International Journal of Current Advanced Research
ISSN: O: 2319-6475, ISSN: P: 2319-6505, Impact Factor: 6.614
Available Online at www.journalijcar.org
Volume 10; Issue 01 (A); January 2021; Page No.23569-23574
DOI: http://dx.doi.org/10.24327/ijcar.2021.23574.4670

Research Article

DEVISE, MODELLING AND PRODUCTION OF A QUADCOPTER FOR AGRICULTURAL USAGE

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A R T I C L E I N F O

Article History:
Received 12th October, 2020
Received in revised form 23rd November, 2020
Accepted 7th December, 2020
Published online 28th January, 2021

Key words:
Unmanned Aerial Vehicle

A B S T R A C T

A quadcopter is a Unmanned Aerial Vehicle (UAV) that has four rotors/propellers and these are employed to raise and push the vehicle. The fame of quadcopters is rising as the sensors and control schemes are fetching more move forwards and less pricey.Drones are able to be employed in agriculture industry to transform agricultural exercises. Learning the whole plan process of a quadcopter allows one to devise its individual drone, not presently a quadcopter, and constructing best suited to its purpose. This opens up the span for new findings and advancements. For the over stated cause it is significant to study the aim of a quadcopter initial from the physics behind its procedure, the control systems, the electronic components concerned and their procedures and purposes, the micro-controller and its code. This plan is purposeful on the mean of the quadcopter chassis, preparing the active model and equations of motion and has a report about assortment of the mechanisms and how the reviewing of farms is accomplished. The flight of the quadcopter is mechanized with stipulated path to envelop a convinced region of a farm. A camera is ascending along with the quadcopter which is concurrent with on-station devices like laptop/mobile and the video is transferred in real time.

INTRODUCTION

A quadcopter has been demonstrated to be the generally adaptable and mechanically-easy-to create independent aerial vehicle. This is since a quadcopter is reasonably simple to construct and organize as the association of the quadcopter in all the 6 degrees of freedom can be effortlessly controlled just by altering the speeds of the four rotors and no mechanical associations are requisite to modify the rotor blade angles like in the case of a helicopter. The research and asset in these aerial vehicles by the different countries R&D has helped in the growth of more sophisticated and resourceful technologies. The smallness preferred the construction of mini UAV or micro UAV (MAV); weighing less than a kilogram. This has motivated creation of innovative vehicles in the private sector and in universities. Rural automation in agriculture industry has been getting better over the most recent years, and the compensation of drones in agribusiness is attainment ever more understand able to farmers. Drone automation purposes in agriculture run from reviewing and mapping to spraying and crop dusting. By all explanations, farming drones that assist in the automation of farming deeds are nothing diverse from the usual drones.

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The employment of the UAV basically changes to fit the desires of the farmer. There are, nevertheless, a not many drones clearly made for horticultural exercise.

In order to achieve the above this project aims to designfabricate a quadcopter for agricultural usage, the quadcopter has to be ascended with a camera to execute surveying of farms. To learn the physics involved in the working of a quadcopter and adopt this knowledge in obtaining the dynamic model of the quadcopter and formulate the governing equations. To designing the quadcopter such a means that a constant flight is attained so that the video recording is clear and referring the choosing of appropriate electronic components. Also preferring of the path in which the quadcopter has to fly and a suitable fabricating means and fabricate it with slightest probable mistakes.

METHODOLGOY

Quadcopter Components

Motors and Propellers

Drones use two types of motors brushed and brushless motors. Brushless is way powerful compared to brushed since they last longer. They are also more efficient(85-90%) compared to brushed DC motor which is 75-80%. So for our project we chose brushless DC motor. Performance factors like kV defines how fast the motor axle rotates for a given voltage given to the motor. Propellers are the lift generating components of a drone. The main factors in choosing the propeller are its pitch and size (diameter).

ESC (Electronic Speed Controller)

ESCs are chosen on basis of the current draw rate of the motors. It is important to note that ESCs must never be loaded with motors that draw more than the current rating of the ESCs.

Battery

Drone battery is the power source of any quadcopter and must be chosen considerably to accomplish an ideal balance between performance and flight time.

Flight Controller

Flight controller is the heart of a quadcopter and controls most onboard electrical components. It is shared by an arduino-like microprocessor and consists of array of sensors.

Cameras

The FPV camera is mounted onto a drone to send real time video down to the ground using a video transmitter. The FPV camera allows you to see where the drone is flying.

Power Distribution Board

Power Distribution Board (PDB) is a printed circuit board that is used to distribute the power from your flight battery to all different components of the multirotor.

GPS

A GPS antenna allows for a quadcopter identifying its rough position, height and ground speed. GPS data can also be displayed on an on-screen display (OSD).

Telemetry

Telemetry is used to find flight information of the drone on the computer or the radio control in order to follow several parameters of the quadcopter on the ground.

Components Used

- Avionic Pro c2826 1000Kv (4 Nos)
- Wolf pack white 20A ESC (4 Nos)
- Wolf pack white 5200mAh 35C/45C battery (1 Nos)
- 8038 standard propellers (4 Nos, 2CW, 2CCW)
- Flight Controller APM
- Camera
- Power distribution board
- GPS
- Telemetry

Design of the Quadcopter Arms

The Chassis has to be designed by taking into account of the specifications of the components. By conventional design technique consider the symmetry in the chassis, one of the arms is considered for designing. This means to say that the various forces to be acting on one of the arms of the quadcopter similar to a cantilever beam under load. These loads include the

- Lift force of each motor based on the voltage, current drawn and blades (Calculated on the Thrust Bench results)
- Self-weight of the chassis
- Weight of each component
- Payload being designed.

For choosing the arm of the quadcopter we considered different sections they are

1. Hollow- cylindrical section
2. Hollow- rectangular section
3. T –section
4. I-section

Based on the calculations performed we choose the right section for the arm of quadcopter section.
Material of the arm: ABS
Ultimate tensile strength: 40Mpa
Weight density: 1.01g/cc

CAD Model of the Quadcopter Chassis

13D Model

A 3D model of the quadcopter (Figs.1-3) is generated using Fusion 360 modelling software. The dimensions of the quadcopter are chosen as follows:

- Arm length: Arm length is chosen on the basis of propeller radius with some extra length as the clearance to avoid any chance of collision with the center body or other propellers.
- Arm sectional dimensions: Arm sectional dimensions are chosen on the basis of motor mounting dimensions and the ESC dimensions (as the ESC will be placed inside the hollow arm in our project).
- Arm thickness: For additive manufacturing requirements, the minimum wall thickness is 1.75 mm, for our project anything above this thickness is good enough.
- Our fabrication process won't have 100% infill; the infill is around 40-70% hence for safety factors we chose a higher value of thickness of 2.5mm.
- Center body dimensions: Center body dimensions are chosen in such a way that all the planned components can fit in with ease.

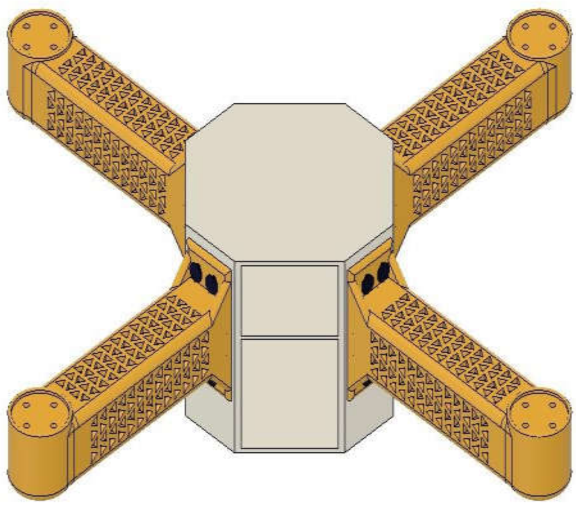

Figure 1 3D model of the chassis assembly

Figure 2 CAD model of a completely assembled quadcopter

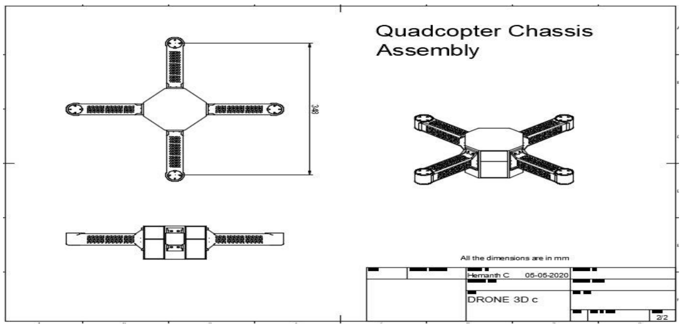

Figure 3 Quadcopter assembly 2D drawings

Material Selection for Quad copter Chassis

Since we are additive mechanized of quadcopter chassis mainly employed materials are PLA, ABS and nylon (Table.1).

PLA (Polylactic acid): PLA is one of the most commonly used materials in 3D printing and can be printed at a low temperature. It is the first material for learning purpose, inexpensive, easy to print, good strength, stiffness and have good dimensional accuracy.

ABS (Acrylonitrile Butadiene Styrene): ABS is inexpensive material, can print tough and durable parts and is heat resistance material. It is the industry's first material used for 3-D printing since of its good quality mechanical possessions like toughness and impact resistance that can hold upto extra practice and wear. It makes a great choice for outdoor employ and high temperature purposes.

Nylon: Nylon is a material which is semi-flexible that endures high impact resistance. It is a popular material for its toughness and flexibility. Nylon filament requires printing temperature as low as 220 ºC.

Table 1 Mechanical properties of ABS, PLA and Nylon

Materials/properties	Impact strength (KJ/m^2)	Density (g/cc)	Cost/gram (Rs)	Tensile strength (MPa)
ABS	20	1.04	15/gm	40
PLA	16	1.24	13.5/gm	65
Nylon	60-85	1.14	25/gm	40 – 85

By comparing the above values from the table following observation is made that ABS plastic has the least weight density, this means that by using this material we get the least weight of quadcopter chassis. Even though PLA has the least cost/gm when compared to ABS, the overall cost per cubic cm is least for ABS plastic.

Calculating for 1cc of material,

ABS

Cost = Rs15/gm, density=1.01g/cc
Therefore total cost for 1cc = 15/gm*1.01g/cc
= 15.15 rupees

PLA

Cost = Rs13.5/gm, density = 1.24g/cc
Therefore total cost for 1cc = 13.5/gm*1.24g/cc
= 16.7 rupees

Therefore cost of ABS plastic is less compared to PLA. ABS plastic can withstand more impact when compared to PLA. Even though tensile strength of ABS is least compared to the rest, it is good enough for our purpose. Based on the above reasons we can say that ABS plastic is more suitable compared to other two materials. Hence, we choose ABS plastic as material for our quadcopter chassis.

RESULTS

The load cases measured for static examination are same as that occupied for the theoretical calculations. The end of the arm that is associated to the center body is set, which means all the degrees of autonomy are controlled. Utmost motor force of about 12.75 N is applied at the free end of the arm where motors are positioned. The stress (Von Mises) distribution is revealed in Fig.1.The eventual tensile potency of ABS plastic is 40MPa and the maximum stress persuades in the quadcopter arm is 1.6MPa. This evaluation is way lesser than the ultimate potency, consequently the design is safe. The deformation plot is shown in Fig.2. The examination we conceded out was taking into consideration the linear performance of ABS plastic. This is since ABS plastic illustrates linear performance at low strain principles (Fig.3). The maximum strain value in our analysis is 0.0007. At this strain value the ABS plastic behaves linearly, hence a linear analysis is good enough (Fig.4).

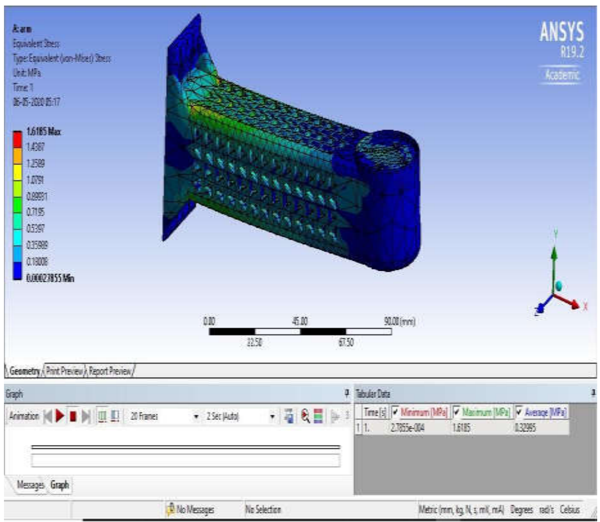

Figure 4 Von Mises stress distribution plot

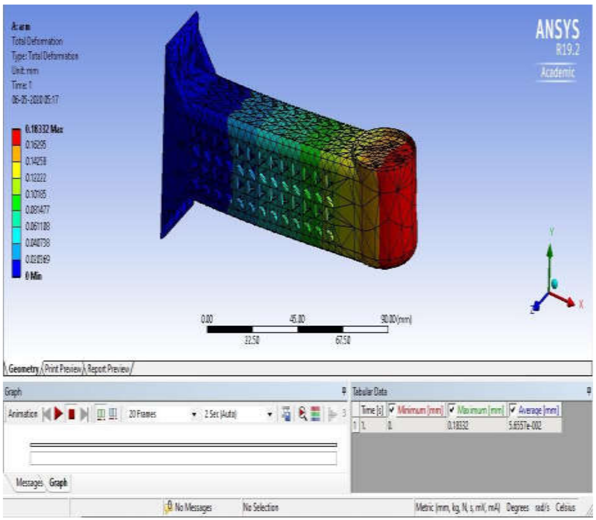

Figure 5 Deformation plot

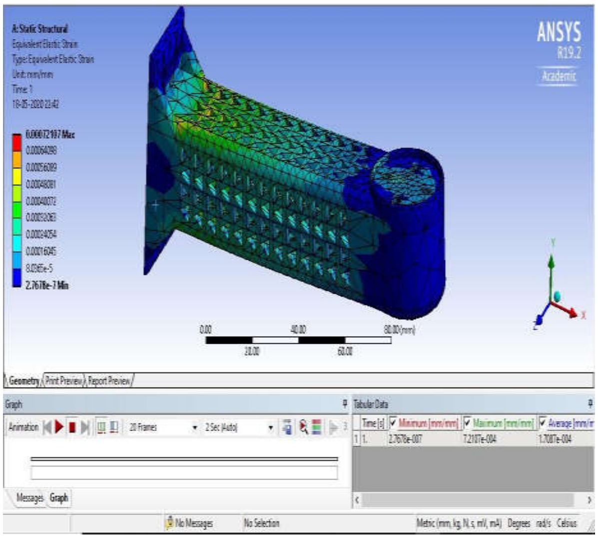

Figure 6 Equivalent Elastic Strain

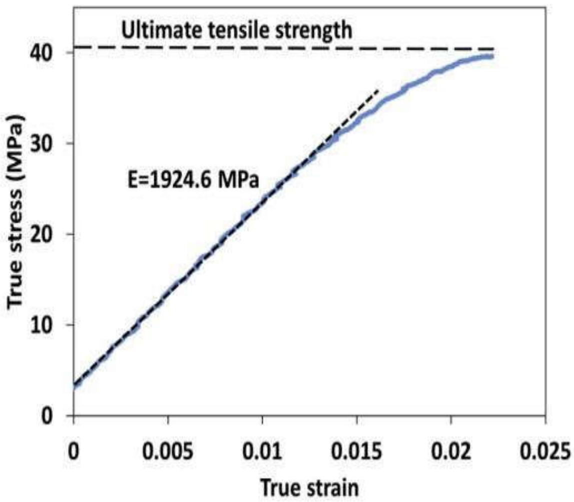

Figure 7 Typical tensile stress strain curve of ABS filament

Additive manufacturing procedure is the newest development in industrialized. It is totally diverse from the conservative means of mechanized. Conservative developed practices engross material exclusion from a raw material to acquire the requisite shape and size. Although additive mechanized, as the name recommends, employs additive skill to form any required shape. Additive skill is nothing but adding material, by fusing it concurrently, to eventually form the needed model. Additive developed has much compensation over conservative means. Any composite shape can be fashioned effortlessly by this system, which otherwise would be very tricky or even unfeasible to form by means of conservative means. With additive developed it is at this time likely to fabricate the plans that are very light and employs fewer materials than the conservative plans with generative design methods. The aerospace industry employs this mechanized practice to construct intricate structures of light weight. Though, lot of work and research is still essential to make use of additive developed in almost all industries as there is a restriction for the materials that can be used. As of now not all materials can be used for additive mechanized and there is also required for upgrading in the accurateness and eradicating the need of a concluding method.

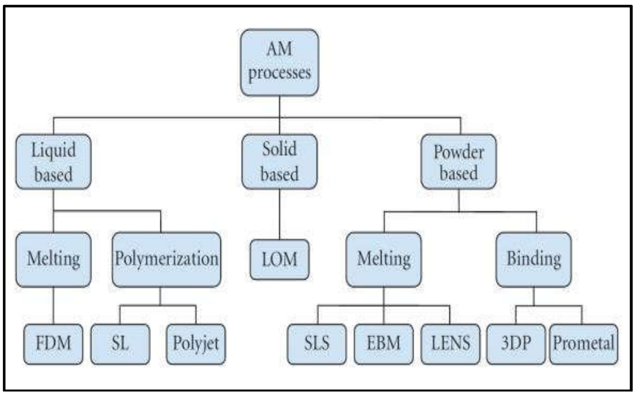

Figure 8 Classification of Additive Manufacturing process

Fused Deposition Modelling (FDM), or Fused Filament Fabrication (FFF), belongs to the material extrusion family and is an additive developed method. In FDM, the body is collected in a programmed path layer-by-layer by predominantly latent the melted fabric. They come in a filament form and materials used are thermoplastic polymers. In FDM 3D printing process an extrusion nozzle movements over a created platform purposes both horizontally and vertically. To produce a 3D object layer by layer the procedure needs the convention of thermoplastic material and is melted when it attains melting point and is then forced out. Each layer as a horizontal cross section is seen when design takes place. Following the final of one layer, the build platform is lowered in order for the next layer of plastic to be added to the devise. When the item has been made, the materials that are employed to assist the item build shall be exiled.

The printer (Fig.6) is encumbered with a coil of thermoplastic filament. Once the nozzle has arrived the obligatory temperature, the filament is fed to the extrusion head and in the nozzle where it melts. The extrusion head is fixed to a 3-axis system that permits it to travel in the X, Y and Z instructions. The melted material is extruded in thin strands and is deposited layerby-layer in prearranged locations, where it cools and solidifies. Sometimes the cooling of the material is hastened through the employ of cooling fans attached on the extrusion head. To loada region, various passes are requisite. Whilst, a layer is ended, the construct platform travels down and a new layer is deposited. This procedure is repetitive awaiting the part is complete. The models fabricated using FDM technology are shown in figures 7 and 8.

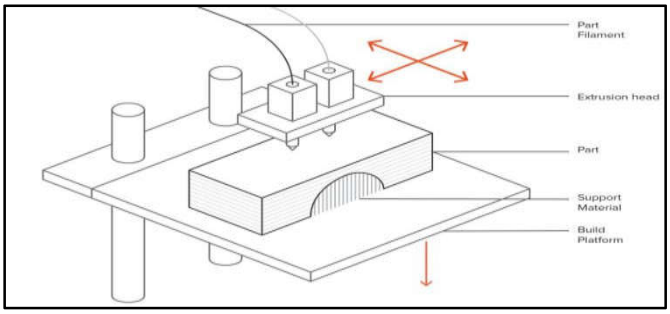

Figure 9 FDM printer setup

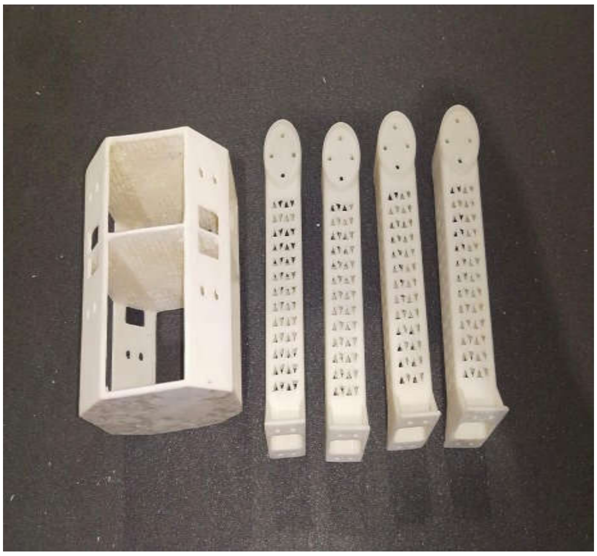

Figure 10 Fabricated models view 1

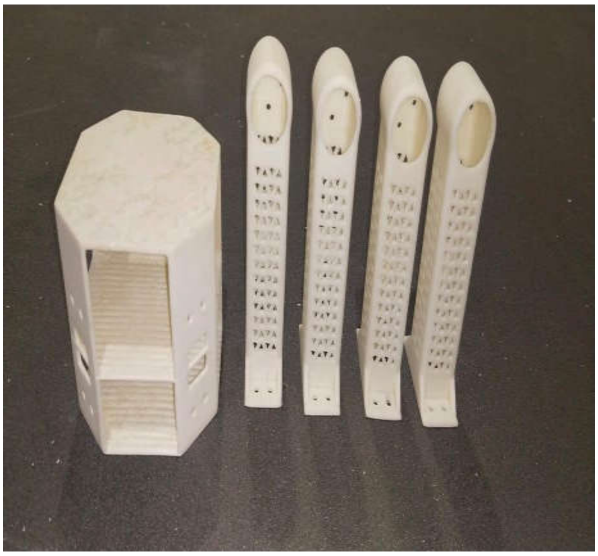

Figure 11 Fabricated models view 2

DISCUSSION AND CONCLUSION

Our key purpose in preferring this plan was to find out the absolute intend method of a quadcopter starting from the physics following its process and obtaining its leading equations to scheming the quadcopter chassis, to preferring the right components to attain a exactidea. Learning the whole plan process of a quadcopter allows one to devise its individual drone, not presently a quadcopter, and constructing best suited to its purpose. Preservative mapping was selected for plan and we can with assurance say it is the prospect of industrialized. Throughout preservative developed any convoluted shape, that is fairly unfeasible to produce completely by conservative mechanized processes, can be effortlessly manufactured with extreme precision. Merely drawback of preservative mechanized is that it is pricey. By means of drones for aerial mapping of a portion of land or field is both cost and time resourceful. Drones can also afford obvious and precise informatione valuate to erstwhile aerial mapping means. Aerial mapping can too be accomplished with satellites, except the detail that satellites are way too far from earth and so the images are not as apparent and correct as we obtain from drones that fly very close up to the land, creates drone mapping a better choice than the ones available from the satellite. Another reason why drones are preferred over conservative means of mapping is the statement that drones can attain places that are unreachable to humans and can still map terrains that are tricky by conservative mapping practices. Drones and quadcopters are escalating in status due to their adaptability and growing easiness of control. The whole system can be mechanized wholly to control a variety of processes of the drone; this resource there is no necessitating of physical incidence of a pilot. As assumed previous drones can attain places that are unreachable to humans and this is one big benefit in by means of drones. Nevertheless, one key drawback of drones is its low flight time and this is somewhat that has to do with the batteries and the motors. There is extent for development in this feature. Approaching to reviewing/mapping there is for eternity range for development in this district. The cameras can be made more influential so that the drones can fly higher and cover upoutsized areas without any concession in trailing the information. The software's used for creating the flight path can be enhanced to acquire the most excellent path potential to map an area.

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How to cite this article:

Shreyas A, Jayanth H N and Sharath Kumar DA (2021) 'Devise, Modelling and Production of A Quadcopter for Agricultural Usage', *International Journal of Current Advanced Research,* 10(01), pp. 23569-23574.
DOI: http://dx.doi.org/10.24327/ijcar.2021.23574.4670

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