

A Review Report on Electrical Tilt Rotor Mechanism for Vertical Take-off Landing

Himanshu Chauhan
Student (BE Aerospace, CU)
himanshu891999@gmail.com

Amit Naglu
Student (BE Aerospace, CU)
Amit.naglu@gmail.com

Kanchan Chauhan
Student (BE Aerospace, CU)
Chauhankanchan99@gmail.com

Pritesh Rai
Student (BE Aerospace, CU)
raipritesh@gmail.com

ABSTRACT

VTOL is the acronym for vertical take-off landing. The shortage of the runway in this world is main problem for aviation so VTOL are introduced as a new concept in aviation. In this era some military aircraft are using VTOL concept but commercially we are only using v-22 osprey and AW609. These aircraft are using hydraulics and mechanical mechanism for VTOL which increase the overall weight of aircraft therefore in this review paper we are going to describe about electrical tilt rotor mechanism for VTOL aircraft, which overall reduce the weight of aircraft.

Keywords

VTOL, V-22 osprey, AW609, Bell XV-15, fuselage.

1. INTRODUCTION

Vertical take-off landing (VTOL) aircraft is one that can hover. The idea of vertical flight has been around from thousands of years and sketch for a VOTL (helicopter) shows up in Leonardo da Vinci's sketch book as shown in fig 1.

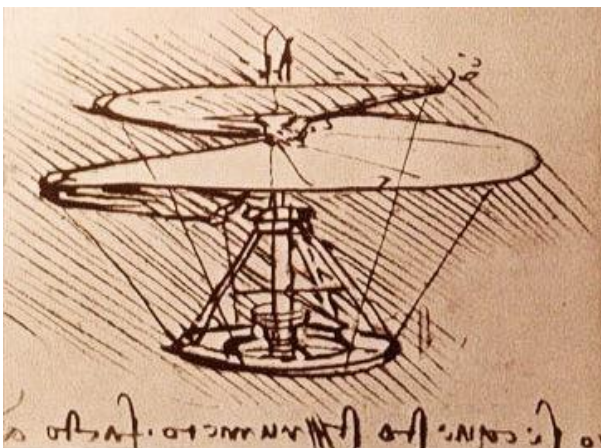


Figure 1. Leonardo Di Vinci's sketch of VTOL.

fig 1 is manned VTOL aircraft, in the form of primitive helicopter, first flew in 1907 and would take until after world war two to perfect. Many approaches have been made to develop practical aircraft including Henry Berliner 1922-1925

(horizontal rotor fixed wing aircraft), NASA has also flown other VTOL aircraft such as Bell XV-15 fig 2.



Figure 2. Bell XV-15.

Generally, till now the VTOL aircraft have been used hydraulics and mechanical system as their main mechanism for motion. The main drawback engineers are facing of increase weight, as weight is very important parameter in aviation and second the increasing pollution in atmosphere by burning of fuel. This shifts our attention from hydraulics and mechanical mechanism to electrical system.

Electrical tilt rotor mechanism for VTOL is very simple as compared to mechanical and hydraulics that have been used till now. The electrical system contains batteries in the fuselage, actuator that runs with the power of batteries, joints and shaft which connected with the both propellers. This mechanism not only reduces the overall weight of aircraft but also contribute in protecting our environment.

2. SYSTEM DESCRIPTION

The electrical mechanism for VTOL generally consists of batteries, actuator, joints, shaft and propellers.

Operation

Electrical mechanism contains batteries for power supply which will be located in fuselage. Batteries are connected with actuator. Actuator is connected with shaft using joint and shaft

is connected with casing of propellers. Location of propeller is on the wing and location of mechanism is in the fuselage.

These batteries are used by actuator (linear), actuator will give linear motion and tilt the shaft using joint. Now shaft will move the casing with the propellers to desired angle.

3. SELECTION OF COMPONENTS

3.1 Introduction

The basic procedure selection adapted to size or selection of the component for modeling and simulation needs a price calculations and selection to be made under the detail design of electrical mechanism

3.2 Batteries

A battery is device that produce electron through electrochemical reactions, and contains positive (+) and negative (-) terminals. A battery consists of one or more electrochemical cells, which transfer stored chemical energy directly into electrical energy. When a external load connect to a battery, electron cross through the negative to positive terminal creating an electric current. This current may power a, a light bulb, a clock, a computer, a cellphone, and other electronic devices or equipment.

TYPES OF BATTRIES

3.2.1 Primary batteries

The batteries which are not rechargeable comes under the category of primary batteries e.g. alkaline batteries.

2. Secondary batteries

secondary batteries are those batteries which chemical reaction can be reversed by applying some voltage to the battery in reversed direction.

These batteries can be rechargeable. There are four basic type of rechargeable batteries.

A) Nickel cadmium batteries

Properties of nickel cadmium batteries are listed below:

- Specific energy: 40-60W-h/kg
- energy density: 50-150W-h/L
- specific power: 150W/kg
- charge/discharge efficiency: 70-90%
- self-discharging rate: 10%/month
- cycle durability/life: 2000cycles

B) Nickel-Metal Hydride Batteries

Properties of nickel-metal hydride batteries are listed below:

- Specific energy: 60-120h/kg
- energy density: 140-300W-h/L
- specific power: 250-1000W/kg
- charge/discharge efficiency: 66-92%
- self-discharging rate: 1.3-2.9%/month at 20 degree Celsius
- cycle durability/life: 180-2000cycles

C) Lithium Ion Batteries

Properties of lithium ion batteries are listed below:

- Specific energy: 100-265W-h/kg
- energy density: 250-693W-h/L
- specific power: 250-340W/kg
- charge/discharge efficiency: 80-90%
- cycle durability/life: 400-1200cycles
- Nominal cell voltage: 3.6/3.5V

D) Lead Acid Batteries

Properties of lead acid batteries are listed below:

- Specific energy: 35-40W-h/kg
- energy density: 80-90W-h/L
- specific power: 180W/kg
- charge/discharge efficiency: 50-95%
- self-discharging rate: 4%/week

3.3 Actuators

Actuator is a component of machine which is responsible for the movement of other device or control surface. A actuator required source of signal or power.

TYPES OF ACTUATORS

3.3.1 Manual

Manual actuator employs levers, gear, or wheel to move the valve stem. Manual actuator power by hand.

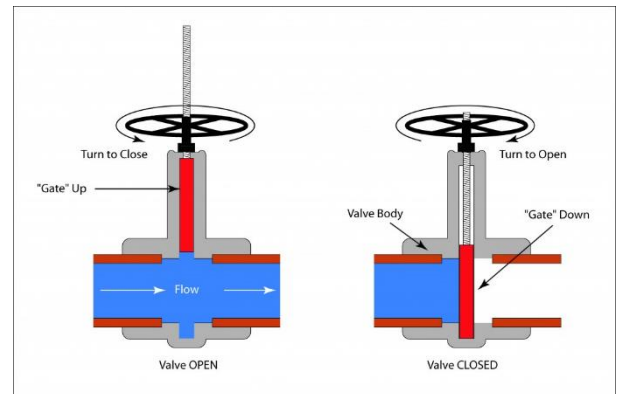


Figure 3 Manual control actuators

3.3.2 Penumatic

Air pressure is the power for pneumatic control valve actuator.

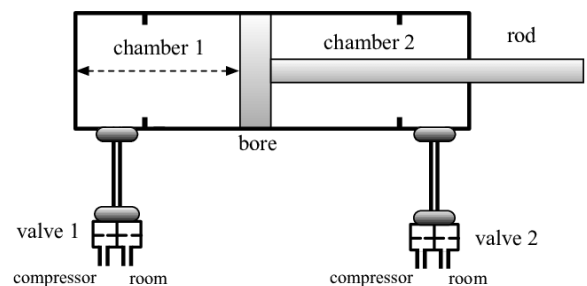


Figure 4 Penumatic control actuator

3.3.3 Hydraulic

Hydraulic actuator convert fluid pressure into motion.

3.3.4 Electrical

Electrical as reflect by its name use electric power to give motion.

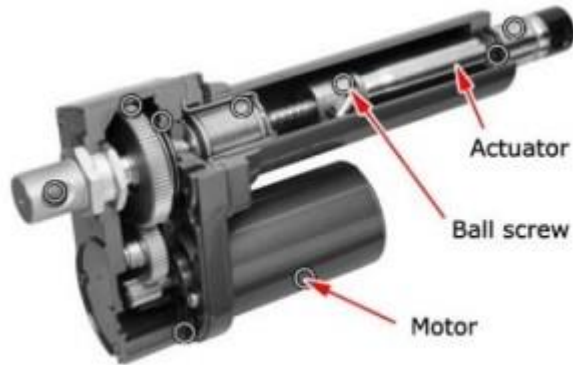


Figure 5 Electrical control actuator

3.4 Shaft

Shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to the another, or from a machine which produce power to a machine which absorb power.

3.5 Propeller

Propeller is a type of fan that transmits power by converting rotational motion into thrust. A pressure difference produced between the forward and rear surface of the airfoil-shaped blade, and fluid is accelerated by pressure difference.

4. SYSTEM SIMULATION MODEL

CATIA V5 R20

CATIA is computer-aided 3-dimensional interactive application is a multi-platform software suite for computer aided designing, manufactured by Dassault system. CATIA is used to make 3D design generally use for mechanical model. CATIA also provide you a kinematics module in which you can simulate your mechanism and check its motion in kinematics module in CATIA V5.

CATIA v5 provide several designing modules as well as kinematics modules so we can simulate our mechanism before practical application.

We design our mechanism on CATIA v5 in part module and simulate its motion in kinematics module of CATIA v5. Motion of our mechanism which is shown by CATIA is smoothly working.

5. CONCLUSION

The VTOL aircraft we are using today is hydraulic, pneumatic and mechanical control mechanism. These mechanisms overall increase the weight of aircraft. Weight is the important parameter in aviation. Electrical mechanism for VTOL is a solution for weight with pollution free system. Electrical

mechanism is overall reducing the weight of the aircraft and contributes toward the pollution free environment.

6. ACKNOWLEDGMENT

We thank aerosphere Pvt. Ltd. for providing the evaluation license of CATIA V5 software for 3D designing and simulation.

7. REFERENCES

- [1] https://en.wikipedia.org/wiki/List_of_VTOL_aircraft
- [2] <https://www.krossblade.com/vtol-vertical-take-off-and-landing>
- [3] <https://circuitdigest.com/article/different-types-of-batteries>
- [4] https://en.wikipedia.org/wiki/Valve_actuator
- [5] https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwiV8bLVr7XkAhUC3Y8KHx-5C9wQjRx6BAgBEAQ&url=https%3A%2F%2Fwww.lobalspec.com%2Flearnmore%2Fflow_transfer_control%2Fvalve_actuators_positioners%2Fmanual_valve_actuators&psig=AOvVaw396RjK2EMbyIkbw6WKR-K&ust=1567624787953291
- [6] <https://www.google.com/url?sa=i&source=images&cd=&ved=2ahUKEwjfpLz5r7XkAhVYmI8KHbYoAloQjRx6BAgBEAQ&url=http%3A%2F%2Fwww.electricalidea.com%2Fbenefits-of-electric-actuator%2F&psig=AOvVaw3N6vIM9Cx6C6xnBG8CnZVQ&ust=1567624892500144>
- [7] <https://en.wikipedia.org/wiki/CATIA>.