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HAL ARDC DIVISION (IRON BIRD) INTERNSHIP REPORT

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ACKNOWLEDGEMENTS

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It was a pleasure stay at HAL under the guidance of our division manager, who always had time for us and other trainer.

OVER VIEW OF REPORT:

This report entails the work experience scheme, Which will be used for our career The primary objective of this scheme is detailed comprehension of the theoretical approach to learning about IRON BIRD and the practical understanding of what is obtained in the ARDC division.The ARDC division trained us on aircraft simulation and testing. We have also learnt about the parts of the aircraft and how the testing of the aircraft takes place,and how to overcome the errors or any issues present in aircraft.

INTRODUCTION

Hindustan Aeronautics Limited (HAL) is an Indian public sector aerospace and defence company, headquartered in Bangalore. Established on 23 December 1940, HAL is one of the oldest and largest aerospace and defence manufacturers in the world. HAL began aircraft manufacturing as early as 1942 with licensed production of Harlow PC-5, Curtiss P-36 Hawk and Vultee A-31 Vengeance for the Indian Air Force HAL currently has 11 dedicated Research and development (R&D) centers and 21 manufacturing divisions under 4 production units spread across India. HAL is managed by a board of directors appointed by the President of India through the Ministry of Defence, Government of India. HAL is currently involved in designing and manufacturing fighter jets, helicopters, jet engines and marine gas turbine engines, avionics, software development, spares supply, overhauling and upgrading of Indian military aircraft.

The HAL HF-24 Marut fighter-bomber was the first indigenous fighter aircraft made in India.

Production Units:

Bangalore Complex:

- Aircraft Division Bangalore
- Engine Division Bangalore
- Overhaul Division Bangalore
- Foundry & Forge Division Bangalore
- Aerospace Division Bangalore
- IMGT Division Bangalore
- Airport Services Centre Bangalore
- LCA-Tejas Division Bangalore

HISTORY

Workers check new fuel tanks during World War II

HAL was established as **Hindustan Aircraft Limited** in Bangalore on 23 December 1940 by Walchand Hirachand in association with the then Kingdom of Mysore. Walchand Hirachand became chairman of the company. The company's office was opened at a bungalow called "Eventide" on Domlur Road.

The organisation and equipment for the factory at Bangalore was set up by William D. Pawley of the Intercontinental Aircraft Corporation of New York. Pawley obtained a large number of machine-tools and equipment from the United States.

The Indian Government bought a one-third stake in the company and by April 1941 by investing ₹25 lakh as it believed this to be a strategic imperative. The decision by the government was primarily motivated to boost British military hardware supplies in Asia to counter the increasing threat posed by Imperial Japan during Second World War. The Kingdom of Mysore supplied two directors, Air Marshal John Higgins was resident director. The first aircraft built was a Harlow PC-5.

On 2 April 1942, the government announced that the company had been nationalised when it had bought out the stakes of Seth Walchand Hirachand and other promoters so that it could act freely. The Mysore Kingdom refused to sell its stake in the company but yielded the management control over to the British Indian Government.

In 1943 the Bangalore factory was handed over to the United States Army Air Forces but still using Hindustan Aircraft management. The factory expanded rapidly and became the centre for major overhaul and repair of American aircraft and was known as the 84th Air Depot. The first aircraft to be overhauled was a Consolidated PBY Catalina followed by every type of aircraft operated in India and Burma. When returned to Indian control two years later the factory had become one of the largest overhaul and repair organisations in the East. In the post war reorganisation the company built railway carriages as an interim activity.

IJT prototype in its hangar

After India gained independence in 1947, the management of the company was passed over to the Government of India. The total number of broad- gauge coaches manufactured by Hindustan Aircraft Limited during the year 1954 is 158.

Hindustan Aeronautics Limited (HAL) was formed on 1 October 1964 (the Registrar of Companies has a registration date of 16 August 1963) when Hindustan Aircraft Limited joined the consortium formed in June by the IAF Aircraft Manufacturing Depot, Kanpur (at the time manufacturing HS748 under licence) and the group recently set up to manufacture MiG-21 under licence, with its new factories planned in Koraput, Nasik and Hyderabad. Though HAL was not used actively for developing newer models of fighter jets, except for the HF-24 Marut, the company has played a crucial role in modernisation of the Indian Air Force. In 1957 company started manufacturing Bristol Siddeley Orpheus jet engines under licence at new factory located in Bangalore.

Production line of the HAL Dhruv at Bangalore

During the 1980s, HAL's operations saw a rapid increase which resulted in the development of new indigenous aircraft such as the HAL Tejas and HAL Dhruv. HAL also developed an advanced version of the Mikoyan-Gurevich MiG-21, known as MiG-21 *Bison*, which increased its life-span by more than 20 years. HAL has also obtained several multimillion-dollar contracts from leading international aerospace firms such as Airbus, Boeing and Honeywell to manufacture aircraft spare parts and engines.

By 2012, HAL was reportedly bogged down in the details of production and has been slipping on its schedules. On 1 April 2015, HAL reconstituted its Board with TS Raju as CMD, S Subrahmanyan as Director (Operations), VM Chamola as Director (HR), CA Ramana Rao as Director (Finance) and D K Venkatesh as Director (Engineering & R&D). There are two government nominees in the board and six independent directors.

ight Combat Helicopter induction into the Indian Army

In March 2017, HAL Chairman and Managing Director T Suvarna Raju announced that the company had finalised plans for an indigenisation drive. The company plans to produce nearly 1, 000 military helicopters, including Kamov 226, LCH (Light Combat Helicopter) ALH (Advanced Light Helicopter), and over 100 planes over the next 10 years. HAL will manufacture the Kamov 226T helicopter under a joint venture agreement with Russian defence manufacturers. The Kamov 226T will replace the country's fleet of Cheetah and Chetak helicopters. Over the next 5 years, HAL will carry out major upgrade of almost the entire fighter fleet of Indian Air Force including Su-30MKI, Jaguars, Mirage and Hawk jets tʟo make them "more lethal". The company will also deliver 123 Tejas Light Combat Aircraft to the IAF from 2018 to 2019, at a rate of 16 jets per year. LCH production will now take place in a newly built Light Combat Helicopter Production Hangar at Helicopter Division in HAL Complex.

In view of Make in India policy and to increase the share of defence exports to achieve the target of $5 billion by 2025, HAL is planning to setup logistic bases in Indonesia, Malaysia, Sri Lanka, and Vietnam with priority target for Southeast Asia, West Asia and North African markets. It would not only help to promote HAL products but also act as service centre for Soviet/Russian origin equipment.

OPERATIONS

One of the largest aerospace companies in Asia, HAL has annual turnover of over US$3 billion. More than 40% of HAL's revenues come from international deals to manufacture aircraft engines, spare parts, and other aircraft materials. A partial list of major operations undertaken by HAL includes the following:

International Agreements:

HAL Dhruv helicopters of the Ecuadorian Air Force in 2009 Aero India

An IAF BAe Hawk being licence-produced at the HAL Hawk production facility in Bangalore

- US$1 billion contract to manufacture aircraft parts for Boeing.
- 120 RD-33MK turbofan engines to be manufactured for MiG-29K by HAL for US$250 million.
- Contract to manufacture 1,000 Honeywell TPE331 aircraft engines for Honeywell worth US$200,000 each (estimates put total value of deal at US$200 million).
- US$120 million deal to manufacture Dornier 228 for RUAG of Switzerland.
- Manufacture of aircraft parts for Airbus SAS worth US$150 million.
- US$100 million contract to export composite materials to Israel Aerospace Industries.
- US$65 million joint-research facility with Honeywell and planned production of Honeywell TPE331 engines.
- US$50.7 million contract to supply Advanced Light Helicopter to Ecuadorian Air Force. HAL will also open a maintenance base in the country.

- US$30 million contract to supply avionics for Malaysian Su-30MKM.
- US$20 million contract to supply ambulance version of HAL Dhruv to Peru.
- Contract of 3 HAL Dhruv helicopters for Turkey. worth US$20 million.
- US$10 million order from Namibia for HAL Chetak and Cheetah helicopters.
- Supply of HAL Dhruv helicopters to Mauritius National Police in a deal worth US$7 million.
- Unmanned helicopter development project with Israel Aerospace Industries.
- US$15 million contract for supplying steel and nickel alloy forgings to GE Aviation for its global military and commercial engine programmes.

Domestic Agreements:

- 221 Sukhoi Su-30MKI being manufactured at HAL's facilities in Nasik, Koraput and Bangalore. The total contract, which also involves Russia's Sukhoi Aerospace, is worth US$3.2 billion.
- 200 HAL Light Combat Helicopters for the Indian Air Force and 500 HAL Dhruv helicopters worth US$5.83 billion.
- US$900 million aerospace hub in Shamshabad, Telangana.
- US$57 million upgrade of SEPECAT Jaguar fleet of the Indian Air Force.
- US$55 million helicopter simulator training facility in Bangalore in collaboration with Canada's CAE.
- 64 MiG-29s to be upgraded by HAL and Russia's MiG Corporation in a programme worth US$960 million.

- Licensed production of 82 BAE Hawk 132.

Indigenous Products:

HAL Tejas

Over the years, HAL has designed and developed several platforms like the HF-24 Marut, the Dhruv, the LUH, and the LCH. HAL also manufactures indigenous products with technology transferred from the DRDO, in association with Bharat Electronics for its avionics and Indian Ordnance Factories for the on-board weapons systems and ammunition.

HAL supplies ISRO, the integrated L-40 stages for GSLV Mk II, propellant tanks, feed lines of PSLV, GSLV MKII and GSLV MKIII launch vehicles and structures of various satellites.

Agricultural Aircraft:

- HA-31 Basant

Fighter Aircraft:

HF-24 Marut

- HF-24 Marut — (retired) Mk.1 and Mk.1T (200+ built)
- HAL HF-73 — (cancelled)
- HAL Ajeet — (retired) a derivative of the British Folland Gnat, 89 built
- Tejas — Mk.1 (40 in service), Mk.1A (83 on order).
- Tejas MK2 (MWF) — 4.5+ generation medium weight fighter (under development) 2023 first flight expected.
- TEDBF — Twin Engine Deck Based Fighter is 4.5+ generation fighter for Indian Navy's aircraft carriers (under development)
- AMCA — Mk.1> 5th generation stealth fighter (under development), Mk.2> 5.5th generation stealth fighter (it will operate in CATS {combat air teaming system}, a UCAV in the swarm will be equipped with a direct energy weapon).

Trainer Aircraft:

HAL-26 Pushpak

HJT-16 Kiran

- HT-2 — First company design to enter production.
- HAL-26 Pushpak — Basic trainer, based on Aeronca Chief
- HPT-32 Deepak — Basic trainer in service for more than three decades.
- HJT-16 Kiran — Mk1, Mk1A and Mk2 - Turbojet trainers scheduled to be replaced with HJT-36 Sitara.
- HTT-34 — Turboprop version of HPT-32 Deepak
- HTT-35 — Proposed replacement for HPT-32 basic trainer in the early 1990s; not pursued
- HJT-36 Sitara — Intermediate jet trainer (under development)
- HTT-40 — Basic trainer (in production) first prototype flew its first flight on 31 May 2016 (106 ordered)
- HJT 39 / CAT — Advanced jet trainer (proposal)
- HLFT-42- Proposed lead fighter trainer.

Passenger, Transport and Utility Aircraft:

Saras, under joint development with National Aerospace Laboratories

- Saras — of 14–19-seater capacity multi-purpose civilian light transport aircraft jointly developed with NAL.
- Indian Regional Jet (IRJ) — (under development) of 70–100-seater capacity regional airliner to be jointly developed with NAL.

Helicopters: **HAL Dhruv of Indian Coast Guard**

Rudra armed helicopter

- Dhruv — (in production) Advanced light helicopter (350+ built)
- Rudra — (in production) Armed and reconnaissance version of Dhruv (90+ built)
- Prachand — (in production) Light attack helicopter (10+ built)
- Light Utility Helicopter — (in limited series production) Light utility helicopter
- Indian Multi-role Helicopter — (under development) medium multi-role helicopter

Observation and Reconnaissance Aircraft:

- HAOP-27 Krishak — Based on
- HAL-26 Pushpak

Unmanned Aerial Vehicles:

- PTA Lakshya - Unmanned Aerial Vehicle

- PTA Lakshya 2 - Unmanned Aerial Vehicle (TARGET DRONE)
- Nishant - Unmanned Aerial Vehicle
- Rustom - Unmanned Aerial Vehicle
- TAPAS - Unmanned Aerial Vehicle (MALE)
- NRUAV
- HAL Combat Air Teaming System (CATS)
- CATS Mothership for Air teaming Exploitation (MAX) - based on Tejas Mark 1A
- CATS Warrior
- CATS Air Launched Flexible Assets (ALFA) - Unmanned carrier and launcher of weaponized swarm drone ALPHA-S.
- CATS Hunter - Modular multi-purpose weapon carrying system
- CATS Infinity - High altitude solar powered atmospheric satellite

Gliders:

G-1 — HAL's first original design, dating from 1941. Only one was built.

- RG-1 Rohini
- Ardhra— training glider

Engines:

GTX-35VS Kaveri prototype testing

- CE-7.5 — cryogenic rocket engine
- CE-20 — cryogenic rocket engine
- PTAE-7 — For indigenously designed Lakshya PTA
- GTSU-110 — for starting main engine GE404 or Kaveri of LCA Tejas (under development)
- Shakti — a turboshaft engine for HAL Dhruv Helicopter, co-developed with Safran Helicopter Engines based on Safran Ardiden 1
- GTX-35VS Kaveri — a turbofan engine can be used in HAL-developed Tejas and AMCA, co-developed with GTRE of (DRDO) and Safran Aircraft Engines (under development or initial stage)
- HTFE-25 — a turbofan engine can be used in single engine trainer jets, business jets and UAVs weighing up to 5 tonnes and in twin engine configuration for same weighing up to 9 tonnes (under development)
- HTSE-1200 — a turboshaft engine can be used as engine alternatives for the HAL-developed LUH, Dhruv, Rudra and LCH helicopters (under development)

Licensed Production:

HAL Ajeet F.1

HAL made Su-30MKI

- Vampire — first combat jet manufactured by HAL, 250+ FB.52, 60 T.55 models
- Harlow PC-5 — first aircraft assembled by HAL
- Percival Prentice — 66 built by HAL
- Mikoyan-Gurevich MiG-21 — FL, M, Bis and Bison upgrades variants 660 built by HAL
- Folland Gnat
- Ajeet — improved version of the Folland Gnat
- Mikoyan-Gurevich MiG-27 — M variant
- SEPECAT Jaguar — IS, IB and IM variants
- BAE Hawk Mk 132 — scheduled production run of 42 aircraft
- Sukhoi Su-30MKI — a derivative of the Sukhoi Su-30
- HS 748 Avro — modified for military usage, includes Series 2M variant with large freight door
- Dornier 228 — 117 built + fuselage, wings and tail unit for production of the upgraded Dornier 228 NG variant
- Aerospatiale SA 315B Lama — HAL Cheetah, Lancer, Cheetal Variants
- Aerospatiale SA 316B Alouette III — HAL Chetak, Chetan Variants

- Rolls-Royce Turbomeca Adour Mk 811 — Engine for SEPECAT Jaguar, produced under licence
- Rolls-Royce Turbomeca Adour Mk 871 — Engine for BAE Hawk Mk 132, produced under licence
- Garrett TPE331-5 — Engine for Dornier 228, produced under licence
- Saturn AL-31FP — Engine for Sukhoi Su-30MKI, produced under licence
- Klimov RD-33MK — Engine for Mikoyan MiG-29, produced under licence
- Turbomeca TM 333 — Engine for HAL Dhruv Helicopter, produced under licence

IRON BIRD

An iron bird is a ground-based test rig used for prototyping and integrating aircraft systems during the development of new aircraft designs. Aircraft systems are installed into the iron bird so their functions can be tested both individually and in correlation with other systems.

Iron birds are used for system integration, reliability testing, and shakedown testing of aircraft systems such as landing gear, avionics, hydraulics, and flight controls. The components may be arranged roughly in the same layout as they will be in the final aircraft design, but left accessible for ease of maintenance. Some iron birds also include a flight deck so that testing can include pilot inputs and simulated flight profiles, and can be used in pre- flight pilot training. Others are used for testing of propulsion systems.

Iron birds can also be used after aircraft certification for troubleshooting ongoing issues and for testing of proposed modifications prior to fleet integration.

- Iron birds are a valuable tool for the development and testing of new aircraft. They help to ensure that the aircraft are safe and reliable, and they can also help to shorten the development time for new aircraft.
- The name "iron bird" is a reference to the fact that the test rig is a metal bird that can fly. The term is often used interchangeably with "ground-based test system" (GBTS).
- Iron birds are a valuable asset to the aircraft industry. They help to ensure that new aircraft are safe and reliable, and they can also help to shorten the development time for new aircraft.

Here are some of the benefits of using iron birds:

- They allow for the testing of aircraft systems in a controlled environment.
- They can be used to test systems that are difficult or impossible to test in flight.
- They can help to identify and correct problems with aircraft systems before the aircraft is flown.
- They can help to shorten the development time for new aircraft.

Iron birds are an important part of the aircraft development process. They help to ensure that new aircraft are safe and reliable, and they can also help to shorten the development time for new aircraft.

PARTS OF TEJAS MK1A :

- REFULING PROBE
- NOISE AIR DATA PROBE
- SIDE AIR DATA PROBE
- AOA VANES
- AOSS VANES
- AESA RADAR

- AIR DATA COMPUTER
- FLIGHT CONTROL PANEL
- DIGITAL FLIGHT CONTROL COMPUTER
- DE-ICING CURRENT SENSING UNIT
- ELCETRONIC SAFER SYSTEM
-
  - TWIN SHORG RANGE MISSLING
  - BEYOND VISUAL RANGE MISSLING
  - LOWER GUIDED BOMB
- INDIGENEOUS SLAT ACTUATORS (6)
- INDIGENEOUS ELEVON ACTUATORS (4)
- INDIGENEOUS AIRBRAKE ACTUATORS (2)
- INDIGENEOUS RUDDER ACTUATORS
- RATE SENSOR ASSEMBLY
- ACCELERATION SENSOR ASSEMBLY
- MIL-1553B RECORDING UNIT
- FIT-RS422 RECORDING UNIT
- TOTAL AIR TEMPERATURE PROBE
- PILOT CONTROL
- NEW AVIONICS SUITE

Combined interrogator transponder	New mission computer	UVDR	Smart multi-functional display	Digital map generator

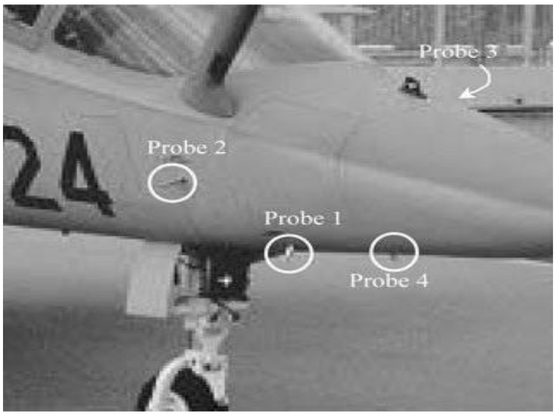
Refuelling probe :

This is attached to a flexible hose that trails behind the refueler. To refuel, the refueler flies in front of the fighter, whose pilot guides the probe into the drogue.It is used for fueling the fighter plane in air.

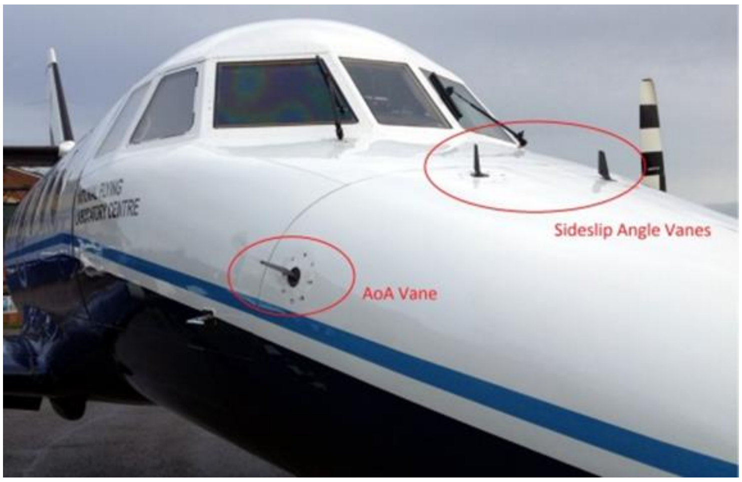
Noise air data probe :

Designed for simple integration with the Micro Air Data Computer (µADC), the Air Data probe is an effective lightweight solution for measuring angle ofattack, angle of sideslip, airspeed, and altitude where mobility is critical,With no moving parts, the Air Data probe is a reliable choice for pilots, drivers, and engineers looking to push the limits of performance and control.

Air Data probes allow for calculation of the complete flow vector. Its comprehensive design improves on traditional air data solutions (ex: Air Data Boom) by eliminating pitch and yaw vanes, which have moving parts with inertial effects that introduce inaccuracy and increase weight and response time.



AOA VANES



The alpha vane (also called AoA vane) is an external probe used to measure the angle of attack. Angle of attack (AOA) is the angle between the oncoming air or relative wind and a reference line on the airplane or wing. Sometimes, the reference line is a line connecting the leading edge and trailing edge at some average point on the wing. small, wedge-shaped vane on the end of a movable arm senses the airflow. The arm is free to rotate through an arc of 60 degrees and is accurately counterbalanced so that the position of the arm is determined entirely by the airstream direction around the wedge-shaped vane.An angle of attack indicator offers a visual indication of the amount of lift the wing is generating at a given airspeed or angle of bank. The AOA delivers critical information visually or through an aural tone to indicate the actual safety margin above an aerodynamic stall.

AOSS VANES

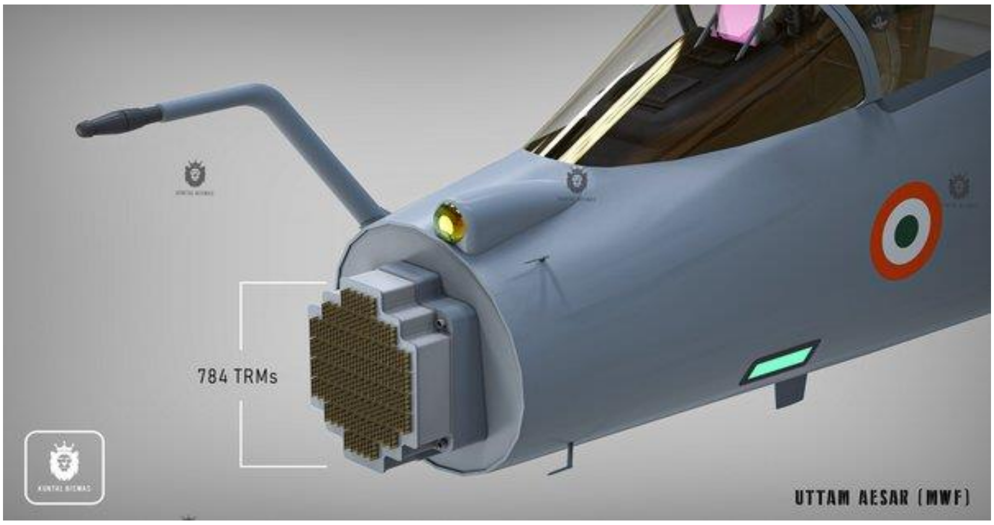
AOSS vanes, or angle-of-sideslip vanes, are small, aerodynamically shaped vanes that are mounted on the wingtips of some aircraft. They are used to measure the angle of sideslip (AOSS), which is the angle between the aircraft's longitudinal axis and the direction of the oncoming airflow. The AOSS vanes measure the AOSS by sensing the difference in pressure between the two sides of the vane.

The AOSS vanes are an important part of the aircraft's air data system, which provides information about the aircraft's attitude, speed, and altitude. The AOSS vanes are used to calculate the aircraft's sideslip angle, which is used by the aircraft's flight control system to maintain the aircraft's heading.AOSS vanes are typically made of lightweight materials, such as aluminum or titanium. They are mounted on the wingtips in such a way that they are aligned with the direction of the oncoming airflow. The vanes are typically very small, with a length of only a few inches.

The AOSS vanes are a relatively simple and reliable way to measure the angle of sideslip. However, they can be affected by the aircraft's speed and altitude. For this reason, the AOSS vanes are typically calibrated before each flight.

Overall, AOSS vanes are a valuable tool for measuring the angle of sideslip in aircraft. They are relatively simple and reliable, and they can be used in a variety of aircraft. However, they are not without their limitations, and they should be used in conjunction with other sensors to provide accurate information about the aircraft's attitude.

AESA RADAR



AESA radar systems use phased array antennas with transmit/receive (T/R) modules dedicated to each element. PESA radar systems use a single T/R module that is shared across all antenna elements. ESA radar systems can scan a volume of space faster and more reliably than radar that is mechanically steered. Dedicated to the Rafale, the RBE2 is the Europe's first-ever AESA radar delivered to Forces. It is combat proven on board the Rafale for the French Air Forces. It also equips the Rafale for Egyptian, Qatari, Indian, Greek, Croatian, UAE and Indonesian Air Forces. Very few countries in the world have developed AESA radar. They are China, US. Israel and European Union. The Indian made AESA is capable of tracking 50 targets in a sky range of 100 km.50 nautical miles, Modern fighter aircraft employing AESA fire control radars are able to acquire and track targets at long ranges, in the order of 50 nautical miles or more. One of the major advantages of an AESA system its high degree of resistance to electronic jamming techniques. Radar jamming is usually done by determining the frequency at which an enemy radar is broadcasting and then transmitting a signal at that same frequency to confuse it.

AIR DATA COMPUTER

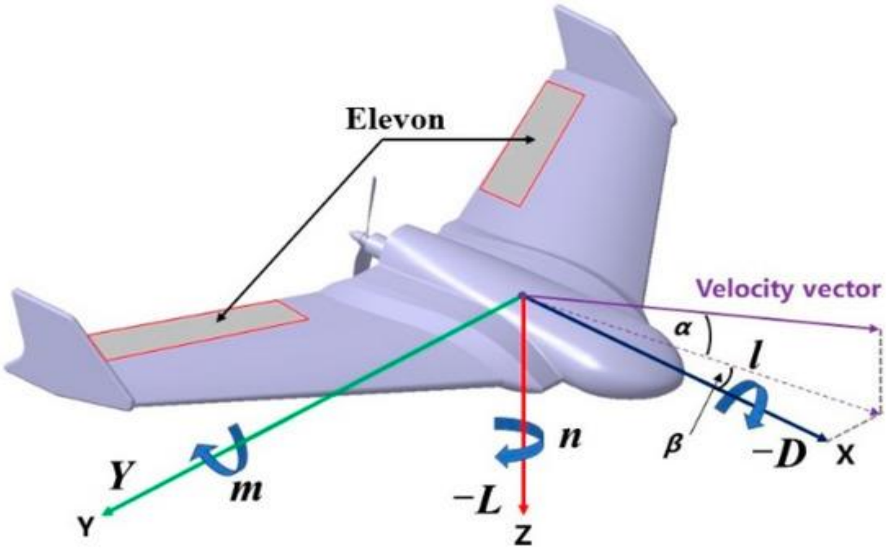
An air data computer (ADC) is an essential avionics component found in aircraft. This computer, rather than individual instruments, can determine the calibrated airspeed, Mach number, altitude, and altitude trend data from an aircraft's Pitot Static System.The air data computer receives inputs of static pressure, pitot pressure, total temperature and angle of attack. These inputs are corrected in the ADC to compensate for errors in the sensing equipment. The ADC can be toggled using the three-position switch found inboard of the throttle levers.Typical components of air data systems are total air temperature (TAT) probes, angle of attack (AOA) vanes and probes, Pitot probes, Pitot Static probes, multi-function probes (MFP) and outside air temperature (OAT) probes. Our air data modules include: Industry-leading modules such as size, weight and power (SWAP).

FLIGHT CONTROL PANEL

The flight control panel is a panel in the cockpit of an aircraft that contains the controls for the aircraft's primary flight controls. These controls are the ailerons, elevators, and rudder. The flight control panel also contains the controls for the aircraft's autopilot and other flight automation systems. The ailerons are located on the trailing edges of the aircraft's wings. They are used to control the aircraft's roll, or side-to-side movement. The elevators are located on the trailing edge of the aircraft's horizontal stabilizer. They are used to control the aircraft's pitch, or up-and-down movement. The rudder is located on the trailing edge of the aircraft's vertical stabilizer. It is used to control the aircraft's yaw, or left-and-right movement.

The flight control panel is typically located in front of the pilot. It is a critical part of the aircraft's flight controls, and it allows the pilot to safely and effectively control the aircraft .Here are some of the components that can be found on a flight control panel. The flight control panel can vary in size and complexity depending on the type of aircraft. However, the basic components listed above are typically found on all flight control panels.

ELEVON ACTUATOR



Elevon actuators :Elevons or tailerons are aircraft control surfaces that combine the functions of the elevator (used for pitch control) and the aileron (used for roll control), hence the name. They are frequently used on tailless aircraft such as flying wings.An elevon serves the same function as an elevator and an aileron. Elevons are moveable control surfaces located on the trailing edge of the wings. Working in unison (both up or both down) they function as elevators.Flaperons" work pretty much the same way as "Elevons" except the elevator component is controlled by the flap channel so there's no upward deflection from the flap channel like there would be if it was the elevator channel.Elevators control motion along the lateral axis. The lateral axis is an imaginary line that extends crosswise, from wingtip to wingtip. Motion about the lateral axis is called pitch.

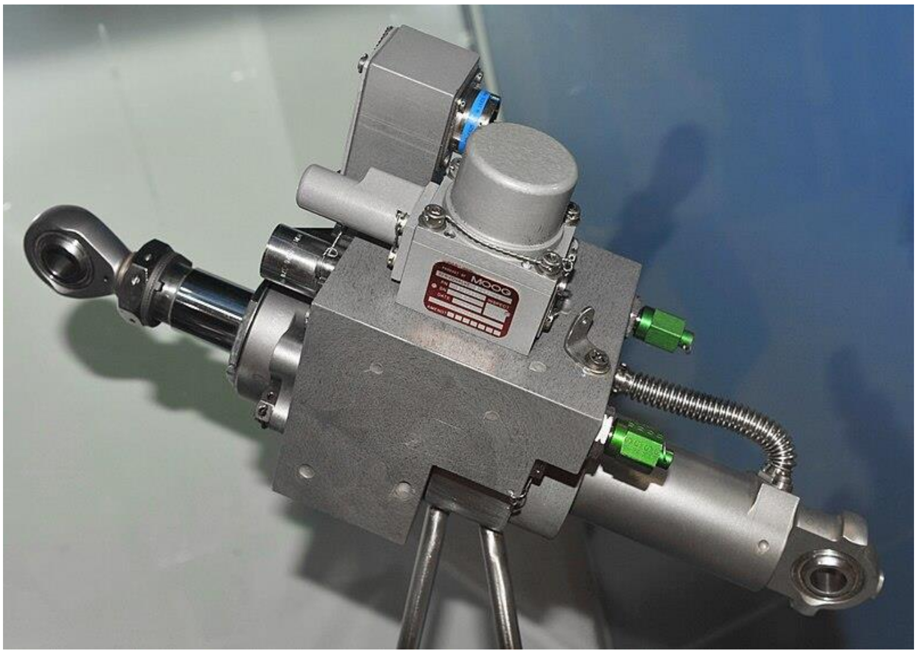
RATE SENSOR ASSEMBLY

Rate sensor assembly in an aircraft is a device that measures the angular velocity of the aircraft around a particular axis. This information is used by the aircraft's flight control system to keep the aircraft stable and to control its attitude. There are two main types of rate sensors used in aircraft. Gyroscopes measure angular velocity by using a spinning wheel or disk. As the wheel spins, it resists any change in its direction of rotation. This resistance is called gyroscopic inertia. The rate sensor measures the amount of gyroscopic inertia that is present, and this information is used to calculate the angular velocity of the aircraft .Here are some of the benefits of using rate sensor assemblies in aircraft:They provide accurate and reliable measurements of angular velocity. They are relatively small and lightweight. They are relatively inexpensive.

AIR BRAKE ACTUATORS

Airbrake actuators are devices that convert compressed air into mechanical force, which is used to apply the brakes on a vehicle. They are typically found on heavy vehicles such as trucks and buses, but they can also be found on some cars. Airbrake actuators work by using a piston to move a lever or a rod. The piston is connected to a chamber that is filled with compressed air. When the air pressure in the chamber increases, it pushes the piston, which moves the lever or rod. This movement applies the brakes on the vehicle. There are two main types of airbrake actuators: service actuators and parking actuators. Service actuators are used to apply the brakes during normal braking, while parking actuators are used to apply the brakes when the vehicle is parked. Here are some of the benefits of airbrake actuators: They are very reliable and durable. They are easy to maintain. They are relatively inexpensive. Here are some of the drawbacks of airbrake actuators: They can be susceptible to leaks. They can be affected by extreme temperatures. They can be difficult to diagnose if they malfunction.

RUDDER ACTUATOR



A rudder actuator is a device that converts hydraulic or pneumatic pressure into mechanical force, which is used to move the rudder on an aircraft. The rudder is a large, vertical fin that is used to control the aircraft's yaw, or left-and-right movement. Rudder actuators are typically located in the tail of the aircraft, and they are connected to the rudder by a linkage system. When the pilot moves the rudder pedals, it sends a signal to the rudder actuator, which in turn moves the rudder. There are two main types of rudder actuators: hydraulic actuators and pneumatic actuators. Hydraulic actuators use hydraulic fluid to move the rudder, while pneumatic actuators use compressed air. Hydraulic actuators are more common, but pneumatic actuators are becoming more popular due to their lighter weight and lower maintenance requirements. Here are some of the benefits of rudder actuators: They allow the pilot to control the aircraft's yaw .They are reliable and durable. They are easy to maintain .Overall, rudder actuators are a safe and effective way to control the rudder on an aircraft. They are reliable, durable, and relatively inexpensive. However, they can be susceptible to leaks and can be affected by extreme temperatures. Here are some of the different types of rudder actuators:Hydraulic actuators: These are the most common type of rudder actuator. They use hydraulic fluid to move the rudder.

TOTAL AIR TEMPERATURE PROBE

Total air temperature (TAT) probe is a device that measures the temperature of the air flowing past an aircraft. The TAT probe is typically mounted on the nose or side of the aircraft, and it is connected to the aircraft's air data computer. Total air temperature (TAT) prob. The TAT probe works by bringing the air to rest relative to the aircraft. As the air is brought to rest, kinetic energy is converted to internal energy. The air is compressed and experiences an adiabatic increase in temperature. Therefore, total air temperature is higher than the static (or ambient) air temperature. TAT is an essential input to the air data computer, which is used to calculate the aircraft's true airspeed, Mach number, and altitude. TAT is also used to determine when to use the aircraft's anti-icing systems. There are two main types of TAT probes: heated and unheated. Heated TAT probes are used in aircraft that fly at high altitudes, where the air is very cold. The heating element in the probe prevents the probe from freezing and prevents the temperature measurement from being inaccurate. Unheated TAT probes are used in aircraft that fly at lower altitudes, where the air is not as cold.TAT probes are an important part of the aircraft's flight control system. They ensure that the aircraft's true airspeed, Mach number, and altitude are accurately measured, which helps to ensure the safe and efficient operation of the aircraft.

DIGITAL FLIGHT CONTROL COMPUTER

The Digital Flight Control Computer (DFCC) plays a crucial role in the Iron Bird of HAL Tejas aircraft during its testing and development phases. The Iron Bird is a full-scale ground-based aircraft simulation platform used to evaluate and validate the aircraft's flight control systems before actual flight testing. The DFCC is an essential component of the Iron Bird, and its functions are as follows:

Flight Control System Simulation: The DFCC emulates the flight control system of the Tejas aircraft on the Iron Bird. It processes control inputs from various sources, including the pilot controls and autopilot, and calculates control surface commands required to achieve the desired flight maneuvers.

Real-Time Monitoring and Feedback: The DFCC continuously monitors the responses of the simulated control surfaces and aircraft systems during the ground tests. It compares the actual responses with the expected outcomes based on the simulated flight conditions, providing real-time feedback to engineers and test pilots.

Verification of Control Laws:The Iron Bird allows engineers to test and validate the effectiveness of different control laws and algorithms designed for the Tejas aircraft. The DFCC implements these control laws and assesses their performance in various flight scenarios.

Stability and Control Analysis:By simulating flight conditions and control inputs, the DFCC helps in analyzing the stability and control characteristics of the Tejas aircraft. Engineers can assess how the aircraft responds to different maneuvers and conditions.

Failure Simulation and Redundancy Testing: The DFCC enables engineers to simulate system failures or anomalies and test the aircraft's ability to handle such situations. It also verifies the functionality of redundant systems in case of primary system failures.

Integration Testing: The DFCC serves as a critical element in the integration testing of the flight control system with other aircraft systems and avionics. It allows engineers to ensure seamless coordination and compatibility among various systems.

Reduced Risk Testing: Using the Iron Bird with the DFCC allows for comprehensive testing in a controlled environment, significantly reducing the risks associated with initial flight testing of a new aircraft.

Overall, the Digital Flight Control Computer in the Iron Bird of HAL Tejas aircraft plays a pivotal role in testing and validating the flight control system, ensuring the safety, reliability, and performance of the aircraft before it undergoes actual flight trials. It allows engineers to fine-tune the aircraft's behavior and optimize its control laws, contributing to the successful development of a high-performance and state-of-the-art fighter aircraft.

AIM:

Design and Demonstration of Pitch and Roll Control Using Elevons in a Fighter Plane Model.

Materials Required:

1. Cardboard: Used for the construction of the fighter plane model's body and wings.
2. Servo Motors: Integrated into the model to simulate elevon movement and control.
3. Arduino Board: Employed as the central control system to drive the servo motors and translate control signals.

1. Jumper Wires: Connected the Arduino board to the servo motors, facilitating the transmission of control signals.
2. Connectors: Ensured secure connections between the servo motors and the Arduino pins.
3. Control Interface (e.g., Remote Control, Computer): Used to activate the servo movements during the model's demonstration.
4. Tools (e.g., Cutting knife, Scissors, Glue Gun): Utilized for the assembly and construction of the fighter plane model.

THEORY:

RUDDER: The rudder is an important control surface on an aircraft that plays a crucial role in controlling its yaw motion. Yaw is the side-to-side movement of the aircraft's nose, usually around the vertical axis. The rudder is typically located at the trailing edge of the vertical stabilizer or fin at the rear of the aircraft.

The primary function of the rudder is to control the yaw by creating a differential drag force on either side of the aircraft. When the pilot applies rudder input, the rudder deflects either to the left or right. If the rudder moves to the left, it creates more drag on the left side of the aircraft, causing it to yaw to the left. Similarly, when the rudder moves to the right, it creates more drag on the right side, causing the aircraft to yaw to the right.

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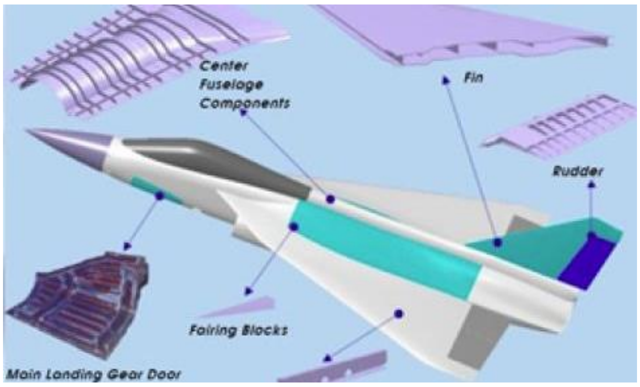
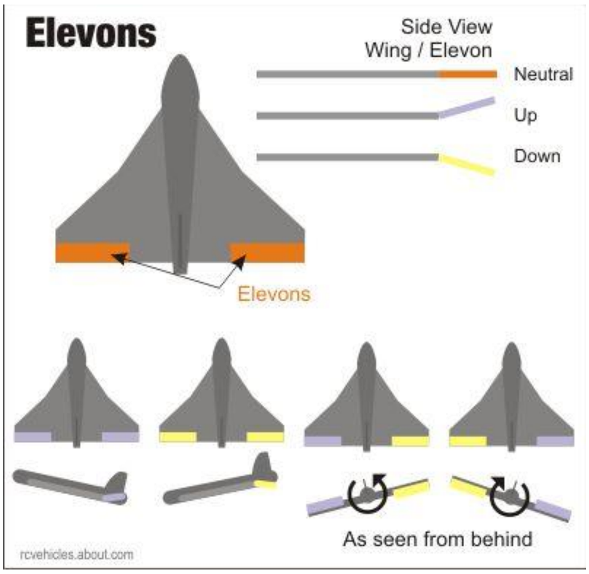


The rudder is especially important during various flight phases, such as takeoff, landing, and coordinated turns. It helps the pilot maintain stability and directional control during crosswind landings, stabilize the aircraft during turns, and assist in maintaining a straight flight path.

Elevons, Levcons, Ailerons, and 3-segment Leading Edge Slats are all different types of control surfaces used on aircraft to control their flight.

1. Elevons:

    - Elevons are control surfaces that combine the functions of elevators and ailerons.
    - They are typically found on delta-wing aircraft and some modern fighter planes.
    - Elevons control both pitch (upward and downward movement) and roll (tilting left and right) of the aircraft.



2. Levcons:

    - Levcons are not a widely known term in the context of aircraft control surfaces.
    - It is possible that there might be a typo or miscommunication, or it could refer to a specific type of control surface used in certain aircraft models not commonly known by that name.

3. 3.AILERONS:

    - Ailerons are control surfaces typically located on the trailing edge of the wings.

- They control the roll motion of the aircraft by moving in opposite directions.
- When one aileron moves up, the other moves down, creating differential lift and causing the aircraft to roll left or right.

4. 3-Segment Leading Edge Slats:
    - Leading Edge Slats are movable surfaces located on the leading edge of the wing.
    - They can be divided into multiple segments, such as 3-segment slats.
    - Leading Edge Slats are used to enhance the lift characteristics of the wing at lower speeds, such as during takeoff and landing, by increasing the wing's camber and airflow over the wing.

PROCEDURE:

1)Gather Components and Materials:

- Arduino board
- Two servo motors with power, ground, and signal wires
- Jumper wires
- Fighter plane model components (cardboard, foam board, adhesive, etc.)

2) Connect Servo Motors to Arduino:

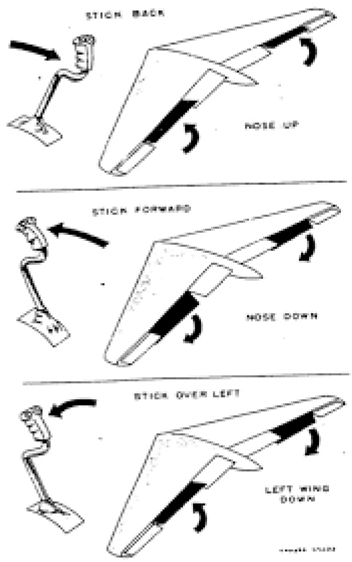
- Connect the power wire (typically red) of each servo motor to the 5V pin on the Arduino board.,Connect the ground wire (typically black or brown) of each servo motor to a ground (GND) pin on the Arduino board and Connect the signal wire (typically yellow or orange) of each servo motor to a PWM (Pulse Width Modulation) pin on the Arduino board, such as pin D3 for servo1 and D5 for servo2.

3) Upload Code to Arduino:

- Connect the Arduino board to your computer using a USB cable.
- Verify that your code has no errors by clicking the "Verify" button in the Arduino IDE.
- If there are no errors, click the "Upload" button to upload the code to your Arduino board.

4) Observe Elevon Movement

movement	Elevonposition
Neutral	0degrees(horizontal)
Pitch up	-45degrees
Pitchdown	+45degrees
Roll left	Left elevon up,right elevon down
Roll right	right elevon up,left elevon down



- Two elevons are present on each wing, making a total of four elevons for the aircraft. These elevons serve as control surfaces that combine the functions of both elevators (for pitch control) and ailerons (for roll control). The use of four elevons allows for precise .
- Pitch Movement: The elevons moved in unison to control the pitch of the model, simulating nose-up and nose-down maneuvers.
- Roll Movement: The elevons moved differentially to induce roll, replicating left and right tilting of the model.
- The stick is in right when the left elevon deflected down causing in downward force and right elevon deflected up then ROLL TO RIGHT movement in jet.

- The stick is in left when the left elevon deflected up causing in downward force and right elevon deflected down then ROLL TO LEFT movement in jet.

- Stick moved farward then pitch down movement occurs.(in pitch down moment both sides elevon in same direction +45 degrees)

- Stick moved backward then pitch up movement occurs.(in pitch up moment both sides elevon in same direction -45 degrees)

5)In our project we are not using the stick we are controlling the elevons using arudino in built program,according to our program (inputs angles in program)the elevon action occurs.

According to the above table the movement occurs.

6) Observe Elevon Movement:

- After uploading the code, the Arduino will control the servo motors connected to the specified PWM pins.

- Observe the elevon movement as the code executes the specified actions (e.g., moving elevons parallel up and down).

- Depending on our project's requirements, we may need to fine-tune the servo positions (angles) and delays to achieve the desired elevon movement behavior.

7) Attach Servo Motors to Fighter Plane Model:

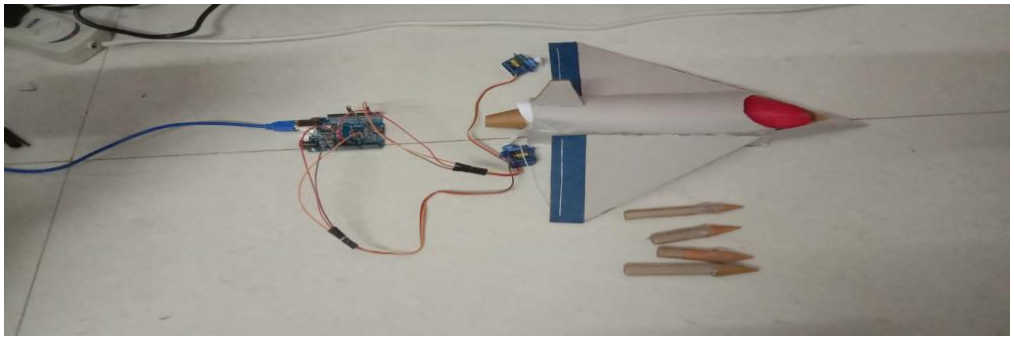
- Mount the servo motors on the model, connecting the elevons to the servo arms in a way that allows controlled movement.

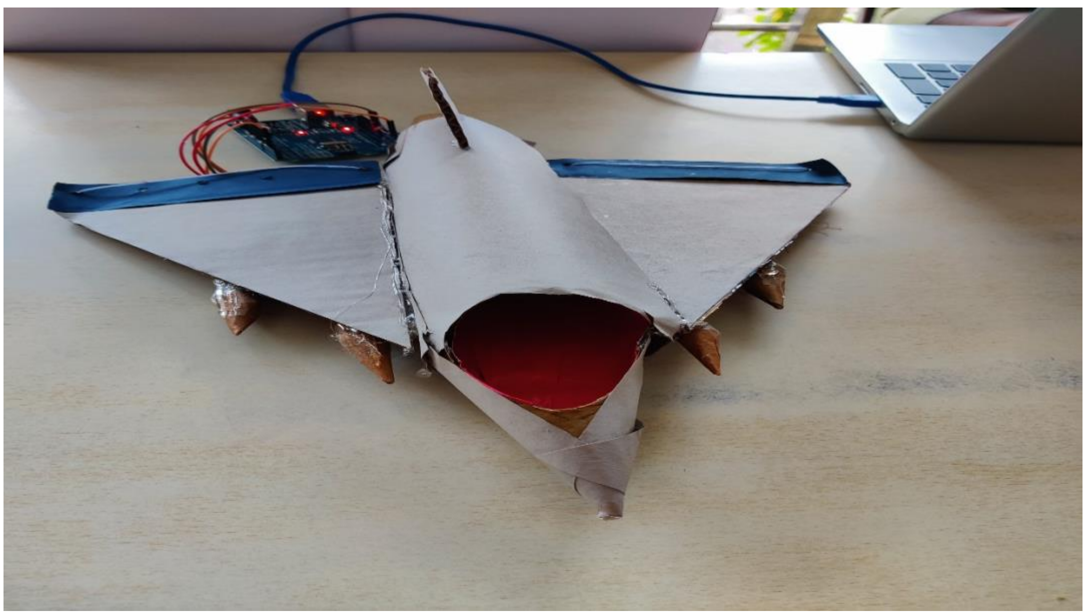
8)observe the elevon movements of pitch,roll .

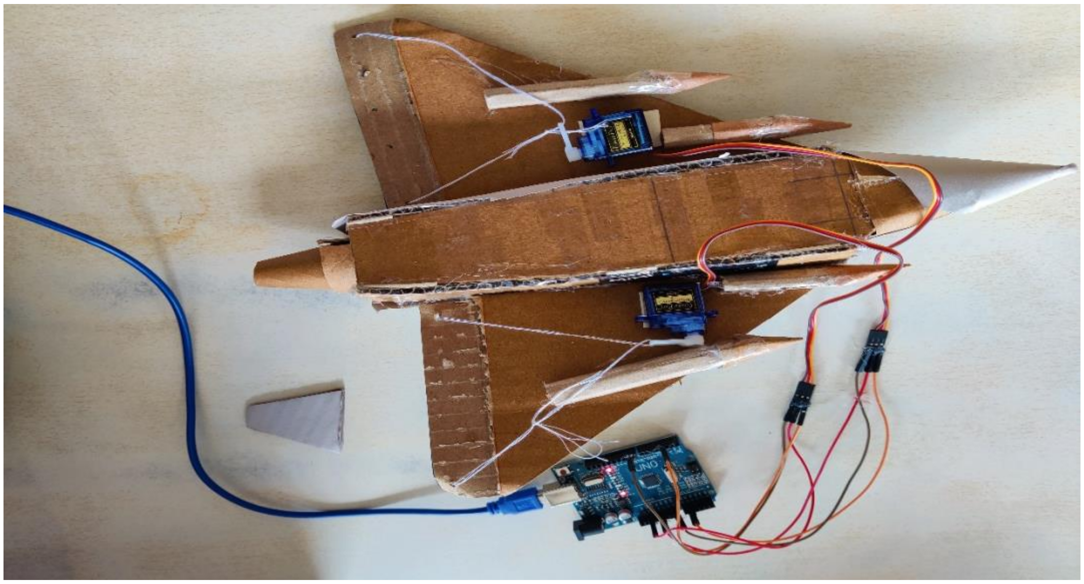
RELATED CODE

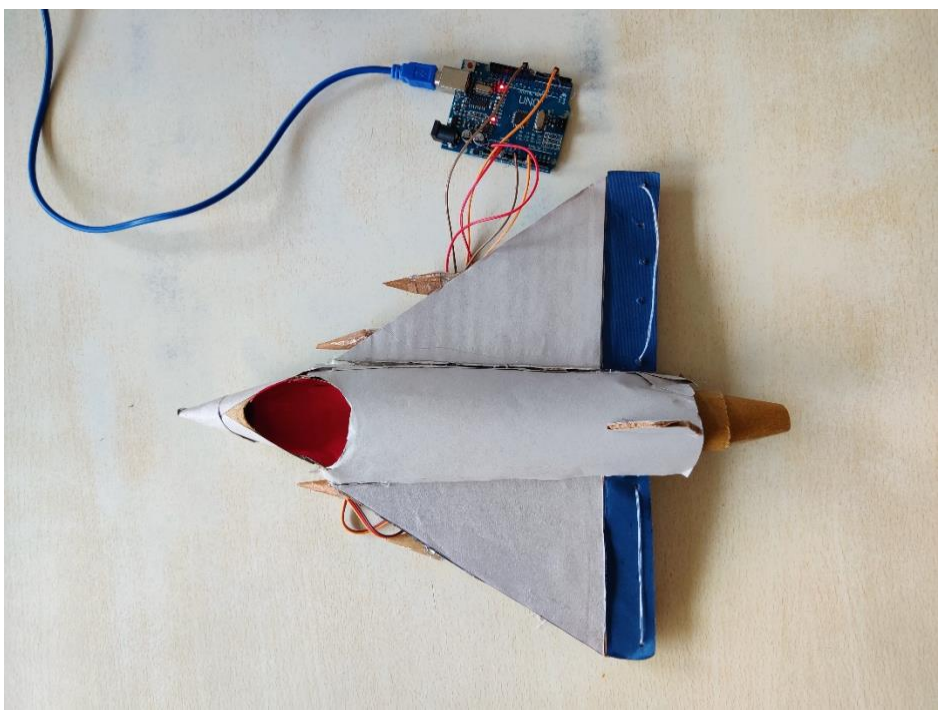
```
#include <Servo.h>
Servo servo1;
Servo servo2;
int servopos = 0;

void setup() {
servo1.attach(3);
servo2.attach(5);
}

void loop() {
for (servopos = 0; servopos <= 180; servopos++) {
servo1.write(servopos);
servo2.write(servopos);
delay(20);
}

for (servopos = 180; servopos >= 0; servopos--) {
servo1.write(servopos); servo2.write(
```

RELATED PICTURES:









VIDEO REFERNCE: https://drive.google.com/drive/folders/19NW6s-h9BRstMmBm0tbLGZrttYgJsMsn?usp=drive_link

Conclusion:

The project achieved its objectives by constructing a realistic delta plane model with movable elevons, integrating two servo motors controlled by an Arduino. The elevons demonstrated effective pitch and roll control during various flight maneuvers, highlighting their importance in aircraft design. As an educational tool, the project provided valuable insights into elevon movement and its significance in achieving stable and agile flight characteristics. Overall, the successful demonstration contributes to advancing knowledge in aerospace engineering.