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DESIGN AND MANUFACTURING OF FIRE FIGHTING UAV

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ABSTRACT

We live in a world which is continuously prone to Fire Hazards. Progressive growth of the Fire Fighting ability is the need of the hour. But nowadays it's facing a lot of problems due to non-using modern techniques. The WHO (World Health Organization) estimates there are more than 1.2 lakh people who die every year. Nowadays, there is a rapid surge in cases of small-scale fire catching incidences which if are not controlled on time, may lead to some severe damage. More of these bigger incidences occur where human intervention is not easily possible to suppress those small fires. To overcome this, Designing and manufacturing a firefighting UAV to specifically aid firefighters can be done.

A remote-controlled UAV (Unmanned Aerial Vehicle) is used to drop a fire extinguisher ball to avoid small scale fires. The UAV is operated by manual flight plans and the dropping mechanism is manually triggered by RF Controller. The movement of the drone is controlled by the radio controller and the speed of the drone is also controlled by it. This project describes the development of UAV and the Dropping Mechanism associated with it. This model is used to throw fire extinguishing content to areas that aren't easily accessible by humans. This helps the user in reducing the time taken and also provides safety to the affected. This drone system mainly works on the principle of thrust. This project mainly concentrates on designing a low weight structure for the drone that drops Fire Extinguishing Ball on consecutive fire.

Keywords: Unmanned Aerial Vehicle (UAV), Remote Sensing, Thrust, Propeller, Radio Controller.

I. INTRODUCTION

Drone technology has evolved into a huge invention that constitutes aid in various areas. One of them is the fire brigade. In this area, drones can be used for many benefits, including. Intelligent detection of trapped organisms, inaccessible supply, fire extinguisher with a simple ball throwing mechanism with only one servo operation Fire extinguishing with a ball. In this new era, this precise technology can be used to increase the productivity and safety of firefighters. With these aspects in mind, drones are automated and developed as needed. This project aims to overcome problems related to the weight of the frame and its compatibility with the equipment used in the system. Originally used in surveillance operations, UAVs have led people to develop systems for use in a variety of applications. Our project combines a drone with a hexa-copter and dropping mechanism. A drone contains various components such as frame, switchboard, motors, propellers, flight controller board, batteries, transmitters and receivers. These are the main components that help drones function and maneuver according to our needs. By changing the assembly equipment and adding a few additional components suitable for use, you can ultimately improve the performance of your drone.

II. METHODOLOGY

In general, drones can fly almost anywhere. Above tall buildings, mountains and forests. Installing additional systems on the UAV can make the UAV a separate application. The UAV is the first major element of this project. In the UAV design process, we went through many stages as shown. From concept design to safety, soldering and flight training, testing and final design reports. The UAV body is the first basic element of a UAV. It serves as the skeleton of the human body and is most susceptible to mechanical stress. It supports all other elements of the UAV such as motors, propellers, ESCs, flight controller systems and batteries. A hexa-copter hull is selected from among several types of UAV hulls such as tri-copters, hexa-copters, hexa-copters with fire pits, and octocopters. Hexa-copters are the most commonly used UAV bodies because they have a fairly simple design. It consists of four rotors fixed to the ends of a frame structure. One pair of rotors rotates clockwise and the other pair rotates counterclockwise. Each rotor is associated with a propeller that generates thrust. According to this big picture, our frame is designed on the Solid-works platform. Depending on the required aircraft quality, the UAV body can be made of materials such as plastic, wood, metal, carbon fiber and metal alloy of these Material, we decided to make the frame out of aluminium and wood. Hexa-copter frames are susceptible to external loads and tend to be unstable. To increase the stability of the hexa-copter, it can be fed under each inclined plastic support made by 3D printing motor. These supports tilt the plane of rotation of each rotor inward, increasing the hexa-copter's internal stability while hovering. A small dihedral angle (6°) is used. Therefore, the reduction in energy efficiency of UAVs is negligible.

III. MODELING AND ANALYSIS

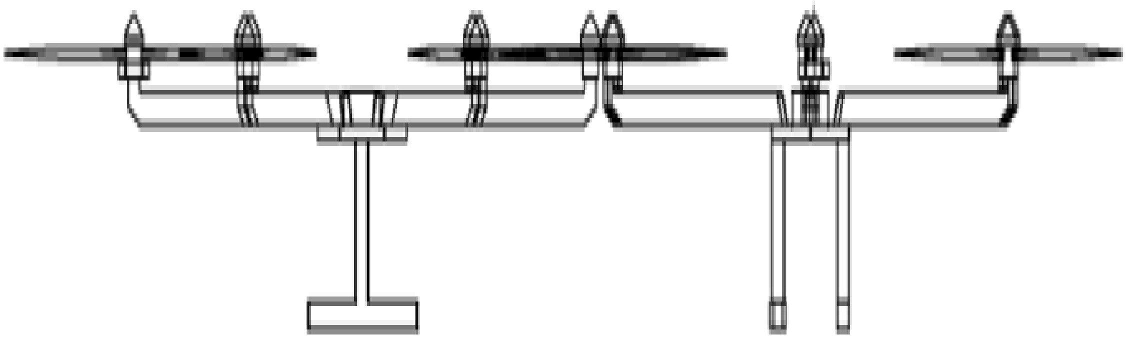

Figure 1: Modelling of Hexa-copter(side view)

Figure 2: Frame

i) Cylindrical Mechanism with stopper arm: - This mechanism will hold the fire extinguishing ball inside it with the help of stopper arm and will be attached to UAV to carry the ball at required place.

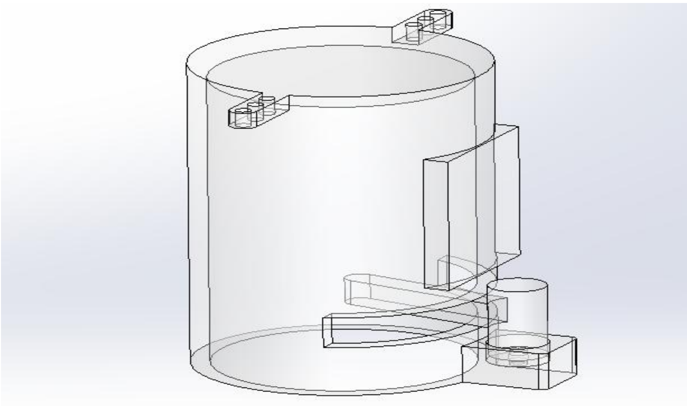

Figure 3: Proposed dropping mechanism

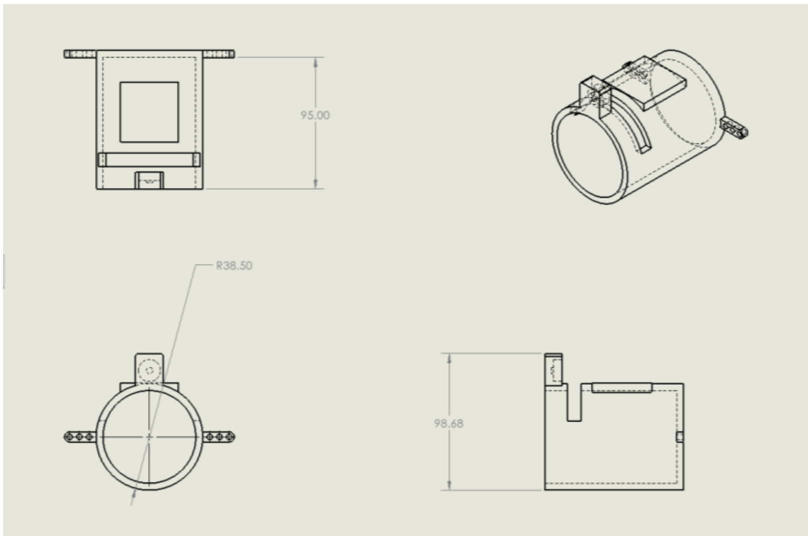

Figure 4: Drawing of Dropping mechanism

ANALYSIS:

When it comes to static distributed loads and dynamics impacts in the uav, force analysis is a key element to consider. These forces will be thoroughly examined by the team. This will allow for a more efficient design of the releasing mechanism. It's worth noting that the tensions are created by the grenade's weight and the release mechanism's loading. The release mechanism and the quad copter frame will be subjected to these stresses. Because the grenade will be rolling throughout the deployment rail till the end at the time of discharge, the dispersed load will be varied.

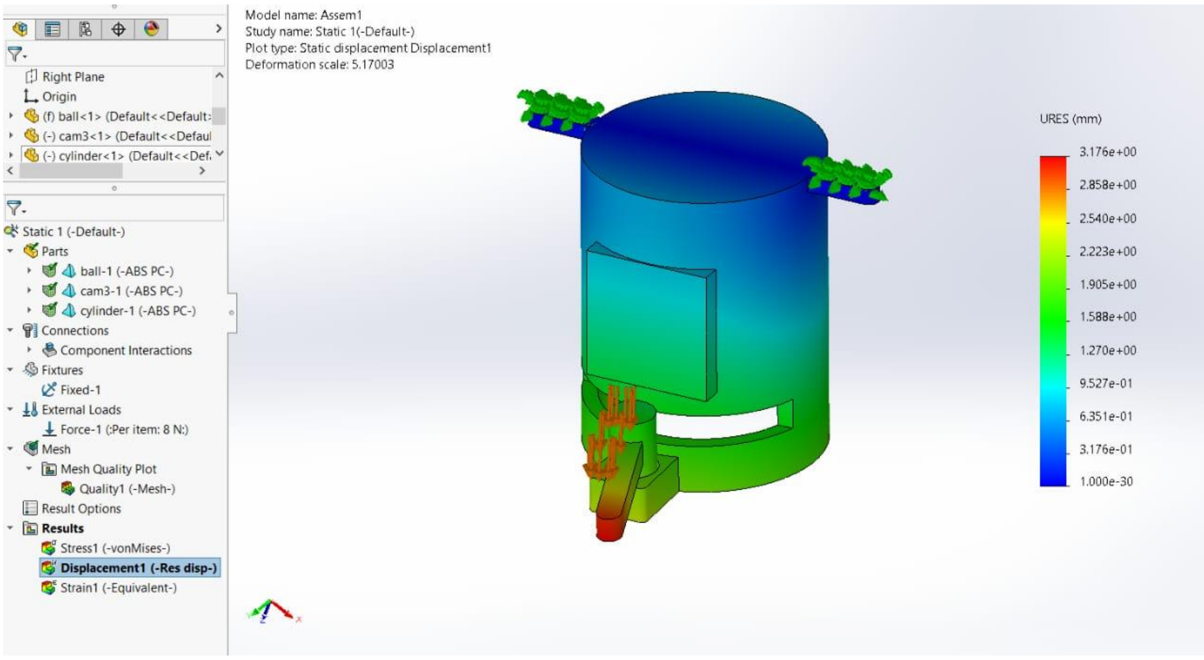

Figure 5: Analysis of Mechanism

IV. RESULTS AND DISCUSSION

After selection of suitable material (Aluminium for UAV arms and wooden plate for carrying battery and controller), we purchased the required components from market and started its assembly. Arms are connected to plate by screws.

Materials Used: Frame-Aluminium square pipes and wooden plates, Dropping mechanism- ABS plastic.

Components used: BLDC 5010 360KV motors, ESCs, Battery 8000mah , Transmitter and receiver, flight controller (Pixhawk) , propellers 1655.

Obtaining total weight of this design: 5174gm.

Considering thrust to weight ratio = 2:1

Required Thrust = Total Weight * 2

= 5174* 2

= 10348 gm

Thrust per motor = 10348/6 = 1724.66g = 1725 gm (approximately).

Selection of Propeller for required Thrust: -

Gabriel staples equation,

$$F = 0.0\,0\,0\,0\,0\,0\,04392399 * RPM\,(d^{3.5}/\,p^{0.5}) * \{(0.000423333 * RPM * p) - V_o\} \qquad ......\ 1)$$

Where,

F = thrust produced in newton

d = diameter of propeller (in inches)

p = pitch of propeller (in inches)

RPM = rotation per minute of propeller

V_o = forward flight speed

As, we have taken a 5010 360 kvmotor, we can assume that it will provide the 5000-rpm speed to propeller at 60-70 % throttle (this data can be verified by the thrust table provided As, from drone weight calculations we need the thrust of 1.725 kg per motor.

Consider the pitch of propeller be 5.5 inch (propellers of 5, 5.5 are widely available and also not bulky). Also decreasing the pitch will increase the diameter of propeller to reach the required thrust.

Therefore,

F = 1.725 kg = 1.725 N

RPM = 5000

P = 5.5 inch

V_o= 0 (as forward speed of air in this case will be 0, because we are calculating the static thrust)

Therefore, putting the all values in equation 1 we can get,

1.725 = 0.00000004392399 * 5000* ($d^{3.5}$/ $(5.5)^{0.5}$) * {(0.000423333 * 4750 * (5.5)) - 0}

d = 16.3261 (approx.)

So, we need a propeller with 16-inchdiameter and the specifications of propeller will be '1655', where 16 is its diameter in inches and 5.5 will be the pitch in inches.

Flight Time Calculations: -

The expected flight time is determined by a simple formula:

$$t_{flight} = \frac{\frac{Q}{1000}}{I_{flying\ load}} \cdot 60$$

Where,

t_{flight} is the flight time of your drone in minutes;

Q is the LiPo battery capacity in mAh;

$I_{flying\ load}$ is the current drawn from the battery by the copter motors and other equipment assuming the selected flying load, which is based on the type of flying (for example, taking video or racing) and the weight of the multicopter.

The maximum current drawn from the battery at full flying load $I_{flying\ load}$ is determined as

$I_{flying\ load} = I_{servo\ motor} + I_{bldc\ motors} \times N_{bldcmotors}$

As, from thrust table of motor we can know that motor is drawing the current of 17 A at full throttle. Also, the servo motor will be drawing the current of 2 A while functioning.

Therefore,

$I_{flying\ load} = I_{servo\ motor} + I_{bldc\ motors} \times N_{bldc\ motors}$

$I_{flying\ load}$ =2 + 17*6

$I_{flying\ load}$ = 102 A

We have selected 8000mah 6s lipo battery

Therefore Q = 8000

Now we can calculate the flight time using above parameters,

$$t_{flight} = \frac{\frac{Q}{1000}}{I_{flying\ load}} \cdot 60$$

t_{flight} = [(8000/1000)/102] *60

t_{flight} = 4.70 minutes (approx.).

V. CONCLUSION

Fires have always been a catastrophic phenomenon, but as technology advances, fires are becoming easier. Work on it. This paper describes such a solution to the problem of fire extinguishing with the help of drone technology. And the corresponding fire extinguishing system. It shows and demonstrates the process of building a drone. You can put out a small fire. In conclusion, there are many ways to put out the fire, it is always safer to use constantly evolving drone technology to reduce the use of firefighters Reduces the risk of personal injury and death. Comparison of this prototype with the existing technology of the fire brigade. Surveillance drones prove the efficiency of this project. One of the advantages of drones is the payload is dynamic. You can equip multiple loads depending on your requirements. With the right one this prototype can be further developed by equipping it with thermal imaging and GPS modules. Detects fires and allows them to move through the flames, fully automating operations, no human controller is needed. It can be further developed by integrating multiple drones with one machine. Fly ad hoc networks and create a drone network. In other words, a swarm of drones to extinguish large building fires and forest fires. Linking provides intelligent services and self-sufficient systems for better coverage over wireless channels B. Fire monitoring and extinguishing. Another possible development is the use of high-quality fire extinguishing fuel. Drones can be equipped with fire bombs. Fire, it withstands better than most of the existing technology used in firefighting. The use of such balls will also help reduce Pressure on the drone.

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