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RAILWAY TRACK CRACK DETECTION USING DEEP LEARNING MODELS

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ABSTRACT: The detection of defects or cracks in rail track plays an important role in railway management, which prevents train accidents in both summer and rainy seasons. During summer, the cracks are formed on the track which slips the train wheel. In rainy environment, the rail tracks are affected by corrosion which also produced cracks on it. Methods: In present method, the cracks or defects are detected Echo image display device or semi conduction magnetism sensor devices which consumes more time. The proposed method enhances the track image using deep learning models to features extracted from the enhanced rail track image. These extracted features are trained and classified using neural network classifier which classifies the rail track image into either cracked or non-cracked image. The novelty of this work is to use soft computing approach for the detection of cracks in rail tracks. This methodology is trained by several crack images which are obtained from different environment. This method automatically classifies the current image based on the trained patterns, thus improves the classification accuracy. Findings: The performance of the proposed system achieves the accuracy rate of 94.9%, with respect to manually crack detected and segmented images.

Keywords: *railway track crack detection, deep learning models*

1. INTRODUCTION

In the modern world, the role of railway network is an essential for the people around the world. The railway system consists of infrastructure, development and maintenance. The infrastructure of the railway network is the planning and construction of the rail tracks and establishing their contacts in railway junction. The development of the railway network is used to extent the tracks to the rural and interior areas of the village. The rail tracks are maintained by maintenance division of the railway network system. The rail tracks are severely affected by corrosion due to the air and floods during rainy season. They make cracks on the rail track which leads the accident of the trains. The quality of the rail track is important to prevent such defects in rail track and these cracks must be frequently checked to avoid accidents.

The procedure for capturing the rail track, in which the pre-checking vehicle is passed over the running track of the rail. The light source in this vehicle

passes the light on the track and these running rail tracks are captured by high definition digital camera which is located on the vehicle. By using a defect inspector to improve inspection by taking into account specific track characteristics such as gaps and no gaps (0 or 1). The premises of this paper is around the concept of a convolutional neural network and building a model which is capable of identifying if cracks are pre-sent on the tracks or not. The data is managed by OpenCV module in python. For the ease of training the data is split into test, validation and training dataset. The images are later resized and the colours are changed to black and white, since we have abundant of images to train to the machine, we process the images in batches, and is sent to the hidden layers which is used in training the data.

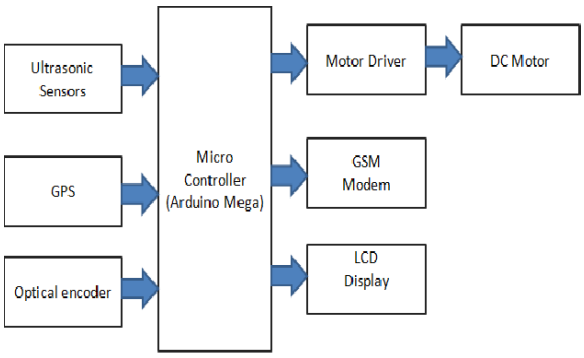

Fig.1: Autonomous railway tracking system

2. LITERATURE REVIEW

2.1 Design of Rail Surface Crack- detecting System Based on Linear CCD Sensor:

The rail surface crack-detecting system was designed for reducing railway accident due to rail crack. The system adopts linear charge coupled device (CCD) TCD1208AP as image sensor, uses high-speed flash A/D converter AD7821 to collect CCD output video signals, and uses CPLD perform CCD timing generator, A/D converter timing generator, data storage and other control logic. Then DSP executes the image processing, such as noises elimination, edges detection, image segmentation and edges linking, used the improved classical algorithm and morphology algorithm to judge whether the signals are the crack signals or not, and gives display and alarm with sound and light. The whole hardware structure and the software design are introduced in this paper. By experiment, the detecting precision and effectiveness of the system are good for detecting the rail surface crack.

2.2 Non invasive rail track detection system using Microwave sensor

As fuel costs continue to rise, efficient public transport, especially rail will play an increasingly important role in the UK and worldwide. For the safe operation of the rail system, it is necessary that the condition of the rails can be monitored on a continual basis. An important part of this monitoring process is crack detection. Much research effort has been spent in the development of reliable, repeatable crack detection methods for the use on the service rail. In this research a new crack detection method has been investigated which utilizes microwave sensors to inspect the rail surface. Initial data from experiment are presented.

2.3 Automatic BrokenTrack Detection Using IR Transmitter and Receiver.

The Transportation of train always depends on railway tracks (rails) only. If there is a crack in these rails, it creates a major problem. Most of the accidents in the train are caused due to cracks in the railway tracks, which cannot be easily identified. Also it takes more time to rectify this problem. In order to avoid this problem, we are using the crack

detector robot, which detects the crack in the rails and gives an alarm. A robot is an apparently human automation, intelligent and obedient but impersonal machine. It is relatively, that robots have started to employ a degree of Artificial Intelligence (AI) in their work and many robots required human operators, or precise guidance throughout their missions. Slowly, robots are becoming more and more autonomous.

2.4 crack detection system for railway track by using ultrasonic and pir sensor:

In country like India, where majority of people depend on railways for transportation, if a crack in railway track is not detected during the early stages they may lead to derailment causing heavy loss to human life and property. In this paper a crack detection system is proposed which detects the crack without human intervention and sends the location of fault to the authorized personnel using GSM. Crack detection by this method can be done during both day and night time and exact location of fault can be obtained.

2.5 Railway Crack Detection System:

In the current rail system, it is more necessary to have safety elements in order to avoid accidents. One of the important causes that can provoke serious accidents is the existence of obstacles on the tracks either fixed or mobile and the cracks that are happened to the track. This project deals with one of the efficient methods to avoid train collision and obstacles detection and crack detection. This project aims for the detection of cracks in railway tracks, distance between the tracks and the presence of humans on railway tracks. The design of system consist a Global Position System (GPS) module, Global System for Mobile (GSM) modem, Infrared (IR) sensor and Passive Infrared (PIR) sensor. Now a days, the cracks in the railway track are measured by a high cost Linear Variable Differential Transformer (LVDT) with a less accuracy. In proposed system, the IR sensors are used for detect the crack in the rail track, ultrasound sensors measure the distance between the two track and the PIR sensors are used to detect the presence of humans the track. If any cracks or obstacles are detected on the railway tracks or if any change in the distance between the two tracks, the longitude and latitude of the track location is messaged to the nearest railway station using GPS and GSM modems. The proposed system is compared with the traditional measuring systems, where it stands as an efficient and cost effective system for railway applications.

3. IMPLEMENTATION

Data compression and invariance are two important functions of this extraction. An over-sampled set of measurements is typically used to extract the feature vector, which contains a carefully chosen set of features. The purpose of the feature selection step is to remove redundancy from the representation. A well-chosen feature vector would contain the majority of the discriminatory information while being significantly smaller in size than the original signal vector. As a result, the classification accuracy improves while the overall computational effort decreases. In this method they use dimensionality reduction techniques to get a better segmentation of the data which is images such as railway tracks rocks, railway links, couplers the method goes as such there are two sides of this dimensional reduction system which is feature selection and feature extraction. In the feature selection we have new methods such as

filters wrappers and embedded systems which uses the method of Bayes weighted vector of an SVM and variable threshold and the use of feature extraction as a matter of non-linear and linear which is based on linear discriminant analysis (LDA) and linear PCA.

Disadvantages:

1. Methods have performance limitations because of wide range of variations in data and amount of data is limited.
2. Issue involved in rainfall classification is choosing the required sampling recess of Observation-Forecasting of rainfall, which is dependent upon the sampling interval of input data.
3. Less accuracy

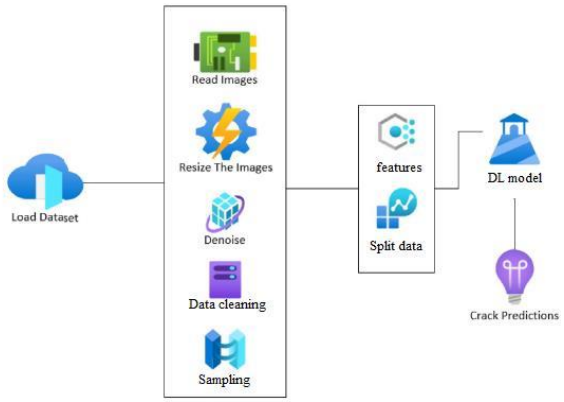

Fig.2 System architecture

The proposed system consists of different deep learning algorithms. To build model, we take railway track dataset which includes all past and present records of the track images, then we perform data preprocessing. We have divided dataset into two parts one is train data and second one is test data. Most of the data is used for training and smaller portion of data is used for testing (Train: 70%, Test: 30%). The aim of training is to make a prediction correctly as often as possible. The test data is used to see how well the machine can predict railway crack and to validate deep learning model behavior. DL models like CNN and VGG16 is implanted and the performance of both the model is compared.

Advantages:

1. By using deep learning for crack detection
2. we minimize time spent performing this job
3. Accuracy is high
4. decreasing costs
5. Increase employee protection, such a method can help remove the disadvantages of manual inspection.

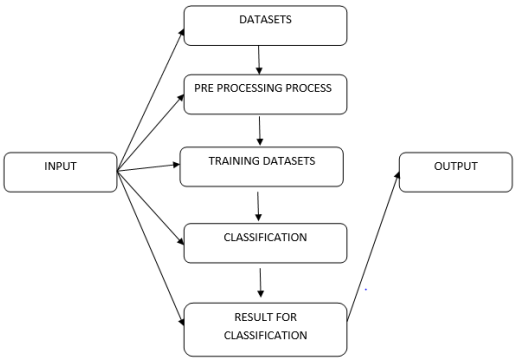

Fig.3: Dataset working

In this paper we use a combination of ideas which helps in making a better and faster method of detecting cracks on the railway tracks one such method is called Otsu segmentation method which helps in optimizing our images by extracting all the unnecessary details and color correction one of its major part which helps in building a better convolutional neural network. Since noise plays a great role in image processing and computer vision the more the noise the image has the less accurate our neural net becomes so this method helps us in getting an optimized image without any noise data and it also

enhances the image. Use the help of opensource railway track images to get a data and train them. The aim of our project is to completely use modern techniques of computer vision and deep learning to produce a more effective solution.

4. ALGORITHMS

CNN:

In the past few decades, Deep Learning has proved to be a very powerful tool because of its ability to handle large amounts of data. The interest to use hidden layers has surpassed traditional techniques, especially in pattern recognition. One of the most popular deep neural networks is Convolutional Neural Networks.

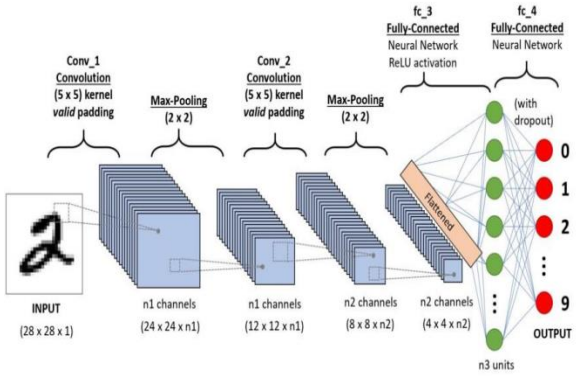

Fig.4: CNN model

Convolutional neural network (CNN/ConvNet) is a class, most commonly applied to analyze visual imagery. Now when we think of a neural network we think about matrix multiplications but that is not the case with ConvNet. It uses a special technique called Convolution. Now in mathematics convolution is a mathematical operation on two functions that produces a third function that expresses how the shape of one is modified by the other. But we don't really need to go behind the mathematics part to understand what a CNN is or how it works.Bottom line is that the role of the ConvNet is to reduce the images into a form that is easier to process, without losing features that are critical for getting a good prediction.

Convolutional neural networks are composed of multiple layers of artificial neurons. Artificial neurons, a rough imitation of their biological counterparts, are mathematical functions that calculate the weighted sum of multiple inputs and outputs an activation value. When you input an image in a ConvNet, each layer generates several activation functions that are passed on to the next layer. The first layer usually extracts basic features such as horizontal or diagonal edges. This output is passed on to the next layer which detects more complex features such as corners or combinational edges. As we move deeper into the network it can identify even more complex features such as objects, faces, etc.

VGG-16:

The ImageNet Large Scale Visual Recognition Challenge is an annual computer vision competition.. The second is to classify images, each labeled with one of 1000 categories, which is called image classification. VGG 16 was proposed by Karen Simonyan and Andrew Zisserman of the Visual Geometry Group Lab of Oxford University in 2014 in the paper "VERY DEEP CONVOLUTIONAL NETWORKS FOR LARGE-SCALE IMAGE RECOGNITION". This model won the 1st and 2nd place on the above categories in 2014 ILSVRC challenge.

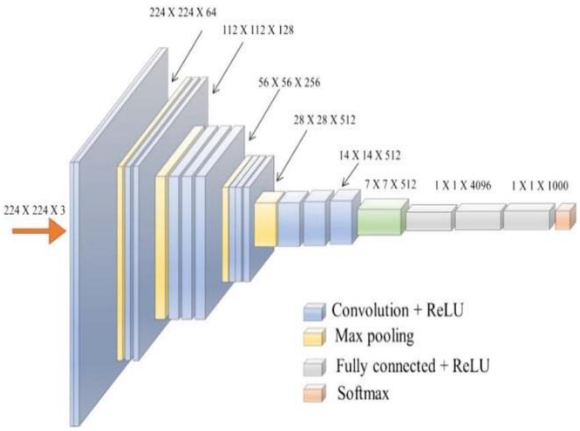

Fig.5:VGG16 model

This model achieves 92.7% top-5 test accuracy on ImageNet dataset which contains 14 million images belonging to 1000 classes. The ImageNet dataset contains images of fixed size of 224*224 and have RGB channels. So, we have a tensor of (224, 224, 3) as our input. This model process the input image and outputs the a vector of 1000 values. class 999 with probability 0.05 and all other class with 0. so, the classification vector for this will be: To make sure these probabilities add to 1, we use softmax function. This softmax function is defined as After this we take the 5 most probable candidates into the vector. and our ground truth vector is definedas

5. EXPERIMENTAL RESULTS

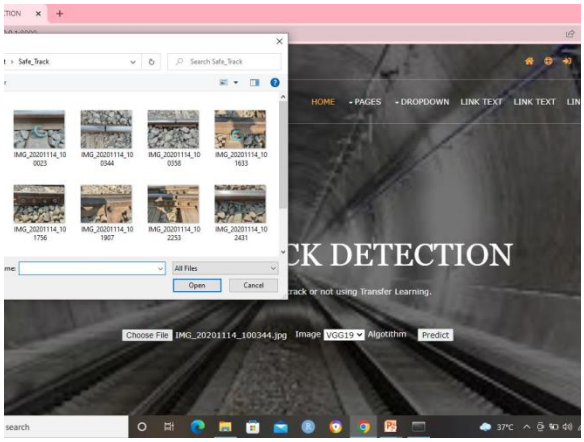

Fig.6: safe track detect

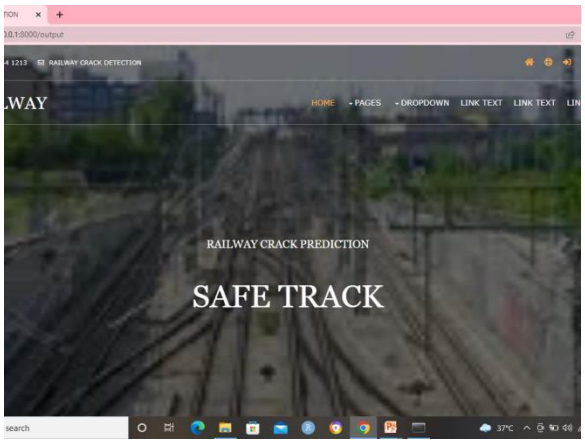

Fig.7: safe track prediction

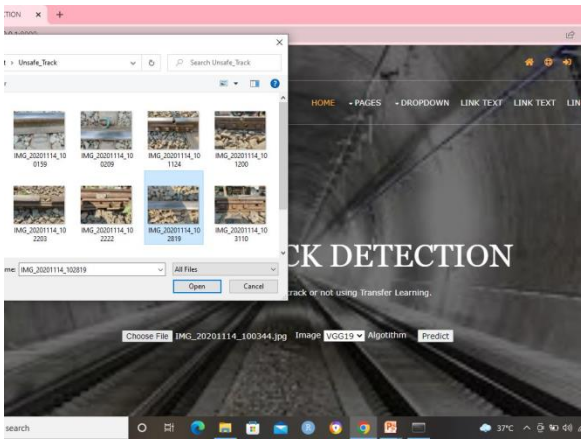

Fig.8: unsafe track detection

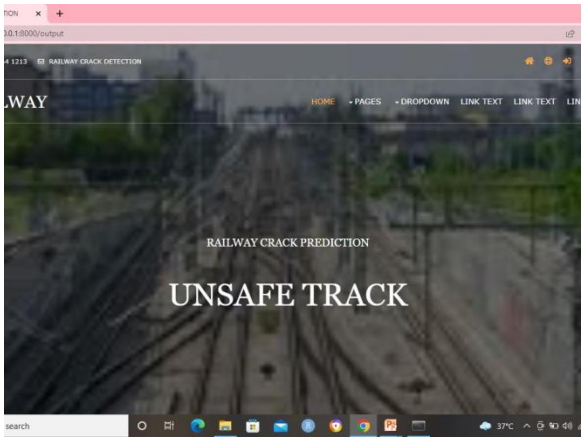

Fig.9: unsafe tack prediction

6. CONCLUSION

This paper elaborates different Existing railway crack system through Machine learning techniques by exploring several methods, concluding the overview of several railway crack system techniques and summarizing the accuracy of different proposed approach regarding several parameters. Moreover, all the existing methods are effective for railway crack system. Some have effective outcome and some are trying to implement another process for increasing their accuracy rate. The result shows that this new innovative technology will increase the reliability of safety systems in railway transport. By implementing these features in real time application, we can avoid more than accidents up to approximately 90%.

7. FUTURE SCOPE

More effective work can be done in order to provide a better speed to the automated vehicle robot. Also enhancement can be done to get better accuracy about the location of the place where the fault had occurred. Also the robot can be made large so that by using its weight track shiftiness i.e. stress and strain parameters of the track can be determined so as to make this system more effective. A better module can also be incorporated for low cost short distance scrutinizing mechanism in order to provide good connectivity at a low input cost. The battery of 12v can be replaced by the solar panel in order to achieve most out of it. A more efficient prototype can be build with image recognisation which will eventually increase the efficiency and accuracy of the vehicle as the vehicle can differentiate between the minor and the major cracks

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