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Design and Analysis of Remotely Amphibious Drone

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Abstract: ***The amphibious drone is the drone that is capable to travel in both air and water. In order to move through water, buoyancy force needs to be balanced and it challenges the structural integrity, it must have a better communication system with more penetration and less attenuation of the signal. To overcome that challenge the radio signal and Acoustic communication are widely used in the amphibious drone. In underwater, we have difficulty to get a clear view of positioning, for that there will be a mini system installed on the drone that will automatically calculate and sets their tracks to find the position, depth and time of the system. To achieve better communication an extra ground station will be installed. For controlling the motions of the drone in an effective manner the microcontroller is used as a flight controller for transmitting and resaving the user data. the aluminum alloy is used in the amphibious drone to avoid structural damage. Based on the above consideration the amphibious drone has been developed and measuring their efficiency in both air and water, after experimentation this amphibious drone may be used for coastal rescue, surveillance, oceanographic research etc. The entire design and development of amphibious drone are in progress and testing to be done in the future.***

Keywords: **Amphibious drone; design; microcontroller.**

I. INTRODUCTION

In this modern era, technologies are advancing from day to day basis. The availability and usage of the unmanned aerial can be seen worldwide. Many developed countries are and already started to utilize their drones for various purposes like surveying, monitoring and home delivery etc. drones are very handy in many situations and lots of experts are already in the fields of upgrading their performance and functions, one of the common drone existing today are unmanned underwater vehicles. This the drone that can operate underwater as well as air by human, a drone with this capability can relate various fields and carry out dangerous mission, UUVs are classified into two remotely operated vehicle (ROVs) autonomous underwater vehicle(AUVs),the difference between these two are ROV works in an operator command and AUV operates on independently, the ROV is widely used for underwater research and seabed cleaning[1-3].

The promising technology in this field was introduced by a Dutch engineer by developing an ambulance drone [4] with webcam and loudspeaker to aware doctors. In the marine field, oceanographic observation has been limited due to technology and the cost of operating ships. The surveying tends to be in a short period, and it is not long enough to resolve the problems [5-7].

The researchers try to come up with combining the aquatic and aerial medium. Therefore, remotely amphibious vehicle (RAV) starts used to indicate drone that able to guide and operate on both mediums. in order to travel the in both mediums quite challenges need to face by engineers during design stage, engineers need to solve those limitations such as design of the body waterproof ability, thrust required to move in both medium and controller capability. However, experts manage to eliminate and overcome the limitation one by one, the product will available in the market. But this very recent not much prototype cannot be seen nor any practical application yet [8].

This RAV can be deployed in marine areas for any aircraft crash occurs and also provide situational awareness to police and coastal guards, the technical challenge of the RAV includes high thrust to weight ratio necessary for the propulsion system. An endurance long enough to perform the operation is also important. The batteries and electronic components are needed to be treating with caution, this will have to be sized to carry necessary payload [9].

II. METHODOLOGY

Based on the literature study, an amphibious drone has to consider both air and water medium. In order to perform under this medium, the electrical components need to properly scaled and work under this medium, by utilizing the thrusters the drone will able to ascent and descent, the level of ascending and descending is controlled by changing the rotation speed of the thruster[10-14] in this case motor paring aerial, the working concept of the motor is same as the normal quadcopter, but in aquatic the high density of the water need more thrust, so motor has to produce more thrush then the air, thus we proper manageability is possible[15].

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By changing the motor speed, the drone can perform yaw, roll, and pitch operation, the lit and torque produced by this motor can be adjusted to get a better experience [16].

Based on literature the design prototype needs to be in low volume so that transition between medium will be easier, in order to study the outcome, several simulations will be carried out for both aerial and aquatic medium the ability to withstand the water pressure is also simulated. To take the control of motor speed the KK 2.1.5 microcontroller is used because of wide availability and the coat is quite low, the KK2.1.5 microcontroller can adjust the PID function inside the computer and the PID values depend upon the motor characteristics [17].

The propeller is a fan that transmits power by converting rotational motion of the motor into thrust, a pressure difference is produced between rare and forward surface of the blade, it is like an airfoil shape that produces lift.

The communication part is quite challenging and complicated for comparing freshwater and seawater, for the freshwater 0.04 s/m is the conductivity and 400 s/m for seawater, which is 100 times greater than the freshwater, the signal will be reflected during seawater propagation. Here the normal quadcopter transmission can also be used for an amphibious drone for the larger distance an extra floating body can be used for modulation and demodulation. [6, 18].

During the development of a prototype, software plays a vital role; design a body frame is easy for a normal drone. But design a body frame that can easily transition between both mediums is difficult and challenging, by using computer-aided drawing software Autodesk fusion 360 and CATIA.

This software makes quickly sketched out the ideas for designers and also provides a detailed drawing. Generally, the Autodesk fusion 360 and CATIA provide an easy operation to create models and assembly, the drafting of the prototype is done of Autodesk fusion 360 and assembly on CATIA software. It is a very challenging practice that the prototype needs to satisfy the requirement in both medium [9]. This draft is comprised of many other parts such as base platform, arms, top cover and propellers every part of the drone is sketched by part by part, after getting all parts assembly feature is used to assemble and combine the parts.

III. DESIGN PROCESS AND RESULTS

A. Total Weight Estimation

Approximate payload 500 g
Approximate weight of 1 Kg
Approximate electronic component weight 900 g
Total weight of 2.4 Kg

B. Selection of Electronic Components

The estimated total weight of the drone was around 2.4 Kg keeping the factor of safety as 1.75. the total thrust required to the drone is 4.8 kg, and the thrust should be provided by each motor.

C. Motor

The amphibious drone required a much powerful battery compared to the normal one,
4(motor)*18A= 72 A
For 3000mAh 40C
3Ah * 40C = 120 A which is greater than 72 A, hence battery is sufficient.

D. Flight Control Board

The KK 2.1.5 microcontroller has an incredibly sensitive MPU 6050 system, making the drone a more stable and auto-level function it contains an Atmel Mega 64PA 8 bit AVR RISC-based microcontroller with the memory of 64k [17].

E. Modeling of Frame and Casing

A computer-based system is used for analyzing creating and modifying the drone, the detailed design process was done in Autodesk Fusion 360.

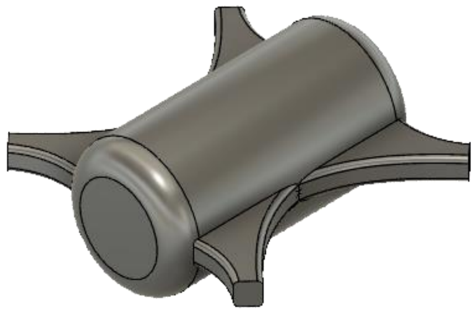

Figure 1 Design of the UAV casing

Based on Figure 1 design is done by AutoCAD fusion 360 software. The design consists of blended shape in forward and backward which makes easier to transition in both medium and also provides space for electronics components and payload. This casing is only for electronic components except for brushless dc motor which is waterproof. The design has two parts top and bottom and connected with screws and silicone water sealant.

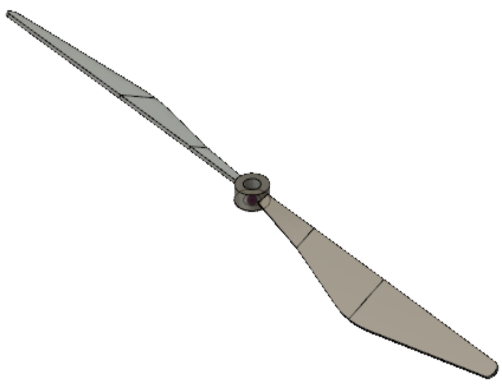

Figure 2 Design of the propeller

From Figure 2 the propeller parameters are taken from an existing amphibious drone. The design contains a small tip and the chord is increased in the middle section and a small root.

Thus, it can push air and water when needed and also able to produce thrust.

From Figures 3 and 4 the stress analysis is simulated by using CATIA software, in both analyses, the pressure is withstanding when 500N of force is applied on the frame for better results. The maximum stress that can withstand is 13.8KPa. From these results, pressure withstands when the transition between medium occurs.

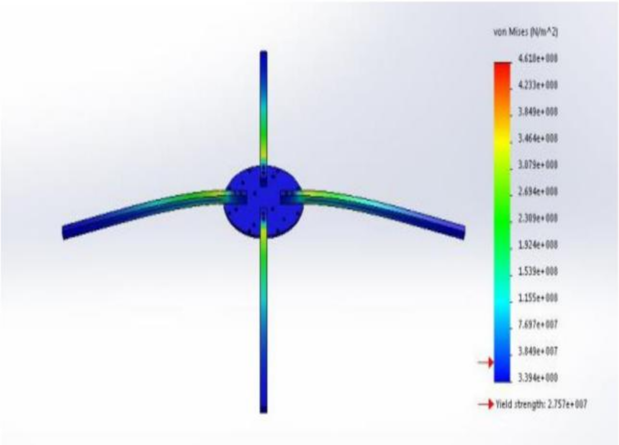

Figure 3 Stress analyses in aluminum alloy

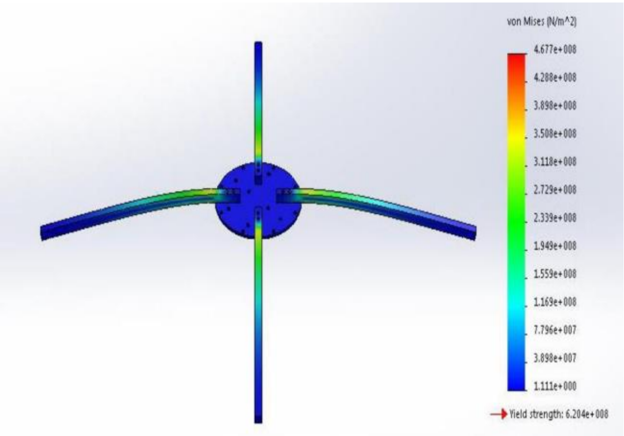

Figure 4 Stress analysis in steel alloy

From Figures 5 and 6 gives the displacement analysis, during the analysis 500N force is applied. Aluminum shows 18.66mm and steel shows 6.15mm.both values are expected and fulfilled the objective for the selection process. In this analysis, steel provides a better result by giving low displacement. While the transition between the medium occurs, the density changes drastically and thereby frame should not break down.

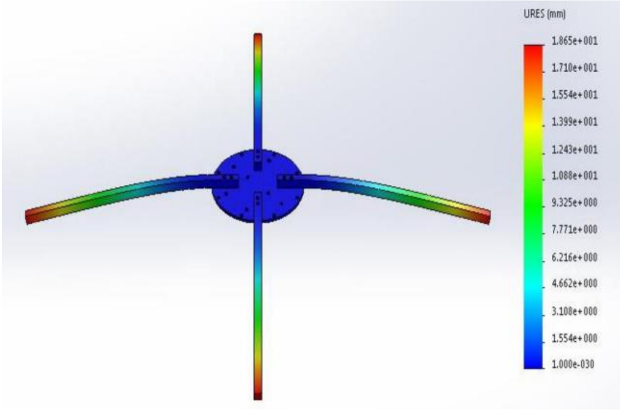

Figure 5 Displacement test in aluminum alloy

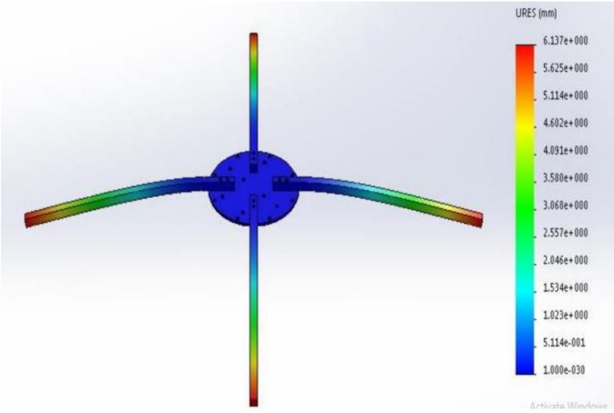

Figure 6 Displacement test inn steel alloy

IV. CONCLUSION

As a conclusion, the high density with low volume body will help to reduce the time for transition in mediums, the buoyancy force is low in the low volume high-density body, and thus the drone model is aimed designed to minimize total volume, to increase the speed movement of the vehicle in both medium. The mechanism and drone design are taken into account. To attain better maneuverability, the drag that is the resistance faced by the drone has to be minimized, large surface area leads to more drag that will affect the total speed and consume more power, for that the blended cylindrical body is designed, besides, the quadcopter concept is also implemented, which give low resistance, high-pressure operation and compact. At this stage design concept and planning of the prototype are done. To testify this some simulation, virtual teat and real-time tests have to be done. By the help of computer-aided technology, stress test and deflection of the frame is carried out. The results from that give a satisfying outcome.

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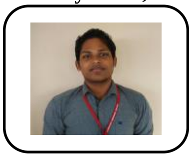

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