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APPLICATION OF DEEP LEARNING IN WASTE MANAGEMENT

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ABSTRACT

One of the main concerns with our environment has been waste management which in addition to disturbing the balance of the environment also has adverse effects on the health of the society. With the development of technologies, the traditional waste management system can be replaced to perform real-time monitoring and allow for better waste management. The aim of this project is to develop a smart waste management system using a deep learning model. It performs object detection with the help of the pre-trained detection model with images. CNN accomplishes high characterization on classification accuracy, which is around 90%.

I.INTRODUCTION

Garbage management refers to appropriate waste treatment in a sustainable and cost-effective manner. In accordance with the laws on waste management, this involves the purchase, treatment, transport, and recycling of trash. Waste may be solid, liquid, or gas, as well as individual form, and has distinct dumping as well as a management system. Garbage treatment covers all types of waste, including household, agricultural and environmental waste. Waste treatment, proper sanitation, and effective disposal of the remains generated are necessary. Due to inconsistent removal of trash occupancy, space for waste disposal has also been determined to be excessively busy.

Waste management deals with all types of waste, including industrial, biological, household, municipal, organic, biomedical, and radioactive wastes. In some cases, waste can pose a threat to human health. Health issues are associated with the entire process of waste management. Health issues can also arise indirectly or directly. Directly, through the handling of solid waste, and indirectly through the consumption of water, soil, and food. Waste is produced by human activity, for example, the extraction and processing of raw materials. Waste management is intended to reduce the adverse effects of waste on human health, the environment, planetary resources, and aesthetics.

Proper management of waste is important for building sustainable and liveable cities, but it remains a challenge for many developing countries and cities. A report found that effective waste management is relatively expensive, usually comprising 20%–50% of municipal

budgets. Operating this essential municipal service requires integrated systems that are efficient, sustainable, and socially supported. A large portion of waste management practices deals with municipal solid waste (MSW) which is the bulk of the waste that is created by household, industrial, and commercial activity. Measures of waste management include measures for integrated techno-economic mechanisms of a circular economy.

1.1 MOTIVATION

Before the development of deep neural networks, features were manually designed, then followed by a classifier. Some research focused on the classification and recycling of garbage a few years ago. Although the traditional object detection already has some mature techniques, due to the morphological diversity, illumination diversity, background diversity and other factors of the target object, the detection precision for the unfixed form objects such as urban garbage is still a tough problem to solve.

The past decade has witnessed the rapid development of massive data and high-performance computing systems such as graphics processing units (GPUs). Now, region-based CNN detection methods have dominated many tasks of computer vision. It is such an exciting area that can extract the high-level features and the hierarchical feature representations of the objects. Girshick et al. introduced a region-based CNN (RCNN) for object detection, from 2014 to now, R-CNN, Fast R-CNN, Faster R-CNN, ION, HyperNet, SDP-CRC, YOLO, G-CNN, SSD and other increasingly fast and accurate object detection methods have emerged.

1.2 OBJECTIVE

This Deep Learning-based program is built using TensorFlow and classifies images from any CCTV camera to identify streets that are unclean. The model is trained with hundreds of images of clean and unclean images so as to let the program identify a new image as clean or unclean.

1.3 PROBLEM STATEMENT

Monitoring and cleanliness assessment of garbage areas in urban scenes mainly rely on manual inspection and photographic records, making it a difficult and time-consuming task. During the inspection process, human intervention and cumbersome problems often happen. The quality of sanitation work has been affected. Different from pedestrians, vehicles, and other objects, garbage has no relatively clear definition. Due to the judgment of garbage always having certain subjectivity, in different situations, it will produce different judgment results. Since the diversity of scenes where garbage appears, the accuracy of test results will be affected. With the development of the smart city, we expect to provide an automatic detection method of urban garbage to help alleviate urban garbage problems.

II.LITERATURE SURVEY

Y. Wang and X. Zhang: With the development of the smart city in major cities at home and abroad, especially the management of smart cities, how to improve the intelligence level of urban environment monitoring and evaluation has become an important research topic. It is of great value to rapidly and accurately detect garbage from urban images in the application of intelligent urban management.

M. Lin and S. Chen: The existing work includes simulation of routing protocols for WSNs in smart cities and some hardware implementation. It presented the implementation of a prototype for smart homes and solid waste

management systems and has also proposed the solution for street light intensity control and traffic congestion detection. For smart homes, fire detection, gas leakage detection, temperature control, and light intensity control are considered, while the designed solid waste control system is capable of detecting garbage levels in the dustbin and conveying it to the central monitoring system. The implemented prototypes for smart homes and waste management show that it will lead to improvement of the living standard of the people living in smart cities by way of energy conservation, health, and hygiene.

III.PROCESS MODEL

The spiral model has four phases. A software project repeatedly passes through these phases in iterations called Spirals. Identification: This phase starts with gathering the business requirements in the baseline spiral. In the subsequent spirals as the product matures, identification of system requirements, subsystem requirements, and unit requirements are all done in this phase. This phase also includes understanding the system requirements by continuous communication between the customer and the system analyst. At the end of the spiral, the product is deployed in the identified market. Design The Design phase starts with the conceptual design in the baseline spiral and involves the architectural design, logical design of modules, physical product design, and the final design in the subsequent spirals. Construct or Build the Construct phase refers to the production of the actual software product at every spiral. In the baseline spiral, when the product is just thought of and the design is being developed a POC (Proof of Concept) is developed in this phase to get customer feedback. Then in the subsequent spirals with higher clarity on requirements and design details a working model of the software called to build is produced with a version number. These builds are sent to the customer for feedback. Evaluation and Risk Analysis: Risk Analysis includes identifying, estimating, and monitoring the technical feasibility and management risks, such as schedule slippage and cost overrun. After testing the build, at the end of the first iteration, the customer evaluates the software and provides feedback. The following illustration is a representation of the Spiral Model, listing the activities in each phase. the software development process enters the next iteration and subsequently follows the linear approach to implement the feedback suggested by the customer.

IV.EXISTING SYSTEM

Traditional waste management system operates based on a daily schedule which is highly inefficient and costly. The existing recycle bin has also proved its ineffectiveness in the public as people do not recycle their waste properly.

LIMITATIONS OF EXISTING SYSTEM

- Low Accuracy
- Low FPS
- Time-consuming.
- Not suitable for large dataset

V.PROPOSED SYSTEM

This program classifies an input image (An image of a street from a CCTV Camera) as clean/unclean. This can later be used to automatically send alerts to respective authorities when a street is found to be unclean. Once a street is found to be unclean, it automatically sends an email alert to the respective authorities who can then take action. The Problem: It is impossible to manually identify streets that require cleaning at a given time. The Solution: With the "CCTV Street Garbage

Detection and Alert System", authorities can get updates about the streets that are unclean.

1) We develop a Faster R-CNN open-source framework with a region proposal network and ResNet network algorithm, using ResNet network to replace the previous VGG network as the basic convolution layers.

2) To optimize the performance of the model, we collect urban scene images containing garbage and urban scene images without garbage. By using finetuning strategy, we apply the pre-training model parameters which have been trained.

3) We propose a dataset fusion strategy, which integrates the garbage dataset with several other datasets of typical categories in urban scenes.

ADVANTAGES OF PROPOSED SYSTEM

- High mean average precision
- Automatic Feature Extraction
- With the "CCTV Street Garbage Detection and Alert System", authorities can get updates about the streets that are unclean.
- High accuracy
- High speed

VI.MODULES

DATA COLLECTION

Data is composed of a different source and optimized for data sets. And the data is used to evaluate descriptively. The dataset is collected from Kaggle and it has several images consisting of garbage and non-garbage.

PREPROCESSING

Preprocessing the data is considered as a significant step machine learning phase. Preprocessing involves adding the missing values, the correct set of data, and extracting the functionality. Data set form is important to the process of analysis.

The proposed system involves three major steps: The images collected are of different sizes and therefore all the images are resized. Image augmentation is done to increase the number of images by resizing, zooming, turning, and so on to increase the data size without adding new images.

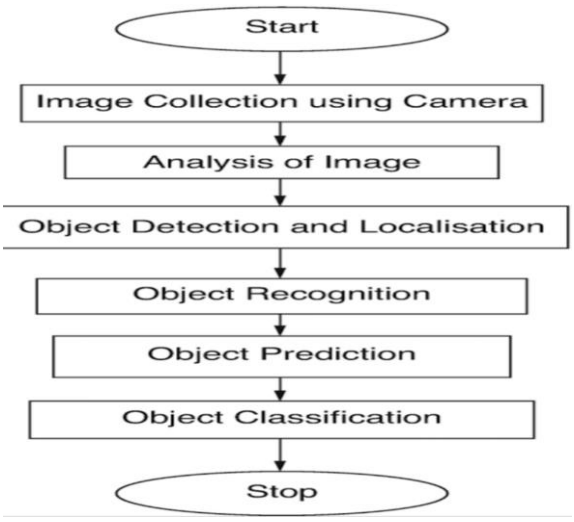
MODEL SELECTION

Here we develop a model using a Convolutional Neural Network. A model will learn and improve on each attempt. To gauge the effectiveness of the model it is vital to split the data into training (70% of the data) and testing (30% of the data). Then it is important to implement the performance metrics to the results given by the model.

RESULT

A model is selected based on the performance metrics. When an input image is received by the camera then it detects the garbage content in the image captured.

6.1 SYSTEM ARCHITECTURE



6.2 ALGORITHM

We firstly use the ResNet network as the basic network and apply it to the Faster R-CNN framework. The ResNet network proposed by Kaiming et al. in can avoid the simple stacking of convolutional neural network gradient disappearance or explosion and precision degradation. Here, the ResNet network is used as the conv layers to extract features from the original image to obtain the feature map. Faster R-CNN solves the speed bottleneck of R-CNN and Fast R-CNN and further improves network performance. The Faster R-CNN object detection method includes four basic steps, including region proposal generation, feature extraction, classification, and location optimization. The specific implementation process of the network is shown. During training, we input the dataset image firstly, through the shared convolution layer of ResNet, generating the feature map. Then RPN layer gets the output and generates a large number of region proposals.

Description of the dataset: We unified all image formats into jpg and named them in consecutive numbers. Both the training picture and the test pictures are placed in a named directory. The garbage dataset of this experiment contained 816 images, 596 among them were train images and 220 were test images. These images were photographed from different scenes and different directions, which could detect the diversity of images effectively. In addition, we used the data fusion strategy and per background class consists of at least 50 images.

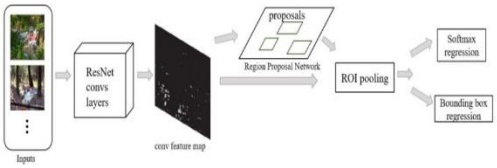
Region Proposal Network (RPN) is modeled with a fully convolutional network, which takes images as input and finally outputs a set of bounding box proposals. To achieve these proposals, at each sliding-window location, we predict k proposal boxes at the same time, so the reg layer has 4k outputs, that is, the coordinate encoding of k boxes. The cls layer outputs 2k scores, which is the estimated probability that each proposal box is a target or a nontarget. The k reference boxes are parameterized by the corresponding k boxes called anchors. Each anchor is centered on the center of the current sliding window and corresponds to specific scale and aspect ratio. Following the default setting of the network, we use 3 scales and 3 aspect ratios, so that there are 9 anchors in each sliding position.

The ROI pooling layer has two inputs, one is the feature map obtained through the conv layers, and the other is an RPN output that represents a matrix of N*5 of candidate rectangular frames. Where N is the number of ROIs, the first column represents the image index, and the remaining four columns represent the remaining top left and bottom right coordinates. Map the coordinates in the ROI to the feature map, and divide the mapped area into sections of the same size (the number of sections is the same as the output dimension). After obtaining the coordinates on the feature map, we use a pooling layer to obtain a uniform output. The biggest benefit of ROI pooling is that it greatly increases processing speed.

Fine-tuning strategy: The mainstream machine learning method in the current vision field is deep learning methods based on high-performance parallel computing and massive training data. However, due to the high complexity of the deep learning model, it is very easy to over-fitting, we need to collect massive data and run it on the GPU for several weeks to solve the problem. These conditions are difficult for most of us to achieve. In order to be able to train with a smaller dataset in a more practical way, we use a technique called transfer learning or fine-tuning to assign a trained network to the new datasets. We can transfer weights from a pre-trained architecture to fine-tune our network architecture. In this paper, we initial weights of the model by ResNet pre-trained results on the coco dataset to solve

the problem of insufficient training datasets.

Data fusion and augmentation: Data collection is the most important preparation for object detection. Our experiment essentially solves a two-class problem, that is, whether the area contains garbage. Considering the complexity and diversity of urban scenes, we collect non-garbage urban scene classes that contain buildings, neat roads, and neat lawns. On the other hand, garbage does not have a certain shape, when using a computer detection strategy, some object classes in the urban scene can match the garbage to similar attributes easily, which causes error detection and reduces the accuracy of the detection. In order to improve the generalization ability of the model, we consider using a data fusion strategy to increase the background classes. We set pedestrians, vehicles, buildings, neat roads, and neat lawns as background classes so that the algorithm can more effectively distinguish between garbage and other object classes.



VII.INPUT SCREEN

VIII.OUTPUT SCREEN

IX.CONCLUSION

Based on the Faster R-CNN object detection framework, we present a way of using the ResNet network algorithm as the convolutions layers, which improves the accuracy of object detection and location. We achieve the experiment results as expected, the network demonstrates its efficient generalization ability when the small region objects occur. Our data fusion strategy overcomes the region misdetection problem. Finally, the near-real-time and high-precision detection of garbage in urban scenes is realized, which has high practical value. It remains an open challenge to further reduce the detection time with the aim of rapidly and high-precision detection.

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