IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
Volume 2, Issue 1, June 2022
Impact Factor: 6.252

Train Track Crack Classification using Convolutional Neural Network.

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Abstract: *About Most of the accidents are occurring at railway track crack in railway tracks resulting in loss of precious life and loss of economy It is required to monitor the track health condition frequently using an crack classify system. This project prevents train derailment by classify cracks in railway track using image processing technology. To propose a solution for track crack recognition that uses a combination of Convolutional Neural Network and specific image pre-processing steps. It described the innovative solution that provides efficient image processing and deep learning with convolutional neural networks (CNNs) has achieved great success in the classification of railway track crack occurred or not. A variety of neuron-wise and layer-wise visualization methods were applied using a CNN, trained with a publicly available from given image dataset. So, it's observed that neural networks can capture the colors and textures of lesions specific to respective cracks in train tracks, which resembles human decision-making.*

Keywords: Train crack classification, deep learning, Tensorflow

I. INTRODUCTION

1.1 Artificial Intelligence

Artificial intelligence (AI) refers to the simulation of human intelligence in machines that are programmed to think like humans and mimic their actions. The term may also be applied to any machine that exhibits traits associated with a human mind such as learning and problem-solving.

Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to the natural intelligence displayed by humans or animals. Leading AI textbooks define the field as the study of "intelligent agents" any system that perceives its environment and takes actions that maximize its chance of achieving its goals. Some popular accounts use the term "artificial intelligence" to describe machines that mimic "cognitive" functions that humans associate with the human mind, such as "learning" and "problem solving", however this definition is rejected by major AI researchers.

Artificial intelligence is the simulation of human intelligence processes by machines, especially computer systems. Specific applications of AI include expert systems, natural language processing, speech recognition and machine vision. AI applications include advanced web search engines, recommendation systems (used by YouTube, Amazon and Netflix), Understanding human speech (such as Siri or Alexa), self-driving cars (e.g., Tesla), and competing at the highest level in strategic game systems (such as chess and Go), As machines become increasingly capable, tasks considered to require "intelligence" are often removed from the definition of AI, a phenomenon known as the AI effect. For instance, optical character recognition is frequently excluded from things considered to be AI, having become a routine technology.

AI programming focuses on three cognitive skills: learning, reasoning and self-correction.

- **Learning processes.** This aspect of AI programming focuses on acquiring data and creating rules for how to turn the data into actionable information. The rules, which are called algorithms, provide computing devices with step-by-step instructions for how to complete a specific task.
- **Reasoning processes.** This aspect of AI programming focuses on choosing the right algorithm to reach a desired outcome.
- **Self-correction processes.** This aspect of AI programming is designed to continually fine-tune algorithms and ensure they provide the most accurate results possible.

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- Artificial neural networks and deep learning artificial intelligence technologies are quickly evolving, primarily because AI processes large amounts of data much faster and makes predictions more accurately than humanly possible.

1.2 Natural Language Processing (NLP)

Natural language processing (NLP) allows machines to read and understand human language. A sufficiently powerful natural language processing system would enable natural-language user interfaces and the acquisition of knowledge directly from human-written sources, such as newswire texts. Some straightforward applications of natural language processing include information retrieval, text mining, question answering and machine translation. Many current approaches use word co-occurrence frequencies to construct syntactic representations of text. "Keyword spotting" strategies for search are popular andscalable but dumb; a search query for "dog" might only match documents with the literal word "dog" and miss a document with the word "poodle". "Lexical affinity" strategies use the occurrence of words such as "accident" to assess the sentiment of a document. Modern statistical NLP approaches can combine all these strategies as well as others, and often achieve acceptable accuracy at the page or paragraph level. Beyond semantic NLP, the ultimate goal of "narrative" NLP is to embody a full understanding of commonsense reasoning. By 2019, transformer-based deep learning architectures could generate coherent text.

II. LITERATURE REVIEW

Title: Analysis of cracking on running surface of rails

Author: Zdenka Popovic

Year : 2013

Montenegrin railways are a part of the European railway network. In the scope of realization of interoperability of the European railway system, rail infrastructure managers are required to have infrastructure subsystem maintenance plans for each conventional railway line [1]. This plan should inter alia include inspection and an appropriate strategy against the rolling contact fatigue (RCF). The rail failure or damage generally results from fatigue cracks and reduces the rail service life, increases the cost of maintenance, and may cause train derailment [2]. An increased traffic density, higher axle load and speed, as well as lubrication of rails, these are all factors that contribute to RCF and are a serious hazard to rail traffic. On the other hand, problems due to RCF can be reduced by applying an appropriate track geometry, correct wheel/ rail contact geometry, and better maintenance strategies. An adequate maintenance strategy should contribute to a longer rail service life, lower rail maintenance costs, and greater safety of railway traffic.

Title: Automatic Crack Detection and Classification Method for Subway Tunnel Safety Monitoring

Author: Wenyu Zhang, Zhenjiang Zhang *, Dapeng Qi and Yun Liu

Year: 2014

Cracks are an important indicator reflecting the safety status of infrastructures. This paper presents an automatic crack detection and classification methodology for subway tunnel safety monitoring. With the application of high-speed complementary metal-oxide-semiconductor (CMOS) industrial cameras, the tunnel surface can be captured and stored in digital images. In a next step, the local dark regions with potential crack defects are segmented from the original gray-scale images by utilizing morphological image processing techniques and thresholding operations. In the feature extraction process, we present a distance histogram based shape descriptor that effectively describes the spatial shape difference between cracks and other irrelevant objects. Along with other features, the classification results successfully remove over 90% misidentified objects. Also, compared with the original gray-scale images, over 90% of the crack length is preserved in the last output binary images. The proposed approach was tested on the safety monitoring for Beijing Subway Line 1. The experimental results revealed the rules of parameter settings and also proved that the proposed approach is effective and efficient for automatic crack detection and classification

Title: Crack detection using image processing: A critical review and analysis

Author: Arun Mohan, Sumathi Poobal

Year : 2017

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Cracks on the concrete surface are one of the earliest indications of degradation of the structure which is critical for the maintenance as well the continuous exposure will lead to the severe damage to the environment. Manual inspection is the acclaimed method for the crack inspection. In the manual inspection, the sketch of the crack is prepared manually, and the conditions of the irregularities are noted. Since the manual approach completely depends on the specialist's knowledge and experience, it lacks objectivity in the quantitative analysis. So, automatic image-based crack detection is proposed as a replacement. Literature presents different techniques to automatically identify the crack and its depth using image processing techniques. In this research, a detailed survey is conducted to identify the research challenges and the achievements till in this field. Accordingly, 50 research papers are taken related to crack detection, and those research papers are reviewed. Based on the review, analysis is provided based on the image processing techniques, objectives, accuracy level, error level, and the image data sets. Finally, we present the various research issues which can be useful for the researchers to accomplish further research on the crack detection.

Title: Crack Detection in Concrete Tunnels Using a Gabor Filter Invariant to Rotation
Author: Roberto Medina 1 , José Llamas 1 ID , Jaime Gómez-García-Bermejo 2,* ID , Eduardo Zalama 2 and Miguel José Segarra 3
Year : 2017
In this article, a system for the detection of cracks in concrete tunnel surfaces, based on image sensors, is presented. Both data acquisition and processing are covered. Linear cameras and proper lighting are used for data acquisition. The required resolution of the camera sensors and the number of cameras is discussed in terms of the crack size and the tunnel type. Data processing is done by applying a new method called Gabor filter invariant to rotation, allowing the detection of cracks in any direction. The parameter values of this filter are set by using a modified genetic algorithm based on the Differential Evolution optimization method. The detection of the pixels belonging to cracks is obtained to a balanced accuracy of 95.27%, thus improving the results of previous approaches.

Title: Automotive Crack Detection for Railway Track Using Ultrasonic Sensorz Article
Author: Sopanharith Sam, V.Ganesh
Year: 2016
In the fast developing country, people are facing many accidents; it would be undesirable for any nation to losing their life for unwanted cause. Railways are one of the important transports in India. There is a need for manual checking to detect the crack on railway track and always railway personnel takes care of this issue, even though the inspection is made regularly. Sometimes the crack may unnotice. Because of this the train accident or derailment may occur. In order to avoid this situation and automate the railway crack detection has been proposed. Here ultrasonic sensor is used to detect the crack in the railway track by measuring distance from track to sensor, if the distance is greater than the assigned value the microcontroller identifies there is a crack, also it tells the exact location of the crack by the formula "DISTANCE=SPEED*TIME". While the checking process is going on, the train may approach, it is identified by the vibration sensor and gives alert to the microcontroller, thereby shrinks the size of the robot between the two tracks. After the train has crossed it returns to its normal position and continue its checking process.

III. SYSTEM ARCHITECTURE

List Of Modules

1. Manual Net
2. AlexNet
3. LeNet
4. Deploy

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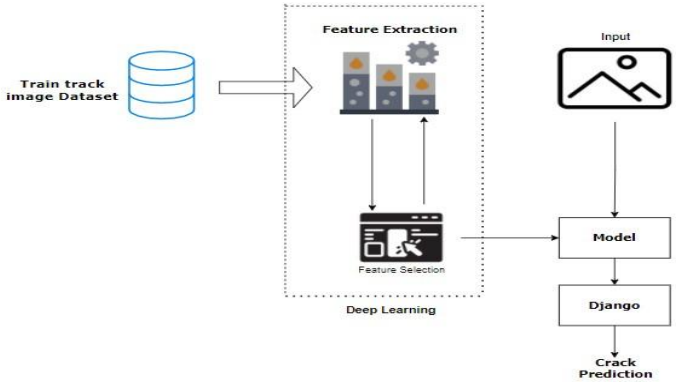

Module Description

ALEXNET:

AlexNet is the name of a convolutional neural network which has had a large impact on the field of machine learning, specifically in the application of deep learning to machine vision. AlexNet was the first convolutional network which used GPU to boost performance.

AlexNet architecture consists of 5 convolutional layers, 3 max-pooling layers, 2 normalization layers, 2 fully connected layers, and 1 softmax layer. Each convolutional layer consists of convolutional filters and a nonlinear activation function ReLU. The pooling layers are used to perform max pooling

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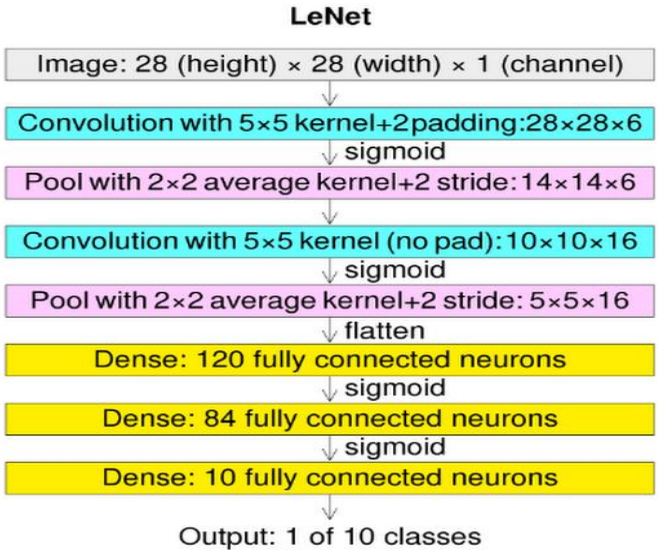
LENET:

LeNet was one among the earliest convolutional neural networks which promoted the event of deep learning. After innumerous years of analysis and plenty of compelling iterations, the end result was named LeNet.

Architecture of LeNet-5:

LeNet-5 CNN architecture is made up of 7 layers. The layer composition consists of 3 convolutional layers, 2 subsampling layers and 2 fully connected layers.



DEPLOY / RESULT:

Deploying the model in Django Framework and predicting output

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IV. 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 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, preprocessing techniques, feature extraction techniques and classification schemes.