Designing a pothole detector using machine learning

Group 301

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UCS1903 Introduction to Machine Learning

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Problem Statement

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Brief discussion of the

problem statement &
proposed solution

Detection of

POTHOLE & PLAIN ROAD

CLASSIFICATION

Problem Statement

Using deep learning and transfer learning techniques to solve the binary image classification problem of separating plain roads and roads with potholes by adopting an accurate model for savings in training time and computational efficiency.

Pothole

Plain road

Introduction

A pothole is a hole in a road surface that results from gradual damage caused by traffic and weather conditions. Potholes, a kind of road defect, can damage vehicles and negatively affect drivers' safe driving, and in severe cases can lead to traffic accidents.The recent convergence of sensor networks and communication technologies has led to the development of internet of things which is fast becoming the new wave in the era of computing.

EXISTING WORK WITH LIMITATION

Despite significant accuracy achieved by the machine learning approach, they ran into these challenges:

(1) manually extracting features must be done by experts to improve the accuracy performance during the pothole detection process, and

(2) their algorithms required a lot of computational power which could not be used by drivers. Convolutional neural networks (CNN) provide an alternative methodof automatically extracting and classifying features using deep learning (DL) methods

Motivation

One of the increasing problems the roads are facing is worsened road conditions. Unexpected hurdles on the road may cause more accidents. Also because of the bad road conditions, fuel consumption of the vehicle increases; causing wastage of precious fuel.

Because of these reasons it is very important to get the information of such bad road conditions, Collect this information and distribute it to other vehicles, which in turn can warn the driver. We in this project try to design and build such a system. In this system the access point collects the information about the potholes in the vicinity of a wireless access point and distributes it to other vehicles using a wireless broadcast.

NOVELITY OF PROJECT

The novelty of the approach lies in using texture-based features to differentiate between crack surfaces and sound roads. The approach performs well in large viewpoint changes, background noise, shadows, and occlusion. The efficacy of the system is shown on standard road crack datasets.

Dataset Details

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Exploration of the dataset

Key Dataset Details

- NAME : Pothole and Plain Road Images
- SOURCE : Google
- RECORD TYPE : .jpg, .jpeg , .png, .gif images
- CLASSES : Binary Classification - pothole and plain
- NUMBER OF RECORDS : 700 (350 each)
- TRAIN-VAL-TEST SPLIT : 60-20-20 ratio (420-140-140)
- FEATURES : Convolutional Base (Deep Learning)

Dataset Stats

In [10]:

```
# Sanity checks
print('total training plain images :', len(os.listdir(train_plain_dir)))
print('total training pothole images : ',len(os.listdir(train_pothole_dir)))
print('total validation plain images :', len(os.listdir(validation_plain_dir)))
print('total validation pothole images :', len(os.listdir(validation_pothole_dir)))
print('total test plain images :', len(os.listdir(test_plain_dir)))
print('total test pothole images :', len(os.listdir(test_pothole_dir)))
```

```
total training plain images : 210
total training pothole images : 210
total validation plain images : 70
total validation pothole images : 70
total test plain images : 70
total test pothole images : 70
```

Directory Structure

Activities Terminal Apr 15 09:44

admin@X507UAR: ~/Desktop/Pothole-Classification-main

```
admin@X507UAR:~/Desktop/Pothole-Classification-main$ tree -Ld 3 .
.
├── Code
├── Data
│   ├── test
│   │   ├── plain
│   │   └── pothole
│   ├── train
│   │   ├── plain
│   │   └── pothole
│   └── validation
│       ├── plain
│       └── pothole
└── Results

12 directories
admin@X507UAR:~/Desktop/Pothole-Classification-main$
```

Methodology

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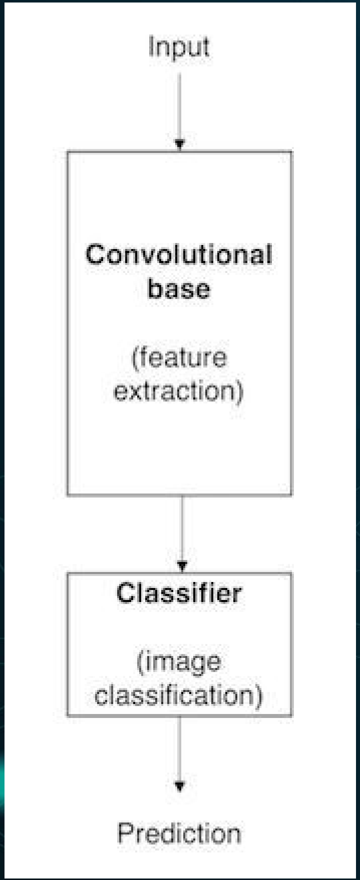
Step-by-step approach to solve the problem and tentative workflow

CNN Architecture



- This deep learning model can automatically learn **hierarchical feature representations**
- This means that **features computed by the first layer are general and can be reused in different problem domains, while features computed by the last layer are specific and depend on the chosen dataset and task**
- *'If first-layer features are general and last-layer features are specific, then there must be a transition from general to specific somewhere in the network'*
- As a result, the convolutional base of CNN — especially its lower layers (those who are closer to the inputs) — refer to general features, whereas the classifier part, and some of the higher layers of the convolutional base, refer to specialised features

Proposed Workflow

PREPARE DATA

Choose appropriate dataset. A smaller version of the original dataset can be used to run the models faster, which is great for people who have limited computational power

EXTRACT FEATURES

Perform feature extraction from convolutional base. These features will feed the classifiers which we want to train

Proposed Workflow

BUILDING CLASSIFIERS

1. **Fully-connected layers** - This classifier adds a stack of fully-connected layers that is fed by the features extracted from the convolutional base.

2. **Global average pooling** - The difference between this case and the previous one is that, instead of adding a stack of fully-connected layers, we will add a global average pooling layer and feed its output into a sigmoid activated layer.

Proposed Workflow

TRAIN MODEL

Train the model by fixing the epochs and batch size

PERFORMANCE ANALYSIS

Analyse the performance of the model using various performance metrics

Result

Input

No pothole detected

Output

Pothole Detected

CONCLUSION

In this paper, we have developed an innovative method to find potholes easily using CNN with Fully connected Layer Model and also with Global Average Pooling Model, YOLO v4 . From this work we analyzed the feasibility and accuracy of These 3 models in the field of pothole detection. After collecting a suitable amount of data containing the images of potholes under various conditions and weather, and implementing augmentation techniques on the data, all three models were trained and their accuracy were noted.

It was like accuracy of

CNN VGG16 with Fully Connected Layer Model = 94.07 %
CNN VGG16 with Global Average Pooling Model = 93 %
Yolo v4 = 92 %

Also, a comparison between the convolutional neural model and Yolo v4 has been done. The results show that images were correctly identified with the best accuracy using one of the pre-trained convolutional neural networks.

Thank You