Design and Development of Drone

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***Abstract* - A drone is a flying robot that can be remotely controlled or fly autonomously using software-controlled flight plans in its embedded systems, that work in conjunction with onboard sensors and a global positioning system (GPS). UAVs were most often associated with the military. They are used in many applications like Photography and Videography, delivering goods, monitoring change in climate, surveillance and target attacks in military, besides these, drones can also be a very good equipment that can be used in times of a disaster. In case of natural disasters like earthquakes, floods and fire accidents, there will be difficulty in locating and visualizing the disaster-affected area and locating where people are trapped. In such a case, a drone can be used to visualize the condition of the disaster occurred area and locate where the people are trapped. The drone is operated using ROS where the communication between ROS and the drone is made. The drone can also be fed with image-processing algorithms to locate people and also the level of damage can be calculated.**

Keywords - Disaster Management, Robot Operating System, Drone, Unmanned Aeriel Vehicle

I. INTRODUCTION

We know that drone can be used for various purposes like film making, military and other commercial purposes. Besides all these application drone also plays an important role in the field of emergency management. Drone can be used to view the disaster occurred area in safer way and method. They have a real high efficiency in supporting emergency management. This project is about how the drone is designed and integrated with ROS for the purpose of disaster management using mapping, path planning, image processing and other means of methodology integrated to achieve the task of finding and locating the people who would have got trapped in disaster occurred area. The drone sends the aerial view of the disaster occurred area to the viewer and it also locates the people in that area. This drone could be a great help to the national authorities to easily and immediately locate the people and also understand the seriousness of the disaster. They could easily target the people in need of help without wasting their time in physically visiting each place and look for people.

A. Problem Statement

A drone is a robot that can fly both autonomously using software-controlled flight plans or can be controlled using a remote controller. There are different types of drones with different designs depending upon their application in disaster management. The 72 hours after the disaster is the most crucial time and by equipping drones at this time the area under cover for management will be higher. This system also helps to get a rough estimation of damage and danger before sending in the rescue squad. Drones have the ability to take on roles where relief workers and manned vehicles or ground vehicles fall short. Drones can be used for management after the following disasters like, Fire, Earthquakes, Floods or Hurricanes, Nuclear Explosion, Gas leaks and War

B. Scope of the Project

Easy visualization of inaccessible area is possible. It also helps in faster mapping of affected areas. The rescue team will have an idea of the scale of disaster from drone captured images. It will be comparatively easier to locate people who are in danger and to search for personal belongings.

II. ROS CONTROLLER

ROS is turning into the norm in mechanical technology programming, in any event in the help robot's area. Consistently, an ever-increasing number of organizations and new companies are basing their organizations in ROS. Prior to ROS, each robot must be customized utilizing the producer's own API. ROS is for robots like Windows is for PCs, android for phones. By having ROSified robot, that is, a robot that sudden spikes in demand for ROS, you can make programs that can be divided between various robots. You can fabricate a route program that is a program to make a robot move around without crashing, for a four-wheeled robot worked by organization and later utilize a similar careful code to move a

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two wheeled robot worked by organization B or even use it on a robot from organization C.

III. PROPOSED METHODOLOGY

- Design of the drone
- Human detection using image Processing
- Testing and analysis of drone structure
- Selection of Components
- Selection of flight controller algorithm

A. Design of drone

Fig 1 .Image of reference for design

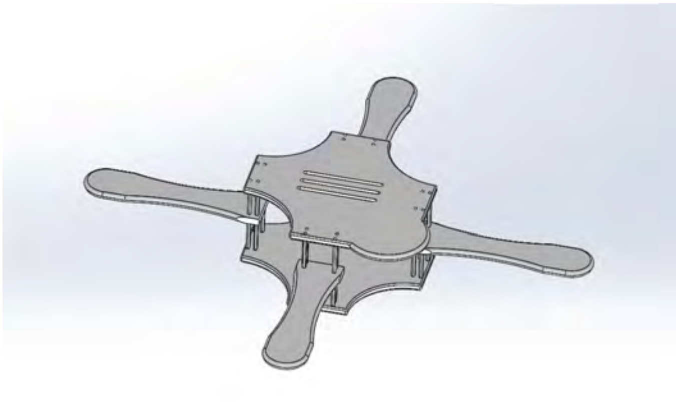
The reference design of the drone was taken from an online website called GrabCad.com. The reference of the design for the drone was taken from the given drone design and we have made certain changes in the design which are discussed below and came up with the current design used in this project.

B. Comparision of the drone deign with existing design

The edges of the given drone design are flat surface which can lead to increase in drag, which inturn can lead to decrese in the performance of the drone. When a flow is moving at a low or high speed, the Drag force is proportional to the velocity for low-speed flow and the squared velocity for high-speed flow, where the distinction between low and high speed is measured by the Reynolds number. Even though the ultimate cause of drag is viscous friction, turbulent drag is independent of viscosity. Due to the flat surface the smooth flow of air won't happen when the drone is in motion. There will be a opposition force due to this flat surface which can also affect the flight time of the drone by decreasing the batttery capapcity.

The edges of the body is filleted and made as curved to reduce the friction due to air flow and in turn reducing the drag force acting on the drone. After making the edges as curved surface it was noticed that the drag was reduced proportionally with the velocity of the drone as this is a low-speed drone.

Instead of Lightweighting and having empty cavity on the body of the drone, the body can be made lightweight by other methods also. As the body of the drone will be manufactured using 3D printing technology, Leightweighting can be done by reducing the infill during the print. Reducing the infill during the print will not affect the structural integrity because of the mesh like internal structure of the printed part due to which the printed part hold it shape even in extreme conditions.



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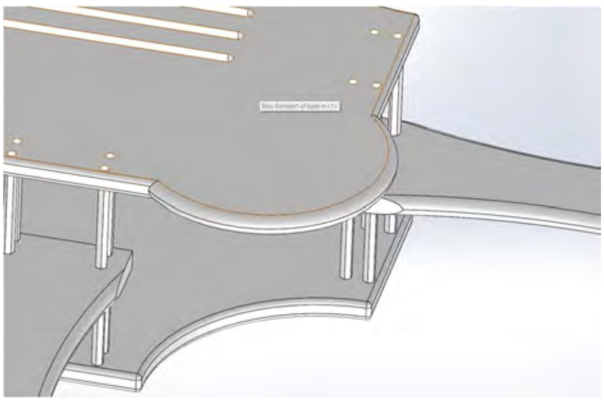
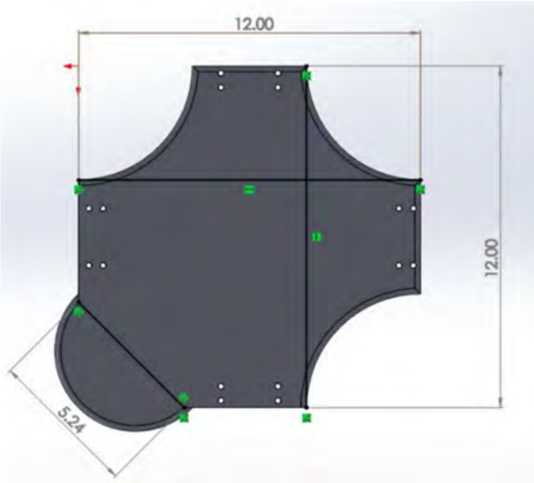


(b)

Fig 2. Design of drone



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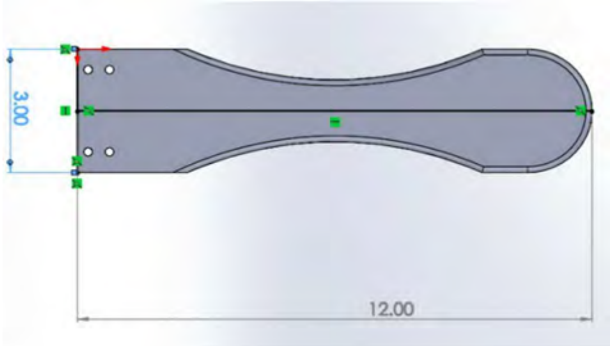


(b)

Fig 3: Dimension of the drone

C. *Working of HOG descriptor*

1. Take the input image you want to calculate HOG features of. Resize the image into an image of 640x480 pixels (640 pixels height and 480 width).

2. The gradient of the image is calculated. The gradient is obtained by combining magnitude and angle from the image. Considering a block of 8x8 pixels, first Gx and Gy is calculated for each pixel. First Gx and Gy is calculated using the formulae below for each pixel value .After calculating Gx and Gy, magnitude and angle of gradient of each pixel is calculated.

3. After obtaining the gradient of each pixel, the gradient matrices (magnitude and angle matrix) are divided into 32x32 cells to form a block. For each block, a 9-point histogram is calculated. A 9-point histogram develops a histogram with 9 bins and each bin has an angle range of 20 degrees. Each of the 9-point histograms can be plotted as histograms with bins showing the intensity of the gradient in that bin. As a block contains 64 different values, for all 64 values of magnitude and gradient the following calculation is performed.

4. After obtaining the centre value of each bin, the values are plotted in a 2D array. The 2D array is then convoluted with the human like 2D array and the result is classified using the SVM classifier as “human” or “no human”.

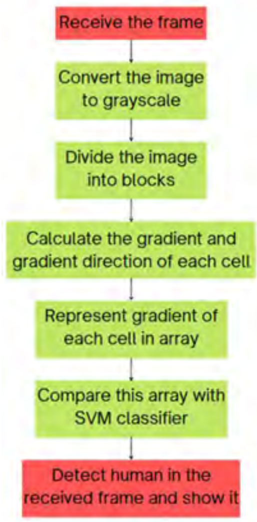
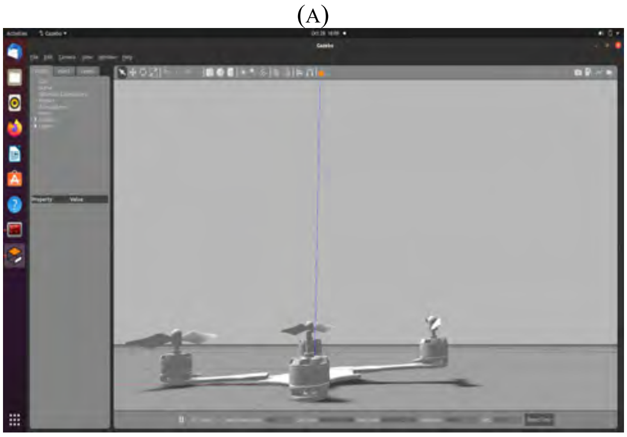


Fig 4: flowchart of HOG descriptor

(A)



(b)

Fig 5 : Unified Robotics Description Format

D. *Calculation of Drag*

Drag Force is the resistance force of a fluid. The force applies acting opposite towards the motion of the object which is moving submerge in a certain fluid. The drag force is defined as the force which resist the motion of a body with fluid.

$$F_D = \frac{1}{2}\rho v^2 C_D A \qquad \ldots \text{eq (1)}$$

Where,

F_D = drag force

ρ= density of fluid

V= speed of drone relative to fluid

A= cross sectional area

C_D= drag coefficient

Density of fluid (kg/m^3 for air) : 1.22

Cross-sectional Area (m^2): 0.0025

Velocity of object (m/s): 8.33

Drag Coefficient (cd): 00.7

By substituting in equation (1)

The drag force is found to be:

Force of Drag (N): 0.0743

E. Hardware components

1) APM 2.8 FLIGHT CONTROLLER

The flight controller is the brain of a drone. There are many flight controllers existing in the current world. But APM 2.8 flight control systems have many sensors available such as gyros, accelerometer, GPS, barometric pressure sensors, and list goes on. The main reason for choosing APM 2.8 is because of its open source firmware and its programming functionalities.APM 2.8 flight controller is the most upgraded version of its kind. There are 2.5 and 2.6 versions too. It comes with a build in compass for the RC drones. APM 2.8 is the ideal one for our project as it comes with built-in compass and external compass via jumper. It's a complete auto pilot system. This has also won the prestigious Outback Challenge UAV Competition. It allows user to turn any fixed, rotary-wing. In addition, it turns multirotor vehicles (even cars and boats) into a fully autonomous vehicle. The APM 2.8 has many interface peripherals and ROS is also one among them. . This is extremely helpful for us since we will need UART telemetry port for APM and MSP430 communication.

2) BRUSHLESS MOTOR

A Brushless DC motor is having one of the most important feature of primary efficiency. Because its rotor is the only thing that bearer of its magnet and it doesn't require any power. It neither has commutator nor brushes. It has permanent magnets attached to it in the rotor part and the armature windings are located on the stator part. It uses electrical commutation to covert the electrical energy into mechanical energy.

3) ELECTRONIC SPEED CONTROLLER

An electronic speed controller is an electronic circuit which is designed to control and regulate the speed of the motor. It can also be used to provide the reversing ability to motor and also the dynamic braking. It controls the speed by referring a signal through any manual inputs and varies the switching rate of a network of field effect transistor. By changing the duty cycles or switching the frequency range of the transistor, the speed of the motor is changed. Brushless ESC systems basically creates a three phase AC power, like a variable frequency drive to run the brushless motors.

4) M8N NEO GPS MODULE

The NEO-M8N GPS Module GY-NEO8 is optimized especially for the cost-sensitive applications, as it provides with the best performance and also makes it easier for RF integration at a very low power consumption levels. The futureproof NEO-M8N module includes an internal flash that will in turn allows the user to install the future firmware updates. This is a easy and simple to use GPS Receiver. IT is the updated version of the hugely popular NEO6M GPS Receiver. Just power it with 5V and it will start sending GPS output in serial interface

5) LITHIUM POLYMER BATTERY

A lithium polymer battery is a rechargeable battery of the lithium ion technology which uses the polymer electrolyte instead of the liquid electrolyte. It has some flexible foil type case, so they are relatively unconstrained. The main advantages of this battery is that it can be of any desired shape. The space and weight requirements of the mobile devices and small computer gadgets can be net easily and also the space consumption and also the overall weight of the product can be reduced in an efficient manner

F. Computational Fluid Dynamics screenshots

The computational fluid flow analysis of the design of the drone was done and the flow simulation results tell about the flow of air around the drone and also the pressure and velocity features. It helps in making the drone stable by analysing the results of the pressure and velocity feature.

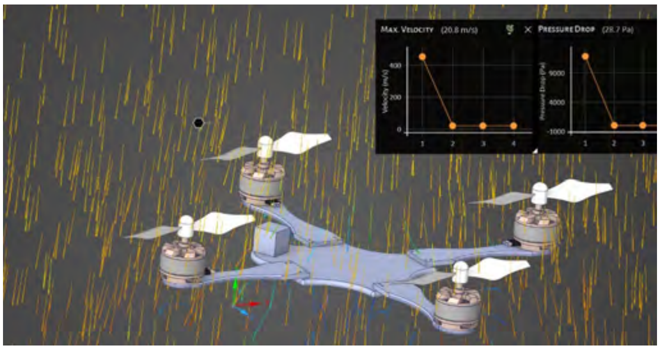


Fig 6 :CFD Ananlysis of velocity and pressure

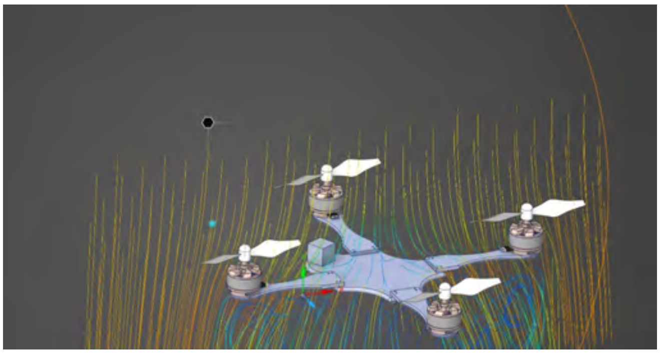


Fig 7 : Air flow around the drone

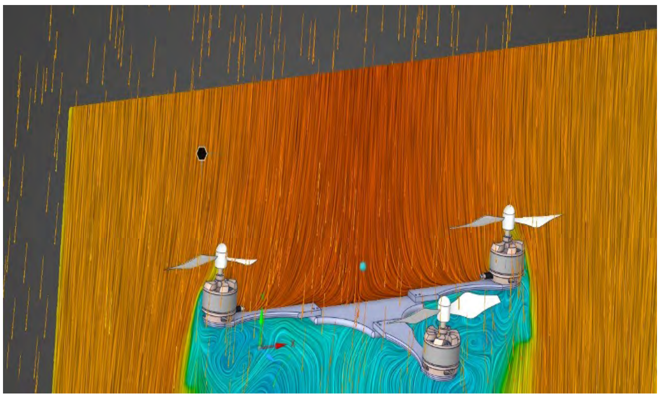


Fig 8 : Flow Simulation

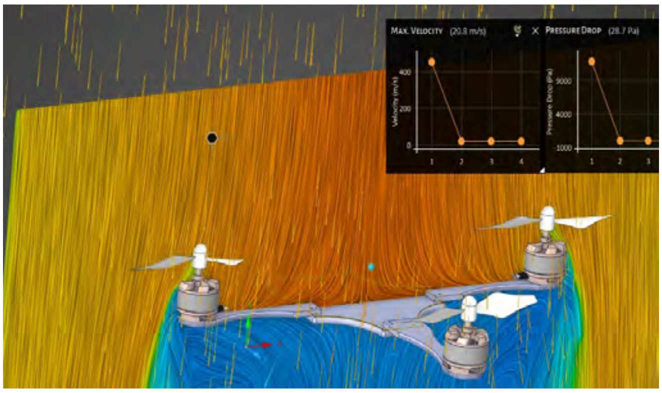


Fig 9 : pressure acting on the drone

TABLE I. PRESSURE RANGE ANALYSIS

S no.	Pressure Range Analysis		
	Pressure	***From range***	***To range***
1.	Very low pressure	-165 pa	*90 pa
2.	Low pressure	-90 pa	0 pa
3.	Normal pressure	0 pa	50 pa
4.	High pressure	50 pa	120 pa
5.	Very high pressure	120 pa	250 pa

TABLE II. VELOCITY RANGE ANALYSIS

S no.	Velocity Range Analysis		
	Pressure	***From range***	***To range***
1.	Very low velocity	0 m/s	4 m/s
2.	Low velocity	4 m/s	7 m/s
3.	Normal velocity	7 m/s	11 m/s
4.	High velocity	11 m/s	16 m/s
5.	Very high velocity	16 m/s	22 m/s

IV. RESULTS & SIMULATION

Drones can be used in a lot of fields to do different kinds of works. The design and development of the drone has helped in the making of a efficiently flying drone which can be put to different uses according to the need of the operator. This particular design can also be used as a multipurpose drone design for different applications.

The simulation results shows that the developed design has easy manoeuvrability. The drone can move around seamlessly through air due to the design which reduces the drag and also the wanted movement of air through the drone surface

V. CONCLUSION & FUTURE WORK

The future work of this project is to make the drone fully autonomous to meet the desired function as per what is needed by the operator of the drone. By making the drone fully autonomous the operator can access the real time date which he wants according to the purpose to which the drone is used for.

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REFERENCES

[1] H. Bendea, P. Boccardo, S. Dequal, F. Giulio Tonolo, D. Marenchino and M. Piras, "Using UAVs as Mobile Sensing Platforms for Disaster Response, Civil Security and Public Safety", 2008

[2] João Manuel and R. S. Tavares, "Image Processing and Analysis: Applications and Trends", 2010

[3] Johannes Meyer, Alexander Sendobry, Stefan Kohlbrecher, Uwe Klingauf, and Oskar von Stry, "Comprehensive Simulation of Quadrotor UAVs using ROS and Gazebo", Proceedings of the Third international conference on Simulation, Modeling, and Programming for Autonomous Robots, 2012

[4] Johannes Meyer, Alexander Sendobry, Stefan Kohlbrecher, Uwe Klingauf and Oskar von Stryk, "Comprehensive Simulation of Quadrotor UAVs using ROS and Gazebo", 2012

[5] Andrew Zulu and Samuel John, "A Review of Control Algorithms for Autonomous Quadrotors", 2014

[6] Agoston Restas, "Drone Applications for Supporting Disaster Management", 2015

[7] M. Kachouane, S. Sahki, M. Lakrouf and N. Ouadah, "HOG based Human Detection", 2018

[8] Hanno Hildmann and Ernö Kovacs, "Using UAVs as Mobile Sensing Platforms for Disaster Response, Civil Security and Public Safety", 2019

[9] Sharifah Mastura Syed Mohd Daud, Mohd Yusmiaidil Putera Mohd Yusof, Chong Chin Heo, Lay See Khoo, Mansharan Kaur Chainchel Singh, Mohd Shah Mahmood and Hapizah Nawawi, "Applications of Drone in Disaster Management: A Scoping Review", 2022

[10] Kashish Chordia, Dhruv Bhagwatkar, Dominique Fernandes, Angad Gill and Aayush Jaju, "Scope of Drone in Disaster Management in India compared to US", 2022

[11] Sankula Likhith Krishna, Guduru Sai Rama Chaitanya, Abbasani Sree Hari Reddy, Arasada Manoj Naidu, S.S. Poorna, and K. Anuraj, "Autonomous Human Detection System Mounted on a Drone