Drone for Packet Dropping Using IOT during Disaster Situations

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Abstract — The primary focus of this paper is to create medical supplies delivery drones, utilizing image processing technology, to revolutionize healthcare in inaccessible areas during disaster situations. This project proposes an efficient drone system for the autonomous delivery of medical supplies. Delivery accuracy is ensured by real-time target detection, using image processing for drop-zone identification. Integrated GPS and wireless connection enable real-time data transfer and autonomous flight. By enhancing healthcare services in rural and disaster areas, the use of these drones can save lives. This report presents an exhaustive study on integration of various drone systems and target detection by using OpenCV.

Keywords: Autonomous Flight, Drone, GPS, Medical Supply, Target Detection

I. Introduction

Innovative drone system designs are being proposed with the goal of quickly and effectively delivering medical supplies to hard-to-reach or distant locations. In pursuit of this objective, various technologies are integrated, including a Pixhawk CubePilot Flight Controller, Raspberry Pi 4, Arduino Nano, GPS module, and camera, to identify target. The primary goal is to create an autonomous drone system equipped with an advanced flight controller capable of managing complex flight patterns and ensuring accurate navigation through the integration of a built-in compass.

To enhance the system's reliability and precision, a GPS module will be incorporated to track the drone's location, guaranteeing the targeted delivery of medical supplies. Furthermore, the aim is to design and 3D print a specialized compartment dedicated to securely transporting medical goods. In the event of emergencies or system failures, a manual control option is provided using a transmitter and receiver. The overarching objective is to establish a drone system that not only ensures the efficient and reliable delivery of medical supplies but also prioritizes safety and adaptability in limited-access environments.

II. Literature survey

Bhagya R Navada, Santosh K V et al (2014) [1] tested edge detection and colour detection in image processing and emphasized the need in a variety of businesses. The report described the software and wireless camera setup used to examine photos' colour detection and edge filtering for identifying.

Xueping Li, Jose Tupaychi et al (2023) [2] addressed larger-scale drone operations and uncertainties taken into account, with emphasizing on realistic modelling, in the study. The report urged for more research and admitted limitations in the literature review, in order to capture industry trends and new difficulties.

Marie Paul Nisingizwe, Pacifique Ndishimye et al (2022) [3] examined the effects of distributing blood products via drones, in Rwanda. When compared to road delivery, Drone delivery showed a notable time-saving of 79–98 minutes with a significant 67% decrease in blood product expirations. It was concluded that the drones offered essential healthcare in environments with poor resources.

Muhammet Fatih Aslan, Akif Durdu et al (2022) [4] investigated the Unmanned Aerial Vehicles (UAVs) applications in precision agriculture, with a focus in greenhouse environments and in open fields. The study emphasized how sophisticated UAV solutions and SLAM techniques could change agriculture in both open fields and controlled situations.

Barbara Bollard, Ashray Doshi et al (2022) [5] studied the use of drone technology to survey and provide high-resolution maps with accurate vegetation classification in vulnerable, isolated and protected areas. The study pointed the benefit of consistent economical survey over conventional techniques, while also acknowledging challenges of long-term monitoring.

Norbert Tusnio, Wojciech Wroblewski et al (2021) [6] observed the importance of mapping, coordinating, and observing successful search and rescue missions, with drones. It showed the importance of automated people detection and thermal imaging by drones to enhance the response times in search and rescue situations.

III. Proposed system

The proposed project plan is that an autonomous drone is able to fly at a lower cruise velocity with maximum payload to the disaster-stricken area, based on the input co-ordinates. It scans the area for the target drop-zone, using image processing, by flying in a predetermined flight path. On identifying the precise co-ordinates of the drop-zone, the drone hovers over the zone. It drops the medical supplies, via the bay-door mechanism in drop-zone. After the completion of supplies drop procedure, the drone autonomously returns back to base.

The A2212/10T 1400KV BLDC motor is selected for drone. It is concluded that motors with higher KV do not deliver enough thrust, whereas the lower KV motors, even though deliver more thrust, provide insufficient speed to sustain cruise flight. Hence the mentioned motor is selected, balancing both the factors. 10x45 propellers are chosen as desired propellers for drone.

30A Electronic Speed Controller (ESC) is used for each motor, as the maximum amount of current being drawn from motor is around 6-12A. A 3S LiPo battery of 11.1V was selected as battery pack unit for drone, keeping in view the current drawn by the motors and flight time.

A. *Selection of motor:*

Total weight of the drone, along with payload is 1200 - 1800g.

For proper flight, the total thrust generated should be twice the weight of the aircraft.

R.P.M = Motor K.V x Operating Voltage (3.1)

R.P.M = 1400 x 11.1 = 15540

Thrust from each arm is given by

$$Tsingle(g) = \frac{\left\lfloor 4.392399\times10^{-8}\times(Prop\ Diameter(in))^{3.5}\times\left(4.2333\times10^{-4}\times R.P.M\times(Prop\ Pitch(in))-(cruise\ speed(m/s))\right)\right\rfloor\times1000}{(Prop\ Pitch(in))^{0.5}\times9.8} \quad (3.2)$$

Therefore, *total thrust = 4 x* T_{single}

R.P.M	Prop Diameter (in)	Prop Pitch (in)	Cruise speed (m/s)	Total Thrust (g)	Total Weight (g)
15540	10	4.5	0(static thrust)	12294	6147
15540	10	4.5	2	11464	5732
15540	10	4.5	4	10633	5316
15540	10	4.5	6	9802	4901
15540	10	4.5	8	8972	4486
15540	10	4.5	10	8141	4070

Table 3.1: Total Thrust Values Corresponding To Different Cruise Speeds.

Thus, this shows that the selected pair of motors and propellers are much more capable of generating enough thrust.

The flight time corresponding to various battery parameters is calculated using the following equations.

Flight Time Calculation:

Flight Time(t) = [Battery Capacity (mAh)× Battery Discharge Rate (%)] / Average Ampere Drawn (A) (3.3)

Average Ampere Drawn Calculation:

Average Ampere Drawn (A) = Total Weight of Drone (Kg)×Power (W/Kg) / Battery Voltage (V) (3.4)

Sr no.	Battery Capacity (mAh)	Battery Discharge Rate (%)	Battery Voltage (V)	Total Weight of Drone (Kg)	Total Flight Time(t)
1.	2200	75	11.1	1.2	5.39
2.	2200	80	11.1	1.6	4.31
3.	3200	75	11.1	1.2	7.84
4.	3200	80	11.1	1.6	6.27

Table 3.2: Flight Time Analysis Corresponding To Various Battery Parameters

Hitec HS-645MG servo motor, with arm deflection of 45° and rated torque of 116.6 oz-in = 0.82337694 N-m was selected for bay-door mechanism.

B. Block Diagram:

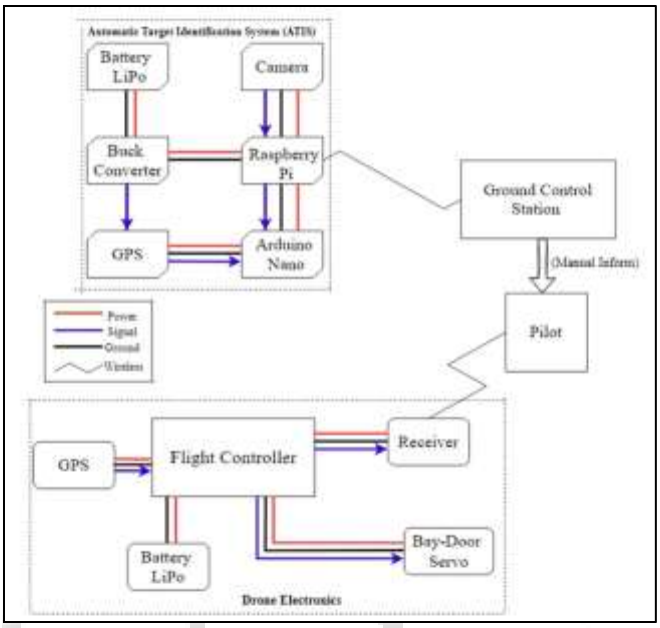

Fig. 3.1: Block Diagram Representing Systems Overview

IV. PRIMARY SYSTEM:

A. (Drone Electronics):

Considering the requirements, the Pixhawk CubePilot flight controller was placed within, to operate and autonomously fly the drone. An on-board Inertial Measurement Unit (IMU) and barometer is present inside the flight controller which, provides the inertial measurements for roll and pitch headings, and altitude data, respectively. The flight controller is attached to a GPS module for providing the real-time co-ordinates of the drone to the ground control station. The servo motor used for the bay-door mechanism. The receiver used to communicate between the drone and the pilot in-case of malfunction, is directly attached to the flight controller. A detachable arming plug is placed between the flight controller and battery pack for safety.

The Mission Planner firmware is used for flashing, data-logging, and operating the flight controller. The drone's data parameters are shown on the Mission Planner firmware at the ground control station using telemetry modules. The altitude when the bay-door mechanism is activated is also recorded in a separate GUI (Graphical User Interface). The flight controller's data logging system records and stores all flight data on an SD card for quick review and backup.

V. SECONDARY SYSTEM:

A. Autonomous Target Identification System (ATIS):

The image processing system consists of the Raspberry Pi (RPi), with the camera and Arduino connected to it. A GPS module is connected to Arduino. The Arduino helps reduce the processing power load on RPi, and prevents excessive heating of it. The RPi processes the data obtained from the camera, using image processing algorithms via python. The Arduino then, with GPS module provides the coordinates of the identified target colour. The RPi then wirelessly transmits this outcome to the ground control station, for live-video-feed. A SD card is present inside RPi, functioning as a backup storage system, in-case of wireless transmission failure. This system is powered by a separate lithium-polymer battery back, connected via buck converter on the PCB.

B. Image Processing Algorithm:

The image processing algorithm is designed to detect colour and obtain the GPS coordinates, using libraries such as OpenCV and various others. The RaspberryPi processes this code and the image processing algorithms. The code works in a way such that, it first identifies the borders, then edges and finally the inner area/space. After this process the given colour marker is identified and its particular GPS coordinates are obtained using the code in Arduino IDE.

Primary and secondary systems communicate with each other, via MavLINK application. Primary system flies the drone autonomously, to the disaster area. The secondary system commands the primary system of the drone to follow the predetermined flight path while scanning for the target drop-zone, in the disaster area using image processing algorithm. On identifying the target drop-zone, the secondary system commands the primary system, to operate the bay-mechanism. After the completion of the dropping of supplies, the primary system flies back the drone to base, autonomously.

VI. Procedure for Testing and Evaluation

The drone system tests, include checks for providing accurate data and amount of flight time. In ATIS, identifying the coloured marker and acquiring the GPS coordinates of it, need to be tested in static conditions first, to acquire accurate results. Once we successfully build its logic, we step up for dynamic testing. The drone carrying the Image Processing system will be flown over objects of different colours, placed at random locations, and the coordinates detected will be verified using Google Maps.

VII. Results

When the camera is passed over the target area, then contours are formed around the region identified, along with the centroid of the contour.

Fig. 5.1: Target Area Is Identified

VIII. Conclusion

The drone system with the flight controller, Raspberry Pi 4, Arduino Nano and GPS, the drone system will be able to fly autonomously and perform image processing, making it a versatile and reliable solution for medical supplies delivery. The drone is designed for medical supplies delivery and features a 3D printed bay for carrying the supplies.

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