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Manufacture Of UAV Skywalker 1900 Flying Vehicles Made Of Composites

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Abstract. The purpose of this research is to make a flying vehicle with the SKYWALKER 1900 UAV model for mapping missions with fiber glass reinforced composite materials on the wings and carbon fiber on the fuselage and tail. With composite materials, it is hoped that the structure of the UAV SKYWALKER 1900 will be stronger than previous materials using styrofoam. The method for making flying vehicles in this study uses 3D printing, to print UAV parts such as wings, fuselag and tail. then molding for components is made, and the final stage is manufacturing parts with composites using glass fiber and carbon fiber reinforcement using the vacuum bagging method. the analysis of weight deviation on the fuselag has a value of 70% and the weight deviation on the wings is 52%, the size deviation on the fuselag and wings weight occurs due to the putty process during finishing. the results of the aerodynamic analysis on the fuselag using solid work software, the UAV flight limit is 20 m/s to get the best flight results when flying

Keywords: Fiber glass, Fiber carbon, Composite, Vacuum Bagging, UAV Fixed wing

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INTRODUCTION

"Unmanned aircraft have enormous benefits for the countries that have them, especially to support social and military activities. The positive functions of using drones in social activities include, among others, as a means of logistics transportation in remote areas that are difficult to access, mapping pipelines, agricultural uses, firefighting and searching for missing persons. Even now the United States has certified the Northrop Grumman Global Hawk unmanned aircraft to be used as a means of cross-country civil transportation. Unmanned aircraft in carrying out military duties has a very good advantage over other military aircraft technology, namely as a reconnaissance tool. [1]

Composite materials that have been widely used in the industrial world, especially in the aerospace industry. One example of the dominant use of composite materials in aviation can be seen in the structure of the Boeing 787 aircraft which uses composites as much as 50% of the total weight and 80% of composites based on the total volume. This is due to the advantages of composite materials which are lighter, stronger and resistant to corrosion.[2]

Wing development for a vehicle is a multi-stage task that includes: wing profile selection, geometric calculations, structural design, material maintenance, numerical analysis and production. One of the main challenges in aviation is how to develop lightweight yet strong structures to withstand the applied loads. This problem can be fatal for pilots. There is a need for materials that can accommodate this.[3]

Vacuum Bag is a method of making composite specimens by pressing using an airtight bag to press a laminate of gelcoat, fiber and other layers on a mold until the layers are fused as a structural composite material. Vacuum Bags use atmospheric pressure as a clamp to press the laminate layers together with equal pressure. The laminate is sealed in an airtight bag.

After the uav has been made, a simulation will be carried out on the wing and body parts to determine the stress and aerodynamics of the uav using the solidworks application. After that, measurements of the dimensions and weight of the UAV were also carried out to find out the differences between the design results and the final results of manufacture, then an analysis of why there was a difference between the design and the final results.

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[1] (Finda Luthfiany Ustidivanissa*, 2017)
[2] (Alemour et al., 2019)
[3] (Fasel et al., 2020)

LITERATUR REVIEW

1. **Drone/UAV**

Drones are aircraft without a pilot. The aircraft is controlled automatically through a computer program designed, or via remote control from a pilot on the ground or in another vehicle. Initially, UAVs were remote-controlled aircraft, but now automated systems are being widely applied. Technological developments have also made drones to be widely applied for civilian needs, especially in the fields of business, industry and logistics.[4]

2. **Airfoil**

a geometric shape which when placed in a fluid flow will produce a lift (lift) more than the drag force. The air flow that passes through the airfoil can cause a vortex (vortex) at each end, the vortex can cause drag or drag that makes the lift or lift force decrease. There are two types of airfoils, namely symmetrical and asymmetrical airfoils, symmetrical airfoils are types where the top and bottom of the airfoil are the same shape, while asymmetric airfoils have different shapes at the top and bottom. [5]

3. **Composite**

Composites are usually composed of two basic materials, namely fiber and matrix. Fibers are usually flexible, have good tensile strength, but cannot be used at high temperatures while the matrix is usually ductile, soft, elastic and binding when it reaches the point of arrangement.[6]

4. Finite element method

Finite element method is increasingly used in the analysis of aircraft structures, including Unmanned Aerial Vehicles (UAVs). The structural model used for finite element analysis however needs to be validated in order to ensure that it correctly represents the physical behaviour of the actual structure. In this work, a case study of a straight, unswept and untapered wing structure made of composite material subjected to aerodynamic loading was modelled and analysed using finite element method.[7]

5. Vacuum Bagging

Atmospheric pressure compresses all sides of the mold at the same time, even above the surface of the mold. The pressure difference between the inside and outside of the mold determines the force that occurs when pressing the laminate inside the mold. Theoretically, the maximum pressure on the laminate when the vacuum works perfectly and can remove air in the mold on all sides of the mold is 14.7 Psi. So that the pressure difference that occurs in the mold is 6-12.5 Psi.[8]

6. 3D Printing

Numerous options exist for the mass production of lattice structures but they become limited for the production of one-offs or small quantities. The problem becomes even more acute for complex designs with undercuts and overhanging features since very few conventional manufacturing techniques can produce them. For testing purposes, multiple variants may be required for different geometric parameters of the design truss diameter, size of unit cell, density of structure which mean more tooling are needed. AM offers a less expensive and more flexible design and manufacturing option as the layer-by-layer approach allows arbitrary shapes, including lattice structures, to be easily produced directly from computer-aided design (CAD) files.20 Also, the per-unit cost of an AM part is the same regardless whether the machine makes one part or hundreds of parts.[9]

7. Lycal Resin

Lycal resin 1011 which includes Epoxy resin Lycal resin is a type of polyester resin and is made specifically for handicrafts and for its very clear and transparent coating. This lycal resin is also very strong against the sun, the nature of this lycal resin is that it has thicker properties and its use uses a ratio of resin: hardener with a ratio.[10]

8. Manufacturing UAV

Unmanned aircraft design process using Autodesk Inventor Professional 2016 software. The results of this unmanned aircraft design Unmanned aircraft dimension data obtained, as well as flight test data for the unmanned aircraft.[11]

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[6] Susanti, 1981
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[10] Billy Suugondo et al., 2022
[11] Sirojuddin et al., 2019

RESEARCH METHODE

This research begins by determining the model of the flying vehicle, namely the UAV Skywalker 1900. Then a technical drawing is carried out using solidwork software and the part printing process is carried out using 3D printing. after the 3D Printing results in the assembly, molding is done for each part of the UAV. The final stage is to manufacture wings, fuselag and tail using composite materials (glass fiber and carbon fiber) using the vacuum bagging method. The work on this research can be seen in the flowchart below Figure 1.

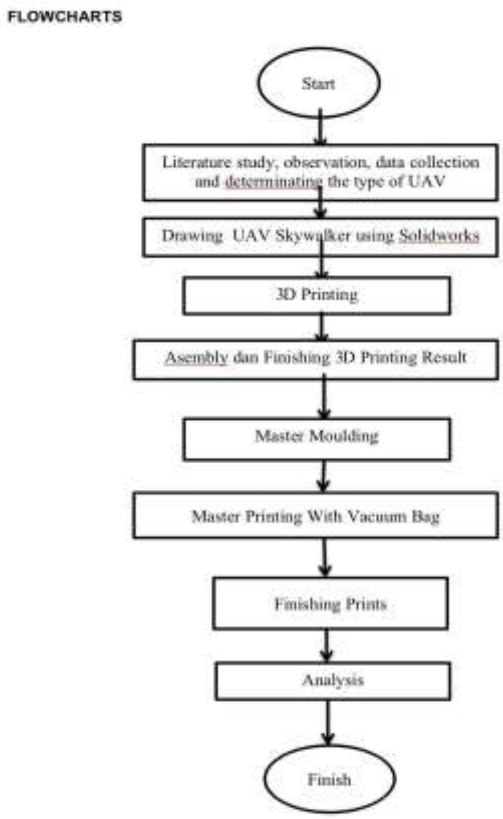


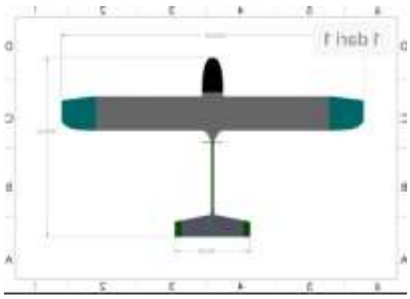
Figure 1. Flowchatrs

DESIGN MATERIALS AND TOOLS

1. Resin, Catalyst, Carbon Fiber
2. Pipe, Plastic bag, Waax, Glass, Spiral
3. 3D printing and Mouding
4. Propeller
5. Flight Control, Flight Main Board Software
6. Camera 5000 MP
7. Dynamo motor, power distribution cable, battery
8. Materials for Drone Frames (Carbon fiber and Fiber glass)
9. Acrylic scales

RESULTS AND DISCOUSINS

The results of the manufacture of the wing structure of the vehicle in this study are in the form of specifications for some of the parts used, the design of making the wing structure of the vehicle using the solidworks application. In the picture below, you can see the making of the wing structure of the vehicle which was designed using solidworks. UAV Skywalker engineering drawings can be seen in Figures 2 and 3


(a)

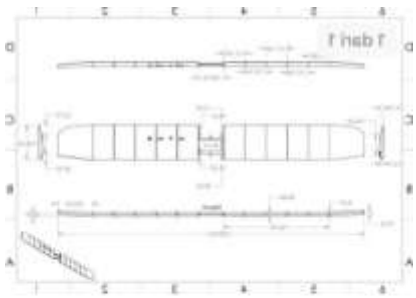
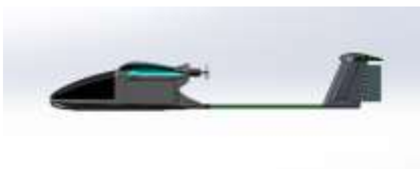

(b)

Figure. 2 (a) Top view design (b) Long wing design


(a)


(b)

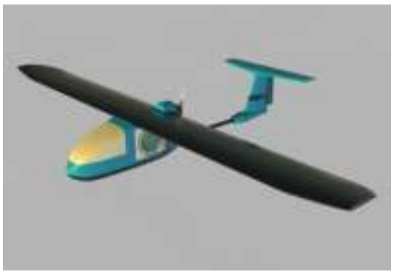

(c)

Figure. 3 (a) Front view design (b) Side view design (c) Visual 3D Design

The design uses solidworks in the picture above, designed as needed to make wings. At this stage complex digital designs are converted into detailed physical models, this aims to simplify the manufacture of wings.

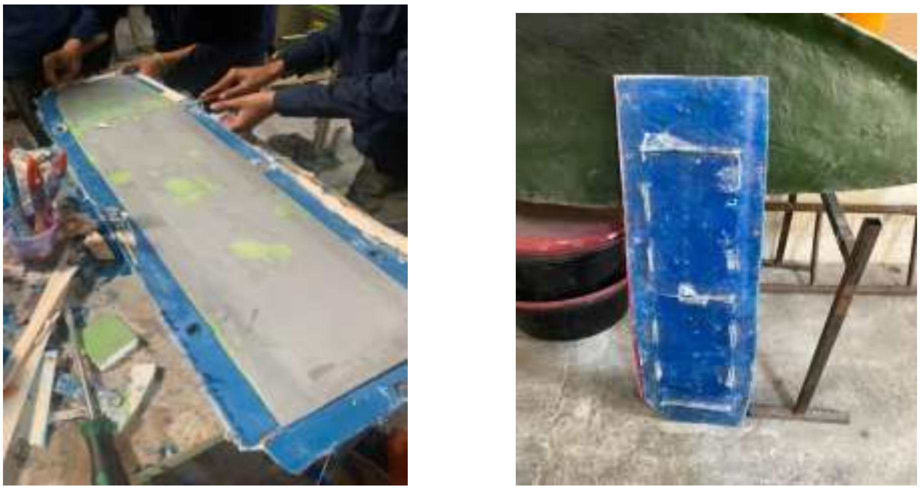
1. Manufacturing Process of Wings SkyWalker 1900

a. Master Wing 3D Printing to make prints, besides using 3D Printing on Wings, Styrofoam is also used. The selected styrofoam is then cut with a manual styrofoam cutter according to the design on the solidwork and added with epoxy so that the results that have been obtained become strong after that it is sanded to refine the part. In the Wing tip section using 3D Printing. The process of making wing parts can be seen in Figure 4.

(a) (b)

Figure 4. (a) Process of refining parts (b) Process of refining wing tip

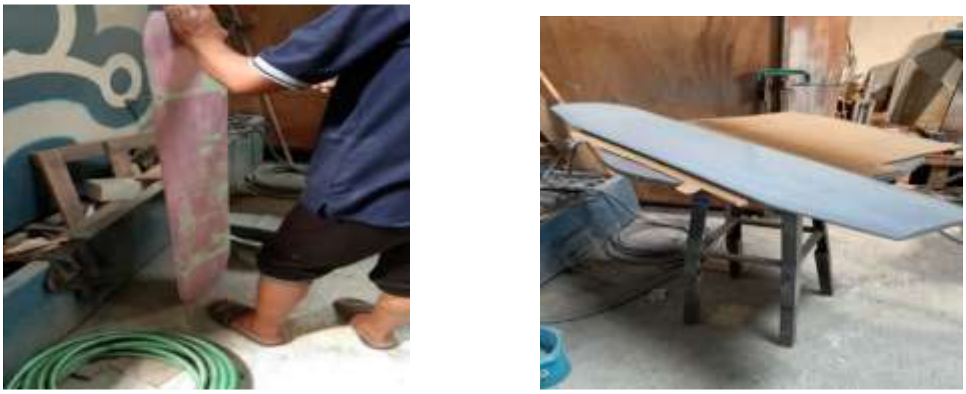
b. Master molding is made after the phase where the Styrofoam has been cut using a cutter according to the shape designed using solidwork and the selected rip-like airfoil shape. The Mamo (Master Molding) process is added using PA Resin and Matt. The results of making molding can be seen in Figure 5.



(a) (b)

Figure 5. (a) Master molding process (b) Moulding result

c. After the Master Molding is complete then putty and sandpaper using coarse and fine sandpaper to remove the pores and adjust the size according to the design on the solidwork and added with epoxy filler to coat the surface and cover the pores of the putty then clear (paint protector). The results of finishing parts for master molding can be seen in Figure 6.



(a) (b)

Figure 6. (a)Pendentation Process (b) Finishing Part Result

d. In the process of making Wings mold using resin, matt and powder. The master that has been putty and cleared is used as a benchmark to form the printout. Then given a miracle gloss to the entire surface of the master evenly. master molding mold for the vacuum bagging process can be seen in figure 7.

(a) (b)

Figure 7. (a) Molding making process (b) Result

e. After the mold is finished, the mold is given a compound to make it smooth and then given a kit so that the mold is smoother and given a miracle gloss so that during the process of printing the wings resin does not stick. In this process, glass fiber, resin and satin cloth are added with plastic so that they can carry out the vacuum process. The wing printing process with vacuum bagging can be seen in Figure 8.

(a) (b)

Figure 8. (a) Procces Vacuum (b) vacuum bagging print results

f. In the finishing stage, after the wings are printed, the wings are sandpaper to reduce the weight on the wings themselves and also washed to make them clear and in this process the wings are combined into one and several rips are added inside. the results of the wing after assembly can be seen in Figure 9.

Figure 9. wing after assembly

2. Manufacturing Process of Fuselag and Tail SkyWalker 1900

a. At the time of conducting literature studies, observations, and data collection, it was decided that the flying vehicle to be made was the Skywalker 1900 UAV which is of the fixed wing type. composite materials are used, as well as carbon fiber as the main material.
b. The design using Solidworks will also be adjusted to the needs for which the design is made. At this stage the complex digital design is converted into a detailed physical model, this aims to make it easier to make the body of the drone flying vehicle physically.
c. At first the Design Results in Solidworks were then transferred to an application called QURA because this application can simplify the printing process on 3D Printing tools. The 3D printing process can be seen in Figure 10.

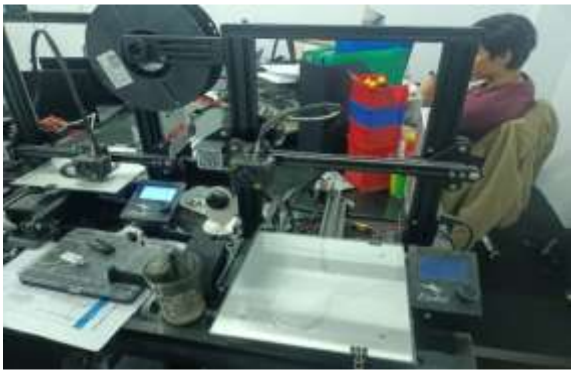


Figure 10. 3D Printing Process

d. After the 3D print is complete, it will be followed by a coarse and fine sanding process on the 3D print part until the outer surface of the part is not sharp and porous. The 3D printing assembly process for making molding can be seen in Figure 11.

Figure 11. Assembly Result and Sandpaper process

e. The next process is the manufacture of molding, the 3D printed body will be carried out with an epoxy filter process to coat the surface and cover the caulking pores and then clear (paint protector). After that, the 3D printed body will be made by master molding by coating all parts using resin. PA and Matt. The manufacture of fuselag molding can be seen in Figure 12.

Figure 12. Moulding Process

f. In this process the mold that has been given a miracle gloss will be coated with carbon fiber which is cut to the size of the mold and sprinkled with carbon powder on all sides and then sprayed with scotch spray which functions as an adhesive between the carbon fiber and the mold, then added another piece of carbon fiber for the second layer. .At the top of the carbon fiber coated with peelply and coated again with PVC Plastic Mesh, in the last layer the entire surface of the mold is covered with plastic and on the sides is added Rubber Butly Tape in order to prevent air from entering during the vacuum process. the process of printing fuselag and tail can be seen in Figure 13.

Figure 13. Step of Vacuum Process

g. At the finishing stage, the wings are sanded again and cleaned if any vacuum-generated material is carried away or sticky. Then the right and left sides of the body will be combined into one, followed by the checking process and ready to proceed for the next process, namely adding a motor and installing avionics. system , also combines with wings and tail. the results of the fuselage assembly from the vacuum bagging prints can be seen in figure 14.

Figure 14. The Result of Vacuum Bag After Assembly

3. Assembly Part and Manufacture UAV

After all the parts have been made using fiber glass for the wings and carbon fiber on the fuselage and tail then assembled and vacuumed using vacuum bagging. The results of the Skywalker 1900 UAV manufacture can be seen in Figure 15.

Figure 15. UAV Skywalker Flight Test

4. Wing and Body Result Analysis and Simulation

a. Dimensional comparison analysis between design results and product results on wings and fuselags can be seen in Tables 1 and 2 below.

Table 1. Wing Comparison of Design Drawings and Product Dimension Value

Parameter Result	Design Dimension Value	Product Dimension Value	Wings Size Deflation and Simulation
fiber thickness (mm)	0.68	0.68	0
weight of wings (gram)	378.94	576	52%
Long wings (mm)	2200	2254	2,45%
wings width (mm)	248	250	0.80%
wings height	37	30	-18%

Table 2. Body Comparison of Design Drawings and Product Dimension Value

Vol.5 No. II Tahun 2022, 134 - 146
P-ISSN: 2621-0215, E-ISSN: 2621-489X

Parameter Result	Design Dimension Value	Product Dimension Value	Wings Size Deflation and Simulation
fiber thickness (mm)	1	1.23	23%
weight of body (gram)	450	765	70%
Long body (mm)	550	590	7.2%
body width(mm)	102	120	17.8%
body height (mm)	207.69	210	0.98%

The difference between the results in the design and the value of the product dimensions are as follows: Weight, Length,Width andHeight have different values because the design and product results have different materials due to consideration of the strength of the material when the flying vehicle operates. and the last one is in the process of making this flying vehicle which has not fully used the engine, so that in the manufacturing process there are several parts or parts that must be sanded and putty to cover the pores on the part or part which can later make the final product of the flying vehicle less maximum.

a. Simulation aerodynamics of body

a. This simulation was carried out 3 times with different speeds, namely 5 m/s, 20 m/s, and 40 m/s in order to see the difference in pressure on the body of the Skywalker UAV, so that it can be determined at what speed the Skywalker UAV can function efficiently. And can fly optimally. aerodynamic simulation can be seen in figure 17

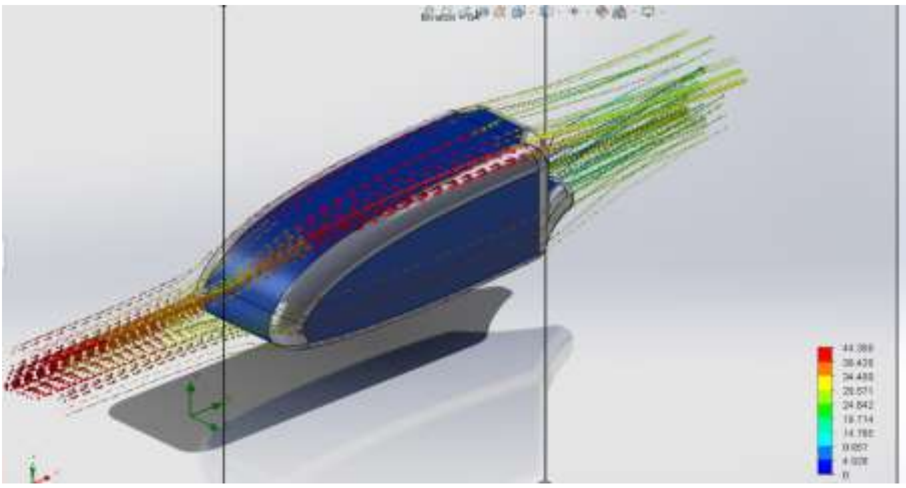


Figure 17. (a) analysys aerodynamics

CONCLUSIONS

The research that has been carried out on the manufacture of the wing structure of the following rides to determine the results of the image design of the wings and to determine the design results with the best product results using solid work software can be concluded as follows:

1. The result a deviation with weight and size in the design compered to the product result on the wings and body of the first UAV in terms of weight, this is due to the process of making this UAV sendpaper, putty in several parts, and coating resin on all parts of the body.This causes an increase in the weight of the Sywalker UAV, causing a difference in weight to the design. Then the difference in dimension is caused by several factors, namely the thickening that occurs due to the process described above, then there is a revision to the material, for example wings, which initially used composites replaced with fiber glass, the last is the addition of length in several parts so that this UAV can fly efficiently.
2. From the results of the simulation of the aerodynamics body from the results of the design and product using solid work software, flying limits UAV is 20 m/s to get best flying result.

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