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Traffic Congestion Detection Using Deep Learning

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ABSTRACT

Despite the huge amount of traffic surveillance videos and images have been accumulated in the daily monitoring, deep learning approaches have been underutilized in the application of traffic intelligent management and control. Traffic images, including various illumination, weather conditions, and vast scenarios are considered and preprocessed to set up a proper training dataset. In order to detect traffic congestion, a network structure is proposed based on residual learning to be pre-trained and fine-tuned. The network is then transferred to the traffic application and retrained with self-established training dataset to generate the Traffic Net. The accuracy of Traffic Net to classify congested and uncongested road states reaches 99% for the validation dataset and 95% for the testing dataset. The trained model is stored in cloud storage for easy access for application from anywhere. The proposed Traffic Net can be used by a regional detection of traffic congestion on a large-scale surveillance system. The effectiveness and efficiencies are magnificently demonstrated with quick detection in the high accuracy in the case study. The experimental trial could extend its successful application to traffic surveillance system and has potential enhancement for intelligent transport system in future.

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INTRODUCTION

With fast development of deep learning-based approaches, they have been shown applicable to many different image recognition tasks in clinical diagnosis, robotics and so on. However, it is surprised that few successful applications in the transportation system have been reported, especially in consideration of huge amount traffic video and image using in monitoring the urban road network and freeway. According to the current situation, most of the cameras play their roles as passive monitory but cannot automatically detect the congestion on time. The detection of congestion mainly relies on lots of manpower to report congestion manually when it happens randomly in the road network. It is extremely tedious and time-consuming to keep watching all the day and identify congestion from the current surveillance system using in traffic monitoring hall. Furthermore, it is impossible to watch all the cameras relies on human eyes considering numerous cameras covering a large-scale region using in the freeway. However, prompt detection of the traffic congestion in large-scale region is important. Prompt detection can prevent extended congestion with devastating evolution from the initial controllable traffic congestion, which is one of the important applications in intelligent transport system (ITS). In order to detect the road state of congestion, commercial video detector, vehicle detector, and other equipment are developed and installed. However, high-cost of those equipment limits their application. The expensive supercomputer is also needed to process cameras local in large-scale region simultaneously. The transmission and computation of the continuous video record consume lots of equipment costs and electrical resources. The processing is uninterruptedly conducted so the high-performance computer is needed to meet the requirement of real-time application. Seeing that the remarkable improvement of the deep learning approaches emerges in those days, it is worth to investigate the image-based detection and extend it to the practical application .

In order to meet the requirement of the practical application, spatial and temporal information of congestion occurrence is vital for subsequence precise regional traffic management and control. With accurate detection of congestion incorporated with spatial and temporal information, the overall distribution of traffic congestion in a region could be sorted out. That multiple dimensional information could be then compounded and reported from cameras in a large-scale range using in regional surveillance systems and automatically visualize the congestion area to assist people watching the monitor system more efficiently.

RELATED WORKS

Deep learning algorithms have the potential implementation meanings to be intensely used in many fields of the transportation system, from traffic flow prediction to traffic congestion recognition. Classification of traffic condition is one of the most important parts of an ITS , which can be widely utilized in traffic control strategies, traffic flow analysis and so on.

In terms of traditional machine learning-based method, K-nearest neighbor (KNN) was commonly used to classify images. Support vector machine (SVM) was also used for classifying hyper spectral images with satisfactory results [13]. All those traditional image processing methods were hard to use in the classification of traffic images in consideration of various scenarios and disturbances.

Deep learning approaches have been dramatically improved with high-performed computer emerged.

Classification method shifted its research direction into the deep learning-based method and moved to artificial intelligence (AI) level. Deep learning method conquered the shortcoming of traditional machine learning algorithms, which rely on hand-designed features. Convolutional neural network (CNN) and recurrent neural network (RNN) are successful examples of supervised deep learning algorithms, which require a considerable amount of training data. In recent years, the CNN-based model appeared as a powerful framework for feature extraction and recognition dominated various image tasks. . In 2012, AlexNet using CNN-based has intensely improved with deep learning algorithm which has been successfully used in the famous image competition ILSVRC . Since then, CNN-based in image recognition has been widely used and became popular in image recognition and visual learning. At the same time, people adopt GPU to solve the problem of training in big data size. VGG networks [28] with more layers of CNN achieved a better result than the previous approaches.

LITRETURE REVIEW

During the last few decades, significant research efforts have been devoted to using closed-circuit television (CCTV) cameras to determine real-time traffic parameters such as volume, density, and speed (12, 13). These methods can be broadly divided into three categories: (a) detection-based methods, (b) motion-based methods, and (c) holistic approaches. Detection-based methods use individual video frames to identify and localize vehicles and thereby perform a counting task. Ozkurt and Camci used neural network methods to perform vehicle counting and classification tasks from video records (6). Kalman filter-based background estimation has also been used to estimate vehicle density (14). In addition, faster recurrent convolution neural networks (RCNNs) have been used for traffic density calculation (15). However, these were found to perform poorly for videos with low resolution and high occlusion. Recent achievements in deep learning methods in image recognition tasks have led to several such methods being used for traffic counting tasks.

Several motion-based methods have been suggested in the literature to estimate traffic flow utilizing vehicle tracking information. Asmaa et al. used microscopic parameters extracted using motion detection in a video sequence (18). However, these methods tend to fail due to lack of motion information and low frame rates of videos; some vehicles appear only once in a video, making it difficult to estimate their trajectories. Holistic approaches avoid the segmentation of each object. Rather, an analysis is performed on the whole image to estimate the overall traffic state.

Overall, significant studies have been conducted in the past using various deep learning models to implement vehicle counting tasks and thereby determine congestion states.

METHODOLGY

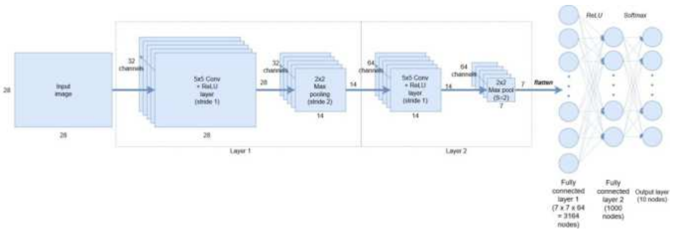
- Dataset collection
- Image pre-processing
- Training using Convolutional 2D neural network
- Cloud Storage
- Recognition

DATASET COLLECTION

Different classes of input traffic scene images are collected from web. The class value output of scenes are given along with dataset image collection. We have created four folders namely sparse_traffic, dense_traffic, fire, accident, every folder contains images of 900 for train and validation purposes. The folder name itself represent the class value for classification output.

IMAGE PRE-PROCESSING
There is no much pre-processing required in this implementation. The training and test dataset is classified in different folder is given as input using a function fro keras " flow_from_directory". This gives necessary pre-process such as dimension reductions. Similarly, the input image for test input is dimension reduction and converting to numpy array.

TRAINING USING CONVOLUTIONAL 2D NEURAL NETWORK
We used convolutional 2D neural network available in keras for traing and testing our model.



CLOUD STORAGE
The trained model is stored in cloud, which can be accessed by the user from any location. The cloud used for the storage and retrieval is drivehq.com. The authentication keys are passed to the system for accessing the data. Through file transfer protocol to access the trained model.

RECOGNITION
Finally, we pass the validation or test data to the fit function, the input image is convereted to numpy array and compared with trained model to get the classified output namely dense_traffic, sparse_traffic, fire or accident.

CONCLUSION
In order to promote the application of the deep learning approaches into transportation application, the theoretical network is specialized to automatically detect road state of congestion. This is proposed to bridge the current advanced deep learning approaches and practical application. We proposed Convolutional Neural Network (CNN) for training and validation. We considered as multi class problem. However, the detection accuracy for the new input images is not as high as that of the validation set.

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