



Gesture Controlled Swarm of Mini Aerial vehicles

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Abstract: Image processing technique is one of the crucial technologies in the modern world problem solving systems. Various application of image processing has been introduced and also are being utilized in the present era. The classification, analysis and approaches of this technique are available in abundant, but the difference between such techniques are still known only to few. It is essential that proper distinctions between such techniques should be interpreted and they should be analyzed. The main aim in our project is to control mini aerial vehicles or micro drones by recognizing and classifying hand gestures to correct directions or instructions for the movement of drones with maximum accuracy possible. This will be done with use of certain hardware components and image processing scripts with a dataset of different hand gestures for different movements or directions.

Index Terms – Gesture control, Micro drones, swarm of drones, reforesting, defense.

1. INTRODUCTION

The application of drone technologies are widespread and in many form. Each application has ability to solve one or more real world problem statements, be it commercial field or awareness, healthcare or disaster management, defense or surveillance, casual fun or in scientific experiments. This technology has been coming up with both conceptual and practical theories and ideas. Many are already in motion and others are yet to be introduced.

Just a year ago during the outbreak of corona pandemic many products and services industries, ecommerce industries tried to find an alternative way of delivering or reaching customers. Some tried to apply the experiment the Amazon undertook before the pandemic that is delivering goods with the help of drones. After one or two test runs which was deemed to be successful the idea was dropped down and the goods were delivered in the old casual way with only difference of 2 feet distance and contactless delivery. The reason for the drop is due to unplanned system for operating the drones for the purpose, because a drone does need an operator to see that the goods are delivered safe and sound to the customer's residence.

Drones can be automated too, i.e program it in such a way that the drones carry the goods to be delivered to the designated address. But that too has its own complication what if the customer fails to understand the process of transaction once the drone delivers the goods? Or what if the person doesn't have knowledge of online payment? Or what if the person is not in touch with modern technologies and by mistakenly or intentionally harms the drone? Too many ifs were found and the program was not released in large scale. But there are some places where it is still in working but in very minor condition and less coverage of distance. Places like Oceania that is regions in Australia and Vanuatu delivery of food and personal healthcare products do take place with help of drones

But what if a person was able to control not one but a swarm of drones with just simple gestures for their movement. The problems like less coverage, time consuming, hazardous and many more could be solved

in many areas. One such practical idea that we propose is how we can use image processing in machine learning and control not just one but a group of micro drones. Through this we can prove how by using gestures we can control a swarm of mini aerial vehicles and throw light on as to which problem statements this idea can help in solving. Thus, this idea is also a means of upgrading the conceptual idea of controlling a single drone using gestures to multiple drones.

I. Real world problem statements

A. Environmental conservation

When it comes to environment we face many facts like deforestation, hunting, poaching, forest fires, involuntary migrations of animals and birds that impacts on ecosystem, etc.. Reforesting a deforested forest is a tedious task since deforestation undertakes in a large scale and area. Manual reforestation do have its own complexity and difficulty and also heavily time consuming and still not getting the work done. Accurate information about forest composition, structure, volume, growth, and extent is essential for sustainable forest management and can be extracted directly or indirectly from remotely sensed imagery. Over the past few decades, increasing attention has been focused on improving remote sensing applications in forestry.

B. Agriculture: Cultivation and fertilization

Farmers find it difficult to cultivate and maintain the land and crops that is cultivated that is spread for around acres and acres of land. Thus, they put maximum and bone breaking efforts to do the same. There are also machineries that are helpful and might save time for the farmers and efforts too, but they are heavy, costly, and also difficult to maintain. When trying to find answers for their difficulties they end up with more problems. Also keeping a sharp lookout for the growth of all crops is a tedious job too.

Which are why there are concepts like smart farming introduced. For agricultural applications, regularized smart-farming solutions are being considered, including the use of unmanned aerial vehicles (UAVs). The UAVs combine information and communication technologies, robots, artificial intelligence, big data, and the Internet of Things. The agricultural UAVs are highly capable, and their use has expanded across all areas of agriculture, including pesticide and fertilizer spraying, seed sowing, and growth assessment and mapping.

III. Introducing gesture-controlled swarm of drones as a solution

In this paper we will introduce you to the solution we came with the problems and also explain the characteristics and functions of these drones.

IV. Methodology

Controlling a drone via a remote controller is one way to achieve the movement of the drone. But when we remove the application of remote control and fuse image processing techniques for the control of drone with simple gestures it turns out to be too easy and lenient way to handle drones. In our proposed idea we will be constructing number of micro drones connect them and configure them together so that they will be working all together with single instruction by a single person relaying the gesture at the same time.

To achieve this stage we have prepared a step by step methodology idea so as to ensure we achieve what we are predicting for. They are as follows (figure 4.1)

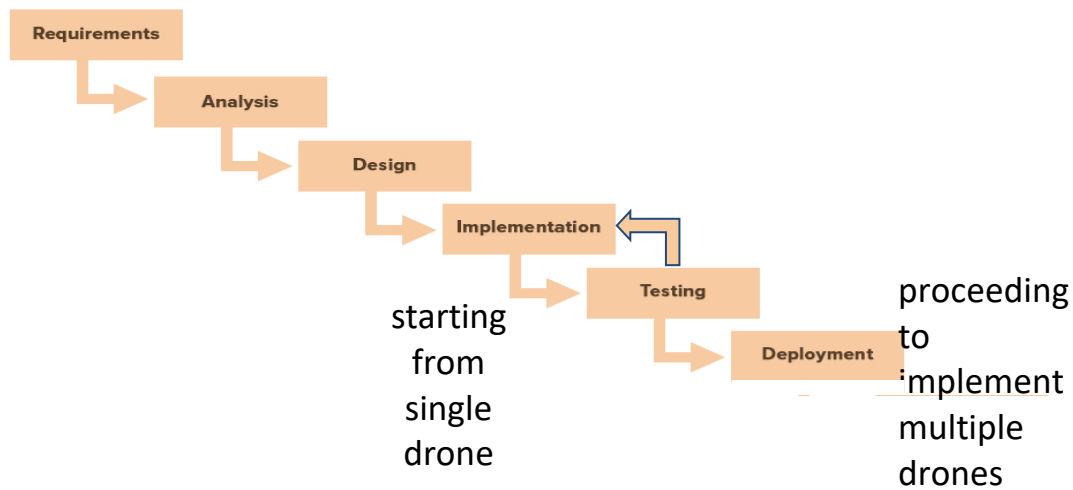


Figure 4.1

Controlling of drones using gesture is a complex task since it includes both hardware and software requirements in equal proportion. Starting from building the drones and configuring it with each other and to the receivers, configuring NANO boards to the scripts that will be used with both Arduino and python scripts, it is a complex and time-consuming procedure.

1. First the requirements for the projects are sorted that includes hardware equipments to be used for build and the scripts to be written for providing information about actions of each gesture.
2. In the analysis stage we will analyze the working of the drones, where we will set out various predictions for the movements of drone accordingly to the gestures this is done to get the accuracy in the testing stage.
3. In Design stage we will design the structure of drones in such a way that it looks compact and light in weight and start building it in implementation stage.
4. Once a single drone is constructed it is tested for the flight and response for the gestures. And once successful the process is repeated with building each drone up to 6 and then in final stage configuring them to work on single command and testing again for the predicted response.
5. On successful testing the final swarm is deployed and analyzed for any further upgrades required

There have been no attempts to avoid collision of the quadcopter with any obstacle which has been successfully covered in our project by mounting pairs of ultrasonic and proximity sensors. The cost of previously completed efforts has been within a range of Rs.20000-64000 which is not at all within an affordable range for commercial sector.

The encoded radio frequency (rf) of gesture signal is sent to the quadcopter by the 433mhz transmitter and on receiving the signal the 433mhz receiver sends the signal to the decoder which decodes the signal from rf to digital signal. This digital signal is then converted by the memory of Naze 32 rev 6 controller through programming that is fed into the controller. The controller then orders to change the Electronic Speed

Controllers to change the speed at which particular motors are rotating to do the required or necessary action.

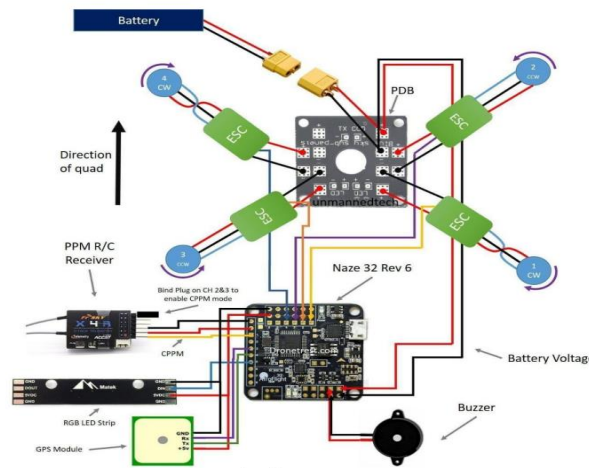


Figure 4.2

The only requirements for building a micro drone from scratch are ready made 3D printed PLA frames. To make it recyclable and reusable PLA and foam boards will be used for designing and building the parts of the drones.



Fig 4.3 : Abstract idea of the drone frame builds

The NRF module is a wireless communication module that can be used to establish a communication link between two or more devices. The module can be connected to an Arduino board to enable wireless communication between the Arduino and other devices. Once all the parts required is assembled, we proceed to wiring of NRF module with the Arduino.

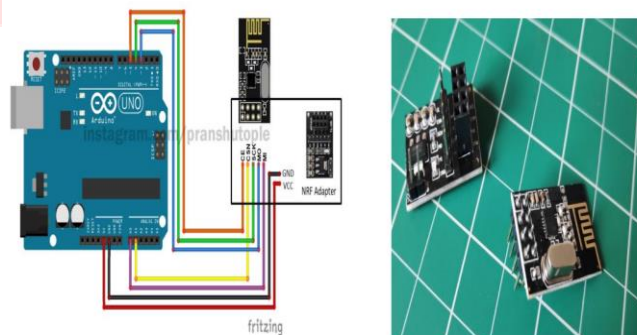


Figure 4.4

The Figure 4.4 is the NRF module and the Adapter is shown with their integrated pins, these have to be attached to their assigned poles so that the wiring of the arduino board can be done accordingly to the proper terminals. The image (fig 3.3.2) the final connection is made first the module and the adapter and then the Arduino terminals with the NRF module.

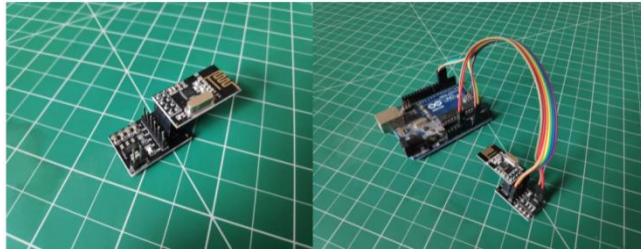


Figure 4.5

The Figure 4.5 Once the connection is done, connect the Arduino to your PC using Arduino Programming USB Cable to program the Drive for the functioning of the drone. The NRF module and adapter can be connected to an Arduino Nano to enable wireless communication between the Arduino Nano and other devices. The connection involves identifying the pins of the NRF module and adapter, connecting the power and communication pins to the corresponding pins on the Arduino Nano, and installing the NRF library in the Arduino IDE. Once the connection is established, you can write code to configure and communicate with the NRF module and adapter, based on your specific application and the devices you are communicating with.

V. Requirements

1. Laptop/Desktop computer with webcam and python installed.
2. Any R/C Drones running on 2.4Ghz Frequency. (*JJRC H36* in this case)
3. Arduino UNO along with its Programming Cable. NRF24L01 2.4GHz Antenna Wireless Transceiver Module.
4. 3.3V Adapter Board for 24L01 Wireless Module. Male to Female Jumper Wires x7

Haar Cascade classifier is used for hand tracking in this project. The Haar Cascade is trained by superimposing the positive image over a set of negative images. And this trained data is usually stored in ".xml" files. You may get Classifier files of almost anything on the internet or you can even create one of your own like this. For this project, as we needed to make it hand gesture-controlled

VI. Applications

- Drones play a major role in forest reforestation, forests that has become barren due to deforestation or forest fires, the drones can carry the tree seedpods and plant them in those region thus helping in re-growth of lost forest.
- Targeted action in plant cultivation and fertilization in agricultural field. Utilizing drones for spraying fertilizers are one of the common uses in present era but with swarm of drones a large area can be covered in no time.
- Security and surveillance, with these micro drones the blind spots that commonly arise with a stationary surveillance system or a single drones can be reduced to nil thus providing even better security surveillance
- Defense field, some industries have started building drones that can be helpful for soldiers during combat stealth missions, and also drones been utilized for surveillance in the border areas.
- Mapping and tracking, both terrain and wildlife can be mapped and also tracking of wild animals from being hunted by poachers and observing their movements.
- Logistics and delivery services due to its fast and compactness delivery services can be helpful via drones.

VII. Results

Once the hardware of the drone is built, it is necessary to check if the transmitter binds with the receiver. The 6-channel buddy box transmitter communicates only the receiver it is binded as the transmitter is pre-encoded. setup code is uploaded to the flight controller to check if the gyro, transmitter, receiver and esc are connected properly and stores all the necessary setup information in the EEPROM of the Arduino.



Figure 7.1

The Figure 7.1 is a multiway simulation of a gesture glove refers to a computerized simulation that can replicate the movement and actions of a glove used for gesture recognition. The simulation takes into account multiple factors such as the movement of the hand, the pressure and position of the fingers, and the orientation of the wrist. In this type of simulation, the user wears a gesture glove that is equipped with sensors that capture the movement and position of the hand and fingers.

Calibration of gyro and ESC is important for the drone to have a stable flight. The calibration code is drone to have a stable flight. calibration code is uploaded to the board and the ESCs area calibrated to ensure that work in perfect synchronization orientation of the gyro is also checked using the same code.

The final flight controller code is uploaded to the board after testing and calibrating the components of the drone. Stable flights can be achieved by setting proper PID values. The main goal of PID is to maintain the desired direction of flight by correcting the errors causes by the external forces We have to be extremely careful while configuring the PID values.



Figure 7.2

The Figure 7.2 is a side view of a drone during the construction process provides a detailed perspective on the design and layout of the drone's frame, as well as the positioning of the various components.

The side view also shows the positioning of the motors and propellers. The motors are mounted at the end of each arm, and the propellers are attached to the motor shafts. The angle and positioning of the propellers can affect the stability and maneuverability of the drone, so careful attention must be paid to their placement during the construction process.

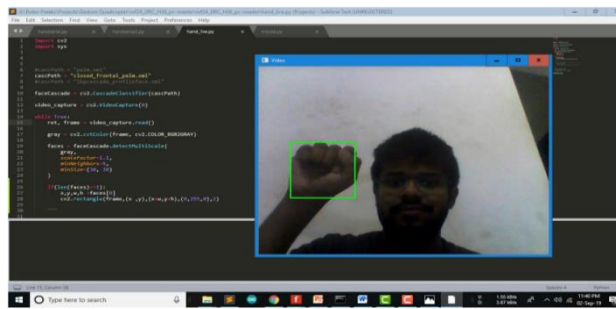


Figure 7.3

The Figure 7.3 shows when the python script is run in the system that will recognize the gesture through the inbuilt camera of the system. we see that with the change in position of hand movement in the frame a new dimension is recorded and scaled accordingly, which then is changed into digital signals and transferred to the drone

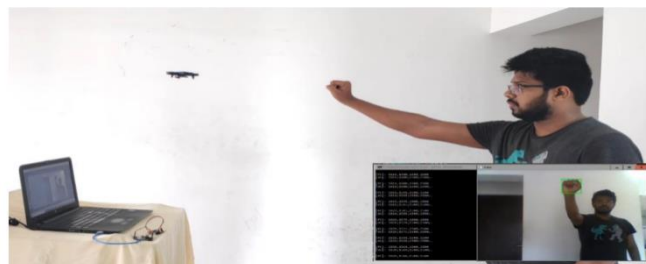


Figure 7.4.

The Figure 7.4 is the Illustration of how a single drone is controlled with the help of movement of the fist in different directions, along the representation of script running with the movement of hand in front of the camera, as represented in the inside picture. Here the direction of the drone movement is basically dependant on the direction of the movement of the fist

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