Development of Flight Simulator Control Trainer (FSCT) for Aviation Education

M. Aswad Bin Othman*, Muhammad Syafiq Bin Mohd. Hanif , Nur Aimi Nazihah Binti Khairul Amilin, Maureen Lizphine Anak Saing

Department of Aircraft Maintenance,
Politeknik Banting Selangor, Banting, 42700, MALAYSIA

*Corresponding Author Designation

Abstract : The Flight Simulator Control Trainer was designed for learning purposes as we cannot get near the live aircraft. There are computer input devices designed to simulate the yoke, intended for flight simulator. As we know, a flight simulator is a machine designed to resemble an aircraft's cockpit, with computer-generated images that mimic the pilot's view and the aircraft's motion. It is to relate with the yoke to help students to understand about the basic theory of flight because when using the digital way, it will help to attract students attention to use their knowledge on how the system work. Besides, students have no access to live aircraft, this is due to the fact that the live aircraft is very sensitive. Thus, we would like to take over the control surface part by using the control panel. So, the simulation method is preferable for training purposes. This Flight Simulator Control Trainer is to demonstrate the flight control system that bases on the module in Politeknik Banting Selangor which is DWM10082 Basic Aerodynamic.

Keywords: Flight Simulator

1. Introduction

Cockpit controls consist of the control column or the control yoke. Yoke is a device used for piloting some fixed-wing aircraft. Yokes come in a variety of shapes and sizes, the most common being of a "U" or "W" design. Some aircraft use "M" style, such as Embraer aircraft and the Concorde. There are also computer input devices designed to simulate a yoke, intended for flight simulators [1]. A flight simulator is a device that artificially re-creates aircraft flight and the environment in which it flies, for pilot training, design, or other purposes. Flight simulator is used for a variety of reasons including flight training mainly for pilots, the design and development of the aircraft itself and research into aircraft characteristics and control handling qualities.

Flight simulators are built as realistically as possible, presumably to enhance their training value. Yet, their training value is determined by the way they are used [2]. Traditionally, simulators have been less important for training than have aircraft, but they currently emerging as primary pilot training vehicles.In this present days, the flight simulator is quite expensive. It is not easy to get it for a

reasonable and affordable price. So, as a student, we are trying to do an innovation by building a reasonable and affordable flight simulator.

The development of the Personal Computer (PC) -based flight simulator industry. In 1981, International Business Machines Corporation (IBM) came out with their PC, bringing the power of flight simulator computers into the reach of the individual general aviation pilot. Flight simulation programs first market as games and the pilot's input to the system was restricted to the keys of the computer keyboard [3]. There are about six PC-based flight simulators designed specifically as instrument flight trainers for individuals who already have a pilot's certificate [3]. There is even market for add-on systems to enhance the visual system of one's PC-based flight simulator. Many PC-based flight simulators were originally designed for IBM and IBM-clone operating with 286 processors [3]. Today with much faster processors and relatively huge storage capacities and Random Access Memory (RAM), the PC-based flight simulator exceeds the power of full-scale flight simulators in many ways.

1.1 Recent research on flight simulator

Simulators are specially suited for training situations which are impractical, difficult, dangerous that aircrew may only encounter frequently [4]. If these situations are encountered they need to be dealt with efficiently to avoid serious consequences. Simulators can be used to present trainees with such unusual scenarios in a repeatable and controllable manner without presenting risk to the crew, the aircraft other operators or to the environment. The different types of Flight Simulator Training Devices (FSTD) are defined in the European Union Aviation Safety Agency (EASA) Certification Specification for Flight Simulation Training Devices (CS FSTD). To be recognized as such, a FSTD must be formally qualified by National Aviation Authorities (NAA) or EASA [4].

1.2 Backgorund of Study

We would like to design Flight Simulator Control Trainer (FSCT) as we cannot get near the live aircraft, so we planned to make a a flight simulator. By using the flight simulator to relate with the yoke it will help students to understand more because using the digital way will help to attract student attention to use their knowledge in interesting way. Thus, from the flight simulator, student will be able to know how the system work in live aircraft and it will help them mentally ready to face the challenge when they get to work in real industry.

Therefore, this flight simulator is created to give flexibility for student to gain more knowledge and learning basic skill about handling the aircraft. The flight simulator also design to assist the aviation student in obtaining deeper understanding by helping them know the system and how the system work in live aircraft. Relate with the yoke, student will be able to know how the yoke work to pitch up the aircraft during the take-off. It is also a medium for student and instructor to approach a new technology that helping student without the time limits.

2. Materials and Methods

First and foremost, the main material is the yoke itself which is Fokker 50 control yoke. To build the structure, we use a metal bar and plywood. To stand the yoke, we attach a spring at both edges of the metal bar for the pitch movement. Furthermore two potentiometers have been mounted at the yoke is one is in the yoke elbow and another one is mounted at the bottom of the yoke. Moreover, we use a cable to connect the potentiometer with the Arduino UNO. The potentiometer on the yoke read the degree of the axis depends on the yoke movement. Then, the Arduino will be receive an output from the potentiometer.

2.1 Materials

    i.   Square hollow stainless steel

    ii.   Swivel Caster wheel

    iii. Metal spring

    iv.   Fokker 50 control yoke

    v.   Plywood sheets

    vi.   Screws

    vii.   Potentiometer

    viii. Cable wire

    ix.   Arduino Uno

2.2 Methods

First and foremost, the main material is the yoke itself which is Fokker 50 control yoke. To build the structure, we use a metal bar and plywood. To stand the yoke, we attach a spring at both edges of the metal bar for the pitch movement. Furthermore two potentiometers have been mounted at the yoke is one is in the yoke elbow and another one is mounted at the bottom of the yoke. Moreover, we use a cable to connect the potentiometer with the Arduino UNO. The potentiometer on the yoke read the degree of the axis depends on the yoke movement. Then, the Arduino will be receive an output from the potentiometer. These are illustrated in Figures 1 to 6.

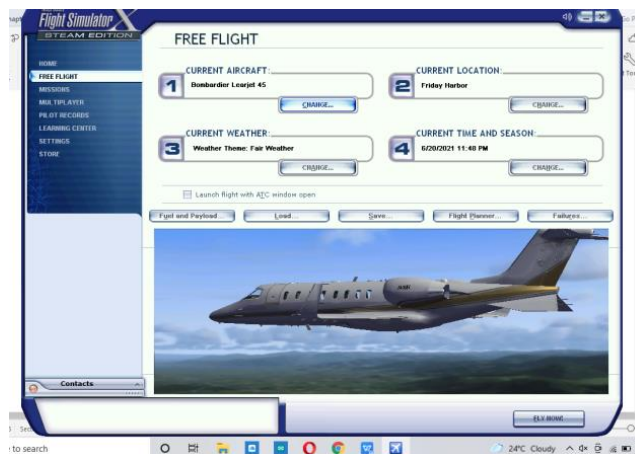**Figure 1: Main structure of the flight simulator**
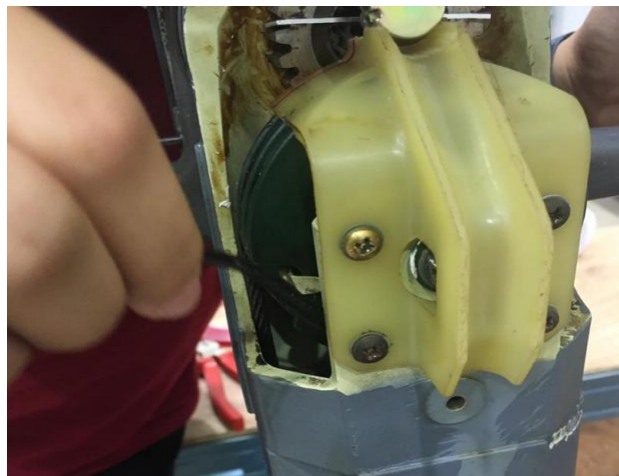
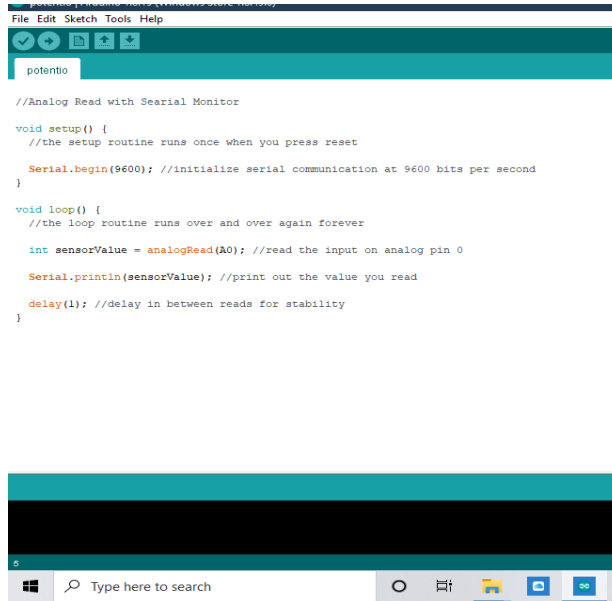**Figure 2: Cable wire has been insert in the body of yoke**
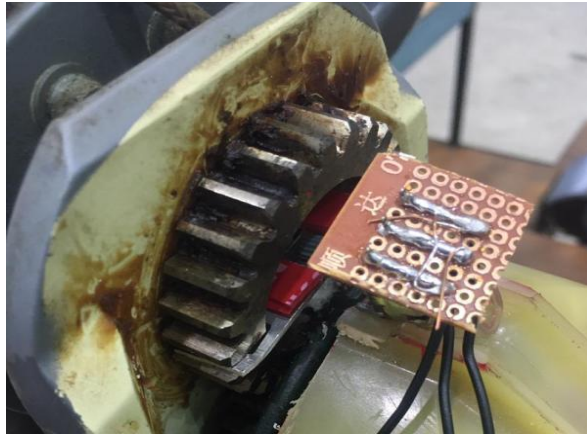
Figure 3: Potentiometer has been installed on top of the doughnut board
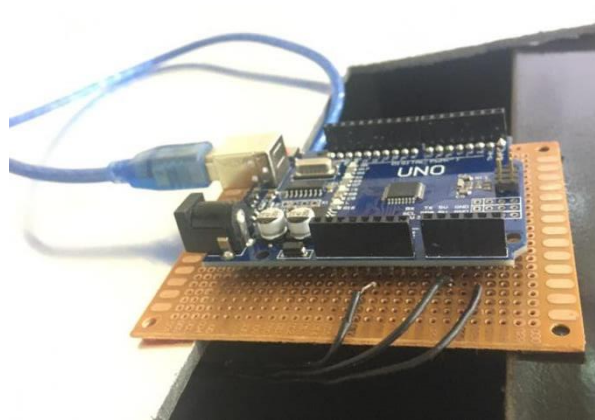
Figure 4: The connection of the potentiometer and Arduino Uno

**Figure 5: The software, Microsoft Flight Simulator X**

```
//Analog Read with Searial Monitor

void setup() {
  //the setup routine runs once when you press reset

  Serial.begin(9600); //initialize serial communication at 9600 bits per second
}

void loop() {
  //the loop routine runs over and over again forever

  int sensorValue = analogRead(A0); //read the input on analog pin 0

  Serial.println(sensorValue); //print out the value you read

  delay(1); //delay in between reads for stability
}
```

Figure 6: Arduino Uno and potentiometer have been programmed as a mechanism to control the flight simulator

3. Results and Discussion

3.1 Results

All the structure and components were successfully assembled. All the movement and axis were displayed on the Flight Simulator X software. The aircraft movement in the Flight Simulator X can be controlled by using the Fokker 50 yoke. Figure 7 shows the final product.
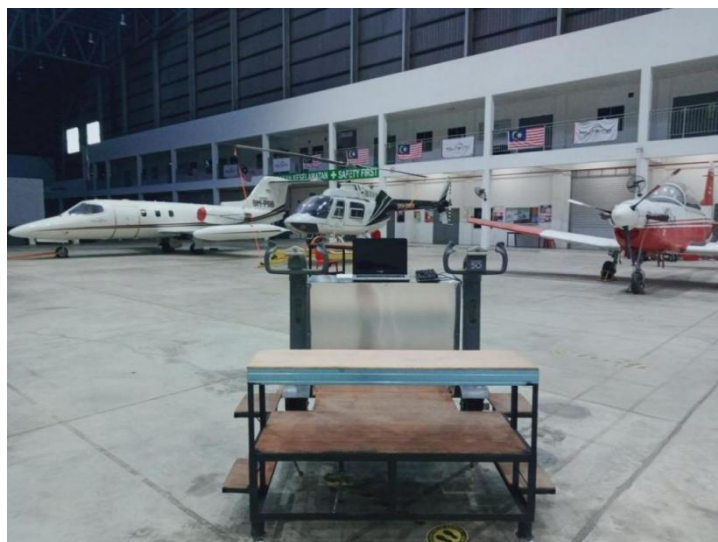
Figure 7: Final Product

3.2 Discussions

The roll axis (or longitudinal axis) has its origin at the center of gravity and is directed forward, parallel to the fuselage reference line. Motion about this axis is called roll. An angular displacement about this axis is called bank. A positive rolling motion lifts the left wing and lowers the right wing.

99

For our project, the role axis motion has been displayed on the laptop screen as we tilt the yoke to the right or left. Figure 8 shows the example when the yoke tilts to the left meanwhile the aircraft which has been displayed on the laptop screen banking to the left as well.

Figure 8: The aircraft banking to the left as the yoke has been tilt to the left

4. Conclusion

In this project, the Flight Simulator Control Trainer was made to overcome the existing problem for students. Therefore, students have an access to simulate a live aircraft. It is because a real live aircraft is very sensitive. So, the simulation method would give students experience similar to a live aircraft. Moreover, students can easily understand the theory of flight. This is due to the fact that the simulation method might help students to understand in depth about the theory of flight instead of theoretical classes. Besides, the flight control system has been successfully demonstrated. Throughout the project developing and experimental phase, there are some factor that affect the accuracy of the experimental result. However, every problem has their own solution and every product has the space for improvement. The improvement is by adding throttle and rudder pedal so that students can simulate the simulator comfortably.

References

[1]   Wikipedia,   Yoke   (aeronautics.   Available
        https://en.wikipedia.org/wiki/Yoke_(aeronautics). [Accessed April, 2021]

[2]   P. W. Caro, "Aircraft Simulators and Pilot Training", Human Research
        Organizations, Fort Rucker, Alabama. [Journal] Retrieved September 2020 at:
        https://twin.sci-hub.do/5882/08d5a1840f8d4c20541081b25d0ac46b/caro1973.pdf,
1973.

[3]   Lawrence Erlbaum Associates, Inc (1998), "Personal Computer-Based Flight Training
        Devices", University of Central Florida, Orlando. [Journal] Retrieved March 2021 at:
        https://zero.sci-
        hub.do/3477/f68bebff8340b5011b7f2ead3a2a3fe1/koonce1998.pdf#view=FitH

[4]   European Helicopter Safety Team (EHEST), "Teaching and Testing in Flight
        Simulation Training Devices (FSTD)". [Journal] Retrieved May 2021 at:
        https://www.easa.europa.eu/sites/default/files/dfu/206904_EASA_EHEST_HE_10.pd
        f