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Train Track Crack Classification Using CNN

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ABSTRACT: A railway crack detection system is proposed in this paper. This research describes a classification method that uses deep learning and convolutional neural networks to classify any crack in railway tracks (CNNs). This research uses image processing technologies to classify faults on railway tracks, preventing train derailment. It showed how an innovative method that combines efficient image processing and deep learning with convolutional neural networks (CNNs) has been very successful in determining whether or not a railway track crack has occurred. Using a CNN trained with a publicly available image dataset, a number of neuron- and layer-wise Visualization methods were employed. As a result, neural networks have been reported to be able to record the textures of lesions related to corresponding railway track breaks, which is similar to human decision-making.

KEYWORDS: Train crack classification, deep learning, Tensorflow.

I. INTRODUCTION

Train positioning is of critical importance for Automatic Train Control (ATC) systems as a failure of a train positioning might lead to fatal accidents. Currently, as the most advanced train control system, the CBTC (Communication Based Train Control) is inseparable from the real-time acquisition of train location information. The efficiency and stability of the system depends on the accuracy of the train's real-time positioning. In addition, accurate train positioning is also of great significance to improve the performance of forward obstacle detection the precise train location can provide detection area, thus, making obstacle detection more accurate. The train positioning system nowadays is mainly dependent on trackside infrastructures likeBalise signal and axle counters. At the same time, with the rapid development of sensors, and the flexibility of installation, the on-board based train positioning systems become possible and attracted many researchers. What is more, the worldwide standardization of railway signal systems and the interoperability between different countries has become a trend and this promote the development of on-board based systems. Besides, the infrastructure-based systems require substantial capital investment. For example, a balise may costs thousands of dollars, and hundreds of balises are needed in a single railway line. On the contrary, the cost of on-board based systems is relatively low, for example, an on-board camera cost only a few hundred dollars, this also promote the development of on-board based systems. At present, the train positioning method based on onboard sensors mainly includes satellite data-based methods and feature-matching-based methods.

II. RELATED WORK

In order to acquire wide knowledge about designing the Train Track Crack Classification Using CNN we have gone through many research papers of various authors related to our project. The papers listed below will give brief explanation of the whole theme.

In 2021 [1] Accurate train location will be critical for railroad safety. We offer a train location method that combines vision and millimeter-wave radar data in this research. Loop closure detection (LCD) and radar-based odometry are the two aspects of the proposed technique. The radar-based odometry section provides a train speed measuring algorithm based on millimeter-wave radar, as well as combining the results of loop closure detection to further train location. Experiments on the Tsuen Wan line of the It can perform an efficient key position identification with 98.57 percent precision and 99.37 percent recall; the speed detection method meets the ETCS standards.In 2019 [2] Integrating new candidate sensors, such as Global Navigation Satellite System (GNSS) and inertial measurement unit (IMU), into fail-safe train positioning systems have recently become a prominent area of research. The results obtained by an extended Kalman filter using GNSS and IMU are compared with velocity recorded by tachometers and Doppler radars, which is considered to be the reference value. An absolute error in velocity lower than 2 km/h in more than 90% of test duration. Finally, railway features (curve radius, cant, and slope) are calculated and analyzed according to train and railway dynamics.In 2019 [3] Geometric features such as track irregularity and gauge deviation are information that directly reflects track quality. They are all functions of track mileage and contain abundant and low-cost position information,

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By collecting the data to be matched and matching it with the background database, the train position which meets the accuracy requirement is obtained.This method provides a new positioning information and idea for multi-sensor fusion train control system and can be used as an auxiliary means to improve the robustness of train positioning system.In 2019 [4] It is very difficult for visually impaired people to perceive and avoid obstacles at a distance. To address this problem, the unified framework of multiple target detection, recognition, and fusion is proposed based on the sensor fusion system comprising a low-power millimeter wave (MMW) radar and an RGB-Depth (RGB-D) sensor. In this paper, the Mask R-CNN and the single shot multibox detector network are utilized to detect and recognize the objects from color images. The experimental results show that the data fusion enriches the detection results. Meanwhile, the effective detection range is expanded compared to using only the RGB-D sensor. As a wearable system, the sensor fusion system has the characteristics of versatility, portability, and cost-effectiveness.In 2019 [5] Loop closure detection (LCD) is crucial for the simultaneous localization and mapping system of an autonomous robot. Image features from a convolution neural network (CNN) have been widely used for LCD in recent years. Instead of directly using the feature vectors to compute the image similarity, we propose a novel and easy-to-implement method that manages features from a CNN via a novel approach to improve the performance. In this method, the elements of feature maps from the higher layer of the CNN are clustered to generate CNN words (CNNW). To encode spatial information of CNNW, we create word pairs (CNNWP) that are based on single words to improve the performance.

III. PROPOSED SYSTEM

The recent success of convolutional neural networks (CNNs) in tasks such as object classification extends to the problem of train track crack classification. In the following sections, we will present an overview of our problem to classify images of train track into track crack identification. Many established image recognition systems use standard deep learning and extracted features, which do not have significant performance when applied to previously unseen data**.** We implemented three different classifiers from scratch A baseline classifier with one convolutional layer A CNN with a fixed size of five convolutional layers A deeper CNN with a parameter number of convolutional layers, filter dimensions, and number of filters. For each of these models, we tuned parameters including learning rate, regularization, and dropout. During training, the system received a training data comprising gray scale images of faces with their respective expression label and learns a set of weights for the network. The training step took as input an image with a face. Output from the second hidden layer is connected to output layer having seven distinct classes and output is obtained using the probabilities for each of the seven classes. The class with the highest probability is the predicted class.

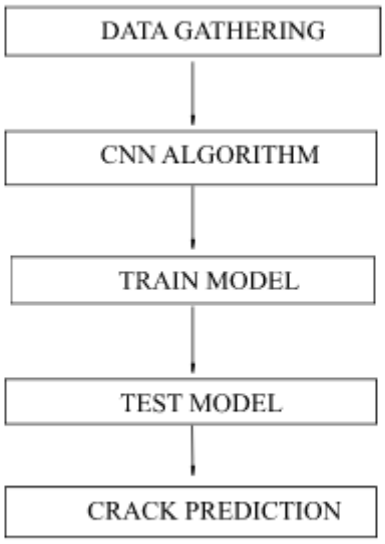

Fig: 1 FLOWCHART OF THE PROPOSED SYSTEM

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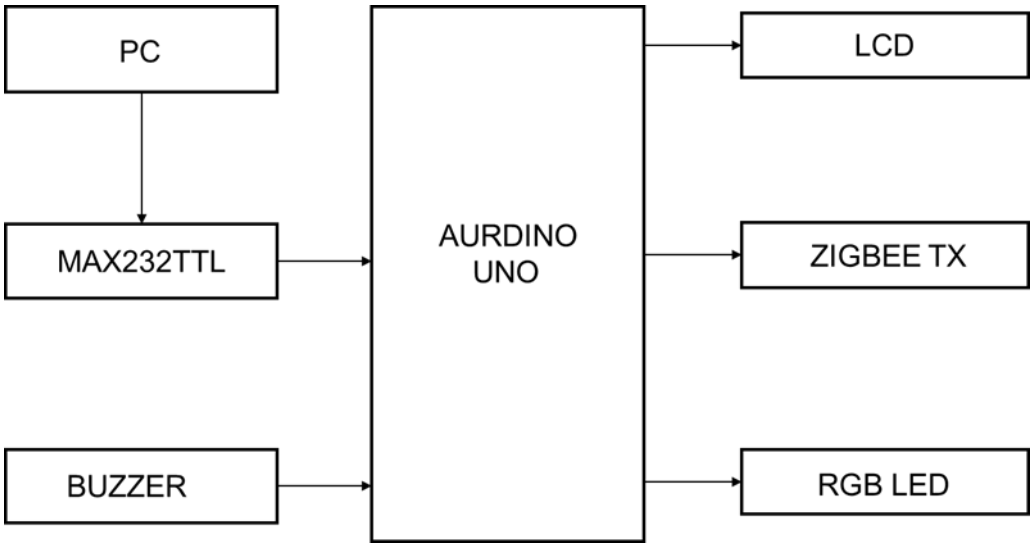

Fig: 2 BLOCK DIAGRAM OF THE TRACK SECTION

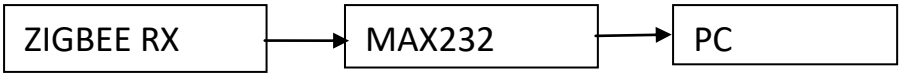

Fig: 3 BLOCK DIAGRAM OF THE STATION SECTION

In the given proposed system the AURDINO UNO act as a microprocessor whichisused to get the value and display the output than the output shown in the track section is transmitted through Zigbee Tx from The track section .And it is received through the Zigbee Rx in the station section . A Convolutional Neural Network) is a Deep Learning algorithm which can take in an input image, assign importance (learnable weights and biases) to various aspects/objects in the image and be able to differentiate one from the other. The pre-processing required in a CNN is much lower as compared to other classification algorithms. While in primitive methods filters are hand-engineered, with enough training, CNN have the ability to learn these filters/characteristics. The architecture of a CNN is analogous to that of the connectivity pattern of Neurons in the Human Brain and was inspired by the organization of the Visual Cortex

IV. HARDWARE DESCRIPTION

AURDINO UNO:

Arduino Uno is a microcontroller board based on the ATmega328P (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again. The Arduino Uno power supply can be done with the help of a USB cable or an external power supply. The external power supplies mainly include AC to DC adapter otherwise a battery. The adapter can be connected to the Arduino Uno by plugging into the power jack of the Arduino board. Similarly, the battery leads can be connected to the Vin pin and the GND pin of the POWER connector. The suggested voltage range will be 7 volts to 12 volts. The 14 digital pins on the Arduino Uno can be used as input & output with the help of the functions like Pin Mode() , DigitalWrite(), & Digital Read().

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ZIGBEE:

Zigbee technology allows diverse devices to communicate with one another. The router, coordinator, and end devices are all used in this network. The primary purpose of these devices is to transmit instructions and messages from the coordinator to single end devices like light bulbs. The coordinator is the most important device in this network, and it is located at the system's heart. There is only one coordinator for each network, who is responsible for various tasks. They select a suitable channel, scan it for the most appropriate one with the least amount of interference, and assign an exclusive ID and address to each device within the network. Messages or instructions can be transferred in the network if there is a network. Routers are located between the coordinator and the end devices, and they are responsible for routing messages between the various nodes. The coordinator sends messages to the routers, which they store until their end devices are in a position to receive them. Other end devices, as well as routers, may be able to connect to the network through these.

LCD:

LCD screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special &even custom characters (unlike in seven segments), animations and so on.Thus, this is all about LCD 16×2 datasheet, which includes what is a 16X2 LCD, pin configuration, working principle, and its applications. The main advantages of this LCD device include power consumption is less and low cost.

BUZZER:

An audio signaling device like a beeper or buzzer may be electromechanical or piezoelectric or mechanical type.The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc.Based on the various designs, it can generate different sounds like alarm, music, bell & siren.

V.SOFTWARE DESCRIPTION

ANACONDA NAVIGATOR:

Download and install anaconda and get the most useful package for machine learning in Python.Load a dataset and understand its structure using statistical summaries and data visualization.Machine learning models, pick the best and build confidence that the accuracy is reliable.Python is a popular and powerful interpreted language. Unlike R, Python is a complete language and platform that you can use for both research and development and developing production systems. There are also a lot of modules and libraries to choose from, providing multiple ways to do each task.

PYCHARM:

PyCharm is a dedicated Python Integrated Development Environment (IDE) providing a wide range of essential tools for Python developers, tightly integrated to create a convenient environment for productive Python, web, and data science development. Code faster and with more easily in a smart and configurable editor with code completion, snippets, code folding and split windows support.

CONVOLUTIONAL NEURAL NETWORK:

A Convolutional neural network (CNN) is one type of Artificial Neural Network.A Convolutional neural network (CNN) is a neural network that has one or more convolutional layers and are used mainly for image processing, classification, segmentation and also for other auto correlated data.

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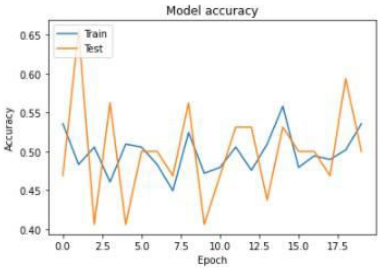

Fig: 4 CNN model trained dataset accuracy

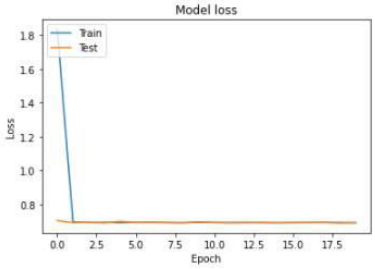

Fig: 5 CNN model trained dataset loss values

LIBRARIES REQUIRED

TENSERFLOW:

- Just to use the tensor board to compare the loss and Adam curve our result data or obtained log.

KERAS :

- To pre-process the image dataset

MATPLOTLIB:

- To display the result of our predictive outcome

VI. RESULT

The input image is given by using Keras pre-processing package. That input Image converted into array value using pillow and image to array function package. We have already classified crack of train crack in our dataset. It classifies what are the train crack. Then we have to predict the train track crack using predict function.

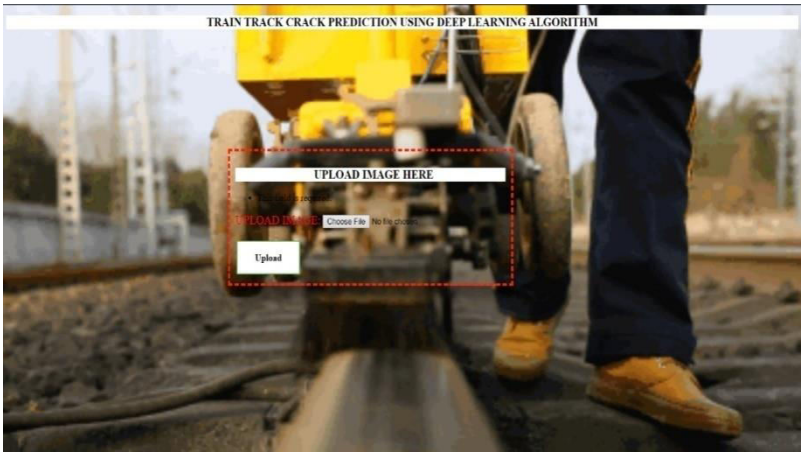

Fig 6: Interface of the Classifier

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Fig 7: Crack not detected

Fig 8: Crack detected

The dataset create size, rescale, range, zoom range, horizontal flipHere we set train, test, and validation also we set target size, batch size and class-mode from this function we have to train using our own created network by adding layers of CNN.To train our dataset using classifier and fit generator function also we make training steps per epoch's then total number of epochs, validation data and validation steps using this data we can train our dataset.

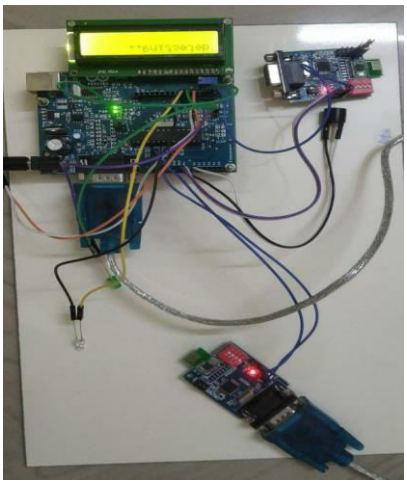

Fig 9: Setup of the Proposed System

V. CONCLUSION

It focused how image from given dataset (trained dataset) and past data set used to predict the pattern of Train track crack using CNN model. This brings some of the following insights about track crack prediction. The major benefit of

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the CNN classification framework is the ability to classify images automatically. In this study, we have discussed the overview of methodologies for detecting the abnormalities in track images which includes collection of train track image data set, pre-processing techniques, feature extraction techniques and classification schemes.

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