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Crack Detection in railway Track using the AI based image recognition techniques

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Abstract:
When it comes to railway track inspection, computer vision based AI technique has a lot of advantages over manual techniques. Inspection automation employing computer vision systems can achieve high levels of performance because they provide scalable, rapid, and cost-effective solutions. Railway tracks can be tested at least objectively and statistically, as the system is independent of the fatigue and subjectivity of human testers. Digitalism of data collection combined with AI based computer vision technology enables archiving of inspection results and data trends, leading to a better understanding of failure prediction models and track structures for maintenance planning. This research study provides AI based computer vision technology. Model has been designed that allows taking images of the tracks on a regular basis and comparing them to an existing database of unbroken track diagrams. If the root section fails, the system immediately recognizes it and takes appropriate action to avoid the failure. Railroad tracks, cracks, manual inspection, image recognition, and computer vision are some of the terms used in this document.

Keywords: Railways Track, Cracks, Manual inspection, Image recognition, Computer Vision

I. INTRODUCTION

In India, the railway is the most important mode of transportation. As a component of the metropolitan public transportation system, rail transportation is critical [1]. Its advantages of speed, punctuality, and vast capacity have made it the most popular mode of transportation among city dwellers. When confronted with the growing challenge of urban traffic congestion, rail transit, as a high-flow, high-density, and somewhat enclosed public transportation system, draws a crowd. Operational security concerns are becoming more significant [2]. Despite the fact that transportation from the railway is the safest transportation, it attracts the public both on board and on the platform. There have been recent incidents in which a major train accident occurred as a result of small failures. In recent years, such instances have become more common. Track failures, impediments appearing on the rail, human congestion, vandalism, signal system failures, Vehicle breakdowns, and other factors, according to data, are the leading causes of transportation accidents from the railway. On a regular basis, railway staff do manual track inspections. In India, the railways constitute a vast network of railway tracks, making it extremely difficult to keep track of their status with agility and precision. Defects in the tracks have caused severe railway accidents in a number of situations, resulting in the loss of lives and property. The idea for and presentation of a computer-based track monitoring system is described in this article.

The A and B categories of high-density rail routes, which connect New Delhi to Howrah, Mumbai, Kharagpur, Vijaywada, and Ahmedabad, account for 40% of total derailments, according to a think-tank panel comprising of NITI Ayog members. "Non-railway users are responsible for the biggest number (40%) of rail accidents," according to the report, which looked at data from 2012-13 to 2016-17.

According to the report, accidents caused by railway employee failure are on the rise, with 22 in 2020-21, 0 in 2019-20, 3 in 2018-19 31 in 2017-18, 64 occurring in 2016-17 compared to 55 in 2015-16, 60 in 2014-15, 51 in 2013-14, and 46 in 2012-13. (2012-13). "In 2020-21, railway employee failure accounted for 61.5 percent of total accidents, with non-railway staff accounting for 82.7 percent."The key take away from the data is that initiatives that reduce the man made errors, such as automated inspection and asset monitoring techniques, replacement of over-aged assets (tracks, signaling), and up-gradation of asset maintenance infrastructure, require priority emphasis," according to the study's findings, which also noted that the contribution of railway staff to human failure has increased over the last five years.

Figure 1: Mahakaushal Express after it accident near Mahoba

The Indian Railways appear to be lacking in innovative technologies, which increases the risk of human error, which is one of the leading causes of train accidents in India. Though technology cannot guarantee safety, it does help to lessen the likelihood of accidents. It was discovered by CNN-IBN after examining the Railways' internal safety report. Human mistake is responsible for 18 out of every 21 accidents. It has also been discovered that majority of the time, organisations make safety compromises. Low investment, a delay in installing anti-collision systems, and a manpower shortage are all reasons why safety measures have been compromised.
A variety of jobs involving automatic detection and monitoring have made use of computer vision and image processing. This research article discusses a computer-based system for automatically detecting railway track cracks and alerting authorities to take preventative measures in a timely manner.

II. LITERATURE REVIEW

The primary cause of wrecking has been identified as poor track maintenance, which has resulted in the formation of breaks in the tracks. Some faults include worn rails, weld troubles, interior deformities, and head checks, squats, spelling, and shelling. On the off event that these flaws go unnoticed and untreated, they might cause rail breaks and crashes. Typically, this project is physically led by trained railroad track examiners who walk along the railway looking for visual anomalies. Overwhelming pull movement necessitates a visit assessment and more stringent upkeep requirements, leaving railways with less time to complete these reviews. Machine vision innovation can be built as a powerful solution to improve the manual examination process in a productive and cost-effective approach [7].
This section contains some of the results of study conducted by researchers. Given the normality of undetermined routes and vehicle noise revealed as external degradation and stochastic process signals, Maoetal. [10] has developed a plot to identify potential rail vehicle suspension system sensor faults by using spectators to detect faults. For the study of image information for locating rail surface defects, Faghih-Roohi et al. [11] provided a thorough convolution neural system response. They looked at the effects of several system structures with different sizes and actuation capacities. Given the numerical form of multiscale and dual structure components, Huetal. [12] identified significant deformation of the rail surface, indicated by non-uniform luster and noise, and an overwhelming grade of rail surface defects. In comparison to traditional edge identification

administrations, the results show that their technique has strong anti-commotion execution and can precisely detect the little deformity edge under clamour.

In light of the bogie speeding up estimations, Shen et al. [13] investigated the component extraction of the turnout deserts. They used SIMPACK to set up both a normal and a defective turnout demonstration, and then dissected the growing speed motion in the time-recurrence area. The results depicted that the power otherworldly thickness (PSD) and all of the recurrence area highlights are useful for identifying the switch point's poor fit defect. Vijayakumar and Sangamithirai [14] developed a method for identifying surface deformities on railheads. To remove the rails from the foundation, the proposed technique used a calculation called Binary Image Based Rail Extraction (BIBRE). With the help of a direct improvement procedure, the extricated rails were upgraded to achieve a uniform foundation. Gabor channels were used to identify the defects in the rails in the revised rail image. Thresholding was carried out due to the liveliness of the flaws.

Yaman et al. [15] used two cameras to photograph the setup trial structure at various points. The Otsu technique was used to preprocess the images. Then, using canny edge extraction and Hough changes calculations, rail surfaces are discovered. The rail surfaces observed in the photos taken by the two cameras are combined to identify track surface disappointments. Pictures taken with two different cameras improve the precision of the suggested technique. Figure 2 depicts the examination's piece chart.

Rail Preprocessing Image 1 Image 2 Camera 1 Camera 2 Surface of the rail has been detected Compare and contrast image 1 & image 2. Rail flaws discovered

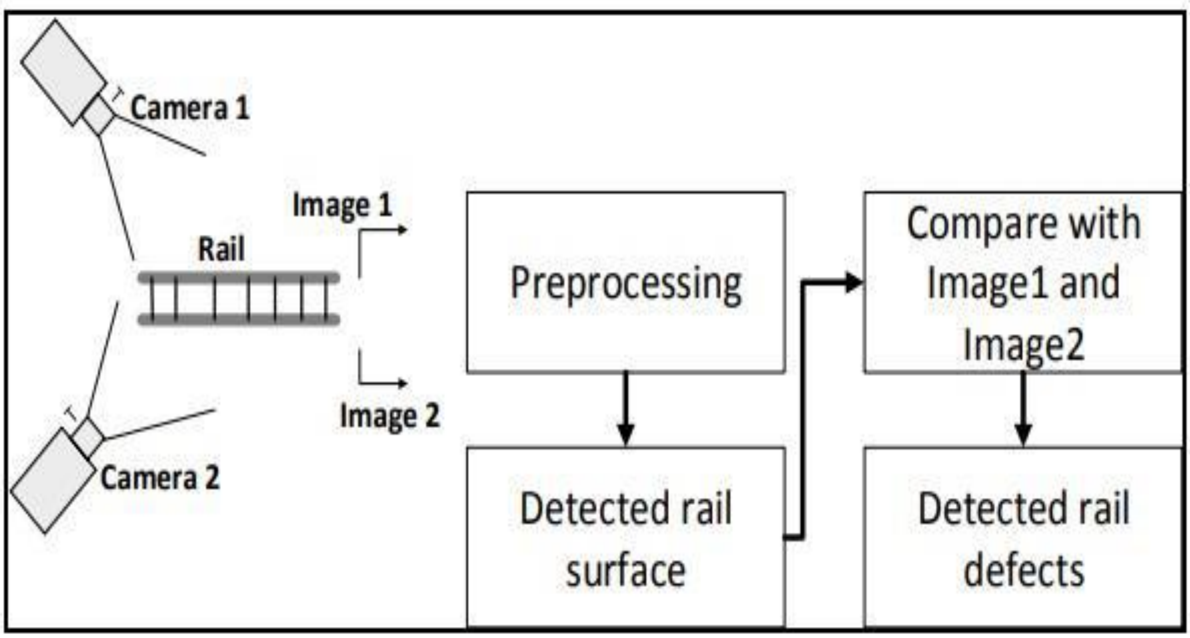


Figure 2: Working of railway crack detection

Working of the image processing method is depicted in Figure 3. Contrast enhancement is used in the pre-processing of photographs. As picture improvement techniques, local normalization (LN) and adaptive histogram equalization have been researched. Crack segmentation is also done using binary segmentation with adaptive thresholding. The observed faults are subsequently post-processed with image cleaning morphological procedures after the algorithm's detection step (such as erosion and dilation of pixels, removal of false defects). The following geometrical properties of each defect are then extracted: length (the maximum distance between any two points along the defect's edge), orientation (orientation about the x axis), area, and perimeter. The rail foot dimension [8] is used to calibrate the measured fault geometry.

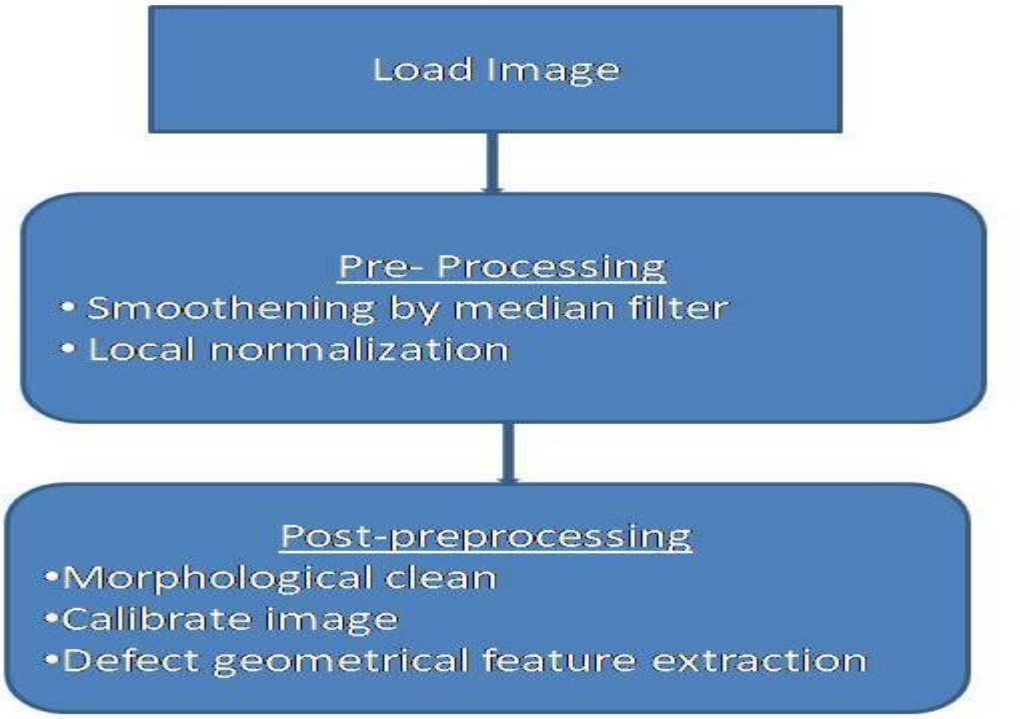


Figure 3: Proposed Algorithm [8]

III. PROPOSED WORK

This section goes into the specifics of how the planned work will be implemented. The connected component approach in the image is used in this paper. The length of railway track photo was taken. This can be occurred by observing the railway track regularly with a video rolling stock. Camera takes the top view of the rail track image in order to locate the break.

Start

- Enter the image of track.
- Adjust the image quality of track image.
- Convert RGB to Gray and Gray to Binary
- Apply For loop to remove unneeded space
- Determine the object's connection.
- If the connectivity is less than one, there will be no crack; otherwise, there will be a crack.

Because the track is brighter than the backdrop due to reflection, histogram enhancement is applied to the image. As a result, the image's track segment may be easily identified. After that, the improved image is transformed to a binary image. The entire area of the track image is used to extract connected components. There is a crack if there is a discontinuity; otherwise, there is no crack.

IV. SIMULATION RESULTS

The software package MATLAB 2021a was used to implement the technique. The following are the specifics of the simulation findings.

Figure 4: Work flow of the Process

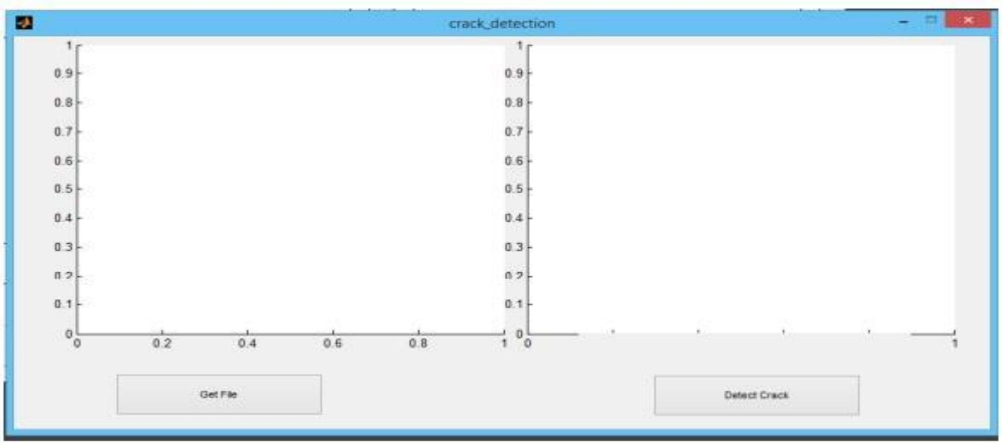
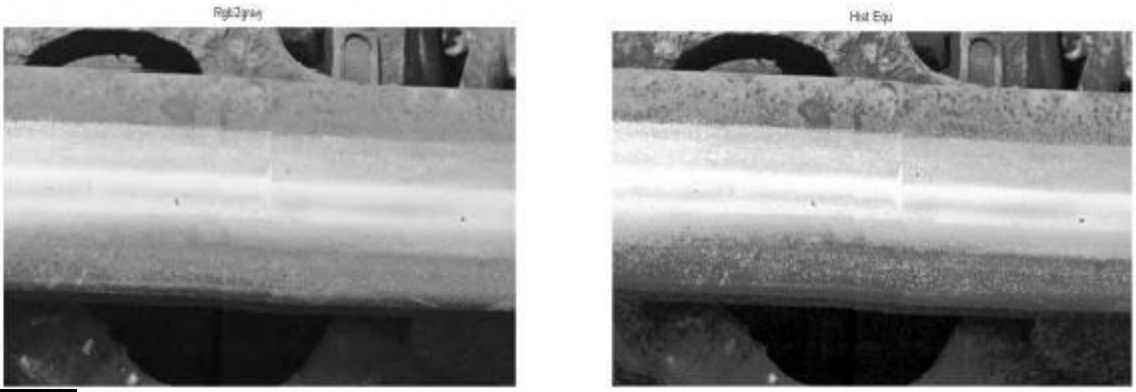


Figure 5: Track detection graphical user interface

The algorithm has been given a GUI (Graphical User Interface) to make it easier to use. It has been successful. It features two axes, one for enhancing the image and the other for displaying the image in black and white, with only one track and one Edit Box for displaying the result. In the fig. 5(a) displays grey conversion image, and in Fig. 5(b) displays histogram equalization to improve the image.



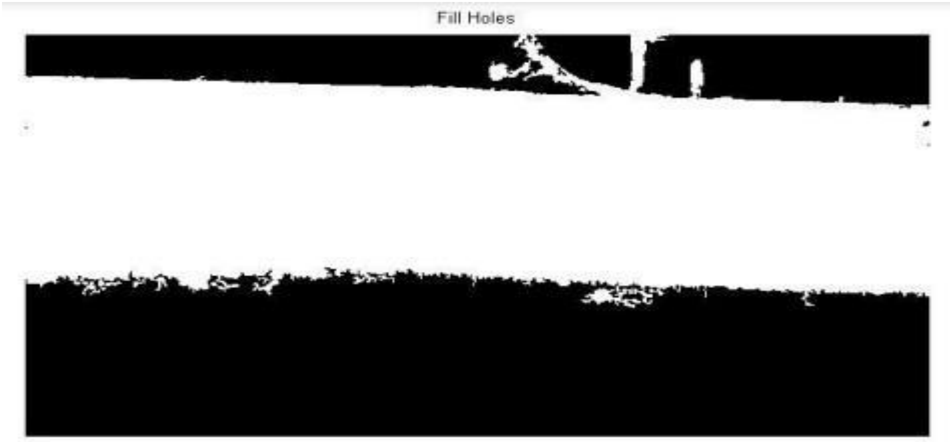
[redacted] **Figure 5: a) Gray conversion Image** **b) Histogram equalization image**

The track image must then be converted into the binary image. Binary converted image and noise removed binary image displays in Fig 6(a) & (b).

Figure 6: a) Binary Image **b) Image with Noise Removed**

The holes (black spots) in the image are eliminated after any noise is removed from the whole track image. After that we tallied the connected components, and crack in the railway track is recognised based on a specified threshold.

Figure 5: Image after filling holes



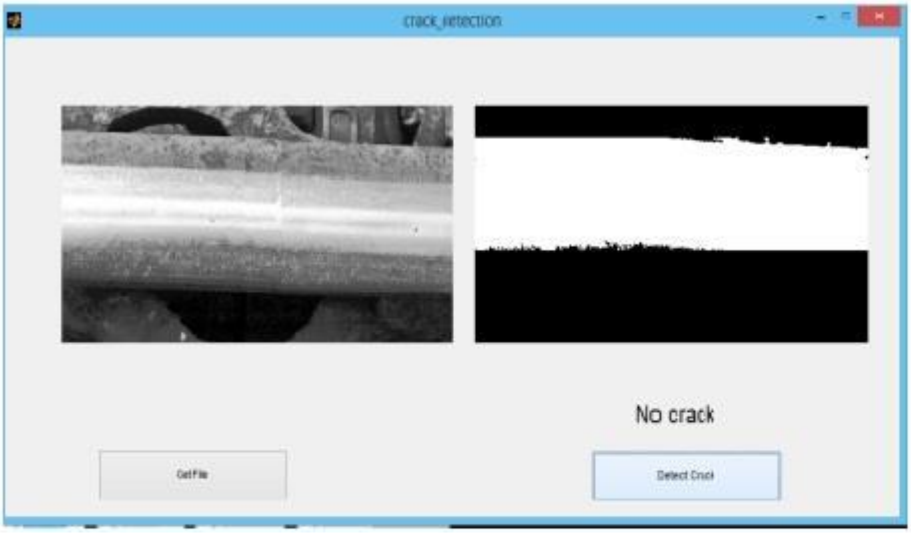


Figure 6: There is no evidence of a crack.

Figure 7: Crack Present is detected

CONCLUSION

Using AI based image recognition techniques; this research presents a method for detecting cracks in railway rails. The method uses automatic inspection to replace manual investigation of the track. Multiple cameras can be installed in multiple zones of the track to capture the images of the track; all these cameras regularly send the images to the recommended system to inspection the track and identify any cracks. This approach will aid in the pre-identification of cracks in the track and reduced the risk of an accident. This approach is fully automated and requires less manual involvement, so this system minimized the risk of accident maximized the efficiency of the system's. AI based image recognition technique pre processed the image and identify the crack earlier. In the future other better image processing techniques can be apply for improving the image quality of the railways track which is too small cannot recognized from glance eyes.

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