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Design and Development of Triphibian Drone

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Abstract: In this paper, we propose the use of triphibian drones equipped with sensors to detect various miscellaneous activities in forest areas. Air dominance and control is a major factor for any country in case of international safety and for domestic purpose. These days unmanned aerial vehicles play a vital role for any country for its international and domestic safety. Modern setup are only limited to amphibious UAV's which can move in air and water or air and land. Seeking to the recent needs and safety with time having a triphibian drone can provide an overall control over the territory. A triphibian drone is a type of UAV the can move in air, water and land. Increase in wildfires, environment degradation caused due to climate change and human activities like deforestation, environmental pollution have put forests in danger. The aim of this project is to build a triphibian quadcopter with on board equipment's to predict wildfires, weather, detecting trespassing, smuggling and other illegal activities in forest areas thereby contributing in reserving the natural resources of the country.

Keywords: UAV, Triphibian Drone, Ultrasonic Sensor, Flight controller.

I. INTRODUCTION

Unmanned aerial vehicles (UAV) are a class of aircrafts that can fly without the on board presence of pilots. Unmanned aircraft consist of the aircraft component, sensor payloads and a ground station. UAV's are classified based on altitude range, endurance and weight, and support a wide range of applications including military and commercial applications.

Figure 1. UAV used in military

Unmanned aerial vehicles are classified based on

- Endurance
- Weight
- Wing type
- Range
- Altitude
- Applications.

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UAVs have been used in a variety of applications over the last decade. Some of the applications of UAV's are:

- Security, Monitoring, and Surveillance
- Disaster Management
- Remote Sensing
- Search and Rescue (SAR)
- Construction and Infrastructure Inspection
- Precision Agriculture
- Real-Time Monitoring of Road Traffic
- Automated Forest Restoration.

The UAV's that are developed and that are being developed these days move in air, air and water and air and land. There are no multi terrain drones available that can move in any terrain and water. Recent increase in forest fire, damage to vegetation due to climate change, damage to wildlife and delay in rescue and search operation during forest fire is a major problem and is a threat to conservation of natural resources. UAV's can play a vital role in such emergency situations. Drones monitor the spread of the fire and identify the hotspots thereby helping the firefighters to locate the hotspots.

Figure 2. Aerial view of forest fire

II. PROBLEM STATEMENT & OBJECTIVE

2.1 Problem Statement

- The UAV's used these days either move in air or is of amphibian type that is it will have two modes of operation.
- Design and development of a drone that can move in air, all terrain and water will provide an overall control over the territory to be surveyed and monitored.
- A triphibian drone can be used in forest areas to predict and detect forest fires, to detect fire hotspots, for surveillance and to prevent illegal activities in forests and border areas.
- Recent increase in terrorism and other illegal activities pose a necessity to have an overall and effective monitoring system to have complete control over the territory.
- It is necessary to use sensors such as thermal sensors, humidity sensors, object detector and surveillance camera to meet the intended applications.

2.2 Objective

- Design and development of quadcopter that can move in air, water and all terrains.
- Developing and equipping the component's to the quadcopter for surveillance, to predict and detect forest fire, detecting unauthorized trade in forest areas and border areas.
- Studying the performance of triphibian drone in all terrains.
- Studying the temperature and humidity variations over forest areas during different seasons and predicting the occurrence of forest fires.

III. METHODOLOGY

- The shortcomings of regular UAV's are studied.
- Studying research articles in order to find solution to issue's related to amphibious UAV's and requirement of

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an all-terrain drone.

- Estimating the weight of the quadcopter and carrying out the basic drone calculation to select the components.
- Based on literature reviews and calculation design of the triphibian drone.
- Selection of all the required components.
- Fabrication of frame, rover and floater.
- Assembling all the components.
- Conducting real time performance analysis.
- Analysis and verification of results and carrying out final improvements.
- Taking note of final results.

IV. CALCULATIONS

Weight
Assumed weight of quadcopter (Al frame and floater):
2.3 kg
Assumed weight of quadcopter (Light weight material):
1.5 kg (Maximum)

Calculating Force
F=Ma (Force)
a=g=9.81 m/s^2 (Acceleration due to gravity)
F=2.3 * 9.81 = 22.563 N - Force required to lift the quadcopter and floater.
Force per propeller, Fp= 22.563/4= 5.6408 N
Thrust in grams to be produced by propeller, Mp = 5.6408/9.81 = 0.575 kg.
Thrust required in grams to lift the quadcopter is Mp Mp is thrust to be produced per propeller.
We need motor that produces almost double the thrust to have good control.

Frame:
For toughness and durability it is suitable to have small size frame.
Frame Dimension:
Wheel base: 250 mm Height: 80 mm
Arm size: 114*25 mm Weight (Al) = 130g

Propellers
Different propellers compatible for the frame
6030R Gemfan => diameter: 6", pitch: 3", mass 2.22 g 6040R King Kong => diameter: 6", pitch: 4", mass 3.38 g
5030R Gemfan => diameter: 5", pitch: 4", mass 3.00 g Out of above mentioned propellers we chose 5” * 4” as it is capable of producing 1000 g of thrust and pitch of 4 makes the drone more stable.
Weight = 4 * 3 = 12g

Motor:
Ready to sky RS2205 motor.
Thrust: 1024 g at 80% thrust when connected 4S battery.
Weight = 4 * 30= 120g

Battery
The motor should not draw more current then the battery can provide, or else the battery could rapidly degrade or overheat.
Current (A) = C rating * Capacity in Ah
For Ready to Sky, RS2205 the maximum reached during various tests is about 42A (from data sheets) Orange 2500mAh 4S 25C (14.8 V) Lithium Polymer Battery Pack (Li-Po)
Current (A) = 25 * 2.5 = 62.5A Weight = 234g

Electronic Speed Controller
48A V2.1 2-6S 4-in-1 Brushless ESC
Weight = 5g

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V. DESIGN

Design tool: Fusion 360.
The quadcopter needs to be compact to carry out the intended tasks. Therefore the dimensions for a 5 inch drone were considered and the design was done based on the calculations. Wheelbase: 250mm. Arm thickness: 3mm.

Flat bottom hull was designed separately with matching dimensions of quadcopter and was then assembled with the quadcopter frame.

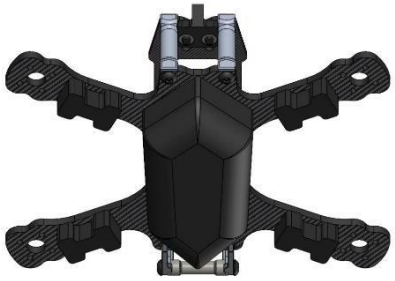

Figure 3. Quadcopter frame design

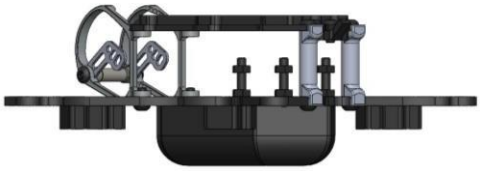

Figure 4. Floater and base plate design

VI. COMPONENTS USED

Table 1. Components used

Components:

Motor- 4	RS2205 2300KV Brushless
Flight Controller	Aocoda-RCF7DUAL
ElectronicSpeed Controller	48A V2.1 2-6S 4-in-1 Brushless ESC
Controller for rover	SmartElex L298N Motor Driver with Onboard Arduino Uno.
Propeller	Gemfan WinDancer 5043 3-Blade Propeller
Battery(Quadcopter)	Orange 2500mAh 4S 25C (14.8 V) Lithium Polymer Battery Pack (Li-Po)

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Line sensor Array	SmartElex RLS-06 Analog & Digital Line Sensor Array
Ultrasonic Range Finder and object detector	HC-SR04-Ultrasonic Range Finder
Temperature sensor	AHT10 High Precision Digital Temperature And Humidity MeasurementModule
Camera	High Definition 1200TVL CMOS Camera with 2.8mm Lens FPV Camera for RC Drone Multi-Copter

Other components:

- Nylon XT60 Connectors Male/Female
- Jumper wires(M-M, M-F, F-F)
- BX100 1-8S Lipo Battery Voltage Tester
- 4 X 100 RPM BO Motor-Straight
- Orange ICR 18650 2500mAh Lithium-Ion Battery
- SG90 Servo Motor (180° Rotation)
- Transmitter and Receiver- FlySky FS-i6x.

6.1 Flight controller and surface vehicle controller

6.1.1 Flight controller:

Aocoda-RCF7DUAL F7 F722 BMI270 30.5MM flight controller 3-6S BEC Betaflight INAV

- MCU STM32F722RET6
- Gyroscope MPU6000
- Barometer BMP280
- Black Box Memory 16MB
- Motor Output 8CH
- Serial Port 5CH
- Input Voltage (V)12~25.2V (3~6S LIPO)
- BEC 5V/2.5A, 9V/3A
- Product Dimensions 37 x 37 mm
- Installation Hole Spacing 30.5mm x 30.5mm
- Weight (g) 9.3g
- Firmware Aocoda RC F7DUAL.

Figure 5: Flight controller

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6.1.2 : Surface vehicle controller

SmartElex L298N Motor Driver with Onboard Arduino Uno. SmartElex L298N Motor Driver with onboard Arduino Uno is specifically designed for mobile robots. It can be used in a wide range of applications such as in racing robots Combat robot, Line sensor robot and many more. ARDUINO UNO + L298N MOTOR DRIVER

which has the same microcontroller on official Arduino UNO where we can select Arduino/Genuino UNO in Arduino IDE to develop the program. With onboard 5V 3A buck converter power supply and a wide range of motor operating Voltage, the driver performs very dynamically in small brushed motor applications as well as 1.2A continuous current motors per channel which can be raised up to Total 4A. SmartElex L298N Motor Driver with Arduino Uno has 3 pin connector (Sig V G) at all digital pin of Arduino. Additionally, it has an On-board connector for the SmartElex RLS-06 Line sensor. The board comes with 8 pin JST Female to Female Interfacing Cable to connect line sensor module to SmartElex L298N Motor Driver.

Features:

- Power Status LED
- 16MHz crystal.
- 5 mm standard DC plug-in jack for Input supply
- On-Board Arduino UNO with USB Port
- On-Board DC motor Driver L298N.
- On-board 5V 3A SMPS circuit.
- On-Board power supply on-off switch.

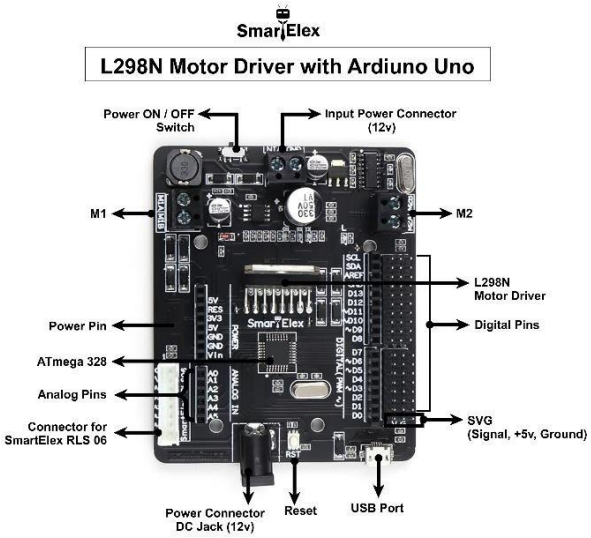

Figure 7: Surface vehicle controller

CONCLUSION

In recent years the development of UAV's have been phenomenal. The extensive technological development in the field of UAV's will provide significant contribution for a country's domestic and international safety. In this context, design and development of all terrain capable triphibian drone will contribute for domestic safety such as aerial survey for conservation of natural resources and for international safety. The calculation, design and fabrication of drone is done and tests are being carried out.

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