Tishk International University
Engineering Faculty
Mechatronics Engineering Department

Avionics

TOPIC:FLY-BY-WIRE(FBW)

Week8_Lecture8

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FLY-BY-WIRE(FBW)

CONTENT

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- History of FBW
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References

fly by wire
powerful systems responding efficiently
in order to facilitate desired outcomes

Figure 1

NEED OF FBW

- **Traditionally commercial gyroscopes were used to control aircrafts.**
- **Result - The response of the system not linear.**
- **Robust control can’t be achieved.**
- **Lift = ½. ρ.V^2.A.C_L**
- **Flights overly responsive at higher speed and less responsive at lower speed.**

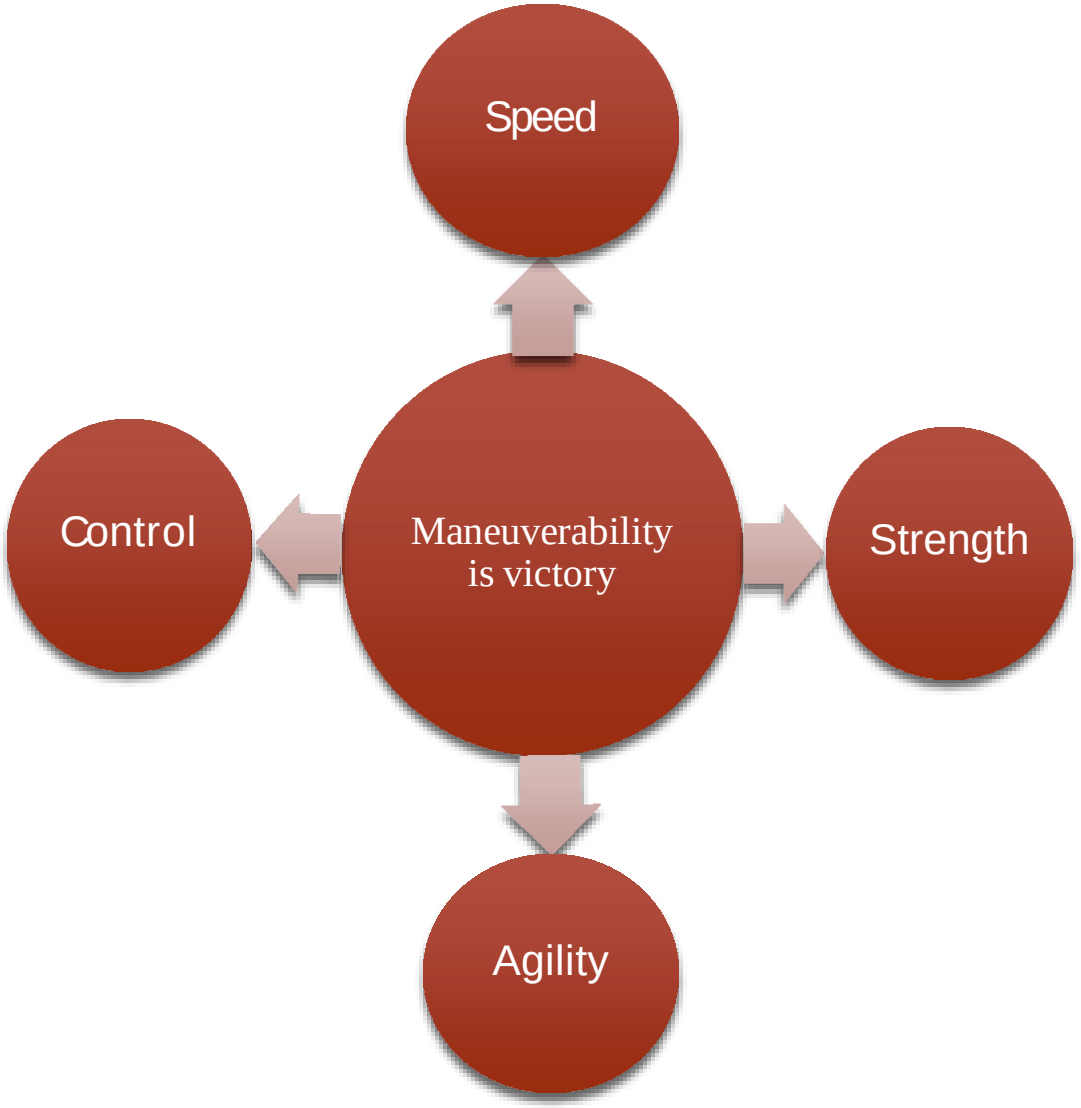

Speed
Control
Maneuverability is victory
Strength
Agility

Figure 2

HISTORY OF FBW

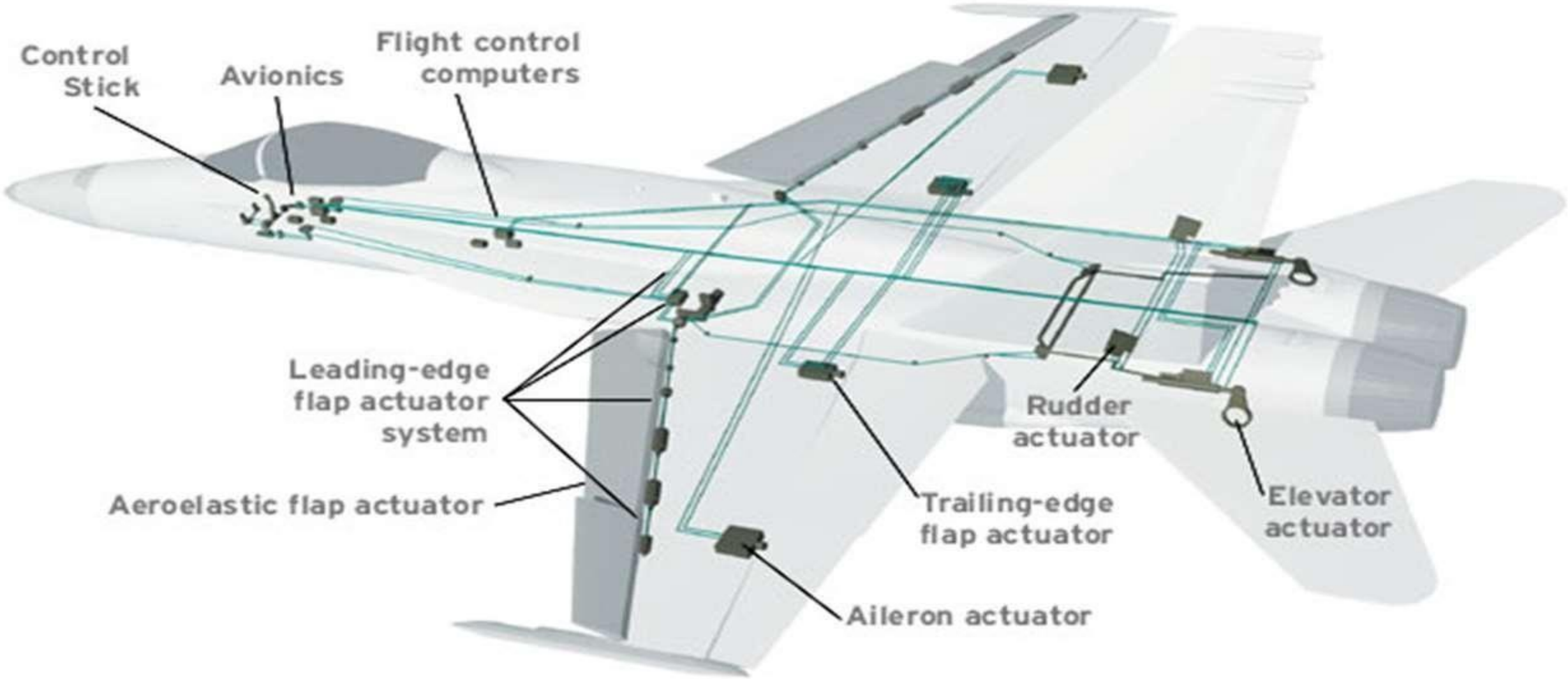
- Mechanical and hydraulic connections replaced with electrical ones.
- Electronic signaling of the control surfaces was tested in the 1950s.
- In 1972 first fly-by-wire aircraft was tested for flying.

INTRODUCTION

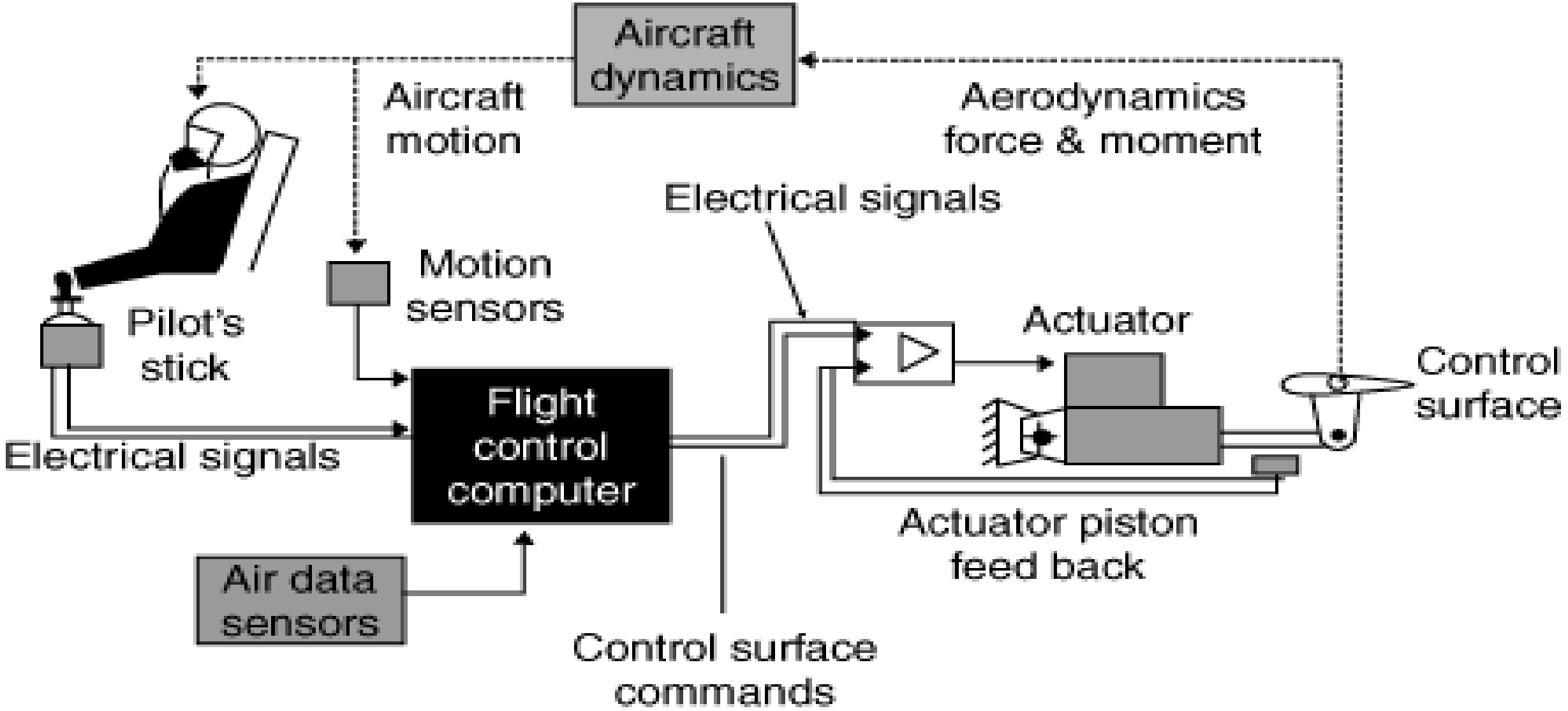
- **“Fly-by-wire" implies a purely electrically-signaled control system.**
- **Used in the general sense of computer-configured controls.**
- **Computer system interposed between the operator and the final control actuators.**
- **Manual inputs of the pilot modified in accordance with control parameters.**

INNER VIEW OF AIRCRAFT

FBW FROM A AIRCRAFT



FLOWCHART OF A TYPICAL FBW DESIGN



ELECTRONICS IN FBW

- Microcontroller becoming very popular.
- Basically Arduino based ATmega microcontroller are used in aircrafts.
- Advantage – Fast response, inbuilt ADC, reprogramming etc.
- Example Arduino Atmel ATmega328P microprocessor.

CONTROL OF AN AIRCRAFT

- **Stability and control governed by movement in 3 dimensions.**

- **Aircraft motion involves controlling roll, pitch, yaw.**

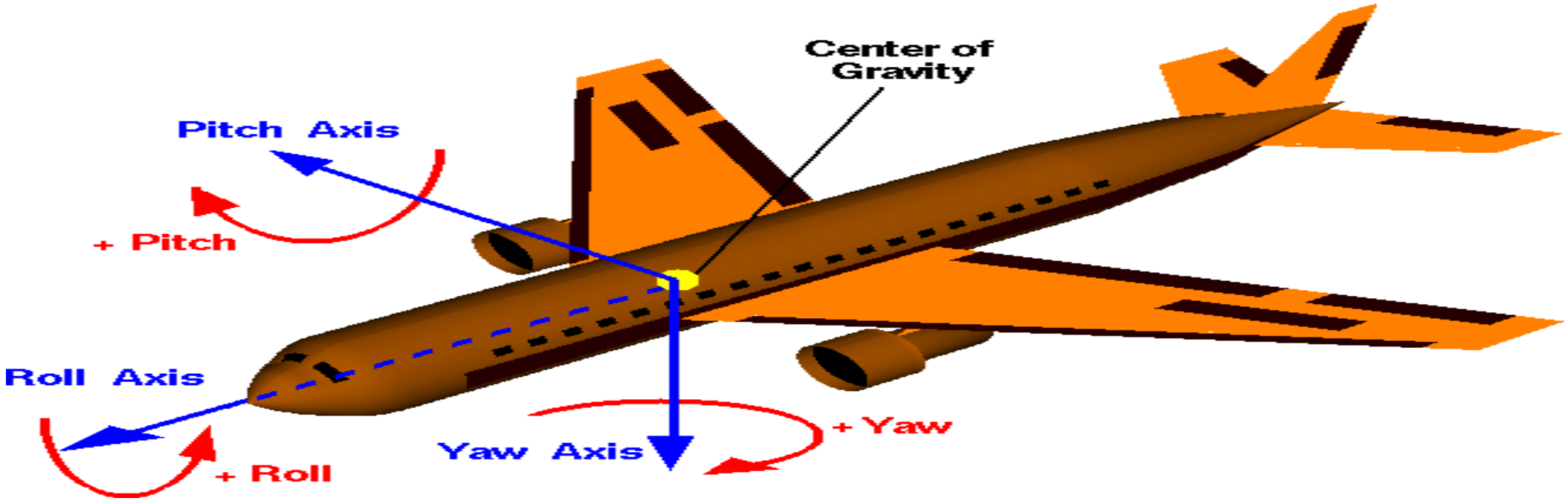
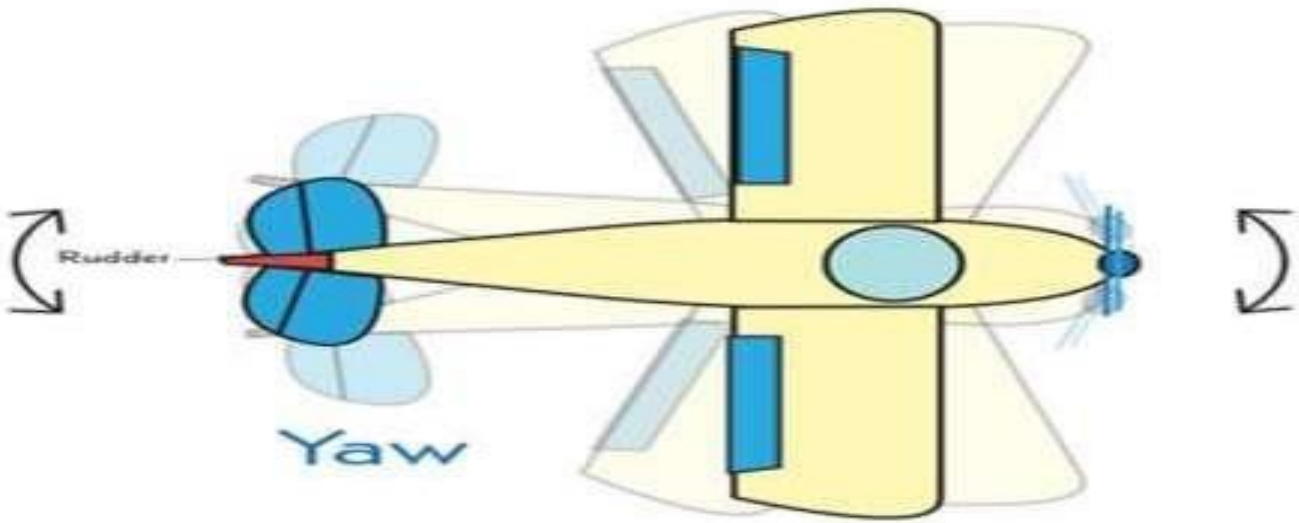


Figure 5

Roll

Use the ailerons to control
Roll



Yaw

Use the rudder to control
Yaw

Pitch

Use the elevators to control
Pitch

WORKING

- Pilot sends control inputs via 2.4 GHz radio link transmitter.
- A receiver (RX) translates it into 50Hz PWM signals b/w 1000 & 2000 µsec in pulse width (setpoint).
- Gyro readings translated and compared with Rx pulse widths.
- Difference b/w the setpoint and gyro reading = error signal.
- Error signal fed to PID controller along with velocity data.
- (Proportional-Integral-Derivative feedback control PID)
- Final signals passed to servo actuators make the aircraft change its flight.

BASIC CONTROL LOOP

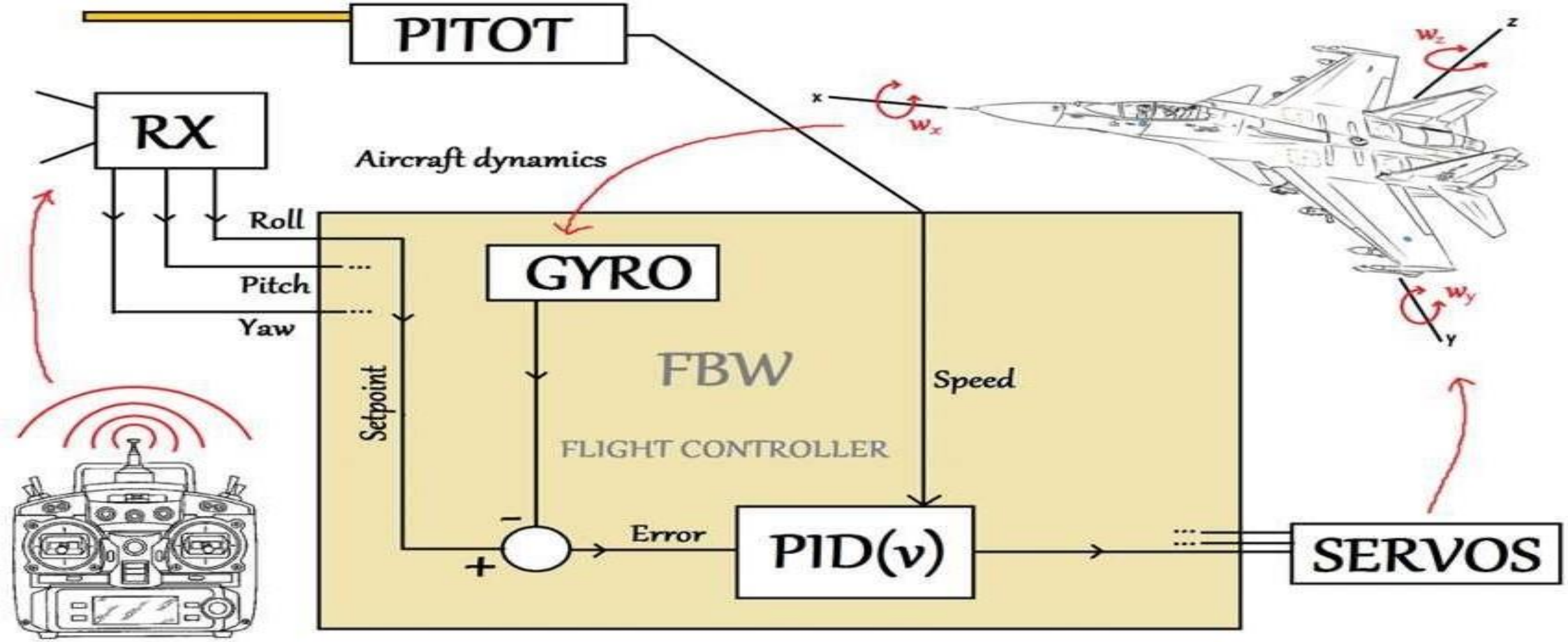


Figure 7

SIMPLE FEEDBACK MECHANISM IN FBW SYSTEM

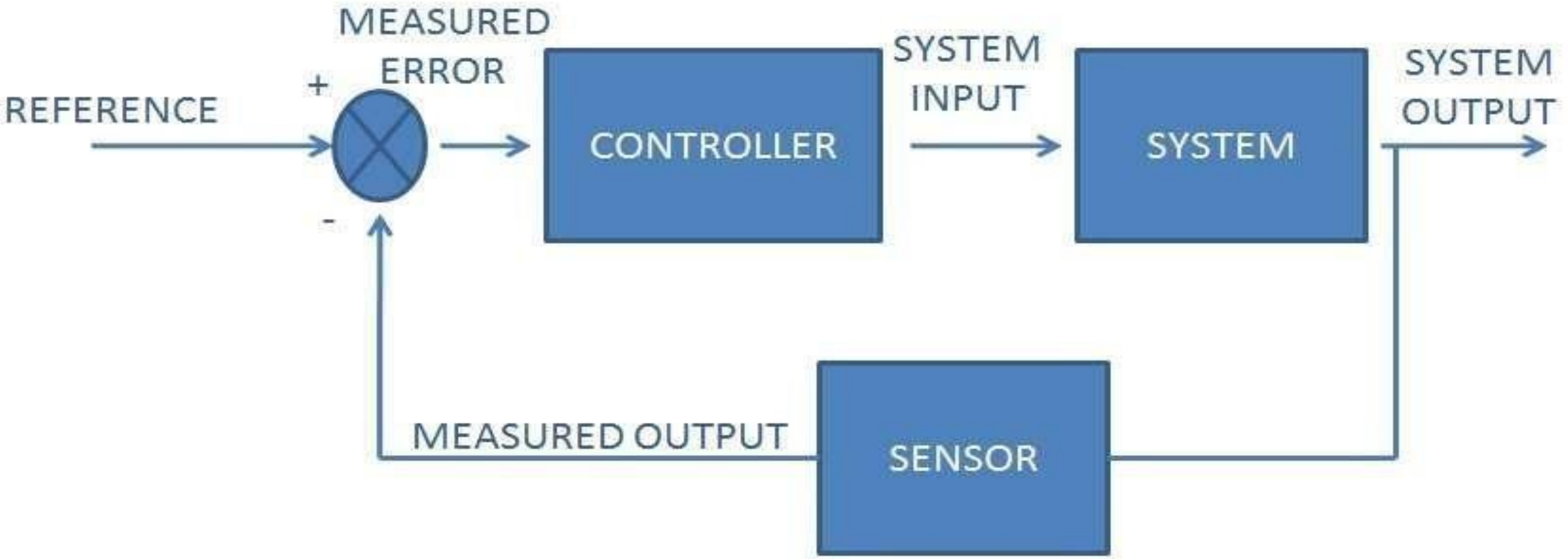


Figure 8

2 TYPES OF FBW SYSTEMS

- **Analog systems**
- **Digital systems**

ANALOG SYSTEMS

- **Replace hydromechanical or electromechanical control systems with electronic circuits.**
- **Control system in cockpit operate signal transducers, to generate the appropriate electronic commands.**
- **Signals are then processed by an electronic controller with an analog signal.**

DIGITAL SYSTEMS

- **A digital FBW control system similar to its analogcounterpart.**
- **Pilot literally can "fly-via-computer“.**
- **Increases the flexibility of the flight control system.**
- **Multiple redundancy techniques.**
- **Increase electronic stability, as system is less dependent on the value**

COMPARISON Analog Vs Digital

ANALOG SYSTEMS	DIGITAL SYSTEMS
Accuracy low.	Accuracy high.
Circuit complication	Circuit is simplified.
Calibration is tough.	Calibration is easy.

APPLICATION

- **Technology used in both military and civilian aircraft.**
- **Satellite manufacturers use this technology in their vehicles and spacecraft.**
- **Space Shuttle**
- **Several unmanned aerial vehicles (UAVs) - IAI Heron etc.**
- **Airbus A320, Boeing 777, Dassault Rafale, Stealth Bomber: F-117, Mikoyan MiG 29k etc.**

ADVANTAGES

- **Reduced wear and tear due to less mechanical contacts.**
- **Intelligent control system.**
- **Higher accuracy and greater maneuverability.**
- **Increased safety and reliability.**
- **Improved survivability and mission performance.**
- **Ease of assembly and maintenance.**

DISADVANTAGES

- **Sometimes software failure due to hacking.**
- **Technical issues.**

FUTURE DEVLOPMENTS

- **Fly-by-wireless**
- **Power-by-wire**

CONCLUSION

- **Assisting pilot in controlling aircraft.**
- **Configured computer systems used to make aircrafts stable and maneuverable.**

REFERENCE

- Airbus fly-by-wire Taverse, Lacaze and Souyris - ICAS in 2006.

- http://airandspace.si.edu/

Thank You!