

Research Article

Implementation of Wing Control Surfaces Airflow Trainer (WICOSAT)

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Abstract: The interaction between air and an object flying through the air or moving along the ground is simulated in wind tunnels, which are large tubes with air blowing through them. Learning the principles of airflow on aircraft's wings is difficult without visual aids since normal human's being cannot see the wind. It is also challenging to comprehend how the use of wing control surfaces like the aileron, flap, and spoiler is affected by airflow. Wing Control Surfaces Airflow Trainer (WICOSAT) demonstrates airflow visualization over the wing control surfaces by using the smoke generator. It can be used by press the switch button or smartphone application. This project will be conduct in data collection that is evaluation. WICOSAT is a tool that instructors and students can use to study the fundamentals of airflow based on Bernoulli's Theorem effects on wing control surfaces. As a result, the use of WICOSAT, in addition to data analysis to visualise airflow over the aircraft wing, may or may not be beneficial.

Keywords: Relative airflow, wind tunnel, smoke generator, airflow trainer



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1. INTRODUCTION

The direction that the atmosphere is moving in relation to an aeroplane or an airfoil is referred to as the relative wind in the field of aeronautics. It travels in direct opposition to how an aeroplane or airfoil does when it interacts with the atmosphere. Huge air-filled tubes make up wind tunnels. Wind tunnels are made of enormous air-filled tubes. The tunnels mimic the movements of an object in flight. Wind tunnels are used by researchers to better understand how an aeroplane would fly. NASA uses wind tunnel testing to evaluate scale models of aircraft and spacecraft. When something is inside a wind tunnel, it seems to be flying.

The air is often blown through the tunnel by large, powerful fans. The test object is secured within the tube to stop movement. It might be a miniature aeroplane model. It might be a component of an aeroplane. It might be a full-size aeroplane or a spacecraft. Even something simple as a tennis ball could be it. The air around the stationary object moves to mimic what would happen if it were to fly through the air. How air moves can be studied using a variety of techniques. You may watch it move by hurling smoke or colour into the air. To demonstrate how the air moves, the object can be augmented using threads. Building a wind tunnel is fairly expensive due to the high cost of construction and

maintenance. Learning about the principles of airflow found in an aircraft's wings is difficult without visual aids since normal humans cannot see the wind. Students may struggle to comprehend how an aircraft may fly over the sky. Next, most students did not comprehend how airflow is deflected by elements other than the fundamental flying controls, such as flaps, ailerons, and spoilers. This will confuse other students, particularly those studying in Module 08 Basic Aerodynamics.

Besides that, there is no training kit available at Politeknik Banting Selangor (PBS) to help students understand airflow better. Students may have difficulties as a result of not receiving proper equipment to learn a relevant subject. Finally, students have a hard time differentiating and understanding the primary flight controls and secondary flight controls which can lead to a lack of understanding. It is extremely risky for students if they do not acquire this information in order to work with aircraft in the future

The objectives of WICOSAT are to design wing simulation control surfaces consisting aileron, flap and spoiler, to construct an airflow visualization over the wing using smoke system within a chamber, and to demonstrate airflow acts on the use of wing control surfaces.

2. METHOD & MATERIAL

2.1 Method

The ADDIE development model consist of analysis, design, development, implementation and evaluation are used to develop WICOSAT.

a. Analysis of WICOSAT

A survey has been done to 57 Diploma Engineering in Aircraft Maintenance, PBS students' semester 1 Session 1 2022/2023 to attain the problem statement in their learning and teaching activities for Course DWM10082 Basic Aerodynamics Topic 2: Aerodynamics. Based on survey, 98.7% of the students responded 'yes' that show their difficulties in understanding the concept and the function of aerodynamics. On the other hand, 100% of the students tend to lose focus in class due to the traditional way of teaching method.

b. Design of WICOSAT

The design of WICOSAT has been done by using AutoCAD. WICOSAT mechanism for its wing/airfoil will be designed to provide multiple functions of control surfaces such as an aileron, speedbrakes/spoilers and flaps to provide visual representation for how these control surfaces will affect the air flowing through the skin of the wing. This is achieved by placing the wing in a wind tunnel to give a visual representation of airflow flowing on the skin on an aircraft wing. The wind tunnel is equipped with a smoke generator which acts as a laminar flow in the testing tunnel. The control surfaces of the wing will be controlled by servos and control cables to provide flexibility and movability of the control surface. WICOSAT electronics system will implement a software which controls the servo of wing mechanism. By using the Blynk App and Arduino IDE program, it's able to produce a fully automated system mainly controlled by the Blynk App itself. This will create a more user-friendly interface which would ease the operation of our product. In conclusion, its able to control the control surfaces of the wing mechanism with the use of an app.

c. Development of WICOSAT

Each component of the kit created, including the module, contains references to data and details about wind tunnels and air movement principles found on airplane wings. The results of the pilot test with the instructors and students of PBS is the content of the module that has been created. In order to ensure that the contents and materials of the produced kit can be used by instructors and students at PBS in solving the problem of understanding how the air flow of Bernoulli's Theorem acts on the use of wing control surfaces such as ailerons, flaps, and spoilers, the kit of materials has been evaluated by course instructors in stages.

d. Implementation of WICOSAT

The validity and reliability of the modules and kit materials have been examined by the appropriate course instructors. The assessment form that the evaluator completed has contributed to bettering the manufacturing of these modules and kits. One enhancement recommended by the course instructors is to change the type of material used to construct the WICOSAT, such as switching from plywood to acrylic for a base structure that has a longer lifespan and greater strength for the air chamber structure.

e. Evaluation of WICOSAT

The relevant parties, namely the teaching staff and students, evaluate the WICOSAT after it has undergone different processes of preparation. They discovered that WICOSAT helped students, particularly those who were not acquainted with the fundamentals of aerodynamic wings. With the aid of this trainer kit prototype, greater comprehension and visual learning may be encouraged. Students find it simpler to comprehend how aircraft control systems work. The aim of assisting users in comprehending the fundamentals of airflow is well supported by visualised simulations, which improve learning and comprehension.

2.2 Material

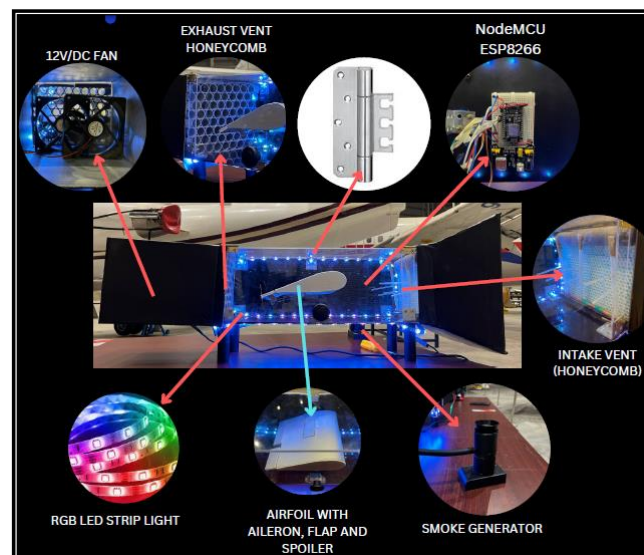


Figure 1. WICOSAT's material

a. Structure

As shown in Figure 1, WICOSAT is built using numerous pieces of acrylic sheets which are then shaped into a rectangular tunnel. The shape is made by riveting multiple 90-degree brackets. Next, the wing structure is made from foam board as the wing shape supported by acrylic pieces as the wing support structure. This wing structure has a few control surfaces that can be extracted and retracted by using Blynk app with the help of servos and control rods that help to move the control surfaces.

b. Electrical/Electronic Mechanism

NodeMCU ESP8266 is used for the main control module of our servo controlled wing control surfaces. This NodeMCU acts as the brain for electrical/electronic mechanisms as it stores all the codes that are created in the coding program which will then control all the servo based on the codes that were made. The electronics are stored behind the wind tunnel itself. This is an easy access panel where we can perform troubleshooting with ease and capable of developing a self-programming code that will make it simple to repair errors, establishing an electronic system that controls the multiple control surfaces on the wing mechanism, and implementing the Internet of Things (IoT) for servo control using the Blynk App on a smartphone, as shown in Figure 2, for wing controls surfaces like the aileron, flap, and spoiler.

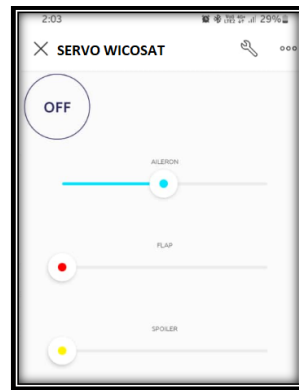


Figure 2. WICOSAT Blynk App

c. Smoke Mechanism

As seen in Figure 3, the smoke mechanism is used to aid in visualising the airflow around the wing and demonstrates how the wing control surface influences the airflow on the wing surface. For the smoke, fogging machine/smoke machine is used to produce the smoke. From the smoke machine output, it will be connected to a hose which then will supply the smoke to the smoke output mechanism in the wind tunnel. The smoke output is made from a copper hose and straws.

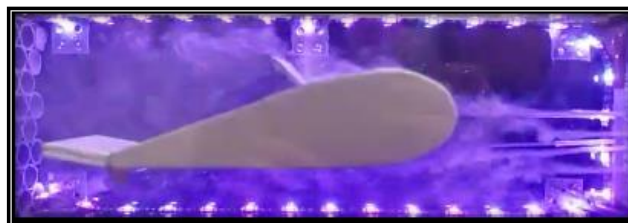


Figure 3. Smoke mechanism

d. Accessories and Finishing

By generating a laminar smoke flow and making the wind tunnel airtight, it was possible to design structures with simple operations and attractive finishing. Thus, there are two accessories which is first the RGB Led Strip. The reason led strip is to make the viewer of product to see the smoke flow

clearer with a bright white colour lighting that covers around the base structure. The second accessory is 12v/DC fan that is used as a turbine which sucks the smoke out from the base structure.

3. FINDINGS

To create an airspace using materials that can withstand heavy loads from other elements and components and, particularly, wing models to reduce manufacturing costs and show the strength and durability of the space structured air, frame structure and skin structure are two distinct processes. WICOSAT also has a system with straightforward controls that demonstrates the operation of the various control surfaces on a simple airfoil wing utilising MCU nodes and servo motors to examine the airflow on the WICOSAT wing visually. WICOSAT can also use Blynk Applications to implement the Internet of Things (IoT) for servo control to create an electronic system that controls the various control surfaces of our wing mechanism. This creates a user-friendly electronic system with a straightforward interface for convenience to users to create their own programming code, which will make it simpler to fix errors. Last but not least, WICOSAT succeeded in creating laminar smoke flow by sealing the wind tunnel.

4. CONCLUSION

Overall, WICOSAT accomplishes its stated goal of helping people understand the basics of air movement. After the pilot test was over, there were problems with students' understanding of fundamental air flow that resulted in the creation of this. Ailerons, flaps, and spoilers are among the control surfaces that make up WICOSAT's fully functional airfoil or wing. An airflow chamber was constructed to demonstrate how laminar airflow might behave in the presence of wings with control surfaces. Users will be able to manage the wing control surfaces (ailerons, flaps, and spoilers) via an app on any smartphone, and they will be able to view how the control surfaces impact the incoming air flow. In conclusion, users claim that WICOSAT is a helpful training tool for resolving issues and comprehending the Bernoulli principle.

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