PALM DRONE*

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ABSTRACT

The project goal is to make a semi-autonomous palm drone (drone that is as tiny as a human palm in size) that can respond to the commands from the user from the palm drone's android application. This drone should carry high-level flying functionalities such as obstacle avoidance technique, point to point maneuver, and return to launch features, along with basic flying. Implanting these High-level flying functionalities in this micro drone is the real challenge while containing all the safety parameters.

KEYWORDS

Mini Drone, Obstacle Avoidance, Safety Check, Small Drone.

I.INTRODUCTION

Drones in 2021 have endless applications, and the world has just started exploring. Some of the drone's unique applications can be seen in a drone for cleaning windows (made by Aerones, based in Latvia)[1], an ambulance drone (made by the Delft University of Technology in the Netherlands)[2], a drone dedicated to conserving wildlife and forest[3]. Some of the hard-to-reach pipes can be analyzed, maintained and made accessible to Piping engineers with the help of drones; these are some of the great attempts to make the world a better place using drones[4].

As the name suggests, the Palm drone is a drone that can fit the size of a palm, but the novelty of this drone is its unique ability to handle multiple technologies just like any bigger drone can carry. The palm drone is of a size 150*150mm H-X frame, weighing less than 250 grams, making it a nano drone, as per DGCA guidelines[5]. The palm drone's novelties are its unique Palm-size, its obstacle avoidance feature in a nano drone and follow me feature. Some important palm drone specifications are its size, compatibility, processing speed, high accuracy but low precision sensors and fully autonomous drone.

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The targeted characteristics of the palm drone are its capability to launch the drone through the human palm and also includes the characteristics of Altitude hold, Position hold and stability to maintain a cruising speed. While soft landing, after performing the desired flight expected from a user, it makes sure the dropping comfortably and softly touchdowns on ground.

The targeted characteristics in advanced flying, also include, point to point cruising, active tracking, obstacle avoidance and return to launch.

With all the safety checks in a drone for safe flying, a nano drone (i.e a drone under

<250 grams) as advanced as this palm drone needs more safety as it is small in size; one can quickly lose it in the air. as it is small in size after a particular level in sky it won’t be visible to a human eye. Also, with weight constraints to fit into the palm, some adjustments had to be made like instead of a single ESC for one motor, four in one ESC's are used, but it comes with certain disadvantages in safety. The 4 in 1 ESC which has a single ESC failure, may need to be completely replaced, whereas individual ESCs could be swapped out a lot easier and at a lot less expense. [6]Moreover, ESCs can easily overheat if they are undersized, so sizing is essential.

The objective of an autonomous Palm drone is to provide a top-notch user experience—an excellent user experience achieved by providing an excellent human interface and visual interaction with the drone. The camera offers live video streaming to improve user experience and capture moments. Palm drone's application also provides a one-tap feature to land and take-off, options to use joystick control and arrow button control, and different flight modes (discussed later below) making it convenient for the pilot to fly and control the drone.

II.BASIC FLYING

a.PALM LAUNCH: The thrust generated by the Palm drone should be enough that it is capable of lifting the drone from the surface; in this case, the surface can be a palm or the ground. The thumb rule is that the thrust produced should be 50% more than the drone's weight. The thrust is produced in the rotor and propellers push down on the air; the air pushes up on the rotor. The faster the rotors spin, the greater the push. Longer propellers can achieve greater lift at a lower rpm but take longer to speed up/slow down. Shorter propellers can change speed quicker and thus are more maneuverable; however, they require a higher rotational speed to achieve the same power as longer blades. This causes excess motor strain and thus reduces motor life span.[7]

A center of gravity affects the

longitudinal stability of the aircraft, and an unbalanced drone won't be able to maintain a level flight. A perfect launch is only possible when COG is maintained. An unique design was prepared for holding the battery, this helped in balancing the drone.

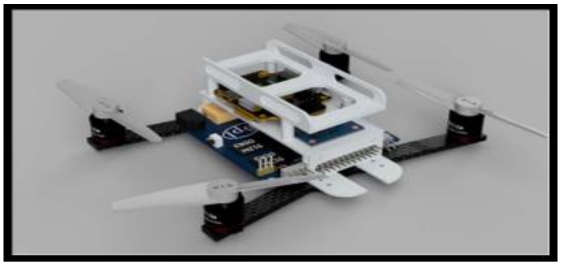

Fig1: The case of the drone is designed to hold the battery in place.

b.ALTITUDE HOLD: Pressure sensor and distance sensor used to determine the height. However, using distance ranging sensors like Sonars, Live feed Cameras, etc. are suitable for better reading. Altitude hold is done to maintain a consistent height.

c.POSITION HOLD: Palm drone hovers the drone in (x, y, z) direction. There is multiple purpose of position hold: taking a picture from the point, hover the drone at a position to record, transmit a video from a point, etc. Moreover, by using the Optical Flow technique, we can control the drone x and y position more precisely with GPS coordinates in outdoor flying and z position using a barometer.

d. CRUISING SPEED: The speed in the palm drone is controlled by the user. The speed control lies in the user's hands for various reasons like a more excellent and comfortable user experience, higher tracking efficiency, and avoiding the crash due to over speeding. The user will be provided with cruise control Joystick sensitivity and adjusting max thrust produced by motors. It is also used for safety checks wherein a defined speed is provided for the drone to return to its home position; an accelerometer is used to calculate the flying vehicle's velocity. We notice that the higher the flying speed, the longer it will take the drone to make a turn given that the acceleration is something that is constrained by the hardware as an agility capability of the product. Therefore, it may not be always better to select a higher-flying speed to minimize the flight time or maximize the application performance if the drone is expected to turn frequently. A lower speed helps the drone to make a quicker turn, which may help achieve particular application goals.[8]

III.ADVANCED FLYING

a.ACTIVE TRACK: The real-time following can be done with GPS, IMU , Laser sensor tracking, Obstacle avoidance as well as using Digital image processing, and also by identifying an object or person over camera feed; One can track the subject from a distance.

b.POINT TO POINT CRUISE: GPS coordinates in the drone are utilized to achieve movement from point A to point B. It primarily uses GPS but needs IR sensors or Ultrasonic sensors to avoid obstacles that come in the path. For the Palm drone, thorough research and analysis selection is made between the two. Factors like processing time, precision, light intensity, range of distance covered in mm, accuracy, weight and response time, matter for the long run.

c.RETURN TO LAUNCH: In 'Return to Launch'(RTL) mode, flight controller will note down takeoff coordinate points so that in case of an emergency such as low battery or poor signal strength, it will automatically return to the position from where the flight was started. During the arming process, the auto-pilot checks the fail- safe conditions like low battery voltage, GPS unable to lock, recalibration of the magnetic compass or any other sensors. When all the fail-safe tests are passed, the drone is ready for take-off. [9] Registering the GPS coordinates during launch and return to the same location when RTL is required. An important feature in any drone is its ability to return to its starting point. The GPS registers the point of start and in case of connective error, GPS lost or technical glitch the drone has the ability to Return to launch, if any battery fail safe triggers.

IV.FUTURE SCOPES

GESTURE CONTROL: With a wearable device worn in hand, all the gestures in the hand will be recognized. This recognized gesture is converted into data and this data is then transmitted to the receiver end of the flight controller in the drone. The flight controller then sends the drone the appropriate signal to move its throttle.

V.SAFETY CHECKS

Before getting into different safety checks, it is important to know the reason for it. As the name suggests. Before getting into different safety checks, it is essential to know the reason for it. As the name suggests, it's for the drone's safety and, more critical safety of the people under it.

a.Battery Check: For the drone to fly smoothly, it is imperative to get a battery check. It ensures that whenever the drone is flying, and there is a low voltage in the battery, it can indicate that the pilot controller must take necessary action to avoid crashing. Also, if there are battery checks regularly, one might detect unnecessary voltage consumption due to component error.

b.Soft Landing: As part of a safety check, a drone's soft landing is essential for its existence. Soft landing is assured by providing a cushion on its landing feet, using a CAD-design model and simulating its impact on the ground using various descent speed while landing. Also, by using different laser ranging sensors, the drone can identify the distance between itself and the platform it is preparing to land on.

c.LED Indicators: It is an underrated safety check but a vital investment in the drone. LED is installed in a drone for various reasons. LED is used to communicate through different light combinations to signal the drone pilot about any mishap in the drone, avoid a collision, for visibility of the drone in the dark, for detecting the drone if it crashes in a dark area, for other flying vehicles to see. With LED, it is also essential to attach a beeper, a beeper, or a buzzer is a noise- producing device to alarm the drone pilot to alert if due to any technical failure the drone crashes, the drone pilot should be able to trace it.

d.Max Altitude: A limit for maximum altitude height is decided in every drone. The maximum altitude is determined according to drone size, weight and communication distance between the drone and the controller. The maximum altitude limit is also set to keep track of the drone. A palm drone being smaller in size won't be visible to the naked eye if it flies off large distances. A closed-loop system is designed to track the distance between the drone and the controller.

e.Cut Off Operations: This operation is one of the most crucial operations; it is also called an emergency cut off operation. The primary purpose is if the drone gets tangled in a tree or a wire, a kill switch is essential to stop it from getting more trapped in the tree or wire.

f.Fly Zone (NPNT): NPNT stands for No Permission and No Take-Off. NPNT is a factor to consider concerning a country's security. It would be an integral part of the system that would restrict drones to fly in restricted and secured locations.

Inside NPNT, there are various aspects that a drone must possess, without which it might get denied to be flown anywhere. It is novel to each country and an element that cannot be neglected or disregarded. In the United States of America, a drone follows FFA (Federal aviation administration) guidelines, wherein a drone has to be registered. In India, under DGCA (Directorate General of Civil Aviation) law, owners of the respective drone need to have a permit from the digital sky platform. After which, they need RPTOs (Remote Pilot Training Organizations) set up in the drone. The DGCA will issue UIN for a particular RPA (Remotely Piloted Aircraft). UIN (Unique Identification Number) is unique to each pilot. Preapproved flights are then allowed to all those who have UIN, RPTOs and a registered drone.

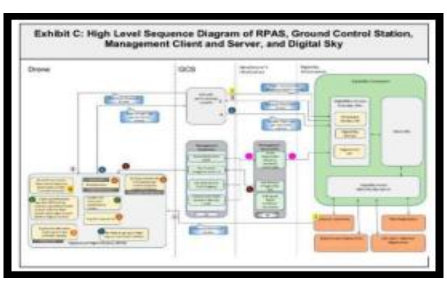

Fig2: Working of NPNT[10]

Fig3: Civil Aviation Regulations for RPAS[11]

VI.HARDWARE INTERFACE

A BLDC motor is a perfect fit for the Palm drone because:

- It produces high efficiency and higher output power to size ratio.
- Less overall maintenance due to lack of brushes.
- High torque to weight ratio.
- High efficiency and high output power to size ratio.
- longer lifetime
- The brushless motors are synchronous units with one or more permanent magnets.
- Higher speed range
- Lower electric noise generation.

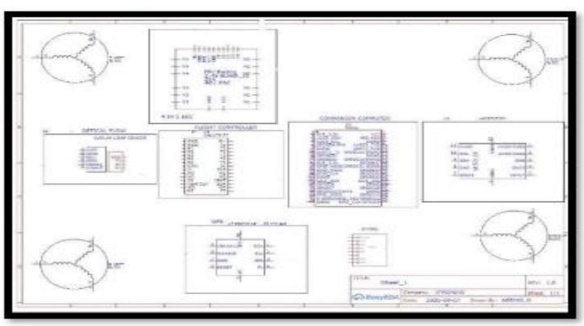

Fig4: Electric diagram of all the component connections

The hardware chosen for the Palm drone is considering multiple factors such as the weight of the individual component, the voltage and current consumed by each part. The battery size is decided based on the amount of consumption. If the battery size is large, the unique drones feature, i.e., Palm drone, is lost. One must also consider the or time taken for a process by the components; any delayed response from a piece is to hamper the other the whole system.

Components required for a drone building are the Flight Controller- the drone's brain, the battery- the heart of the drone that circulates current with a voltage, IMU (Inertial Measurement Unit) is a device used to determine speed, rotation, orientation and position. ESC- Electronic Speed Controller regulates the current consumed by the motors, GPS- Global positioning system, which helps to monitor and track the drone position in the world. Additional components are Companion computer- it is a device to handle multiple higher level, more complex tasks that enhance the overall capability of the drone. Separate components are Obstacle avoidance sensors like Ultrasonic sensor, infrared sensor; Lidar sensor-it is a sensor that saves the drone from crashing into objects.

VII.SOFTWARE INTERFACE

To control the drone remotely, Palm drone for its prototype uses Ground control Station (GCS). MAVlink protocol is used as a data link between drone and Ground control station. The Palm drone uses a communication Protocol allowing entities to communicate over a wireless channel. When used in drones, it is used for the bidirectional communications between the drone and the GCS. [12]

To live stream camera footage installed in the drone, we use a bridge to connect the live stream to an Android application. The bridge uses the Real-time protocol that sends image data with a timestamp to the android application to stream live footage. The live stream can be posted from the server to the application using WebRTC. The goal of the server here is to convert RTSP (The Real- Time Streaming Protocol) to WebRTC and feed the result to the mobile application. The real-time streaming protocol sends audio and video data packets to android.

To implant additional application capabilities like control part, different flying modes. We are using ROS as middleware to deliver these to the drone. Here, MAVROS is an extendable communication node for ROS that will translate ROS data into MAVLINK messages (firmware understands this message type). ROS framework also provides a platform to emulate objective drone functions to efficiently simulate the drone's response to any command from the application in the external environment created in simulation, helping the pilot to forge the response before an actual flight. Therefore, parallelly advanced drone features can also be tested in simulation before the actual flight. The palm drone simulated in the

Gazebo platform by sending commands from the application using the localhost server. All responses were affirmative. Thus, it concludes the successful building of an application and also implementation of autonomous features of the drone.

VIII.CONCLUSION

Making a semi-autonomous drone has its own set of challenges, but one can overcome this with proper research and discipline. Problems in components are common but avoidable by selecting components that are compatible with one another. The amalgamation of all the aspects of the project is a must, aspects like the Android application working co-operatively with the camera, controls on the application working with ESC of the drone to provide the proper current to the motors.

IX.ACKNOWLEDGMENT

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