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Cleaner Drone

Ameya Parkar[1], Aditi Prabhudesai[2]

[1]Assistant Professor, Mumbai University,Mumbai,India
[2]MCA 3rd Year Student, Mumbai University, Mumbai, India

Abstract - *Cleaner drone is a system designed to locate garbage in an area with help of drone. The drone comes with high quality camera and a GPS tracker in it. The drone will follow a pre-assigned path to which it will be assigned. It will locate potential garbage material and send snapshot of the same along with its GPS location. On the server side, analysis of the image sent by drone will be done with help of Computer vision technology that mainly involves segmentation, recognition and reconstruction. If garbage is found in an image, the server will check for cleaners stationed nearby and give an alert for garbage collection to the one with closest proximity. The cleaner who received alert will go to the location and update the status after cleaning garbage. For verification, a checker drone will monitor status at those specific locations where garbage was located. It will check whether garbage was cleaned properly or not. This endeavor will contribute to the 'Swachcha Bharat mission' of the government by keeping the area neat and clean with the help of regular drone surveillance.*

Key Words*: *Cleaner drone, detector drone, checker drone, cleaner

1.INTRODUCTION

A detector drone will start its work from location, say x which is predefined in the database. It will continuously capture images and send it to server. Drone will follow the pre assigned path and will keep sending images of that area. Server on the other hand, will receive image captured by drone. Captured image will be processed with the help of image processing algorithms in computer vision technology. The captured image will be segmented and each segment will be compared with datasets of garbage images. If any garbage object is recognized, an alert will be generated by the system. On receiving alert, server will check for closeness of cleaners (to the location where potential garbage is detected). Server will send alert message to the cleaner who is closest to the garbage location. The cleaner will receive an alert message from the server on his smartphone with garbage location information. When the cleaner will select, view location, a directed path will be provided to him to reach that specific location. Once the cleaner reaches the location, status update window will be enabled on his mobile screen, wher e he is supposed to update the status as 'Cleaned', once cleaning work has been finished. If he carries insufficient equipment to clean the garbage or requires an additional hand, he will select 'Help' option which will connect him to his superior through a call. After a certain timeslot (say 30 minutes) the checker drone starts flying from its current location to those specific locations where garbage was located by detector drone & system had verified object as garbage. Checker drone will verify if the cleaner has cleaned the place or not. A single checker drone is assigned supervision of multiple detector drones. Fig.1 explains working of Cleaner drone.

2. WORKING OF DRONE

2.1 Detector Drone

Drone starts flying from location it is currently stationed at. It follows the path which has been programmed into it by system. The drone is fit with a small camera on the dorsal side. It will click pictures at periodic intervals as decided by operator. These images are sent to the server. The server does the work of identifying garbage in the images sent by the drone. If garbage is detected, the image is saved with its GPS co-ordinates. Server activates Swachh Bharat app, which locates cleaner with closest proximity to area where garbage has been detected. The image is then sent via app to the cleaner. The cleaner accepts the job and starts his journey. His journey is tracked till he reaches the location. He updates his status at location. If it's a false call, he reports it. On completion of the job, he clicks a picture and sends it to the server with status updated as complete. Else, if there is incomplete manpower or equipment; request for the same is sent. There will be multiple Detector drones assigned to an area depending on the budget, the level of efficiency expected and size of the area segment.

1.2 Checker Drone

It checks whether the garbage detected in areas are cleaned or not. The drone revolves in the area allocated and hence does not follow a linear path. It verifies and validates the garbage cleaning process. In contrast to the Detector drones, the checker drone is singular. It monitors the work of all detector drones working in the designated area. Thus, cross validation of work by the cleaner.

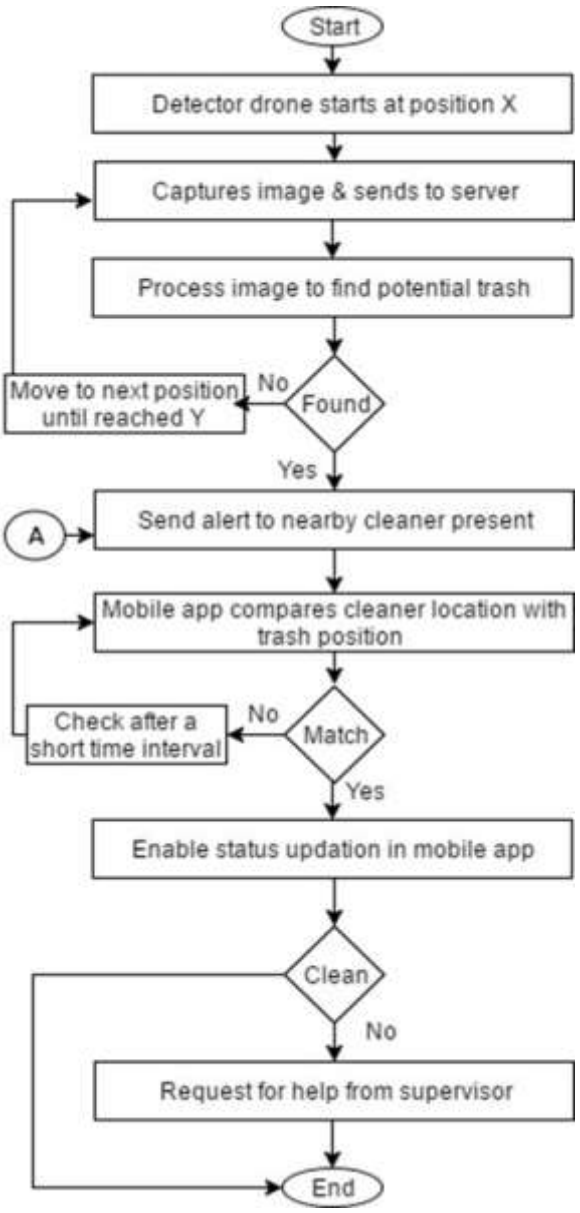

Fig.1

3. IMAGE PROCESSING AT BACKEND

3.1 Computer Vision System

Computer vision is an interdisciplinary field that deals with how computer can be made for gaining high level understanding from digital images. Computer vision tries to do what human brain does with retinal data that means understanding scene based on image data. It automates tasks that the human visual system can do. Tasks include methods for acquiring, processing, analyzing & understanding digital images, then extraction of high dimensional data.

3.2 Convolutional Neural Network

It is the core & crux of Computer Vision System.

Among neural networks, Convolutional Neural Networks or CNN's seemed the most rational choice due to best possible correction detection rates achieved. They use stochastic & not deterministic methods, hence random variables are picked up. This ensures a non-linear approach to feature definitions or selections at the final output stage.

CNN's are usually classified into the following layers:-

1. Convolutional Layers-Feature extraction occurs here. At the initial convolutional layers, simple features such as lines, curves or points are extracted. The shapes get complex in subsequent layers.
2. Pooling Layers- Reduction is performed on resolution of object's features. Robust features are selected while lesser features with noise & distortion are filtered out. The features are averaged out or max_value is selected among sub array of similar features.
3. ReLu Layers-. Used as a triggering or a non-linear activation function. Makes sure that the size of input is equal to size of output generated. But, at the same time makes data more sparse. Has reduced likelihood of vanishing gradient problem though it generate dead filters as the sparsity of data increases for several features. Functions that could be used for non-linear data functions include hyperbolic tangents, absolute hyperbolic tangents or sigmoids.
4. Fully Connected Layers- Here, final computation of the output occurs. It involves taking elements of previous features & computing them together to generate the final output.

CNN's can have anywhere between 5 to 25 layers, depending on how deep you want to construct the network. Another reason why CNN's are the preferred network is because they are shift variant, that is, the same weights are maintained across the network space. Since, the weights are constant, memory usage is also significantly lesser.

3.3 Maintain Dataset

- Datasets under consideration are ImageSet, a readily available repository of images.
- Images generated by drones & through constant machine learning at geo-sites.
- CNN's had a problem with respect to identifying off-center or skewed objects. Window sliding techniques are used to take successive images which are stored as a separate image in the dataset.

3.4 Segmentation & Recognition

Image Segmentation- The image initially undergoes image coding, where its bandwidth is reduced & then image enhancement techniques are used to improve its appearance.

Image Recognition- Two potential methods identified were Template Matching & model based object recognition.

a. Model Based – Geometric state transformations are used to classify objects & maps into a sensory co-ordinate system. It offers good running time but can generate errors while using hashing algorithm techniques.
b. Template Based- It is a hierarchical process where scaling & rotation iterations are performed on objects. An object is first saved with x & y co-ordinate positions of its center & the co-ordinates of other pixels. The sum of products of the center & each pixel are computed. The highest value is chosen as the best position & is saved as template filter mask. The number of increment related computing can be reduced by using clustering techniques.

The images of potential garbage will be stored as dataset in system. When server will receive an image from drone, it will check the image with pre-loaded dataset. The comparison will be done with help of template based object recognition. If match found from dataset, an alert message will be generated by the server with GPS location of the image.

4. END USER APPLICATION

The cleaner is one of the end users of this system. The proposed system can help the cleaner a great deal**.** They do not have to wander from place to place in search of garbage. It can save time, money and resources such as using vehicle in search of garbage. This search can instead be done by the drones now.

Today smartphone is a basic necessity and many people use it. Smartphones with the help of an android app connects the cleaner and system together to complete their task, i.e cleaner to clean the trash and later notify system regarding work done.

The Report Status activity of the android application gets enabled when cleaner reaches the destination (where the trash is located). The application is programmed to compare the user & garbage locations in periodic intervals to see if it matches. On getting the same location the user is directed to window with two options. First option: Convey to the system that the trash is cleaned and Second: Asking Help. In case the cleaner is unable to clean the trash or needs some more equipment.

5. TASK COMPLETION VERIFICATION

Fig.2 explains the verification process of garbage collection by checker drone.

Considering possibilities of wrong updates by cleaners, process of verification is necessary.
In this process, a checker drone who is having data of multiple drones will visit to the spots where potential garbage was located and will check if it is actually cleared or not. Working process of checker drone is as follows:

1.Checker drone navigates to spots where the detector drone had captured images with garbage.

2.It captures image of the same position where the detector drone have detected garbage . This location is fed into Checker drone by the server.

4.At the server site, using image processing it again tries to detect garbage. If it's cleaned, the job status is validated. If not cleaned, server sends notification to nearest available cleaner.

5.The checker drone repeats the same activity for all alerted positions by detector drone.

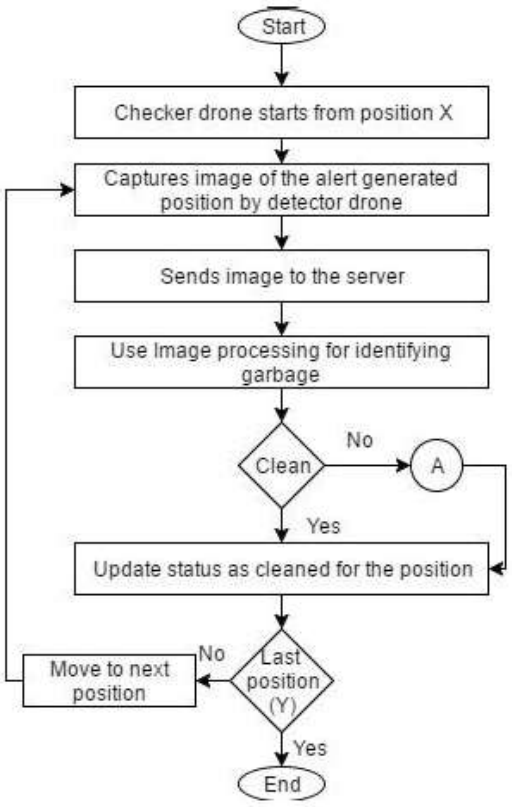

Fig. 2

6. CONCLUSIONS

With help of modern technology, we can maintain our area neat and clean without investing more manpower and can lead to good governance of keeping our own country clean.

7. ACKNOWLEDGEMENT

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