PUSHPAK

A SMART UAV

Capstone Project Proposal

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Mentor Consent Form

I hereby agree to be the mentor of the following Capstone Project Team

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Project Overview

Hand gestures and body postures are common and natural forms of communication for humans to interact with machines. Due to the enormous widespread usage of drones in various applications, such as surveillance for sports events, transportation for emergency equipment and goods, filming, and aerial photography- many studies have been done to find the most appropriate way for humans to interact with drones. Using hand gestures in drone manipulation is becoming a popular way to interact; this thesis will explore that concept and propose a complete system to control drones using hand gestures. The proposed system should function in real-time, and the accuracy in detecting and recognizing the gestures is an essential factor to notice.

'PUSHPAK' presents research detailing the use of hand gestures to control drones. This work consists of three main modules: hand gesture recognition, face tracking and line path follower. A deep learning method is incorporated and utilized in the first module to detect and track the hands in real time with high accuracy and from a single Red-Blue-Green (RGB) image. Image processing algorithms and techniques are introduced as a dynamic way to identify the hand gestures and motions. Finally, the Drone Controller module is responsible for communicating with the drones. It sends and receives the messages between the proposed system and the drone which is connected to the system. Apart from gesture recognition, the system will also perform face tracking and line follower for specific use cases.

Problem Statement

The rapid evolution and spread of drones make them a popular area for researchers in many different domains, either for commercial or personal usage. There can be many utilities of a drone to use for different purposes like recording extreme sports footage or for use in fire-fighting emergency services. Keeping in mind such use cases, the proposed system will help in controlling the drone using various hand gestures like up, down, forward, land, stop, etc. It will also be equipped with a face tracking system which will be implemented using image processing. A line follower mechanism will also be incorporated in the system. This project will aid in further exploring this field of research more deeply.

Need Analysis

Although drones are considered robots, the rapid increase in the popularity of drones has pushed to launch a new branch of research called HumanDrone Interaction (HDI), and it is dedicated to the drone world. Most of the time, it is not possible to interact with drones by touching them directly, so they need special methods. Much research has been done in HDI, and many investigations studied hand gestures or postures to interact with drones [1]. Some researchers have studied the interaction with drones using the front-facing camera connected directly to a drone. Others have studied the interaction with drones from the camera's perspective, which is connected to a ground station computer.

Although gesture control for drones have not been widely explored lately, the approach has some advantages: i) No additional equipment needed; ii) More human-friendly controls; iii) All you need is a camera that is already on all drones. With all these features, such a control method has many applications.

Flying action camera**.** In extreme sports, drones are a trendy video recording tool. However, they tend to have a very cumbersome control panel. They were using basic gestures to control the drone (while in action) without reaching for the remote control which would make it easier to use the drone as a selfie camera. And the ability to customize gestures would completely cover all the necessary actions [2].

This type of control as an alternative would be helpful in an industrial environment like, for example, construction conditions when there may be several drone operators (gesture can be used as a stop signal in case of losing the primary source of control).

The Emergencies and Rescue Services could use this system for mini-drones indoors or in hard-to-reach places where one of the hands is busy. Together with the obstacle avoidance system, this would make the drone fully autonomous but still manageable when needed without additional equipment.

Literature Survey

The world has recently discovered drones, and using them requires very high training. The drone will become a commodity in the future and have a wide range of use cases. For this to happen, drones should become easier to operate.

1. The Concept Behind Problem Statement

Drone usage will become very common in days to come. But the tasks of operating a drone will become highly repetitive and manually heavy [3]. So, some solution needs to be developed to reduce manual intervention. Additionally, it will help to increase efficiency. We aim to improve the existing interface of drone flying and introduce gesture-based navigation so that even an amateur can fly the drone.

2. Current System

The drone is comparatively a new technology and is currently not vastly adopted. The current arrangement only makes hassle-free operation for trained operators and the average public. This is hindering the adoption of drones on a vast scale. Additionally, the drones in circulation do not have DL capabilities to open their scope to new test cases [4]. Drones do not have significant features due to which they are not being adopted by even the Armed forces on a large scale.

3. Problem Faced due to Current System

The current system limits the usage of drones. There is a lot of hindrance in adopting them. First of all, the cost of a drone is very high. Secondly, even if you manage to get your hands on one, you must undertake specific training to fly it, even on an informal basis. Drones are needed a lot in surveillance. It can be very tedious considering drones are operated from a height. Keeping track of objects can be highly inaccurate [5], and inaccuracy in this field may lead to even wrongful death. So, some computer intervention is needed since this much information is not required to be processed by humans. There is

a cut-throat environment in armed operations, requiring 100% precision. If not, wrongful conviction / civilian casualty/ escape of convicts can happen. India is a highly crowded nation, and there are instances when surveillance needs to be done without causing any turmoil to the public. The surveillance drones are usually deployed in areas of panic and enemies put jammers to hinder communication. This restricts proper control of the drone by the operator. Therefore a system is needed that provides optimum communication of the drone even if there is a jamming situation [6].

4. Our Proposed System

Keeping in mind the problems mentioned above, we aim to provide a well-equipped, fully functioning and interactive drone for public safety and surveillance.

Our project is designed to skip this extreme learning curve by making predefined actions for the drone, such as elevate, de-elevate, move left, right, forward, and backward. The operator only needs to get familiar with hand gestures. We provide functionalities of a wide range of use-cases. We have enabled facial and object recognition with which the drone will follow the target. To overcome the problem of jamming, we have also configured gesture-based controls. Another feature that we have added is a path following [7], using which a predefined path can be traced and a repetitive process can be thus automated.

5. Advantages of our proposed system

It takes extensive training and time to learn how to operate the drone safely with the common RC remote that comes with most drones, and drones can be very dangerous if flown incorrectly or if it goes off-course due to the operator not knowing how to use the remote control. Our project is designed to skip this extreme learning curve by making predefined actions for the drone, such as elevate, de-elevate, move left, right, forward, and backward, so that the user can simply pick up the drone and start using it without the worry of accidentally thrusting the drone into a tree, damaging the several hundred dollar drone [8] that they just bought minutes after using it. On top of that, the user does not

even need to operate any extraneous hardware to perform those actions, they simply need to only use their hands. Our gesture schema has been set up to be accessible to any and all that have full motion of all of their fingers. Thus, our system tackles the problem of extensive training requirements to operate the drones. With our easy-to-use hand gesture control mode of operating, anyone with the basic understanding and one-time training can operate the drone [9].

Also, the functionality of automating the repeated process of tracing a predefined path is extremely advantageous in surveillance purposes such as in agricultural farms to prevent crop damage by animals, or tracking the infiltrators etc.

Moreover, in cases of military counter-insurgency operations [10], our proposed system could prove to be a great asset as it can locate the positions of infiltrators without risking the lives of our soldiers and overcoming the hindrance in operating the traditionally available remote-controlled drones, caused by low-cost jamming equipments which are readily available and used by infiltrators to block the radio signals from the remote control [11]. To conclude, our project is going to be a new way to interact with drones making it user-friendly.

Objectives

- To programme a drone to create a more personalized approach to control it using hand gestures.
- To programme a drone so that it will be capable of face tracking. It will be able to follow the person keeping a specific distance from him/her whose face the drone would have detected.
- To programme a drone with a functionality which will enable it to follow a specified color path using line path reflection and corresponding clockwise and anticlockwise direction turns.

Methodology

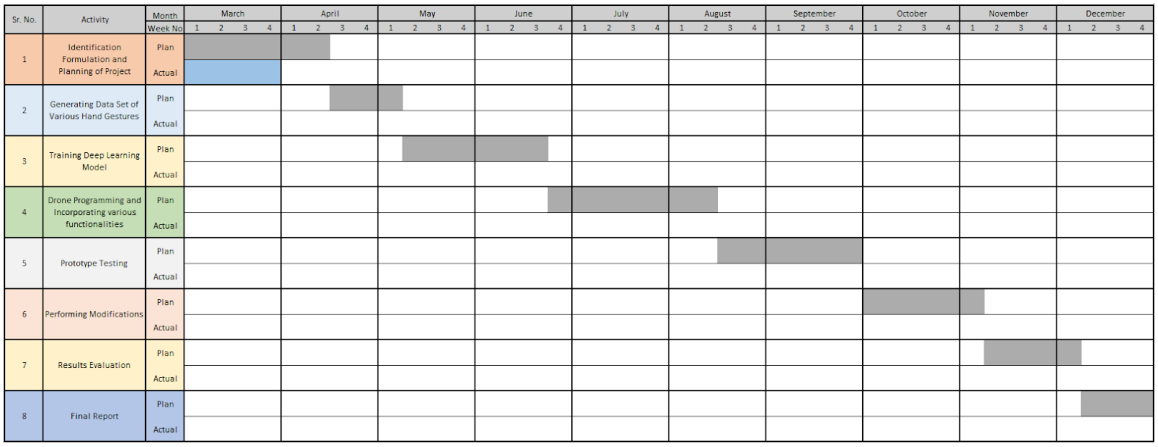
- For recognition of hand gestures to programme the drone there is a need for a dataset. The dataset will be generated using opencv metalib. The palm of the hand will be divided into 21, 2D points each having x,y coordinate and id ranging from 0 to 20 [12]. This will be supplemented by a gesture id that will be given as an input each time a new gesture is shown to the system. Consequently 42 columns will be filled corresponding to x and y coordinates of each defined point on the palm. Corresponding to each gesture id there will be a functionality name given which will correlate with the operation to be performed by the drone. A custom deep learning model with 4 layers will be applied using relu and softmax function [13] which will be able to detect gestures whose data we had generated. For a given gesture that is detected there will be an operation that the drone will perform, the drone will be programmed for the same. Furthermore, there will be an additional programme to control the drone using a keyboard in case the conditions aren't ambient for gesture detection.
- For face tracking application, we will first programme the drone to capture the image of a face using face recognition models. Then to track it, the drone will have to maintain a fixed distance from the source, however it moves. To achieve this the drone calculates the area around the face in pixels (length multiplied by breadth) [14]. If the value of area comes out to be greater than a fixed threshold range, it will imply that the object has come close to the drone and it will move backwards. Similarly if the value of area comes out to be less than the threshold range, it will suggest that the object has moved farther away hence the drone will move forwards. In the same manner if the object goes left or right of the center of the drone beyond a threshold yaw angle then the drone will accordingly move clockwise or anticlockwise so as to get the object within the center view of the drone once again. Here the angular rotation velocity for moving in clockwise or anticlockwise direction will be kept in such a manner that it gradually decreases

because the drone will not stop suddenly due to momentum [15] and might exceed the center view by a few degrees.

- For line follower functionality, the image is divided into three adjacent columns. Because the camera is in front of the drone and the line directly below it we will attach a mirror using a clip or glue gun to take reflection of the path directly below the drone and then that reflection is processed [16]. If the color of the line to be followed comes directly in the center of the three adjacent columns, it implies that the drone is directly above and it will continue moving forward. If the color of the line comes in the right column it will mean that the line to be followed is taking a right turn and the drone will be slowly moved in clockwise direction till the line comes in the center column once again. Similarly if the color of the line comes in the left column then it will suggest that the line is taking a left turn and the drone will be moved in an anticlockwise direction. The extent of the clockwise or anticlockwise rotation will be determined by the degree to which the line color will be to the right or to the left of left and right columns of the three region divided window respectively.

Fig 1. Flowchart of methodology

Work Plan



Project Outcomes & Individual Roles

At the end of this project, we will be presenting an easily operable, hand-gesture controlled drone system.We will be automating the repeated process of tracing a predefined path. The drone will involve face tracking functionality which will be highly advantageous in surveillance.

To achieve this we will be dividing tasks among our team members as follows:

1. Ayush Kaushik : Creating dataset, Data preprocessing, Drone Programming(Module-1&2), Testing, Final Documentation
2. Akshat Thakur : Creating dataset, Data preprocessing, Training DL Model, Drone Programming(Module-3), Testing, Final Documentation
3. Rahul Mishra : Creating dataset, Data preprocessing, Training DL Model, Drone Programming(Module-3), Modifications in prototype, Final Documentation
4. Ridham Behl : Creating dataset, Data preprocessing, Drone Programming(Module-1&2), Modifications in prototype, Final Documentation

Course Subjects

1. Machine Learning (UML501)
2. Deep Learning
3. Embedded Systems (UCS614)
4. Software Engineering (UCS503)
5. AI Applications (UCS655)
6. Predictive Analysis Using Statistics (UCS654)

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