DESIGN AND DEVELOPMENT OF SURFACE PRIMARY FLIGHT CONTROL TOOLS FOR CESSNA 172 AS LEARNING MEDIA IN POLYTECHNIC AVIATION ACADEMIC SURABAYA

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Abstract

The purpose of designing this final project is for teaching aids and modeling the workings of Primary Flight Control in the form of simulations that make it easier for cadets and in learning about Primary Flight Control, especially in Primary Flight Control props which demonstrate Primary Flight Control and can be visualized with 3 axis axis movement and portable. With the method of visualizing the 3 axis axis movement in real terms, this makes cadets understand more about the movement of the aircraft from the movement of the axis directly in the movement by Radio Control. This research uses several methods, namely data collection, problem identification. This props uses wood, polyfoam, wire. The technique of making tools to assemble the aircraft is to use gluing techniques and for the stand using nailing techniques and adding glue to strengthen the structure of the props stand. The design which has the aim as a learning media support tool for cadets at the Surabaya Aviation Polytechnic campus, especially in basic Primary Flight Control learning. The results of making optimal props are then made in the form of a prototype as an analysis material for comparison between the simulation of design work tools carried out in the Radio Control-based Primary Flight Control design process. The system of the trainer uses Radio control as the main controller and tools supported by other components such as Servo, Esc, Battery, and which can control Primary Flight Control.

Keywords: Primary Flight Control, Unmanned Aerial Vehicle, Radio Control

INTRODUCTION

In this era of globalization, the development of the Industry in the field of Aerospace is getting bigger. This can be seen through the use of tools as learning media. Similar tools such as props are very helpful in the learning process because someone can understand basically how a tool works and then apply it to real tools. For example, many aerospace industries use model airplanes as basic learning media in skill schools and lectures.

A model airplane is a replica airplane that is made exactly the same as the original airplane. Model aircraft are not just ordinary artificial aircraft, model aircraft also incorporate elements of modification and can also be designed more simply than the original aircraft. Model aircraft from several analysis combinations that have been done before. The purpose of making this model aircraft can be created because it makes it easier for cadets who want to learn more about Primary flight control where in the ata chapter is in ATA Chapter 27 and the movement of the 3 axis axis and can be explained by visualizing the flight control.

Based on the above background, the authors are interested in making a tool design with the title "PRIMARY FLIGHT CONTROL SURFACE DEVICE DESIGN OF CESSNA 172 AIRCRAFT AS A LEARNING MEDIA AT THE AIRPORT POLITECHINE OF SURABAYA". The problem of primary flight control props on this model aircraft can be tested because it helps learning in AMTO and relieves cadets in understanding how primary flight control itself works. But in the props that I designed mechanical parts from the control cable and pedals to the primary flight control are ignored.

1.1. Second Level Heading

Based on the research topic that has been determined, the following problem formulation is obtained:

1.1.1. How to build a model aircraft and visualize the primary flight contol movement of the aircraft attitude?

1.1.2. How to design a primary flight control demonstration mechanism on an airplane using radio control input?

1.1.3. How does the 3-axis primary flight control work on the aircraft?

1.2. Problem Objective

The objectives to be achieved in making this design are as follows.

1.2.1. General Objective

So that cadets can apply the knowledge learned and experience all kinds of problems that arise in making a production tool so that it can be applied in the field of entrepreneurship, especially in the field of Aeromodelling. To full fill one of the final requirements in completing lectures at the Surabaya Aviation Polytechnic. In addition, it increases the author's knowledge in applying the fields of theory and practice, especially inflight control lessons obtained while attending lectures at the Surabaya Aviation Polytechnic.

1.2.2. Specific Objective

Can be able to make a tool that can visualize flight control movements in real places such as the movement of the primary flight control and the movement of the 3 axis axis. And can make learning tools as efficient as possible, both in terms of the process of workmanship and the use of materials needed. Can work on making a learning tool that works progressively.

METHODS

In solving this problem, researchers used several stages, namely problem identification, data collection, tool design, tool making, tool testing, analysis and conclusion. Analysis of this research data states that the primary flight control surface props of the Cessna 172 aircraft are successful if the tool moves perfectly and all connected components move perfectly without any obstacles. The primary flight control surface props of the Cessna 172 aircraft are declared a failure if some components do not work. The research design that the author will do is described in a flowchart. Flowchart itself is a diagram, which uses symbols separately describing or representing sequential process steps, making the process simpler and easier to understand.

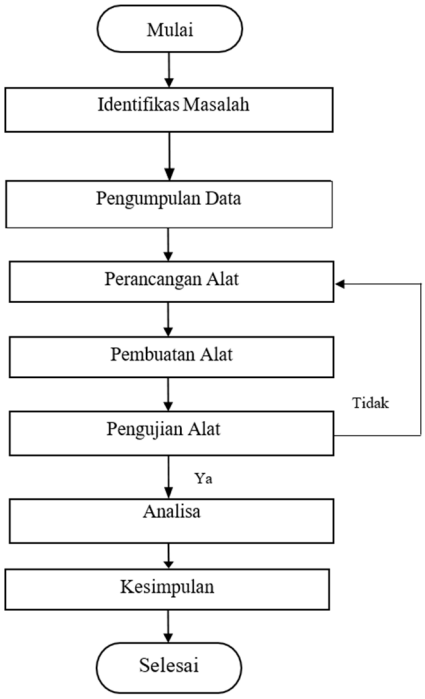


Figure 1 Research Flow Diagram Source: Author's Process 2023

There are components of props instruments that need to be prepared. The following components of tools and materials will be used to compile the instrument / tool Cessna 172 Tip aircraft:

- Radio Control Flsky i6
  The tool functions as a remote control of an electronic device.
- Servo Motor SG90
  The servo motor used is the SG-90 servo motor which has a rotation of 180 °. Used to drive Primary flught control and 3 axis axis.
- MG996R Servo Motor
  The servo motor used is the MG-996R servo motor which has a rotation of 180 °. Used to drive the axis axis in the yawing section.

- Receiver FS-IA6
  Receiver is a part that functions to receive signals or data sent by the transmitter.
- Li-ion Battery 7.4V 450 mAh
  Li-ion battery or LIB Lithium ion battery is one of the members of the rechargeable battery family.

- Esc 30A
  ESC (Electronic Speed Control) which functions as a motor speed regulator, but also functions to increase the amount of current required by the motor.
- Mini Cross Joint

Mini Cross Joint is used to transmit movement, strength, or both. And in this props is used for the support or holder of the props so that it is easy to move.

The testing technique for the primary flight control surface props of the Cessna 172 aircraft was carried out at the Surabaya aviation polytechnic hangar with 3 procedures. First, put the props on a table or flat plane to test this tool. Second, connect the battery to the ESC for the model aircraft props and turn on the radio control. Third, move the radio control according to the guidelines in point 3.5 to move the primary flight control and 3 axis.

Meanwhile, the data analysis technique, the writing states that the primary flight control surface props of the Cessna 172 aircraft are successful if the tool moves perfectly and all connected components move perfectly without any obstacles. The primary flight control surface props of the Cessna 172 aircraft are declared a failure if some components do not work.

The planning time for this research starts from September 2022 to April 2023. In September the search for the title of the final guideline began and in December 2022 was the preparation and implementation of the final guideline proposal examination, until April the final guideline session was held where this research was conducted on the Surabaya Aviation Polytechnic campus.

RESULT AND DISCUSSION

Testing of the main flight control surface props on the Cessna 172 aircraft was carried out to determine whether the movement of the Aileron, Elevator, Rudder was connected to the movement of the main axis of the props which were controlled using radio control.

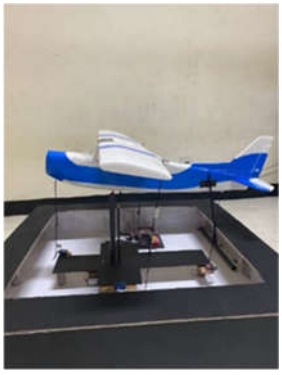
Figure 1 Research Results

The results and discussion will be divided into 3 parts, namely Primary Flight Control Movement along with Axis Axis, Tool Operation, and Tool Size. The following discussion is based on each part:

A. Movement of Primary Flight Control and Axis
   In achieving the movement in this stage, 6 tests were conducted to obtain the overall results of the Primary Flight Control movement.

1. Testing aileron and longitudinal axis
   This stage tests the movement of the aileron and the axis of the longitudinal axis which is controlled using radio control as a transmitter and connected to the receiver and whether it works according to its movement. By moving channel 1. Data from the results of the movement of the movement of the aileron and the axis axis of the longitudinal axis, namely

the left roll and right roll it works and for the move rate of 25 °.




Left Rolling Right Rolling

Figure 3 Longitudinal Axis Movement

2. Rudder and vertical axis testing
   This stage tests the movement of the rudder and the axis of the vertical axis which is controlled using radio control as a transmitter and connected to the receiver whether it works according to its movement. Data from the results of the movement of the movement of the rudder, which is moving left and right and the axis axis of the vertical axis, namely yaw to the left and right, is working and for the move rate of 55 °.


Left Yaw Right Yaw

Figute 4 Vertical Axis Movement

3. Elevator and lateral axis testing
   This stage will test the movement of the elevator and the axis of the lateral axis which is controlled using radio control as a transmitter and connected to the receiver whether it works according to its movement. Data from the results of the movement of the movement of the elevator and the axis of the lateral axis, namely pitch up and pitch down, works as much as and for the rate of move 15 °.

Pitch up Pitch down

Gambar 5 Pergerakan Lateral Axis

4. Testing the combination of elevator and rudder


This stage will test the movement of the elevator and rudder on the lateral axis and vertical axis axis which is controlled using radio control as a transmitter and connected to the receiver whether it works according to its movement. Data from the results of the combination movement of the elevator and rudder on the lateral axis and vertical axis axis is working and for the move rate of 15 ° for pitching and 55 ° for yawing.

Pitch up + Yaw left Pitch up + Yaw right

Pitch down + Yaw left Pitch down +Yaw right

Gambar 6 Movement Combination pitching & yawing

5. Testing the combination of aileron and rudder
   This stage will test the movement of the aileron and rudder on the longitudinal axis and vertical axis which is controlled using


radio control as a transmitter and connected

to the receiver whether it works according to its movement. Data from the results of the combination movement of Aileron and rudder on the longitudinal axis and vertical axis axis is working and for the move rate of 25 ° for rolling and 55 ° for yawing.

Roll left + Yaw left

Roll left + Yaw right

Roll right + Yaw left

Roll right + Yaw right

Gambar 7 Movement Combination Rolling & Yawing

6. Testing the combination of elevator and aileron

   This stage will test the movement of the elevator and aileron on the lateral axis and longitudinal axis axis which is controlled using radio control as a transmitter and connected to the receiver whether it works according to its movement. Data from the results of the combination movement of the aileron and elevator on the longitudinal axis and lateral axis axis is working and for the move rate of 25 ° for rolling and 15 ° for pitching.

Pitch up + Roll left

Pitch up + Roll right

Pitch down + Roll left

Pitch down + Roll right

Gambar 8 Movement Combination Pitching & Rolling

7. Overall test discussion

   Based on the data that has been obtained, the measurement of servo movement on flight control and axis movement is measured using visual and meter. However, for the movement of the vertical axis, namely yaw left and yaw right, the aircraft movement is still not strong enough in its movement. To facilitate the reader, it is described as table 1. as follows:

Table 1. Test results

No	Flight Control	Movement	Condition	Result	Remarks
1	Aileron & Longitudinal Axis	A. Roll right B. Roll left	Good	Good	-
2	Rudder & Vertical Axis	A. Yaw left B. Yaw right	Good	Good	Airplane handle is not sturdy enough
3	Elevator & Lateral Axis	A. Pitch up B. Pitch down	Good	Good	-
4	Elevator & Rudder	A. Pitch up & yaw left B. Pitch up & yaw right C. Pitch down & Yaw left	Good	Good	-

		D. Pitch down & Yaw right			
5	Aileron & Rudder	A. Roll left & Yaw left B. Roll right & Yaw right C. Roll left & Yaw right D. Roll right & Yaw left	Good	Good	-
6	Elevator & Aileron	A. Pitch up + Roll left B. Pitch up + Roll right C. Pitch down+ Roll left D. Pitch down + Roll right	Good	Good	-

B. Tool Operation

How the Primary Flight Control Surface Trainer on a Cessna 172 Airplane will demonstrate the movement of the Primary Flight Control and 3 main axes on a Cessna 172 aircraft.

1. Turn on the Radio Control which is the transmitter.
2. Connect the battery cable to the ESC, where the ESC is connected to the Receiver.
3. Connect the servo cable used to the Receiver.
4. When all components are connected and on, proceed to the next process.
5. Start controlling the Radio Control where the movement corresponds to the movement of RC aircraft in Aeromodeling.
6. Left stick when moving left and right will move the rudder and vertical axis movement or right Yaw and left Yaw.
7. The right stick in the vertical position that moves up and down will move the elevator and lateral axis or pitch up and down.
8. The right stick in the horizontal position that moves left and right will move the aileron and the movement of the longitudinal axis or roll left and roll right.

C. Tool Size

The following is the size of the components contained in the Cessna 172 aircraft flight control surface props.

Tabel 2. Ukuran alat

No	Component	Size (cm)
1	Props mat	80x80
2	Miniature RC airplane a. Aircraft length b. Wing length c. *Horizontal stabilizer length* d. *Vertical stabilizer length*	 a. 50 cm b. 75 cm c. 26 cm d. 17 cm
3	RC airplane stand a. Stand Height b. Width of stand base	 a. 15 cm b. 80 cm
4	*Axis wire* a. Wire length for aileron for longitudinal axis left & right b. Wire length for aileron for front & rear lateral axis	 a. 37,5 cm & 37,5 cm b. 25 cm & 25 cm

1. Advantages and disadvantages of tools

There are 3 advantages and 3 disadvantages of props. The first advantage is that the tool is simpler and more portable because it uses a battery. Second, the props have been controlled using Radio Control. Third, it has demonstrated Primary flight control along with the axis. Meanwhile, the first drawback is that the display of props is less neat. Second, the tool is disassembled so it takes time to operate it. Third, the movement of the axis is still stiff.

D. CONCLUSION

Conclusion

Conclusions that can be obtained from testing and measuring the design, conclusions are drawn according to the formulation of the problem that has been determined, so that the conclusions are as follows:

1. This trainer can be used as a flight control practice at the Surabaya aviation polytechnic.
2. This trainer helps cadets easily understand the movement of flight control and axis.
3. From the results of testing the primary flight control props surface of the Cessna 172 aircraft, it was found that the movement of the tool moved well.

Suggestion

Some suggestions given with the discussion to make it easier to develop this final project are:

1. Adding Arduino so that the movement can move smoothly and add movement using degrees when moving flight control switches such as moving when turning left etc.

2. It is hoped that this tool is well stored and maintained, so that it can be used to assist learning activities in hangars and classes for a long time.

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