accurate results but consumes a lot of power and time for processing images. Hence, this paper proposes a simple method using image processing, which takes less time. In the proposed system, video recorder will be mounted on the train to capture video of sleepers. High speed video camera will be used so as to reduce the effect of blur. The speed of the train should be controlled enough, so that sleepers in the video are distinguishable for a human eye to see. It is a pre-requirement for the system that no unidentified objects should be present on the sleepers. It has also been assumed that sleepers will have unique identification number written on them. System will identify sleepers uniquely using these identification numbers by extracting text from the image. Section IV of this paper gives detailed description of the algorithm. These captured videos will then be stored in a local database where further processing will be done for detecting cracks.

IV. METHODOLOGY

The crack detection is done in three stages as described below.

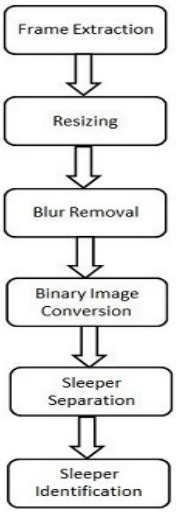


A. Data Acquisition

Video will be taken as an input for detecting crack in the concrete sleepers. Video recorder will be mounted on a train which will be moving with controlled speed. This video should be taken at an angle of 90° so as to reduce the effect of shadowing. The crack in the image should be visible to human eye. If human eye cannot detect the crack in the image, then it is impossible to identify crack using this model. Images ought to be taken in suitable lighting, ideally not in serious daylight.

B. Image Pre-processing

Various steps included in image pre-processing are as follows:



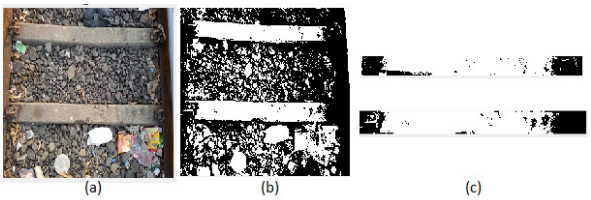


Figure (a) - Original Image of sleeper(frame)
Figure (b) - Binary Image
Figure (c) - Sleepers separated from binary image

1. Frame extraction and Resizing:

Input is in the form of video from which frames are extracted for processing. These frames are resized to size of 256 × 256 pixels. This is done to provide uniformity to the images and reduce the processing speed. It has been observed that small images get processed faster as compared to larger images.

1. Blur removal:

Due to motion, images might not be clear and blur images will not give effective output. Hence, to improve image quality, it becomes a necessary step. To get rid of the fuzziness from the image, Weiner filter will be used.

2. Binary image conversion:

Binary image has only two values for each color pixel i.e. black (0) and white (1). Image is regenerated into binary to

scale back the color distinction of a sleeper with reference to background image.

3. Sleeper separation:
Sleeper separation is done on the basis of the color of each pixel. Sleepers appear as white in color. Therefore, these sleepers will be detected by counting the number of white pixels. These detected sleepers will be saved as separate image.

4. Sleeper identification:
As stated in section III, each sleeper will have unique identification number. Based on these identification numbers, sleepers will be saved as separate images in a database for further process of detecting cracks.

C. Crack Detection
Separated sleepers will be stored in database along with their identification numbers. Crack will be identified by using line detection and curve detection algorithms available in image processing. Line detection algorithm which is used for the purpose is Hough transform.

V. ADVANTAGES & LIMITATIONS

Currently, crack detection of sleepers is done manually. This process can be hazardous to the lives of gang men. Manual checking also does not guarantee accurate results as the workers may lose concentration due to long hours of work.
Giving identification numbers to each and every sleeper is a tedious task, even though it is a one time work. But if this task is done, crack detection can take place smoothly. Also, Matlab software will be required for image processing, which will increase the cost of the system. For accurate results, sunlight should be optimal. Thus, in case of improper sunlight, results will not be accurate.

VI. FUTURE WORK

Database will be created to store media when implemented in real time. Future work also includes comparison of previous image stored in the database with current image to find the severity of the crack and thus finding out whether the crack needs to be immediately replaced or not.

VII. CONCLUSION

Image processing has been suggested and used as a possible tool for the detection of cracks of the sleepers. The algorithms suggested take lesser time than the techniques such as morphological approach and image segmentation. The use of the algorithm proposed will help in the proper maintenance of the tracks of the railway network and also decrease the damage to life and property.

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