Artificial Intelligence Based Aerial Surveillance for Smart City

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Abstract— The proposed system has been developed with the aim of minimum human intervention and an ability for smart decision making using latest technologies like artificial intelligence. The system mainly consists of an Aerial Object, which will be flying across the city, keeping an eye beneath. A High definition Camera attached to the Aerial Object will be capturing different areas of the cities. These images will be streamline with the Cloud Server, which is capable of detecting garbage pileups, potholes, pollution near river sides, encroachment, traffic congestions and even accidents. The project is cost-effective, which can be utilized not only by smart cities but also by small towns.

Keywords: Artificial Intelligence, Smart City, Garbage Detection, Pothole Detection, Aerial Object, Faster-RCNN-Inception-V2, Flood Surveillance, Festival Surveillance, Political Rallies Surveillance, Machine Learning, TensorFlow

I. INTRODUCTION

India, being a developing country, counters many day to day problems affecting human life to great. Controlling Mundane affairs like waste management, road and safety maintenance, potholes, traffic, needs systems which are automatic and require less human intervention.

With rapid urbanisation, the country is facing massive waste management challenge. Over 377 million urban people live in 7,935 towns and cities and generate 62 million tonnes of municipal solid waste per annum. Only 43 million tonnes (MT) of the waste is collected. [1] The uncollected waste lies in water bodies, on streets and roads, near dumps that remain uncollected for days and so on. Injury or death due to accidents caused by potholes is another major cause of concern in India. As per latest figures by several state governments [2], potholes across the country claimed 3,597 lives in 2018, a more than 50 pc rise in the toll last year. In 2018, potholes claimed six lives every day in India.

The main focus is on monitoring such incidents and giving an early warning with minimum human intervention. Using Artificial Intelligence, it is a self-learning system that is smart enough to detect potential places of accidents and to handle day to day affairs like waste management and traffic control.

II. WORKFLOW

A. Overview

The process starts with video capturing through ariel devices such as drone and blimp. This video is also used for live surveillance which is necessary for special events like festivals and political rallies. The video is pre-processed at ariel device itself. Then it is sent to cloud server which processes the video to detect various anomalies. If the anomalies are detected then it will generate an alert message. This notification is received by authorities responsible through text message or an alert on google maps.

B. Prior Research

A lot of work has been carried out separately in the area of drone development and object detection using Artificial Intelligence. Very few efforts have been done in amalgamating these two broad areas. Our project is one such which helps in bridging this gap. Gregoy McNeal [5] has provided the pros and cons related to ariel surveillance by drones. A Dev et al. [4], has provided a smart solution for garbage management using IOT. A new solution for garbage collection and disposal was suggested by [6]. In [7], an automated solution for smart cities waste collection is highlighted. [8] has focused on surveillance and patrolling for security purposes.

C. Dataset

A robust classifier of TensorFlow needs immense amount images to train. Several images of desired objects with various backgrounds, lighting conditions and random objects plays an important role to train the model. In addition to that, data set must also contain intended object which is partially visible in image. The team has done an immense work to search qualitative images of garbage spillage and potholes in India. As no prior dataset are available on internet it became very difficult to find images. There are almost 5000 images of garbage spillages and potholes in dataset. Out of which 70-80% of images are downloaded from online sources and rest are captured images from places around the city. All the images are then labelled which eventually tells the detector about anomalies and are converted into a csv for training.

D. Choosing required TensorFlow Model

Several object detections in TensorFlow's model zoo which has pre-trained classifier with specific neural network architectures. Team initially started with the SSD-MobileNet-V1 model with faster identification speed but it didn't had more accuracy which led to re-train the detector on the Faster-RCNN-Inception-V2 model, and the detection worked quite better, but with a slower identification speed.[3]

E. System Architecture

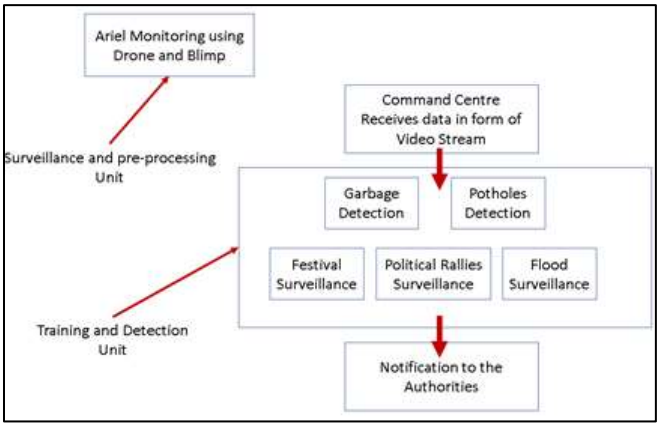

Fig. 1: Detection of Activities through Images, using Machine Learning

F. Training and Testing

The model used which is Faster-RCNN-Inception-V2 is trained nearly 50,000 steps on Geforce RTX1080Ti which took up to 8-10 hours. However, loss is reported at each step of training which starts from higher loss and gets lower and lower as training commences further. The model started at about 3.0 and quickly dropped below 0.8. Furthermore, it is highly recommended to train the model until the loss drops to 0.05, which might take up to 2 hours depending upon CPU and GPU.

The system can detect anomalies effectively. For testing of images, 50 images were given to the machine in which 40 images were having anomalies and 10 images were not having it. By using false-positive method, out of 40 images 36 images were detected perfectly and anomalies in 4 images were not detected, and alert was not generated. In the case of 10 images without anomalies, 2 images were falsely detected and shown an alert. Hence, according to this false-positive method, the model has an efficient accuracy.

G. Detection of Activities

Once the images and videos are pre-processed, the next step is to detect occurrence of any major incidences. The data comprising of images or videos will be transmitted to Training and detection unit, which will examine, them frame by frame and will automatically try to detect any major incidence which has to be brought to notice of the authorities.

Fig. 2: Detection of Activities through Images, using Machine Learning

The Control unit has been developed using the concept of Machine Learning. The entire system has been trained uniquely to identify specific objects in the images and co-relate them to the particular incidences that might have occurred. We are using TensorFlow Framework for implementing object detection algorithms. A pre-trained model has been developed, which will take frame by frame input from a video or an image and will classify it into any of the mentioned scenarios. Figure 2 provides the actual results that we obtained by providing different frames. The system detected the objects in the frames and classified them into one of six, correlating scenarios.

III. Constraints and Challenges

The task of this project is providing surveillance to the entire city. Monitoring this large portion is always challenging and requires careful planning and meticulous efforts. Hence, keeping this as primary focus in mind to elaborate some issues that can be considered as hurdles that needs to be addressed carefully.

Ariel Surveillance can be considered as the best option, as it has large canopy of coverage and can be navigated without much effort. So, Drones and blimps are included in this project. Manoeuvring this ariel equipment is itself a challenge. A careful planning is required to handle these objects during ariel surveillance.

There will always be areas in cities where surveillance will be strictly prohibited, like national and defence headquarters, Government buildings, Research Organizations, secretariats and VIP zones. Hence, an advanced geo-navigation mechanism is required along with surveillance.

Ariel Objects used for monitoring will always face hurdles like stormy or windy weather, turbulences, rain and lightning strikes. This will provide limitations regarding the optimal environment for flying the objects.

Loss of communication and hacking of ariel objects can also be considered a major challenge that needs powerful security protocols for implementation.

IV. Conclusion

This proposed system is helpful to the authorities of the smart cities in many ways. It helps in keeping the cities clean by providing indication of possible garbage spillage and pollutants spread across the city. Better and efficient Surveillance of the Festivals, riots and political rallies. Potholes detection helps Municipality corporations to take steps as required to reduce accidents dur to potholes.

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