Urban street cleanliness assessment using mobile edge computing and deep learning

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Abstract:

During the construction of smart cities, city leaders always spend a lot of energy and money to clean up the street garbage due to irregularity of street garbage. Therefore, visual assessments of street cleanliness is particularly important. However, current measures have some shortcomings, for example, the collection of road waste data is not automated and road maintenance data is not scheduled. To solve these problems, this paper proposes a new urban security assessment using mobile applications and deep learning. First of all, high resolution cameras are placed in the vehicle to record images. Mobile edge servers are used to temporarily store and store data in transit. Second, this road information is sent to weather data from the city network for analysis. At the same time, a faster regional convolutional neutral network (faster R-CNN) is used to detect and count debris on the road. Finally presenting the results clearly during the calculation process and finally cleaning the visual path makes it easier for the city leaders to plan a good cleaning staff. The photo of Jiangning District Street in Nanjing, China was used to illustrate and illustrate the entire show. Practical application shows the feasibility and effectiveness of this method.

1. Introduction:

Smart cities are large cities that use technologies such as the interest of things and cloud computing to manage and measure urban and environmental resources. The city is in the good way. The smart cities concept combine information and communication technologies and various networked physical devices to improve city operations and services. However, the rapid development of smart cities, city leaders face serious challenges on how to develop and manage smart cities. Street cleaning represents the spiritual and human perspective of the city. Keeping the city clean is good for the development of modern cities. Many large cities now consider urban cleaning and important task of urban life. If the cleanliness of the city's streets doesn't meet the required standards, this will affect the public interest and the general reputation of the city. The European urban cleaning network summit also noted that regular street cleaning is a good way to improve urban cleanliness.

Currently, many roads leads to uncontrollable road debris. At the same time, the process of searching for road debris is not automatic and requires intervention at almost every level. Citizens manually check the dumps and send reports to city officials, who then schedule city workers to clean up the trash. In some cities, cameras have been installed at intersections to control litter in the area. However, the solution of the book can't be applied to clean the garbage in all the street of the city. To this end, Researchers around the world are working on automated systems that use car washes equipped with cameras to continuously to capture the road and road data such as road view, area, date and time. Additionally, existing target detection algorithms are used to identify the images on remote cloud platforms. Finally, the test results are sent to the city administration to decision.

In light of this research, this article presents a new urban health assessment using mobile technology and deep learning. High definition cameras are mounted on the vehicles to record the scenes. At the same time, edge servers at the edge of the network are used to temporarily store and process traffic information and then send this processed information from the city network to the remote cloud center. Faster R-CNN (Faster region-convolutional neural network) is used to detect the debris on the road and calculate debris. The results are presented cleanly measure the standard of measurement. Finally, this method improves the cleanliness of streets, making it easier for cities managers to schedule cleaning workers on time.

In summary, the main contribution of this architecture are as follows:

We describe the new edge computing architecture. There is a layer between the cloud servers and mobile terminals. We setup edge servers (micro data centres) to manage some services for edge mobile devices. Data can also be stored temporarily and data can be transferred over time.

- Faster R-CNN is used to detect debris on the road and count debris. Use a multilevel, multilevel evaluation model. The whole city is divided into five layers: city, district, block, street and point. Road cleaning calculations are made at all levels.
- We provide information about our collections of public waste data which can be used as a reference for street waste monitoring and street cleaning. We also use these data to present the monitoring system of Jiangning district in Nanging, China. This application analyses the feasibility and effectiveness of the plan. The findings could help improve and improve sanitation in city.

The sections of this article are organized as follows:

Section 2 discusses the current study and its limitations.

Chapter 3 provides some preliminary information, including mobile application, multilayer measurement models and deep networks.

Chapter 4 presents methods for urban waste detection and sanitation measures. We acknowledge that we used street photographs collected from Jiangning streets in section 5.

Finally section 6 includes the paper and looks at future work.

2. Related work:

2.1. Smart cities:

The construction of smart cities has become the main focus of the whole society. Smart cities use technologies such as the internet of things and cloud computing to intelligently understand and operate cities, which can improve the quality of services of all the areas of the economy. Smart cities can also achieve the goal of reducing costs and resource consumption. Now many researchers around the world have done many studies son smart cities. Zijaris et al. A concept called the “Smart city reference model” has been proposed. Urban designers can use this framework to define smart city concepts and apply urban models to green, interconnected, open, integrated, smart and innovative concepts. This framework provides strategies to achieve sustainable development of smart cities. A new application is the analysis of smart city planning

in major cities such as Barcelona, Amsterdam and Edinberg. Hefnawy et al combine the concept of smart city and lifecycle to create information and knowledge sharing platforms suitable for smart city. It aims to solve the problems of improper planning, lack of planning and coordination of major events in the city and achieve the goals of coordination and action.

In addition, large companies are trying to invest in smart city research. China telecom announces it's to build a smart city focusing on 12 applications, including smart communities, smart transportation, smart energy and smart healthcare. IBM has launched Watson's "Big Data and Analytics platform" to help solve smart city problem such as smart transportation and air pollution.

Microsoft announced the "City of the Future" project to capture, integrate and solve problems such as environmental damage and traffic. However, to the best of our knowledge, there is currently no specific research topic on urban maintenance for smart city development.

3. Proposed method:

3.1. Mobile edge computing:

With the rapid development of smart cities, networks are producing large amounts of data. Cloud computing always requires data to be sent to the cloud for centralized processing. The remote cloud is an intelligent brain that processes big data. Since cloud centres are often far from end users, they often cannot provide low latency. To solve this problem, mobile edge computing has been proposed to distribute computing devices to devices close to the terminal. The European Telecommunications Standards Institute (ETSI) defines mobile edge computing (MEC) as a decentralized mobile cloud computing (MCC) system. The computing equipment is close to the mobile phone, and computing, storage, processing and other functions are added to the wireless network side. In fact, mobile computing is based on cloud computing. Includes minor services only. This is especially important for big data analytics. For example, when a user uploads a video or leaves a message, it can be sent from the edge of the virtual server to a remote server. Edge virtual servers can extract video content and predict the likelihood that others might want to watch the video. If the duration is higher, the server caches the video locally, so anyone who likes this video can retrieve the video directly from its cache, instead receive the video from the remote, which saves transmission resources and reduces latency. In this paper, we use mobile edge calculator to preprocess images and filter images that meet our needs, which is beneficial for cognitive processing.

3.2. Multi-level assessment model:

To measure the cleanliness of urban streets, our street cleanliness evaluation system provides a multi-level evaluation model at multiple levels. The model can be divided into five layers as shown in Fig. 1. The first layer is the first layer that defines the urban area and determines the evaluation. The first layer covers all streets of the city. Tier 2 is the second layer that divides the city into several regions, each of which is an administrative area. Layer 3 is the third layer and each region is divided into several groups based on control centers. Each block is uniquely identified by a combination of the control field and the block name. Tier 4 is the fourth layer where there are multiple roads in each community. Level 5 is the lowest level and has many records on each track.

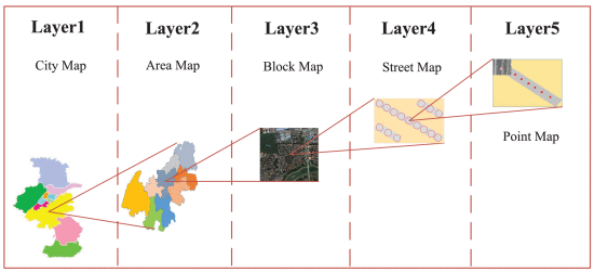

Figure. 1: Multi-level assessment model based on Nanjing

3.3. Deep network:

Deep learning originated from artificial neural networks. By creating more layers and training more data, useful features can be learned to achieve the desired classification. In recent years, deep learning has become a hot topic in target search. Girsick et al. Faster R-CNN, a well-established search engine based on regional recommendations, was developed. This algorithm has two main modules: Region Proposal Network (RPN) bid box extraction module and Fast RCNN detector module. RPN is a fully convolutional neural network. His task is to find the proposed plan on the map and delete the boxes. Fast R-CNN is a detection strategy based on RPN retrieval that identifies objects in a text box. RPN shares the same layer using a convolutional neural network as object detection and a convolutional neural network that creates input windows...

- The image is input to the convolutional neural network, and spread to the shared convolutional layer to get the feature map;
- The feature map extracted by the shared convolutional layer generates a suggestion window through RPN network, and gives region suggestions and region scores;

- The feature map of the first step is input to the pooling layer in Fast R-CNN to extract area features. Combined with region suggestions and region scores, classification probabilities and bounding box regression are trained, the classification scores of the region are output, and the results are finally tested.

Faster R-CNN is considered as one of the most precise image detection approaches. It has high detection accuracy and speed. Consequently, the street garbage detection approach in this paper adopts Faster R-CNN (Regional-Convolutional Neural Network) as the underlying model to detect the type and quantity of street garbage.

4. Conclusion:

The development of novel technologies has driven a number of cities into the way to smart cities. Street cleanliness is one of the concerns for smart cities. Consequently, this paper proposes a novel urban street cleanliness assessment approach using mobile edge computing and deep learning. A visual street cleanliness road diagram is presented, such an automated system can help city administrators to know the cleaning state of the street easily.

Several directions for future work are possible. These directions are described as follows:

- We plan to develop a solution that can automatically implement image filtering preprocessing at the mobile edge because manual filtering greatly affects the real-time transmission and wastes time.
- Our model contains common street garbage data. However, the model does not play a great role in the uncommon garbage data. Thus, the training data needs to be further expanded to improve the accuracy of the model.
- Our model is always used on sunny days, and the cleanliness on rainy days is also worth studying in the future.

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