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# Crack Analysis System over Railway Track Using Pre captured 2D signals

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**ABSTRACT**

Railway network is the convoluted, mass connectivity where diverse span of individuals use it to travel every day. Over the prodigious network, the railway track plays an important role. The damage occurred in the track of railways may cause a massive impact atop the humanity. This can be prevented, but utmost the cracks arise in the track. The crack cropped up may be at any certain point. This requires analysis of the crack, based on the cracked and crack less 2D representations (Grayscale) of the track. The analysis approach is focused on the histogram equalization and the median filter deployment along with the no manual interpretation. Also a comparative study was made between the unequalized and equalized histograms with filter positioning. Analysis is done on top of MATLAB which is capable of providing a scenario that a crack is detected or no crack found by the comparison process. Therefore, the constructed analyzer setup provides no cost initiative and is a coherent one.

**Keywords :** Railway track, Crack, 2Dsignals, Grayscale image, RGB image, Histogram, Histogram equalization and Median filter

## 1 Introduction

The railway track analysis setup is the need of an hour as the daily routine in India for urban begins with the train travel even for local purposes and this creates the necessity for certain system highly concerned on the crack detection [1]. Aliza Raza Rizvi et al. discussed the crack occurrence and its detection in railway track based on 2D signals with certain pre-processing methods [1][7].

Ankesh Dabhade et al. proposed that the image i.e. the 2D concept used where the predefined image of the railway track is compared with the captured image of the track [2][7]. In this paper, they will plot the histograms of the reference image which is without a crack and one capture image which can be with or without a crack [2]. After plotting the histograms for both, they found whether there is a crack on the track. Since RGB image is three-dimensional image (captured image), Urvashi Dube et al. approached with method where conversion of image arises into a grayscale one and further into histogram equalized images [8]. All the above stated methodology gets its way for implementation as the image acquisition system plays an important role. To accomplish the acquiring task, Eshu Sharma and Mr. Swet Chandan jointly proposed the techniques for capturing of railway track and the processing tasks within the PC based on FPGA processor [4].

In [3] Bustos et al. demonstrated that vibration signals can be used to find proper features that point out the operation status of a high-speed train running in a gear operating state. In [9,10], vibration signals are worn to perceive defects on railway tracks. Intentionally, Wei et al. [9] apply the wavelet packet transform (WPT) to process signals with good results.

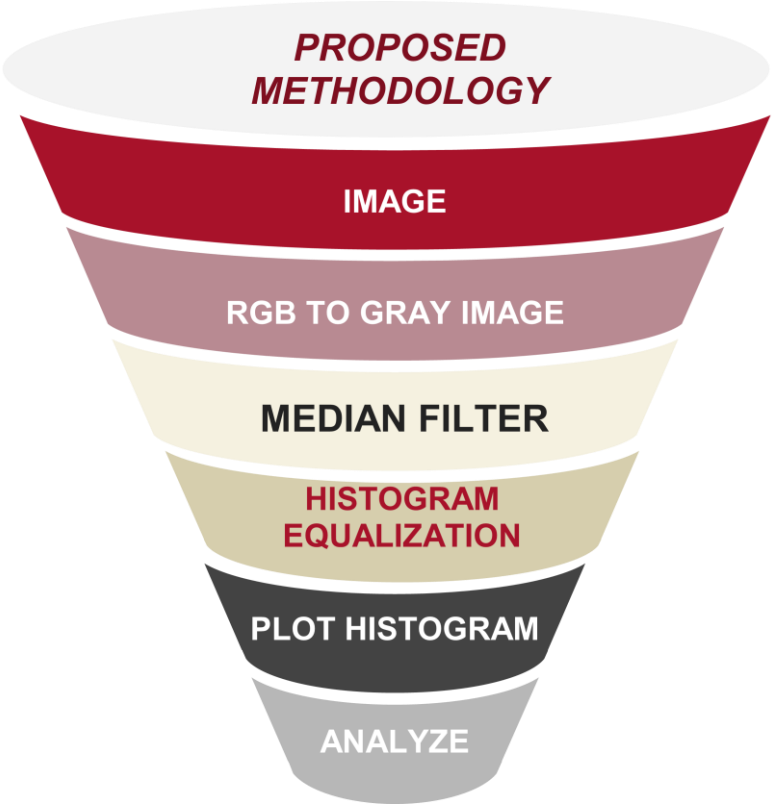
Also, the histogram equalization technique used to enhance the images acquired was elaborated by Eshu Sharma et al. and further the crack analysis is made by combination of various proposed ideologies[2][4]. Urvashi Dube et al. also conveyed that the use of median filter in providing enhancement at the edge as it could perform edge preservation when the defected pixels are present over the pre-captured images [5][8]. The user

friendly accessibility over the proposed system will be useful in an efficient manner by displaying the required results without the need for manual interpretation [6].

## 2 Proposed Methodology

The experimental analysis in this paper concerns about the initial conversion of the RGB image of the track captured to grayscale image. The histogram for the converted image of both the reference track image and the pre captured track image with crack are obtained and the differences are noted. The accuracy points are not highly varying over the plotted histogram. This turns out the efficiency on top of histogram equalization where a better image processing is done. The histogram then plotted shows greater accurate points that makes the inspection for crack detection easier. Even though the less contrast area gets improvised by equalization, the edges in the pre captured 2D signals were not preserved.

The above uncertainty get the better of the median filter as the reduction of noise in the images are done by squandering the 2D signal entries and are replaced with the median value of the adjoining entries. Altogether the image been processed are made into entries which further placed in a pattern called window. This filtered output is equalized once again and the analyzed based on histogram. The last call on the experiment takes the job of no human enacting is required as the comparison is made and reproduces an alert message about the exact state of the railway track.




### 2.1 Low level processing

The process in which the 2D signal is given as input and the corresponding output is also a 2D signal, then it is low level processing. This helps in easy analysis of the data in 2D signals.

RGB to Grayscale conversion

The conversion presumes a strategy called Weighted or Luminosity Method where red contributes for about 30%, green contributes 59% and blue contributes 11%. The grayscale value of an image is got by forming a weighted sum of R, G and B components in that particular image. 0.2989 * R + 0.5870 * G + 0.1140 * B

As the calculation of grayscale value produces certain coefficients, those can also be used to find the luminance after rounding the desirability to 3 decimal points.

### 2.2 Histogram and its equalization

Histogram is defined as the graphical representation of the intensity distribution of an image where the coordinates of the graph depicts the x-axis as the tonal scale (black at the left and white at the right), and y-axis as the number of pixels in an image. It shows the number of pixels for each brightness level.

Histogram Equalization is a digital image processing technique used to improve contrast in an image as it effectively spreads out the most frequent intensity values. This allows the areas of lower local contrast to gain higher contrast. The processing of histogram equalization relies on the use of the cumulative probability function (cdf). The cdf is a cumulative sum of all the probabilities lying in its domain and defined by:

$$F(x) = \sum_{k=-\infty}^{x} P(k)$$

The idea of this processing is to give to the resulting image a linear cumulative distribution function. Indeed, a linear cdf is associated to the uniform histogram that we want the resulting image to have. So we are going to implement the following formula to get the new pdf:

$$S(k) = (L-1)F(x)$$

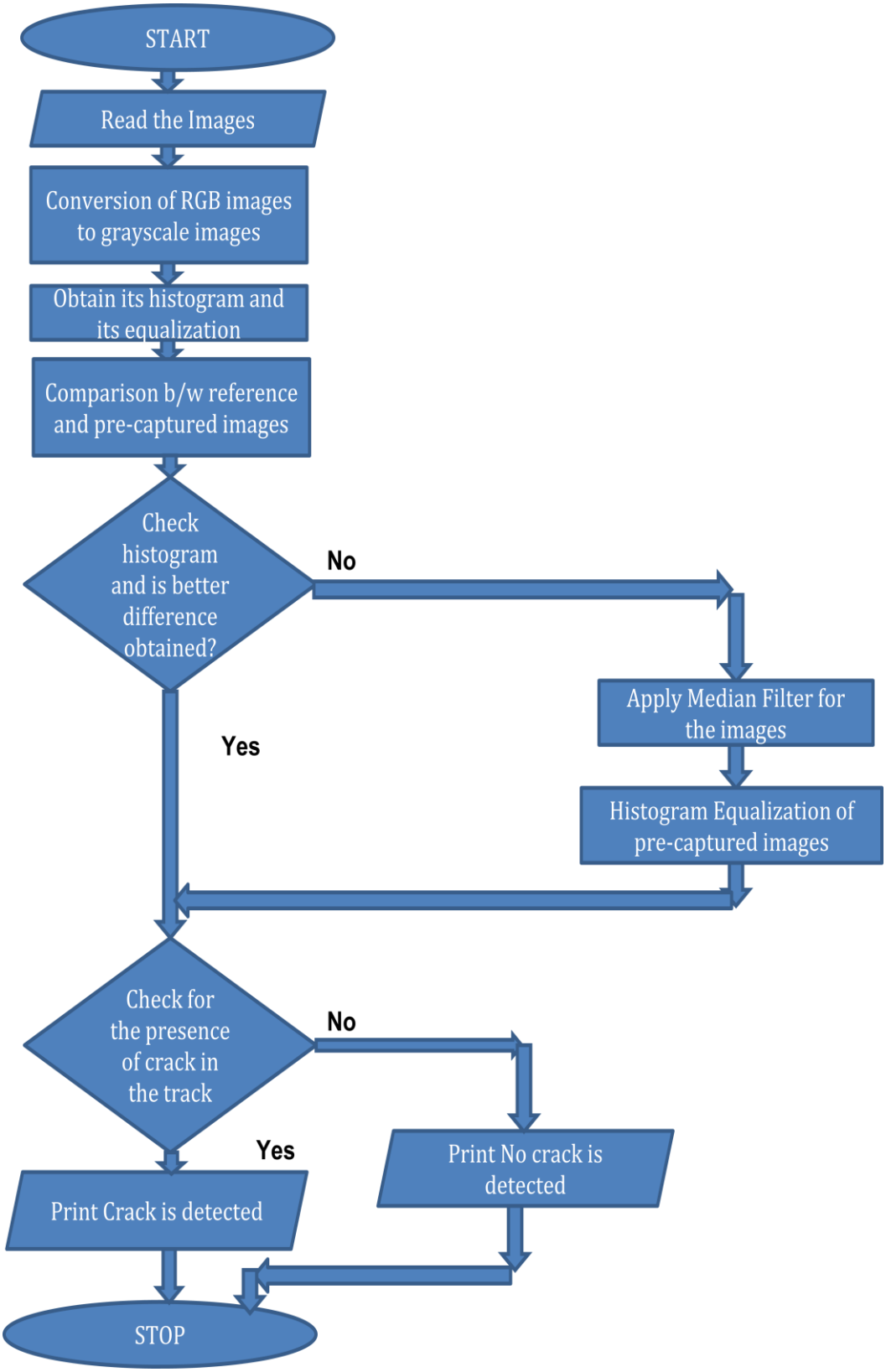
Since for computer vision and image processing tasks, the image of track doesn't provide much information as most of its areas are blurry due to lack of contrast, histogram equalization is implemented.

### 2.3 Median Filter

Median filter is the non linear digital filter technique which is useful in the reduction of noise over any sort of signal. In image processing, the edges are preserved as a part of noise reduction that remains the advantageous point of the median filter. Main idea to place the filtering mechanism is to run through signal (2D) entry by entry and replace each entry with the median of the neighboring entries. All entries are included for image processing-placed in a pattern called window, that is in a median filter, a window slides along the image, and the median intensity value of the pixels within the window becomes the output intensity of the pixel being processed [5].

## 3 Observations

The flowchart for the observations been noted is given as follows where the major point here could be the place to notify the crack presence in the railway track at the execution part:




The observations made are represented by the figures obtained as output of the above listed steps or the procedural setup.

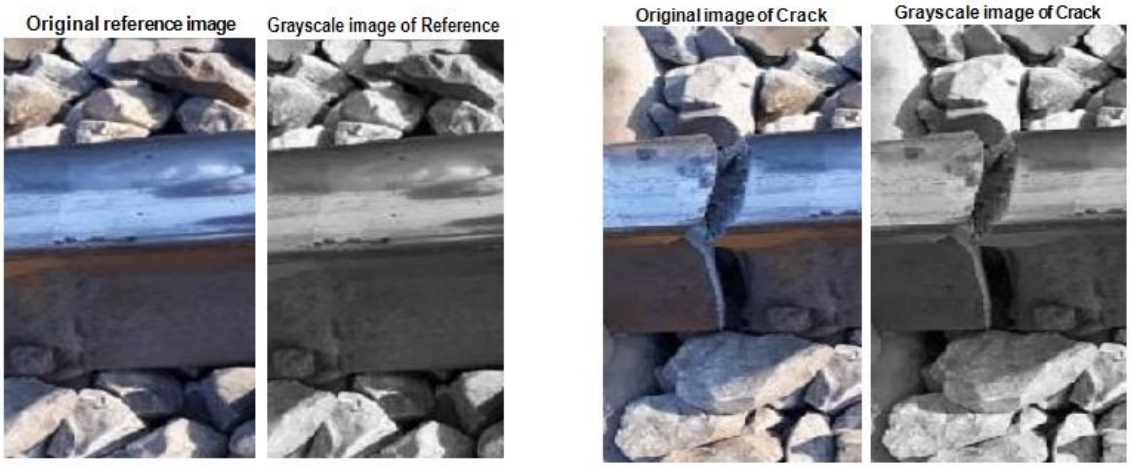



Fig 1.Grayscale Conversions of the pre-captured images of the railway track

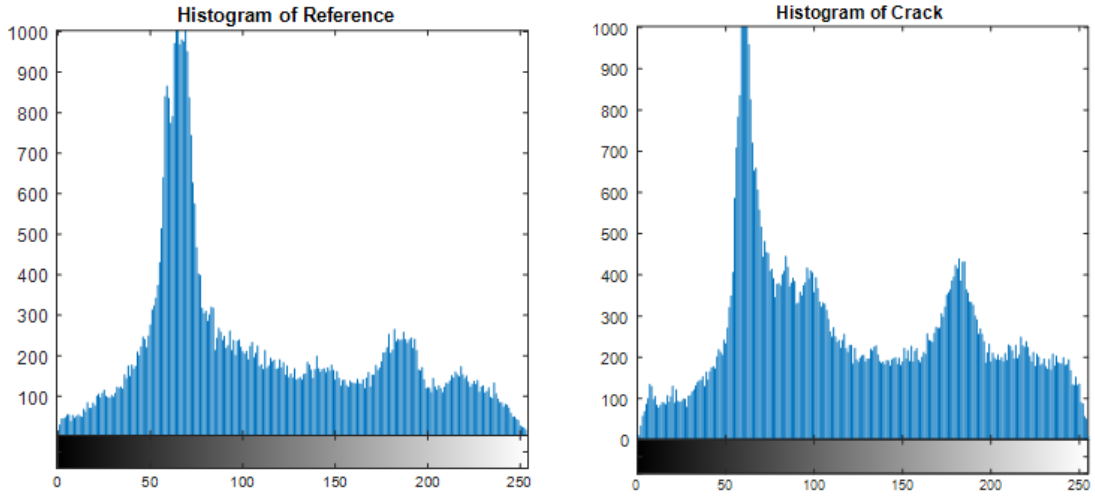



Fig 2.Histogram of the pre-captured images


Fig 3.Histogram equalization of the pre-captured images

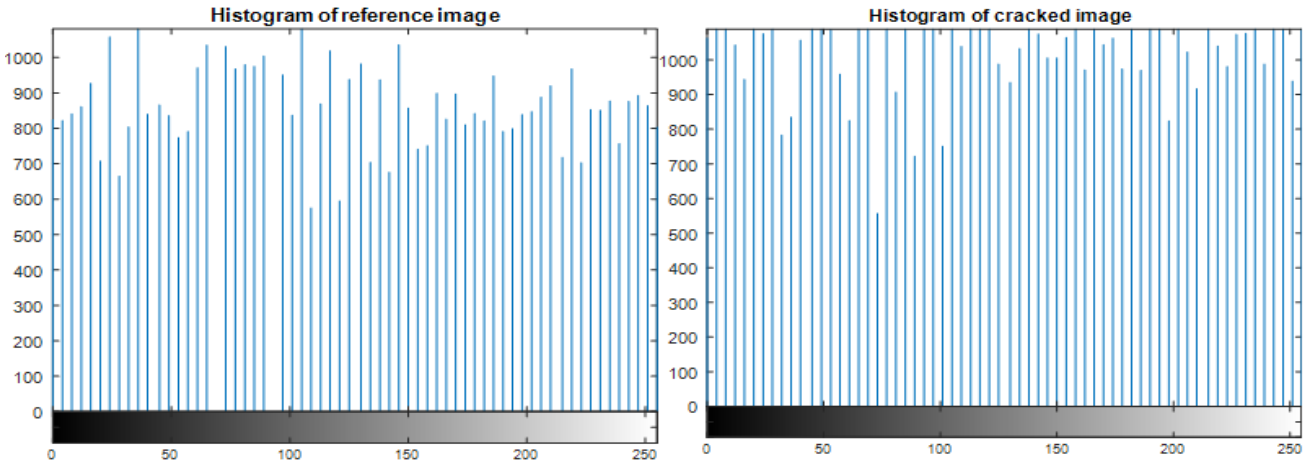



Fig 4.Histogram of the pre-captured images after equalization

## 4 Results and Analysis

The setup holds no cost as it is built over MATLAB and becomes an exceptional in terms of the image capturing process.The resulting information based on the histogram equalization method and the median filter of the grayscale image are compared and analyzed.

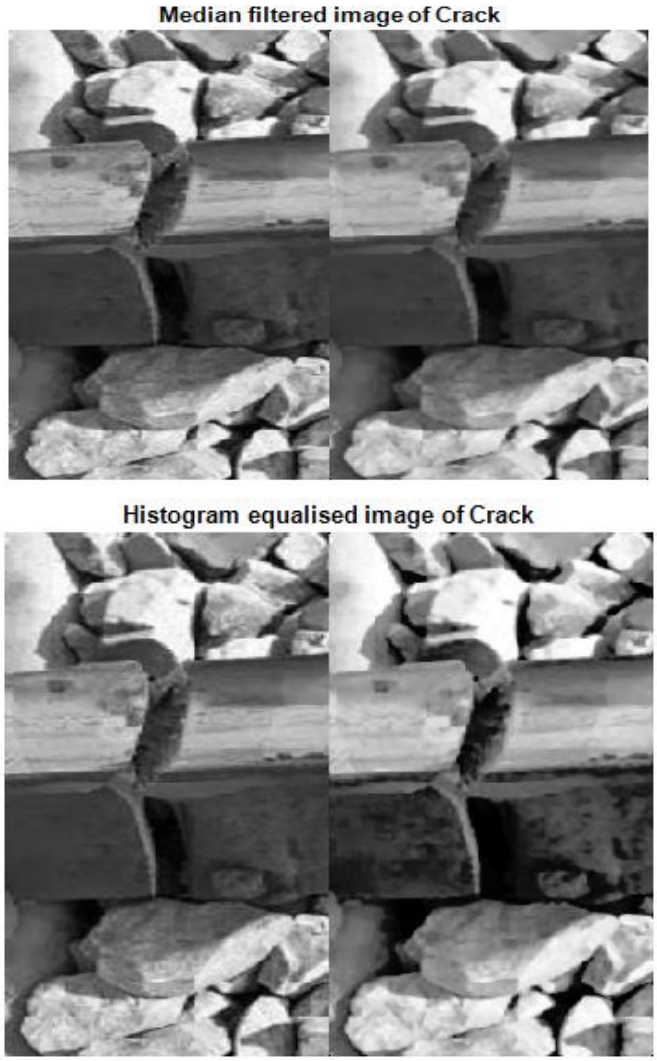



Fig 5.Images obtained after applying median filter and histogram equalization

The image processing techniques are used in a user-friendly manner with a great level of standard as of its in built nature.

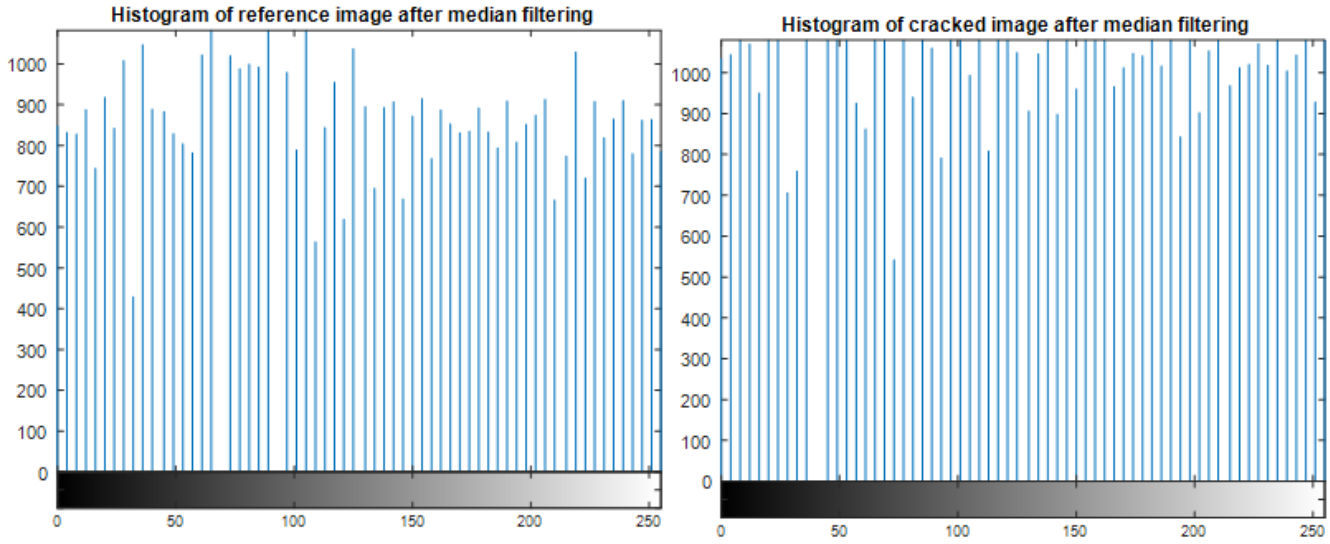



Fig 6.Histogram obtained at output of median filter along with histogram equalization of pre-captured images

The comparison is done for the histograms obtained before and after placing a filter (median) to remove noise and present the edges on it.

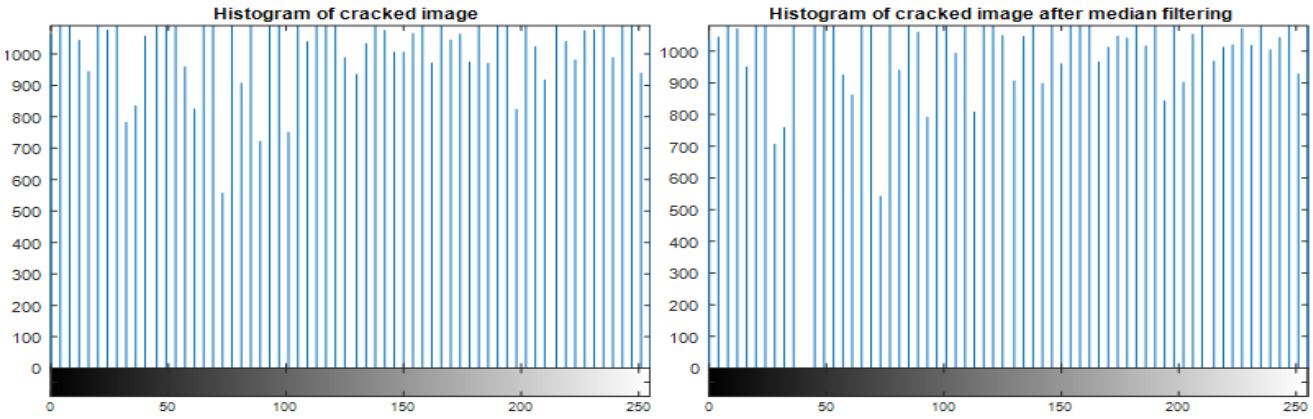



Fig 7.Histogram of the crack image after equalization and after applying median filter with equalization

The result denoting the presence of crack in the railway track is displayed automatically after executing the MATLAB code and analysis is done in a user friendly manner.

## 5 Conclusion

Our proposed system will automatically inspect the rail track component and calibrations of rail track by using the histogram equalization method, where we located the crack in the image, fine-tuned the image for better detection of fault. Thus, the railway track crack detection system is been built in MATLAB platform, such that providing efficient results by comparing with the reference image of the track. The future work for this proposed methodology could be extended towards the capturing system that can communicate the signals over cloud and

make the further computation easier in the other end. Also, the computed 2D signals can be stored in cloud for future references based on Artificial Intelligence.


## ACKNOWLEDGMENT

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## REFERENCES


[1] Aliza Raza Rizvi, Pervez Rauf Khan, and Dr. Shafeeq Ahmad, "Crack Detection in Railway Track Using Image Processing", International Journal of Advance Research, Ideas and Innovations in Technology, Volume 3(4), 2017, 489 - 496.

[2] Ankesh Dabhade ,Rahul Kale, Saurabh Fulzele and Prof. K.S.Kalkonde, **"**Railway Track Crack Fault Detection using Method of Histograms in Image Processing of MATLAB", International Journal of Engineering Trends and Technology (IJETT) – Volume 58 Issue 3 April 2018, 130 - 136.

[3] Bustos A., Rubio H., Castejón C., García-Prada J.C. EMD-Based Methodology for the Identification of a High-Speed Train Running in a Gear Operating State. *Sensors.* 2018;**18**:793.

[4] Eshu Sharma, Swet Chandan, "Review Paper On Rail Track Flaw Detection Using Matlab", International Journal For Technological Research In Engineering Volume 3, Issue 8, April-2016 ISSN (Online): 2347 – 4718, 1728 -1730.

[5] https://nptel.ac.in/content/storage2/courses/117104069/chapter_8/8_16.html#:~:text=Median%20filtering%20is%20a%20nonlinear,salt%2Dand%2Dpepper%20noise.&text=In%20a%20median%20filter%2C%20a,of%20the%20pixel%20being%20processed

[6] https://in.mathworks.com/matlabcentral/answers/85447-comparison-of-two-histograms-using-pdist2

[7] C. Saravanan**, "**Color Image to Grayscale Image Conversion**", 2010** Second International Conference on Computer Engineering and Applications, IEEE Explore, 196 – 199 , DOI:10.1109/ICCEA.2010.192.

[8] Urvashi Dube, Sudhish Subramaniam, Dr.Subha Subramaniam, "Cost Effective Railway Track Fault Detection Using Image Processing", 2nd International Conference on IoT Based Control Networks and Intelligent Systems (ICICNIS 2021), 1 - 7.

[9] Wei J., Liu C., Ren T., Liu H., Zhou W. Online Condition Monitoring of a Rail Fastening System on High-Speed Railways Based on Wavelet Packet analysis, *Sensor* 2017;**17**:318.

[10] Wei J., Núñez A., Li Z., Dollevoet R. Evaluating Degradation at Railway Crossings Using Axle Box Acceleration Measurements. *Sensors.* 2017;**17**:2236.