POTHOLE CRACK DETECTION USING MACHINE LEARNING

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ABSTRACT

Potholes are perennial problem across the world. They are dangerous and causes road accidents. The potholes often begin as imperceptible microscopic cracks in the road surface. The main reason behind these potholes formation are bad weather, poor drainage maintenance and construction, high traffic, which causes that surface to loosen and damage. This issue has to be reported to the roadways department by identifying cracks and potholes on the roads. This would help them to resolve the issue effectively and prevent the potholes from causing fatal damages. Image Processing helps in detecting the Potholes, and the predictions made are quite accurate. By utilizing the images of the cracked potholes, asphalt failures and fatigue potholes on the roads, a system is proposed to identify the potholes. The images are fed into the YOLO (You Only Look Once) algorithm, which is used to detect the cracks leading to deep potholes. YOLOv2 helps us predict potholes in real time object detection at the rate of 45 FPS (Frames Per Second).

Keywords: Pothole Detection, Deep learning, YOLOv2

I. INTRODUCTION

Modern day road faces many accidents and potholes are the main reason for that. These potholes are considered to be very dangerous and causes frequent road accidents. The main reason for the formation of potholes are heavy traffic and bad road construction and maintenance. These potholes need to be detected before it causes severe fatigue, So we follow a new approach in detecting potholes cracks on road. Machine Learning is a key technology, which is going to play a vital role here. By using appropriate machine learning algorithm, we will be able to detect cracks and potholes on road, by processing the captured images or video files. With the advanced deep learning, the last many years has seen the research extend to use these networks to make conclusion on potholes detection on roads from images or videos. By using this method it will give an accuracy and perfect prediction.

In deep learning approach, the YOLOv2 is a deep neural network method, most commonly used for object detection in videos upto 45 FPS. There are different modules to explain our project flow. In module 1 we import the given image from dataset. In module 2 we extract features of Neural Network Layers. In module 3 we will Train model in YOLOv2 and predicting using Trained Weights. In last the module we can easily identify the potholes and cracks on the roads. This approach is very useful for Roadways Department because the early detection of the potholes can reduce the cost to repair the damaged roads and prevent accidents.

II. RELATED WORK

In this technique various algorithms have been proposed for pothole detection and predicting accuracy in loss of damage to roads. To detect the potholes, the use of deep learning approach are planned so that the potholes can be easily predicted at the early stage of cracks. Here the YOLOv2 algorithm is used to analyze the images and identify the cracks.

Yifan Pan, Xianfeng Zhang, Guido Cervone, Liping Yang. Detection of asphalt pavement potholes and cracks based machine algorithms such as Artificial neural network (ANN), asphalt roads, multispectral imagery, pavement distress,random forest(RF),support vector machine (SVM), unmanned aerial vehicle (UAV) and remote sensing system used as a new tool for monitoring the asphalt road pavement condition, which they have used as decision support for road maintenance practice.

Qin Zou, Zheng Zhang, Qingquan Li, Xianbiao Qi, Qian Wang, and Song Wang have project proposal deals with line detection, edge detection, contour grouping, crack detection, convolutional neural network. They have used a DeepCrack net on the architecture of SegNet, and pairwisely fuse the convolutional features generated within the encoder network and within the decoder network at an equivalent scale. They have trained a DeepCrack net on one crack dataset and evaluated it on three others. Their experimentation of the DeepCrack has achieved F-Measure of 0.87 on the three challenging dataset.

Dihao Ai, Guiyuan Jiang, Lam Siew Kei, And Chengwu Li have made project proposal Pavement crack detection, probability map, multi-scale neighborhoods, probabilistic generative mode, support vector machine. They have used pixel intensity information, which is a probabilistic generative model (PGM) based method that is developed to calculate the probability of a crack for each pixel. They have proposed a support vector machine (SVM) based on the method to calculate the probability maps and by using information of multi-scale neighborhoods.

Yue Fei, Kelvin C. P. Wang, Allen Zhang , Cheng Chen, Joshua Q. Li, Yang Liu, Guangwei Yang, and Baoxian Li have made project proposes CrackNet, CrackNet-V, deep learning, surface cracks. Their VGG network, CrackNet-V used 3 × 3 size of filters for the first six convolutional layers and stacks several 3×3 convolutional layers together for the deep abstraction, which resulted in reduced number of parameters and efficient feature extraction. Their CrackNet-V had 64113 parameters and consisted of ten

layers, including one pre-process layer, eight convolutional layers, and one output layer.

Amita Dhiman and Reihard Kletten have made research work on the object detection using OpenCV (Computer Vision). Mainly focused on the pothole detection, stereo vision and deep learning. The image processing algorithms proposed were Convolutional Neural Networks (CNN) models. The proposal of Transfer Learning in Mask R-CNN.

. *III. LITERATURE SURVEY*

1. Detection of Asphalt Pavement Potholes and Cracks Based on the Unmanned Aerial Vehicle Multispectral Imagery (IEEE 2018)

Author: Yifan Pan, Xianfeng Zhang, Guido Cervone, Liping Yang.

Detection of asphalt pavement potholes and cracks based machine algorithms such as Artificial neural network (ANN), asphalt roads, multispectral imagery, pavement distress, random forest (RF),support vector machine (SVM), unmanned aerial vehicle (UAV) and remote sensing system used as a new tool for monitoring the asphalt road pavement condition, which they have used as decision support for road maintenance practice.

2. DeepCrack: Learning The Hierarchical Convolutional Features for Crack Detection (IEEE 2018)

Author: Qin Zou, Zheng Zhang, Qingquan Li, Xianbiao Qi, Qian Wang, and Song Wang.

Line detection, edge detection, contour grouping, crack detection, convolutional neural network. They have used a DeepCrack net on the architecture of SegNet, and pairwisely fuse the convolutional features generated within the encoder network and within the decoder network at an equivalent scale. They have trained a DeepCrack net on one crack dataset and evaluated it on three others. Their experimentation of the DeepCrack has achieved F-Measure of 0.87 on the three challenging dataset.

3. Automatic Pixel-Level Pavement Crack Detection Using Information of Multi-Scale Neighborhoods (IEEE 2018)

Author: Dihao Ai, Guiyuan Jiang, Lam Siew Kei, And Chengwu Li.

Pavement crack detection, probability map, multi-scale neighborhoods, probabilistic generative mode, support vector machine. They have used pixel intensity information, which is a probabilistic generative model (PGM) based method that is developed to calculate the probability of a crack for each pixel. They have proposed a support vector machine (SVM) based on the method to calculate the probability maps and by using information of multi-scale neighborhoods.

4. Pixel-Level Cracking Detection on 3D Asphalt Pavement Images Through Deep-Learning Based CrackNet-V (IEEE 2018)

Author: Yue Fei, Kelvin C. P. Wang, Allen Zhang , Cheng Chen, Joshua Q. Li, Yang Liu, Guangwei Yang, and Baoxian Li

CrackNet, CrackNet-V, deep learning, surface cracks. Their VGG network, CrackNet-V used 3×3 size of filters for the first six convolutional layers and stacks several 3×3 convolutional layers together for the deep abstraction, which resulted in reduced number of parameters and efficient feature extraction. Their CrackNet-V had 64113 parameters and consisted of ten layers, including one pre-process layer, eight convolutional layers, and one output layer.

5. Object-Based Crack Detection and Attribute Extraction From Laser-Scanning 3D Profile Data (IEEE 2019)

Author: Rong Gui , Xin Xu , Dejin Zhang And Fangling Pu.

Laser-scanning 3D, fracture detection, OBIA, fracture quality, student volumes. This paper presents an object-based image analysis (OBIA) method for cracking and subtraction detection from 3D laser scanning with high accuracy of approximately 0.25mm. First, the large amount of structural space passed in our previous research was used to clear the transition state in 3D data, then used the smallest algorithm for small values, to find the points of the powder and the bottom of the structure.

6. Method for detecting micron cracks on a magnetic rotor surface based on a support vector machine (IEEE 2018)

Author: Haodi Hu, Guanting Dong, Bo Peng, Jian Xing, And Wenlong Song.

Micro-scale crack, high-level scoring, calculating, regional algorithm, support equipment, improved learning area algorithm, online adoption. Computer-based approach and Support Vector Machine (SVM) that can detect microscale cracks accurately and quickly. SVM was later used to distinguish between two types of image sources. An Improved Language Algorithm (IROA) has been proposed to increase the efficiency of continuous disc images affecting online adoption.

7. Automatic Pavement Object Detection Using Superpixel Segmentation Combined With Conditional Random Field (IEEE 2018)

Author: Waqas Sultani, Soroush Mokhtari, and Hae-Bum Yun.

Image acquisition, superpixel segmentation, random random effects. To find the object in the form of a direct objection, they first divide the image into smaller unchanged regions called super pixels. These superpixels are quick to calculate and maintain object boundaries. They combine several textures and intensity measures within each superpixel. Next, they train the vector support vector machine (SVM). Therefore, in order to use the superpixel label variable, they used a content-based strategy i.e., one-dimensional default (CRF).

8. Pothole Detection Using Computer Vision and Learning (IEEE 2019)

Author: Amita Dhiman and Reihard Klette.

Object detection using OpenCV (Computer Vision). Mainly focused on the pothole detection, stereo vision and deep learning. The image processing algorithms proposed were Convolutional Neural Networks (CNN) models. The proposal of Transfer Learning in Mask R-CNN.

IV. EXISTING SYSTEM

1. Automatic Pixel-Level Pavement Crack Detection Using Information of Multi-Scale Neighborhoods (IEEE 2018)

Dihao Ai, Giiyuan Jiang, Lam Siew Kei, and Chengwu Li presented the discovery of simple Pavement cracks, probability mapping, crowded terrain, proabilistic generating mode, vector support. Using pixel thickness information, the PGM-based method is used to calculate the probability of each pixel breaking. Point out that the neighborhoods of each pixel contain sensitive information for cracking, and then propose a vector-based vector (SVM) method to calculate maps that may be using spatial information.

Disadvantage

Only concentrated in predicting the cracks and high quality images are required by the system to detect cracks with high probability.

2. Pothole Detection Using Computer Vision and Learning (IEEE 2016)

Amita Dhiman and Reihard Klette did project proposes research work on the object detection using OpenCV (Computer Vision). Mainly focused on the pothole detection, stereo vision and deep learning. The image processing algorithms proposed were Convolutional Neural Networks (CNN) models. The proposal of Transfer Learning in Mask R-CNN.

Disadvantage

This project does not predicts cracks and potholes through video files as input and the prediction is only 90% on images. When there are multiple potholes in an image.

V.PROPOSED SYSTEM:

To detect the Potholes and cracks, deep learning approach is proposed so that roads can be maintained properly by identifying pavements in its early stages, this will help the roadways department and avoid accidents caused by road damages.

VI.MODULE DESCRIPTION:

1. To build model for training datasets.
2. Feature Extraction of Neural Network Layers.
3. Training Model in YOLOv2 and predicting using Trained weights.
4. Pothole crack detection.

To build model for training datasets

Training dataset is training an algorithm to understand how to apply neural network concepts and produce results. Here the

images are trained by using dataset classifier and fit generator function. Fit generator function accepts the datasets, performs back propagation and update the weighs in the proposed model. By using this function the dataset can be easily classified and trained. In this module the grayscale base and edge base are used to identify the model loss and model accuracy. In this module training, testing, validation can be done.

Feature Extraction of Neural Network Layers.

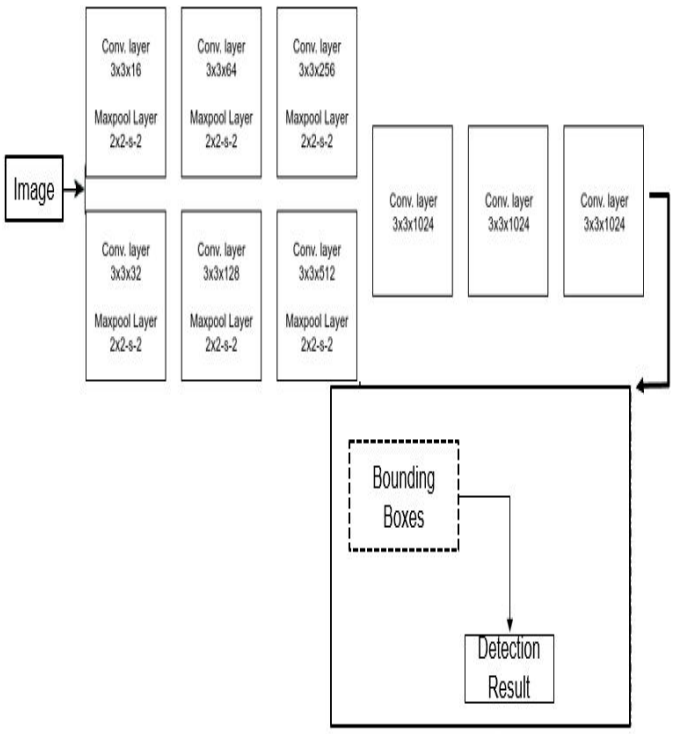
The trained dataset is used in this module to train the Convolutional model so that it can identify the test image and the cracks. Deep Neural Network has different layers like dense, dropout, activation, flatten, convolution 2D, and Max pooling 2D. After the model is trained successfully. Here the convolution 2D layer is used to combine the image into multiple images activation. This is called as activation function. And Max pooling 2D is used to max pool the value from the given size matrix and also check the similarity and give it to dense. Flatten layer is used to generate the fitting function of an image after convolution 2d image is obtained. Dense layer is mainly used for classification. These processes will run in a hidden layer. By using these layers we can easily predict the cracks and also find the accuracy.

Training Model in YOLOv2 and predicting using Trained weights.

In this module, YOLOv2 model is trained by the trained weights from the previous Convolutional neural network layers are fed into the YOLOv2 and the sample images and videos are loaded into the YOLOv2 model. By this the model is fully trained to predict the potholes and cracks on the roads.

Pothole crack detection.

We give input image or video using preprocessing package. That input image or video are converted into array value and image to array function package. We have already identified cracks in our dataset. Compare both as did in module 3. Then we have to predict potholes using predict function.



VII.ALGORITHM

A You Only Look Once (YOLO) is one of the types of Deep Learning algorithm which can take an input as an image or video, then assign importance (learnable weights and biases) to the various objects in an image and it can easily able to differentiate one from the other. The pre-processing required in a ConvNet is much lower as compared to other classification algorithms. While in primitive method, the filters are done with a hand crafted features of enough training and ConvNets and RestNets have the ability to learn these filters/characteristics. YOLO predicts multiple binding boxes with a single grid cell. To compensate for the loss of the true good, we want one of them to turn itself into something. For this purpose, we choose the one with the highest IoU (mediation) and global truth. This strategy leads to the choice between bond box ties. Each predictor gets better at guessing the specific size and size of the features.

$B_x = \sigma(t_x)+c_x$

$B_y = \sigma(t_y)+c_y$

$B_w = p_w e^{tw}$

$B_h = p_h e^{th}$

Pr (Pothole) * IOU (b,Pothole) = $\sigma(t_o)$

t_x, t_y, t_w, t_h - predictions made by YOLO

c_x, c_y - grid cell

p_w, p_h – width and height of anchor

B_x, B_y, B_w, B_h – predicted boundary box

$\sigma(t_o)$ – box confidence

Fig 1 Orginal Image

Fig 2 Potholes Detected Image

VIII.FUTURE ENHANCEMENT

Implementation of the prediction system in traffic CCTV and process the real-time pothole crack detection with high accuracy and create reporting system to detect the potholes on the roads and report to the road damage on the particular location.

IX.CONCLUSION

Pothole Crack Detection predicts the potholes in the early stages and prevents the fatal damages. Our system which is developed using YOLOv2 algorithm will be able to all kinds of road fatigue. This is very useful for the people and the government to maintain proper road condition. We have achieved an accuracy of 98% in predicting potholes. By this we can avoid road accidents and reduce the cost for road reconstruction.

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