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Crack Detection in Railway Track Using Image Processing

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***Abstract:** Computer vision can provide many potential advantages over manual methods of railway track inspection. Great levels of performance can be achieved through the automation of inspection using computer vision systems, as they allow scalable, quick, and cost-effective solutions to tasks otherwise unsuited to humans. At a minimum, railway track components can be objectively and quantitatively inspected, as the system does not suffer from fatigue or the subjectivity inherent with human inspectors. The digital nature of the data collection involved with a computer vision based method, archiving inspection results and trending of the data becomes feasible, leading to more advanced failure prediction models for maintenance scheduling and a more thorough understanding of railway track structure. In this research paper, a computer vision based method is presented. A system has been suggested which can periodically take images of the railway tracks and compared with the existing database of non-faulty track images on a continuous basis. If a fault arises in the track section, the system will automatically detect the fault and necessary actions can be taken, to avoid any mishappening.*

***Keywords:** Railway Track, Cracks, Manual inspection, Image Processing, Computer Vision.*

I. INTRODUCTION

The railway is the biggest means of transportation in India. Rail transportation is the utmost importance as a component of urban public transport system [1]. Its advantages of fast, punctual and large capacity make to become the most frequent choice for urban inhabitants. However, as a high-density, high flow, and relatively enclosed public transportation system, rail transportation brings gathered a crowd when encounters the growing problem of urban traffic congestion. The operational security issues have become increasingly prominent [2]. Although the rail transportation is the safest approach to public transportation, rail transportation easily creates gathered crowd both on board and on the platform. There have been cases of late, where due to minor failures a big mishap have happened in the railway. Such incidents have been on a rise in the recent past. According to the statistics, the accident of rail transportation is mainly caused by vehicle breakdowns, track failures, obstacles appear on the rail, human congestion, vandalism, signal systems failures, etc. The track inspection is done manually by railway employees on a time to time basis. The railways form a big network of railway tracks in India and as such it's very difficult to monitor the condition of tracks with agility and perfection. Nonetheless, despite the high level of inspection effort involved, the continuing high accident rate raises questions about the extent to which the railway comply with the inspection requirements as well as about the extent to which inspections can help to avert accidents. In a number of cases, the defects in the tracks have resulted in major railway accidents causing loss of lives and property. In this thesis, a computer based track monitoring system has been ideated and presented.

A think-tank panel comprised of members of NITI Ayog has also noted that in A and B category of high-density rail routes, which connect New Delhi to Howrah, Mumbai, Kharagpur, Vijaywada and Ahmedabad account for 40 per cent of total derailments. The study and that analysed data from 2012-13 to 2016-17 also noted that “non-railway users are responsible for the largest number (40 per cent) of rail accidents”.

The study stressed that the accidents due to the failure of railways staff have been on the rise, as they stood at 64 (2016-17) against 55 (2015-16), 60 (2014-15), 51 (2013-14), and 46 (2012-13). “Failure of railway staff accounted for 61.5 per cent of the total accidents in 2016-17, which along with non-railway staff stood at 82.7 per cent. “The key take away from data is that initiatives that reduce the potential for human errors such as automated inspection and asset monitoring techniques, replacement of over-aged assets (tracks, signaling) and up-gradation of asset maintenance infrastructure needs priority emphasis," the findings of the study noted while stressing that human failure contribution of railway staff has consistently increased over the last five years.

Figure 1: The Delhi-bound Jabalpur-Mahakaushal Express after it derailed near Mahoba railway(PTI)

The Indian Railways apparently lacks new technologies, therefore chances of human error are more and it is one of the major causes of rail accidents in India. Though nothing can be fool proof with technology it certainly reduces the chances of accidents. It has been found out by CNN-IBN after assessing the internal safety report of the Railways. 18 out of every 21 accidents occur because of human error. It has also been found out that most of the time organizations compromise on the safety measures. Reasons, why safety measures are compromised, are a low investment, delay in installing anti-collision devices and shortage in manpower.

Computer Vision and Image Processing have been used in a number of tasks involving automatic detection and monitoring. In this research paper, a computer based methodology has been discussed to automatically detect railway track cracks and inform the authorities to take evasive action in time.

II. LITERATURE REVIEW

The inappropriate upkeep of tracks which have brought about the arrangement of breaks in the tracks has been distinguished to be the primary driver of wrecking. A portion of the imperfections is exhausted rails, weld issues, interior deformities, and head checks, squats, spelling, and shelling. On the off chance that undetected as well as untreated these imperfections can prompt rail breaks and crash. Customarily, this undertaking is physically led via prepared railroad track examiners strolling along the track hunting down visual abnormalities. Tracks that are subjected to overwhelming pull movement require visit assessment and have more escalated upkeep prerequisites, leaving railways with less time to fulfill these reviews. To enhance the manual examination process in a productive and financially savvy way, machine vision innovation can be created as a powerful option [7].

Some of the research done by researchers is presented in this section. Mao et al. [10] built up a sensor blame location conspire for rail vehicle latent suspension frameworks, utilizing a blame discovery spectator, within the sight of indeterminate track normality and vehicle clamors that are demonstrated as outer aggravations and stochastic process signals. Faghih-Roohi et al. [11] proposed a profound convolutional neural system answer for the investigation of picture information for the location of rail surface deformities. They looked at the consequences of various system structures described by various sizes and actuation capacities. Hu et al. [12] recognized uneven shine and clamor, the substantial rail surface deformities, as indicated by the qualities of overwhelming rail surface imperfections, in light of the numerical morphology of multi-scale and double structure components. Contrasted and the customary edge identification administrators, the outcomes demonstrate that their technique possesses solid hostile to commotion execution, can identify the little deformity edge precisely under clamor.

Shen et al. [13] explored the component extraction of the turnout deserts in view of the bogie speeding up estimations. They set up the ordinary turnout demonstrate and defective turnout show in light of SIMPACK and afterward dissected the increasing speed motion in the time-recurrence area. The outcomes demonstrated that the power otherworldly thickness (PSD) and all the recurrence area highlights are valuable for distinguishing the poor fit imperfection of the switch point. Vijayakumar and Sangamithirai [14] built up a technique that distinguishes the surface deformity on railheads. The proposed strategy utilized Binary Image Based Rail Extraction (BIBRE) calculation to extricate the rails from the foundation. The extricated rails were upgraded to accomplish uniform foundation with the assistance of direct improvement technique. The improved rail picture utilized Gabor channels to recognize the imperfections from the rails. Thresholding was done in view of the vitality of the imperfections.

Yaman et al. [15], took pictures from two cameras set at various points on the setup trial structure. The pictures were preprocessed utilizing the Otsu strategy. At that point, rail surfaces are identified utilizing canny edge extraction and Hough changes calculations. The rail surfaces identified in the pictures taken from the two cameras are joined to recognize disappointments on the track surface. The precision of the proposed technique is upgraded by pictures taken from two unique cameras. Piece chart of this examination is given in Figure 2.

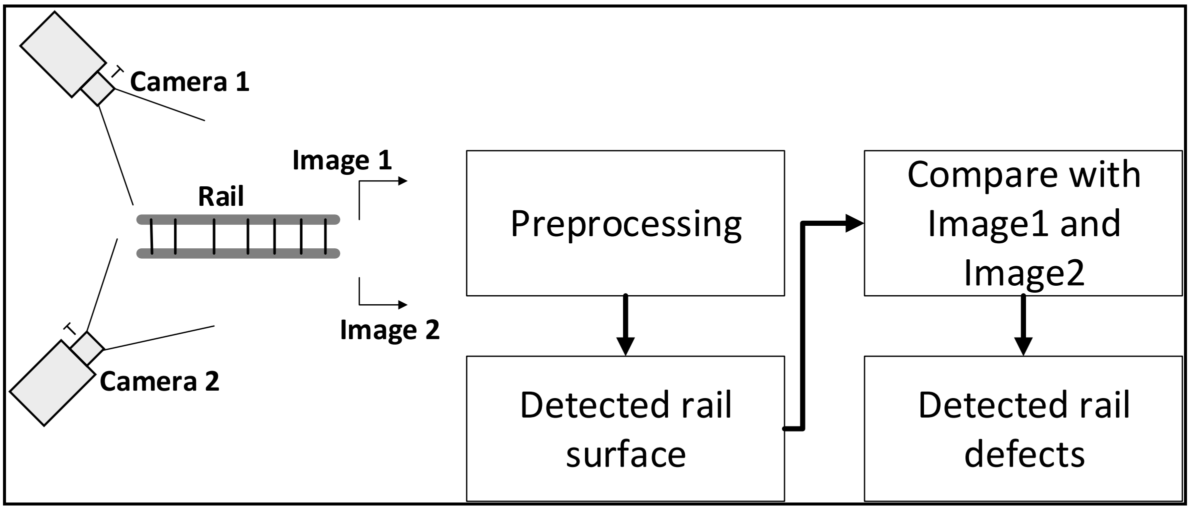


Figure 2: Block diagram of rail failure detection in the literature [15]

Figure 3 describes the steps of the image processing algorithm. The pre-processing of images is done by contrast enhancement. The local normalisation (LN) and adaptive histogram equalisation have been investigated as image enhancement techniques. Also, binary segmentation by adaptive thresholding is used for crack segmentation. After the detection stage of the algorithm, the detected defects are further post-processed with image cleaning morphological operations (such as erosion and dilation of pixels, removal of false defects). Then the following geometrical properties of each defect are extracted: length (maximum distance between any two points along the boundary of the defect), the orientation of the defect (orientation about x axis), area, and perimeter. The measured defect geometry is calibrated using the rail foot dimension [8].

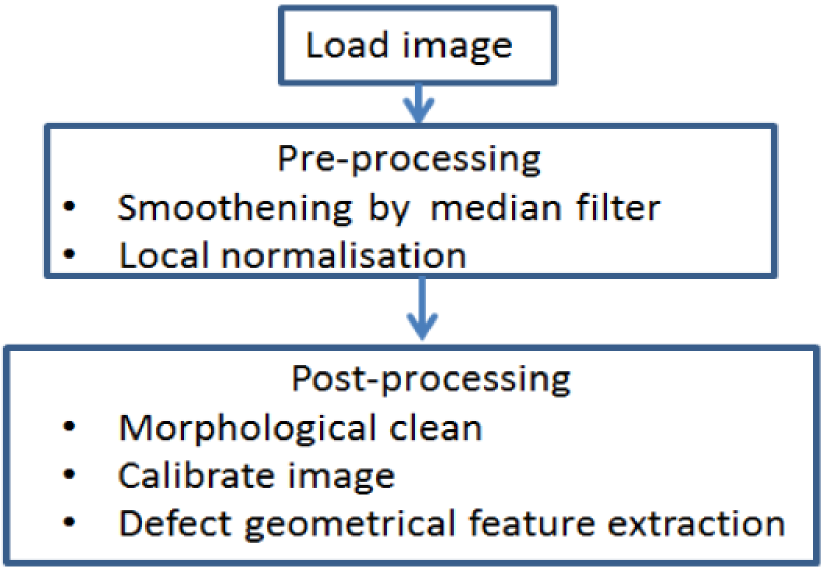


Figure 3: Image Processing Algorithm [8]

III.PROPOSED WORK

This section discusses the implementation details of the proposed work. The Proposed work use the method of the connected component in the image. The image is acquired from a section of the railway track. This can be done using a camera rolling stock continuously monitoring the railway track. For detecting the crack, the image of rail track and it must contain the top view of the track.

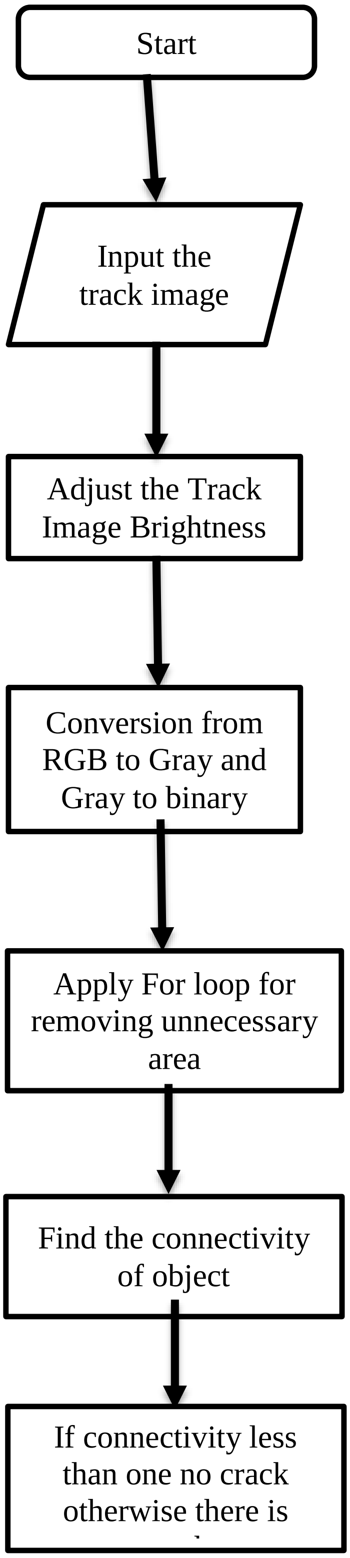


Figure 1: Fl
Flowchart of the Process

Histogram enhancement of the image is performed because the track is brighter than the background due to reflection. Thus, the track section of the image is clearly identified. The enhanced image is then converted to binary image form. Connected components are obtained from the complete area of the track image. If there is discontinuity then there is crack otherwise no crack.

IV. SIMULATION RESULTS

The algorithm has been implemented using MATLAB 2013a software tool. Following are the details of the simulation results obtained.

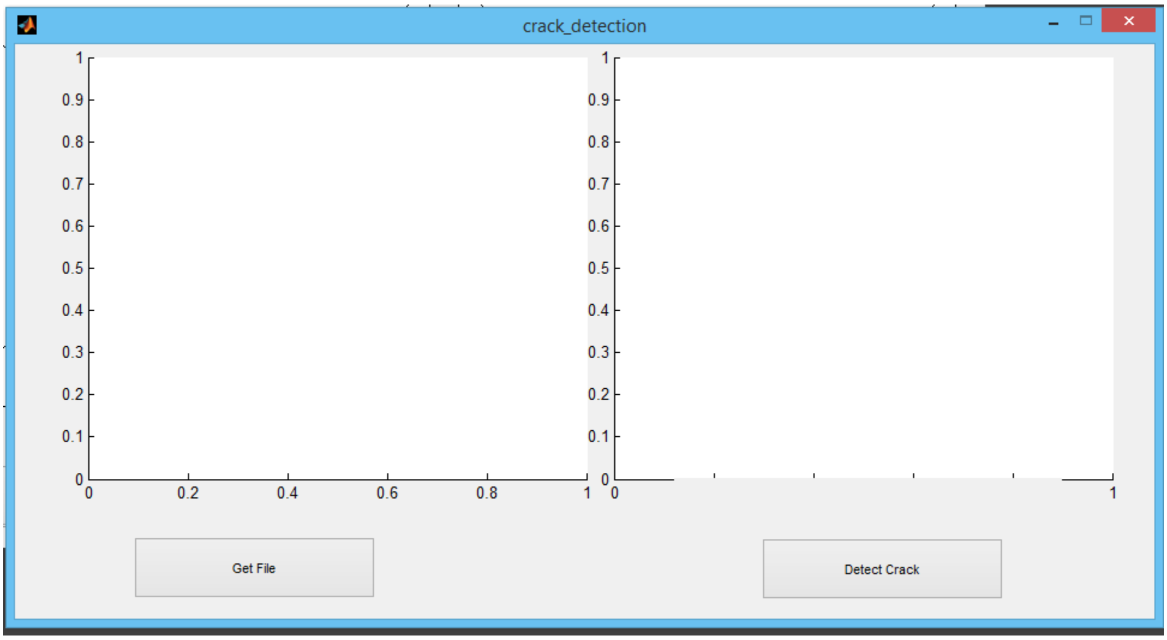
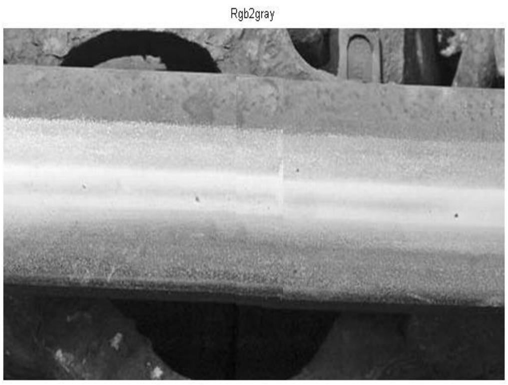
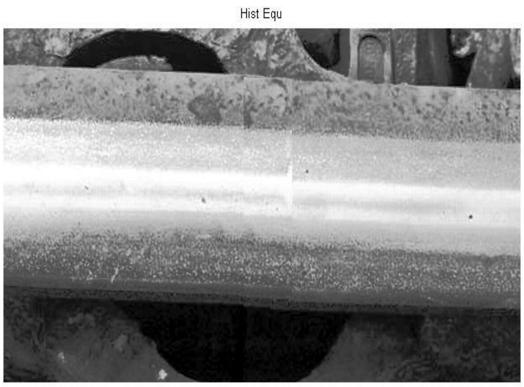


Figure 2: GUI for the track detection

A GUI (Graphical User Interface) has been developed for easy usage of the algorithm. It has It has two axes one show the enhance image other one show the black and white of image with only track and one Edit Box for showing the result.

Figure 3(a) shows the result after gray conversion and figure 3(b) shows the image after histogram equalization to enhance the image.





(a) **(b)**

Figure 3: a) Image after gray conversion **b) Image after histogram equalization**

The next step is to convert the track image into binary form. Figure 4(a) shows the binary converted image and Figure 4(b) shows the binary image after removing the noise.

(a) (b)

Figure 4: a) Binary Image b) Image after removing Noise

After removing any noise present in the image, the holes (black spots) appearing in the image are removed to obtain the complete track image. The connected components are counted and based on a certain threshold the crack in the railway track is detected.

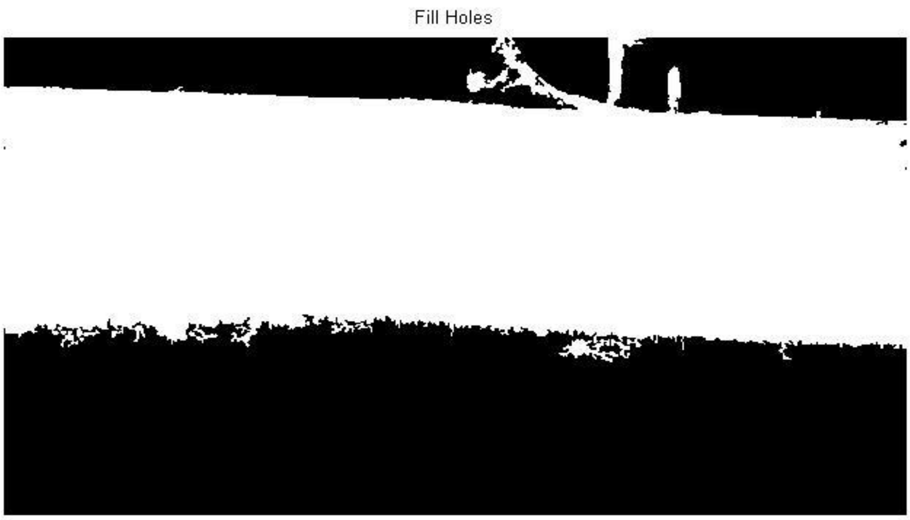


Figure 5: Image after filling holes

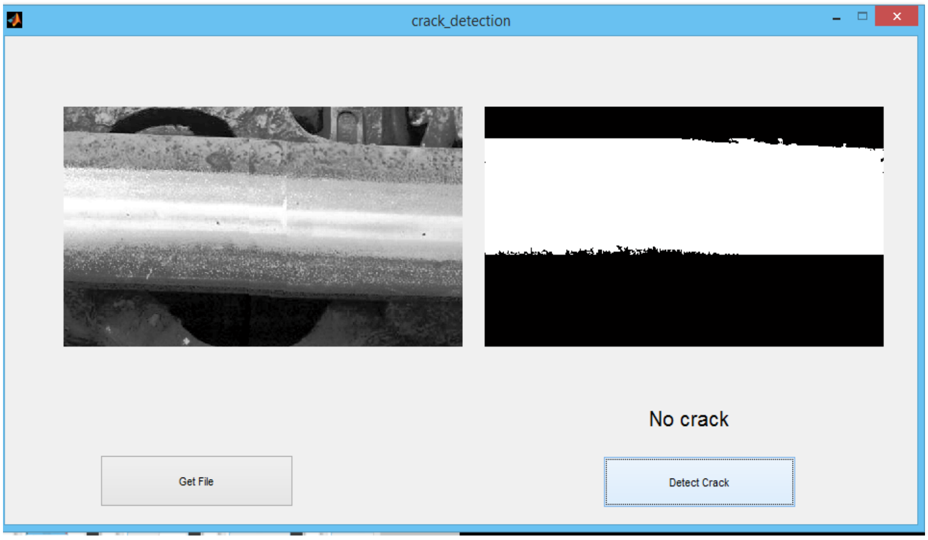


Figure 6: No Crack Detected

Figure 7: Crack Present is detected

CONCLUSION

In this paper, a method to detect cracks in railway tracks has been presented using image processing techniques. The method replaces manual inspection of the track section, by automatic inspection. A video camera can be installed in separate sections of the track to take images of the track section and then it can be input to the suggested system to detect any cracks in the track section. This will help to detect cracks immediately and reduce the possibilities of any mis happening. Since the system would be automatic and will require less manual intervention, the utmost efficiency of the system can be ensured.

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