Demonstration of Flight Control System

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Abstract

Our team project is about the working of flight control surfaces by using mechanical system. In mechanical flight control system the control stick is moved by external force of pilot to deflect the primary and secondary control surface. The prototype of flight control surface was made from Cessna-172 aircraft by reducing scale ratio of it. The movement of control surface is obtained by the applied force on the control stick or pedal is transmitted to pulleys by cable. Then the tension of cable to make the control surface deflection. Demonstrate the mechanism of mechanical flight control system and their components. Understand the concept of force transfer through the pulleys, cables, gears and chain.

Keywords: cable, control stick, control surfaces, deflection, gear, pulleys, tension force

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I. INTRODUCTION

Pulley-cable system is a mechanical flight control system. It is a basic method of controlling an aircraft. It is used in early aircrafts and currently used in small aircrafts where the aerodynamic forces are not excessive. It uses a collection of mechanical parts such as rods, tension cables, pulleys, counterweights, and sometimes chains to transmit the forces applied from the cockpit to control directly the control surfaces. An airplane uses flight controls to adjust and control the airplane's flight attitude. These controls exist of surfaces on the outside of the airplane that are moveable. The pilot can move these surfaces by means of cables that are attached to the surfaces outside the airplane.

A. Definition of flight Controls

The airplane has a system that controls the movement around the three axis: the flight control system. In order to understand how the flight controls work, you need to understand which forces and laws of physics work on the controls.

There are two types of flight controls. First the primary flight controls, consisting of rudder, ailerons, elevator and trim, and secondary flight controls, the slats, flaps and spoilers.

B. Primary flight controls

1) Aileron

The ailerons are the control surfaces mounted on the rear of each wing and are designed to make the airplane roll around it's longitudinal axis.

2) Elevator

The elevator used to turn the airplane around the lateral axis.

3) Rudder

The rudder is the control surface on the tail of the airplane that can make the airplane yaw around its normal axis.

C. Secondary flight control

1) Flaps

Flaps are used during take-off and landing. They increase lift so the airplane can fly at a slower speed.

2) Slats

A Cessna is a small airplane and does not have slats. Every big airplane like a Boeing or Airbus is equipped with slats. These slats increase lift and camber, nose radius and the surface of the wing.

3) Spoilers

Spoilers have an important function; this is to counter the ground effect. Commercial airplanes have two kinds of spoilers: flight spoilers which are used during flight and ground spoilers which are only used on ground or during landings.

D. Flight Control System

Flight control system is the system, to actuate the flight control surfaces effective way by mechanically or electrically for the safe travel in aircraft. In our project we are using mechanical flight control system. It is explained in introduction page.

II. DESIGN METHODOLOGY

A. Wing Inner Parts Design

In our project, we have designed the ribs of various control surfaces (Elevator, Aileron, Flap, Rudder) by using Auto-CAD software. In our project, we have designed the plate type ribs. Plate type ribs are formed by using sheet metals.

B. CAD Diagram of Ribs

Various sizes of ribs are present in wings. The schematic view of each size of ribs are given below:

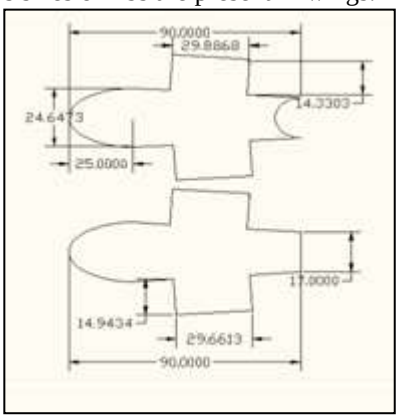

Fig. 1: Wing Ribs

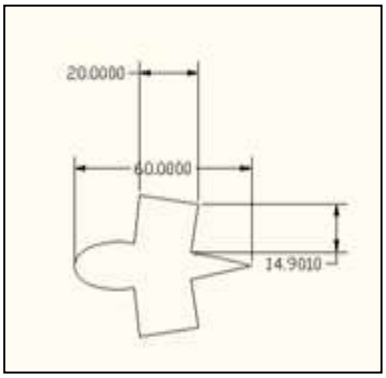

Fig. 2: Aileron and Flap Ribs

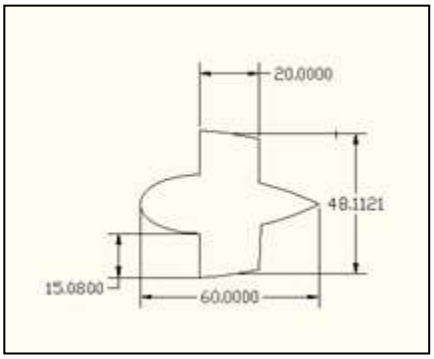

Fig. 3: Rudder Ribs

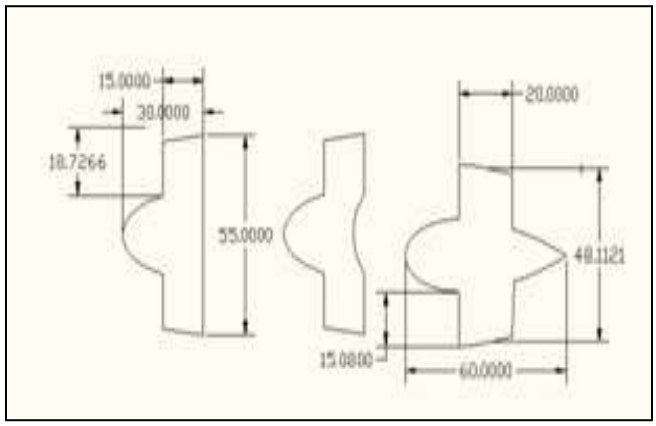

Fig. 4: Elevator Ribs

C. Making of ribs

Ribs are made using stainless steel material. The shapes of the ribs are made using LASER CUTTING METHOD. The thickness of the stainless steel material is 1.2mm.

Fig. 5: Fabricated ribs

D. Materials used in aircraft control surfaces

Control surfaces in aircraft are most commonly made by using materials which are Aluminum, Steel, Titanium, Composites. By comparing the above materials, we have used ALUMINUM and STAINLESS STEEL MATERIAL for fabrication of control surfaces.

III. FABRICATION OF FLIGHT CONTROL SURFACES

A. Fabrication

Fabrication of primary and secondary control surfaces of an aircraft is made by the use of various hand tools and machine tools.

Fig. 6: Schematic view of wing having ribs in it

IV. WORKING OF FLIGHT CONTROL SURFACES

A. Working of control surfaces

Control stick is turn left the left aileron move upwards and the right aileron move downwards. This imbalance of lift will cause the aircraft to rolls to left. Control stick is turning right the right aileron move upwards and the left aileron move downwards. This imbalance of lift will cause the aircraft to rolls to right. Move the control stick to right the elevator move upwards. In tail portion, the lift acts downwards. So, the nose moves up which leads to aircraft climb up. Move the control stick to left the elevator move downwards. In tail portion, lift increased. So, nose move down which leads to descent. Rudder of an aircraft controlled by rudder pedals. If the right pedal pushed the rudder moves to right. So the aircraft yaws to right. If the left pedal pushed the rudder moves to left. So the aircraft yaws to left. Flaps are controlled by lever. If the lever pulls back the flaps are moves downwards which lead to aircraft will get more lift. It is used to change the altitude of an aircraft during flight and it is also used both take-off & landing.

V. CONCLUSION

On analyzing the result of this project the primary control surfaces like aileron, rudder, elevator and flaps can also be controlled successfully, using mechanical linkage and pulley-cable system. In this project we are modify the elevator control. The control stick movement of elevator is left and right. The control stick move right the elevator deflect upwards and the control stick move left the elevator deflect downwards. But in aircraft, the forward and backward movement of control sticks to control the elevator deflection.

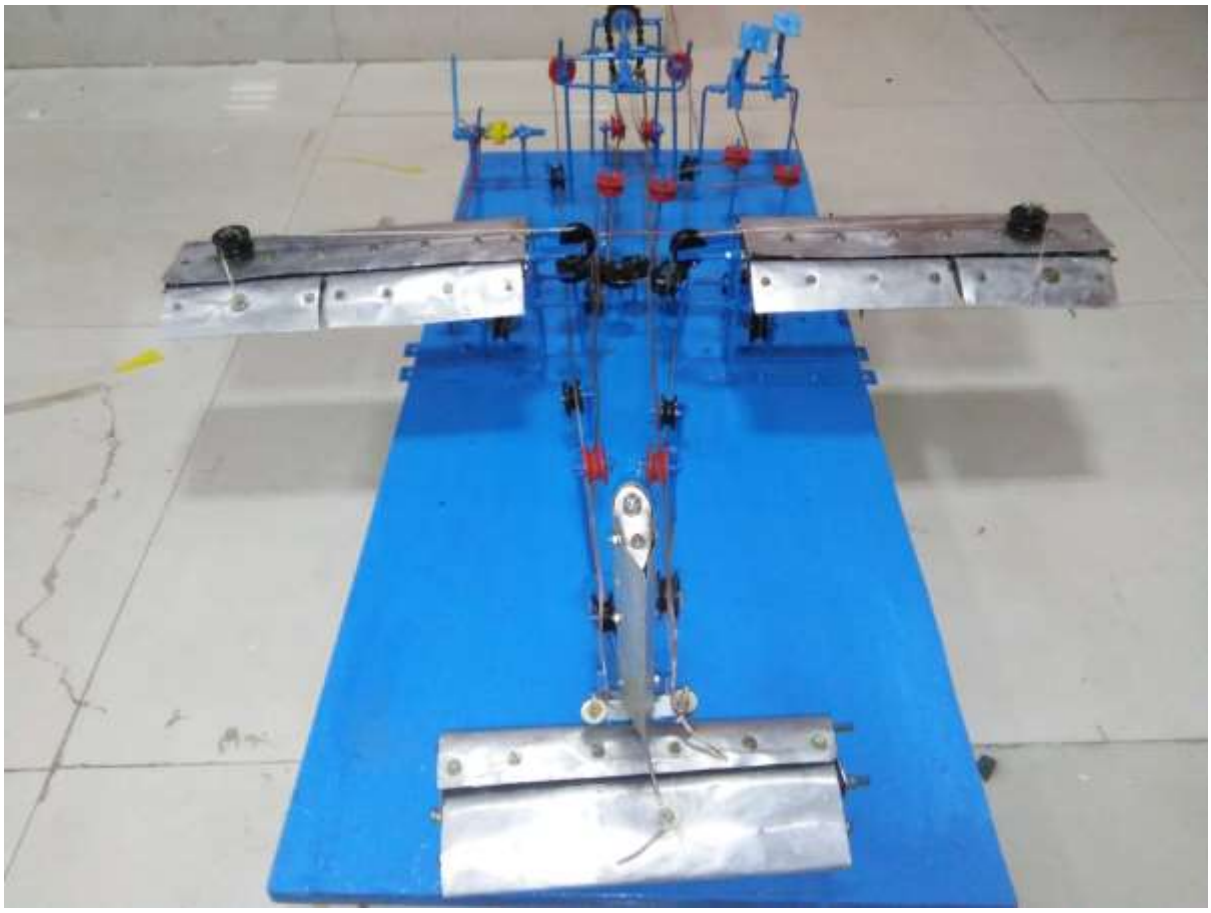

Fig. 7: Fabricated Project

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