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Drone Based Plant Monitoring :
Monitoring Plants On Indian Highways

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***Abstract*—This paper intends to implement a modern approach to the monitoring of plants on highways where manual inspection for such large distances becomes a tedious and time- consuming procedure, requiring large human resource. The paper proposes a drone based monitoring with live feed and image transmission options for the monitoring process.**

Keywords—drone, image transmission, plant monitoring, highways

I. INTRODUCTION

Research suggests that for the number of trees being cut every year, it seems quite impossible for the Earth to replenish the resources for ecological balance. Deforestation for timber, agricultural land, industry raw materials has resulted in large parts of lush forests being reduced to industries and barren land. These have had serious consequences that have come down the generations and are still a source of fear. These factors are globally affecting all beings and have been considered to become even more critical in the near future.

In view of the recent ill effects of severe deforestation like global warming, pollution, soil erosion, etc., the Indian Government had come up with an innovative method for overcoming, though a small fraction, of these problems by planting several saplings along the medians of National Highways [1]. With an additional aesthetic appeal these also help maintain an ecological balance as a small starting step. Plants on these highways are prone to some problems themselves as mentioned in [4] and [5] but still do a great task of minimizing pollution. Press reports and articles by the authorities regarding these undertakings are mentioned in [3]

Figure 1 represents the Government's motive of a highway median that needs to be implemented. Figure 2 and 3 represent the poor state of the same due to poor maintenance and monitoring, hence losing their primary motive.

But with such large lengths of plants, monitoring becomes challenging. Such undertakings in other countries have been highlighted in [2], about a place in Pennsylvania. The Government is trying its best to maintain these in good condition by undertaking various measures [1]. But still a bad plight of the project in several places has motivated this paper that tries to overcome the hurdles by an efficient drone supported monitoring approach.

Figure 1: A well maintained patch of highway median.

Figure 2: A poorly maintained highway median.

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Figure 3: Poorly Maintained Highway medians pose a threat for people using them to change lanes (NH24)

The approach proposes two options for the user i) a live feed video monitoring with the drone camera for real time monitoring and ii) image transmission based monitoring for pre-set time inspection. This surely would aid the Government in maintaining the objective of afforestation and continue further for ecological balance.

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot onboard. UAVs are a component of an unmanned aircraft system (UAS); which include a UAV, a ground-based controller, and a system for communication between the two. The flight of UAVs may be controlled either by a transmitter or by a human operator or autonomously by onboard computers and AutoPilots

UAVs were originally used in military applications, and their use has rapidly expanded into applications in commercial, scientific, recreational, agricultural, and extended applications like policing, peacekeeping surveillance, product deliveries, aerial photography, agriculture, smuggling and drone racing. Civilian UAVs now vastly outnumber military UAVs, with estimates of over a million sold by 2015, so they can be seen as easily accessible commercial commodities with autonomous capabilities, to be followed by the autonomous Canard home robots.

II. PRILIMINARY DESIGN

A. UNMANNED AERIAL VEHICLE (UAV)

The project requires a small, portable and easily deployable UAV that can travel in very small spaces with excellent maneuverability. Having gone through various configurations of drones, the idea of a fixed wing aircraft was let go due to its requirement of space for takeoff and landing and its large requirement of space for maneuvering. Hence the option of using a multirotor was considered suitable for the application. A quadcopter being simple was also very stable with appreciable payload carrying capacity. Hence it was decided to incorporate a Quadcopter. The design of the same is as shown in figure 4.

The chassis is designed in a modelling software called SolidWorks and is to be fabricated in carbon fiber for increased strength to weight ratio. Simulation is also done in the same software. Motors used are DC brushless motors with composite based propellers. The power sources are 2 three cell 5000 mAh LiPo batteries.

Since the application requires a stabilized flight to prevent any harm to people using the highways, a PID controlled AutoPilot “PixHawk” is to be integrated for the stability. The controller also has GPS and compass that can help obtain location and heading of the UAV. The supporting software also helps plan out the mission beforehand making it very handy.

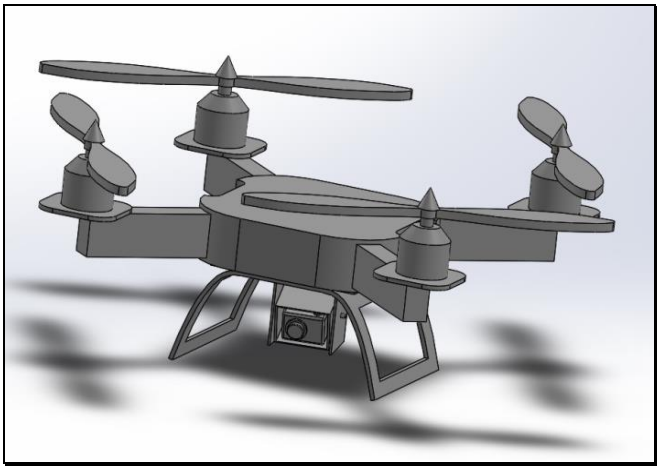

Figure 4: CAD model of UAV

B. CAMERA GIMBAL

The application requires that the UAV has to have a camera to provide pictures or videos to the operator for the purpose of monitoring. The camera must possess a minimum of two degrees of freedom, i.e., in yaw and pitch. The above movements are provided by means of an electronic servo controlled gimbal built out of a lightweight wood called balsa as shown in figure 5.

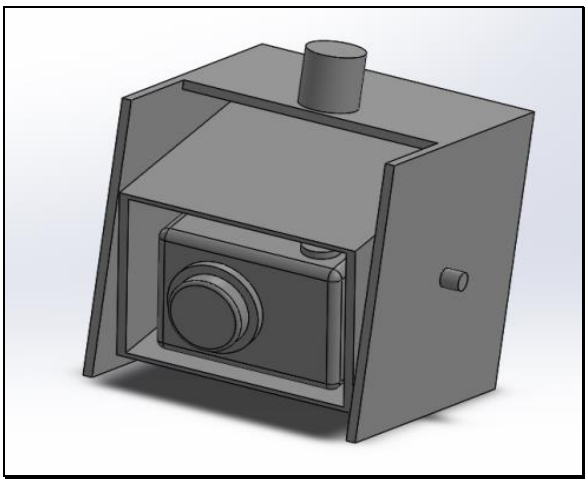

Figure 5: CAD model of camera Gimbal

C. IMAGE TRANSMISSION

The camera provides live feed data for real time data analysis in the presence of the operator. In this mode, the operator can himself observe the video and detect the dried

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plants and thus monitor the same. Another useful option is the use of image transmission. The drone can be set to run at predetermined times during the day even in the absence of the operator. During such operation, the camera captures pictures at a specified rate for a predetermined path of the highway median. The on-board computers collect this data and the data is transmitted via antennae, which can be stored on the operator's computers. Screenshot of mission is shown in figure 6.

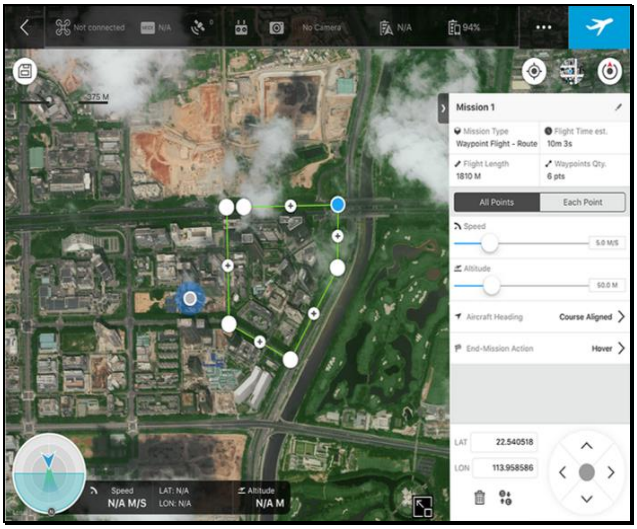

Figure 6: Mission of the UAV loaded in AutoPilot

III. WORKING MODULE

The proposed working module will be described in two modes of operation in this section, namely Mode-1 and Mode-2. The major difference between the modes is the presence of operator in the former and his absence in the latter.

A. *MODE - 1*

- This mode is used in the presence of the operator. It is a very direct and simple approach of monitoring as the operator himself can view the condition of the plant as the UAV performs its mission.
- Initially the operator loads the firmware onto the UAV and loads the map of the surrounding area.
- He then selects waypoints along which the UAV is supposed to travel along the highway median.
- The camera live feed is turned on and is synced to the operator's mode of display.
- Once the path of the UAV is decided the UAV is armed.
- The operator has an option of selecting the altitude at which the drone must fly and also the speed by means of the AutoPilot.
- A new feature is the ability to create a Geofence boundary for the UAV to fly, that prevents it from flying away from its path.
- A schematic of the same is provided below in figure 7

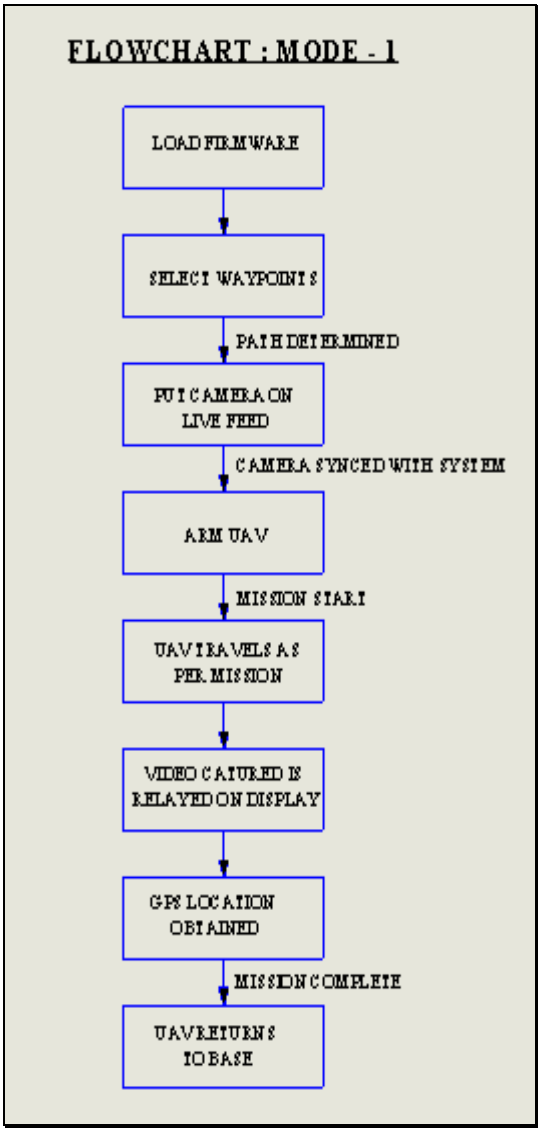

Figure 7. Flow Chart

B. *MODE - 2*

- This mode is used in the absence of the operator. It is an advantageous mode for use when the operator is physically not present. The mode can be deployed on a timely basis for a fixed path.
- The drone at the stipulated time take off from its base and starts moving along its predetermined path.
- The camera is set and bound to the controller such that it takes pictures at a stipulated rate sufficient to cover the enter area to be monitored.
- The onboard computer collects these images and sends them to the base via antennae. These are stored for inspection later on.
- The schematic of same is provided in figure 8.

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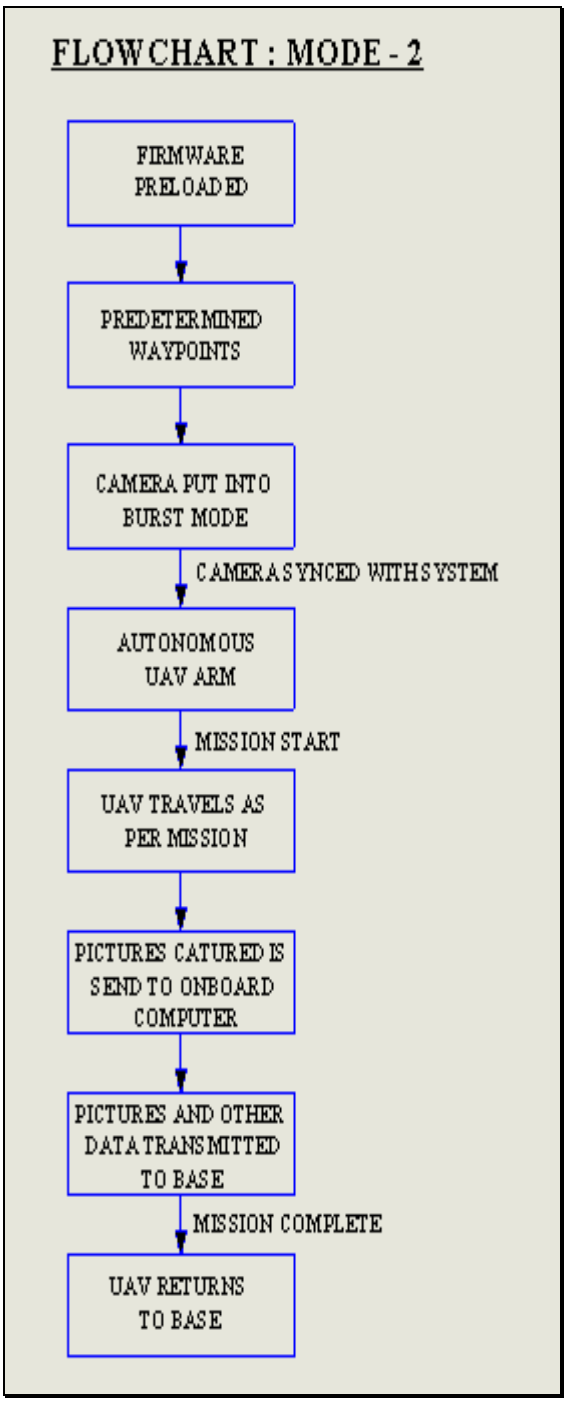

Figure 8 . Flow Chart mode 2

IV. RESULTS AND CONCLUSIONS

The UAV performance is monitored and it is observed that the video and picture quality of the camera depends on the speed and stability of the drone. The system is very useful and easy to deploy. Camera provides very good quality pictures. Since mission is alterable it gives great flexibility to user, to monitor different regions on different days thus reducing human resource and any possible accidents on such heavily trafficked roads.

In mode 1, the operator due to the high quality live stream video, is easily able to recognize the conditions of the plants on the highways. This mode can be used to show the higher authorities about the maintenance during their inspection visits. Thus, monitoring with this mode gives the operator the exact location where the plants have to be given more attention for the betterment of their condition.

In mode 2, the operator can preset all flight parameters and then monitor the plants after some amount of time. This reduces the need for continuous human intervention and the pictures can be accessed anywhere in case they have been uploaded to the cloud. This becomes suitable for a regular basis of inspection even in the absence of the operator.

V. OTHER APPLICATIONS

During calamities, there are chances of trees and plants falling onto the roads causing lot of inconvenience. This can also be monitored by the drones.

Trespassers and people damaging roads or other public property can also be monitored.

VI. FUTURE SCOPE

The video and images taken by the UAV can be made such that it is directly uploaded to a Cloud storage. This can be accessed anywhere. This can hence be viewed by the higher officials on a periodic basis rather than visiting the site repeatedly.

Swarm robotics can be employed for monitoring large areas at once reducing time for the same. Several drones working together can map the entire path in a very short time.

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