Tishk International University
Engineering Faculty
Mechatronics Department

Avionics

TOPIC:FLY-BY-WIRE(FBW)

Week10_Lecture1

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FLY-BY-WIRE(FBW)

CONTENT

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- Need for FBW
- History of FBW
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- Electronics of FBW
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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.

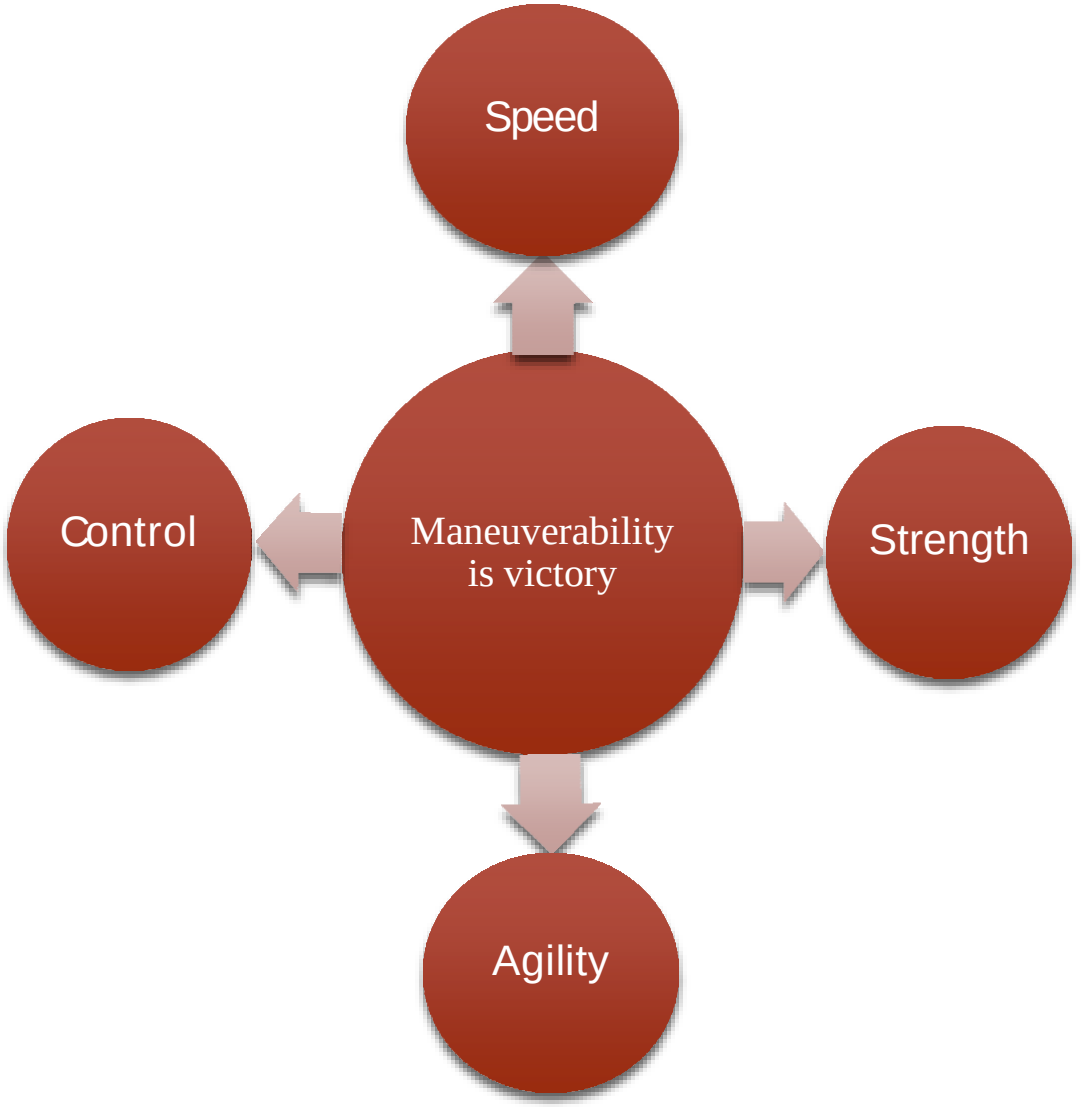

Speed
Control
Maneuverability is victory
Strength
Agility

Figure 2

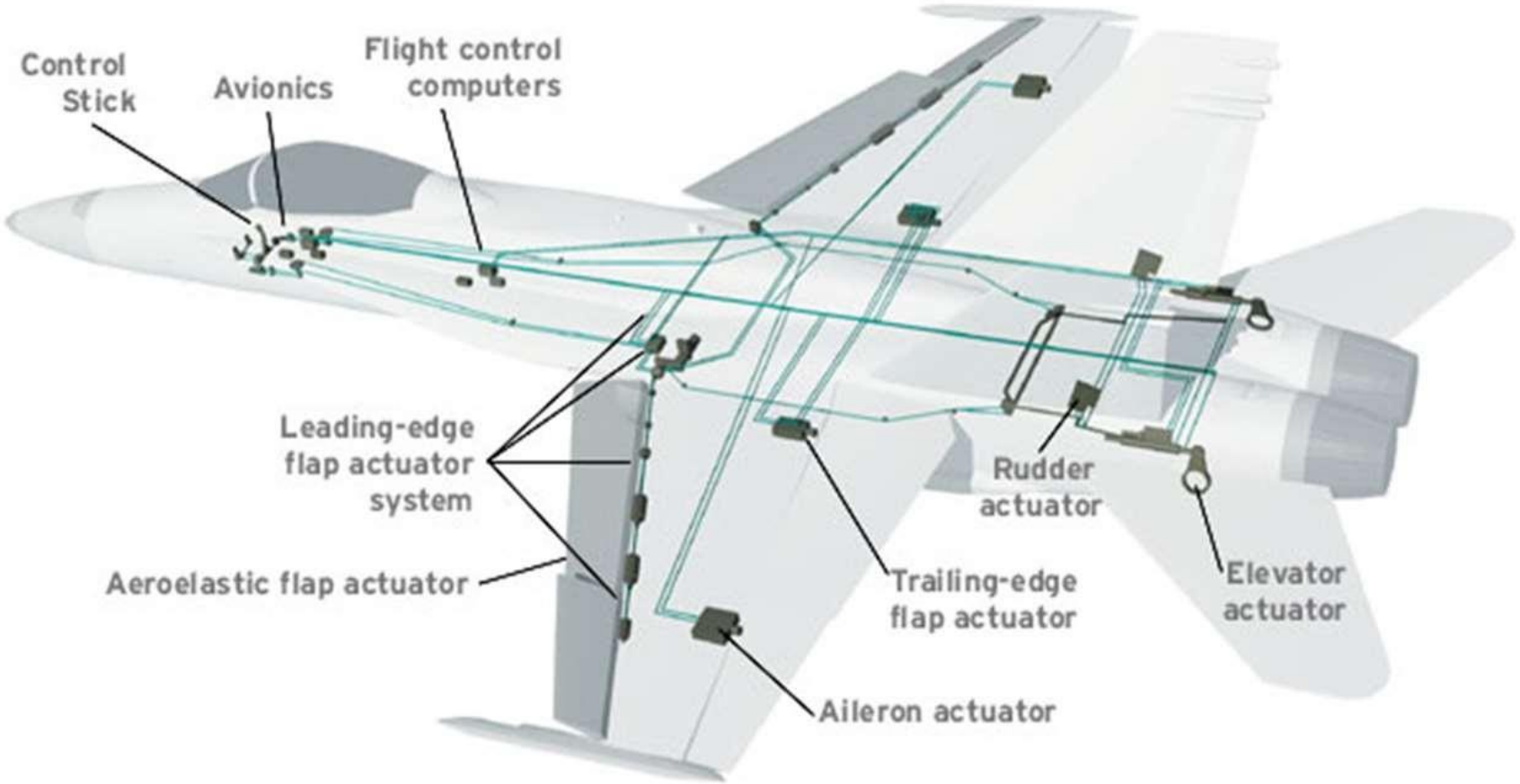
HISTORY OF FBW

- 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.

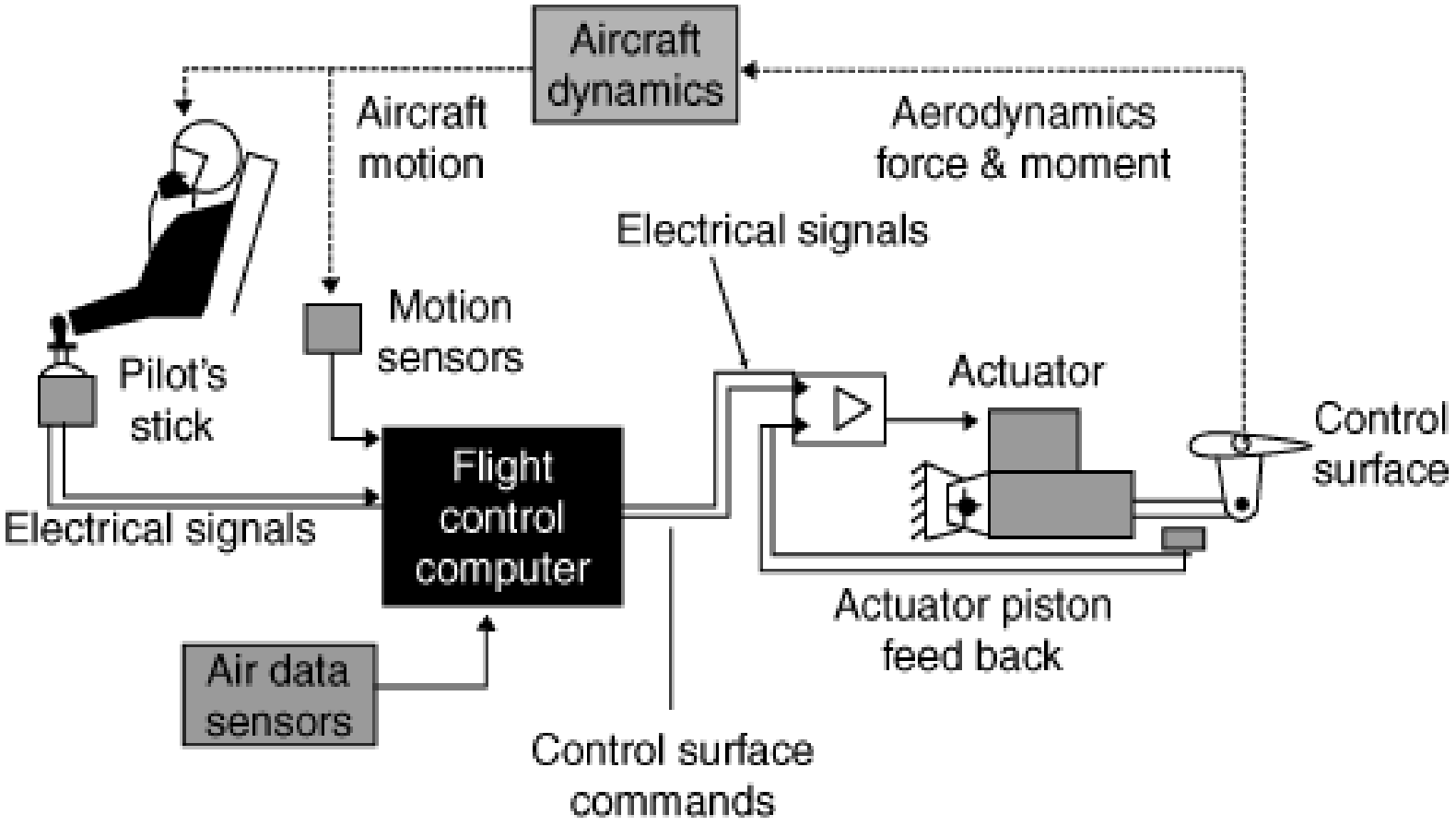
INTRODUCTION

- “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 A 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 AtmelATmega328P microprocessor.

CONTROL OF AN AIRCRAFT

- Stability and control governed by movement in 3 dimensions.

- Aircraft motion involves controlling roll, pitch, yaw.

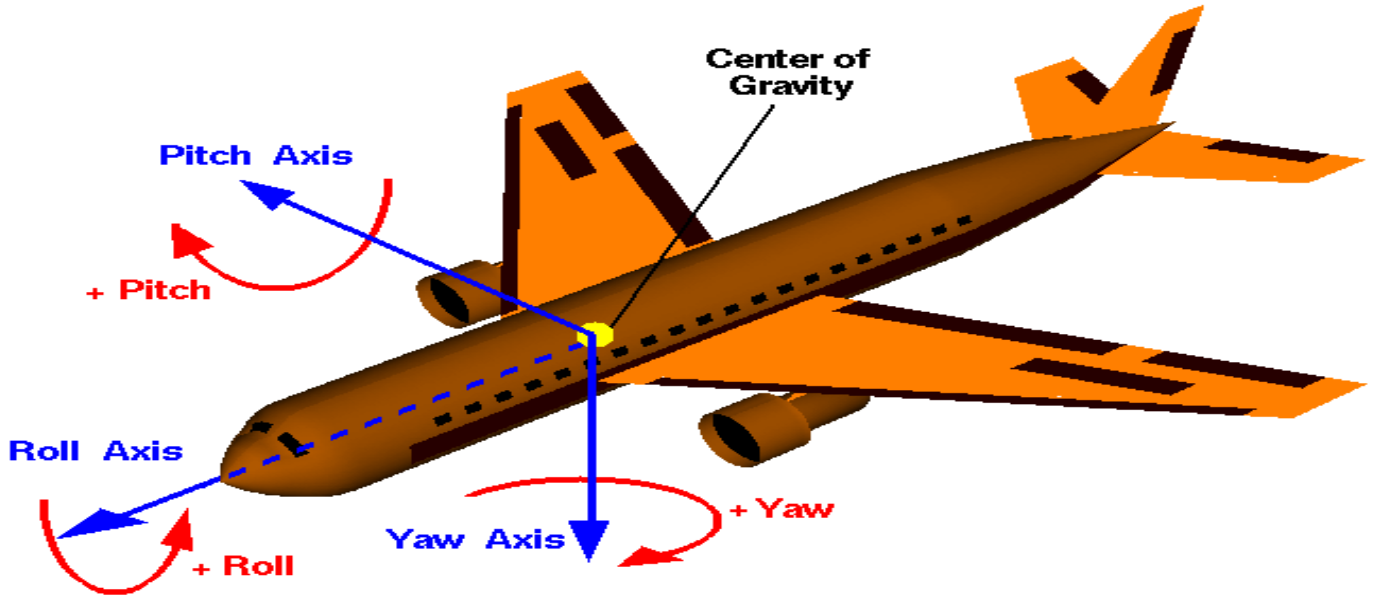
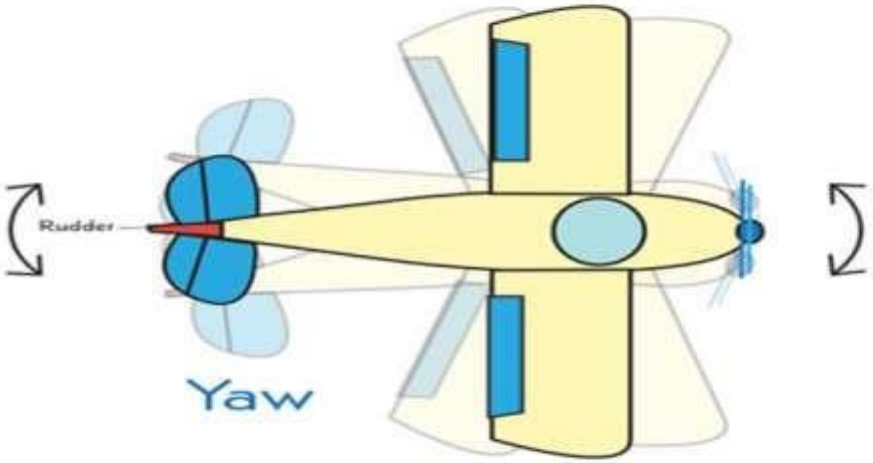


Figure 5

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

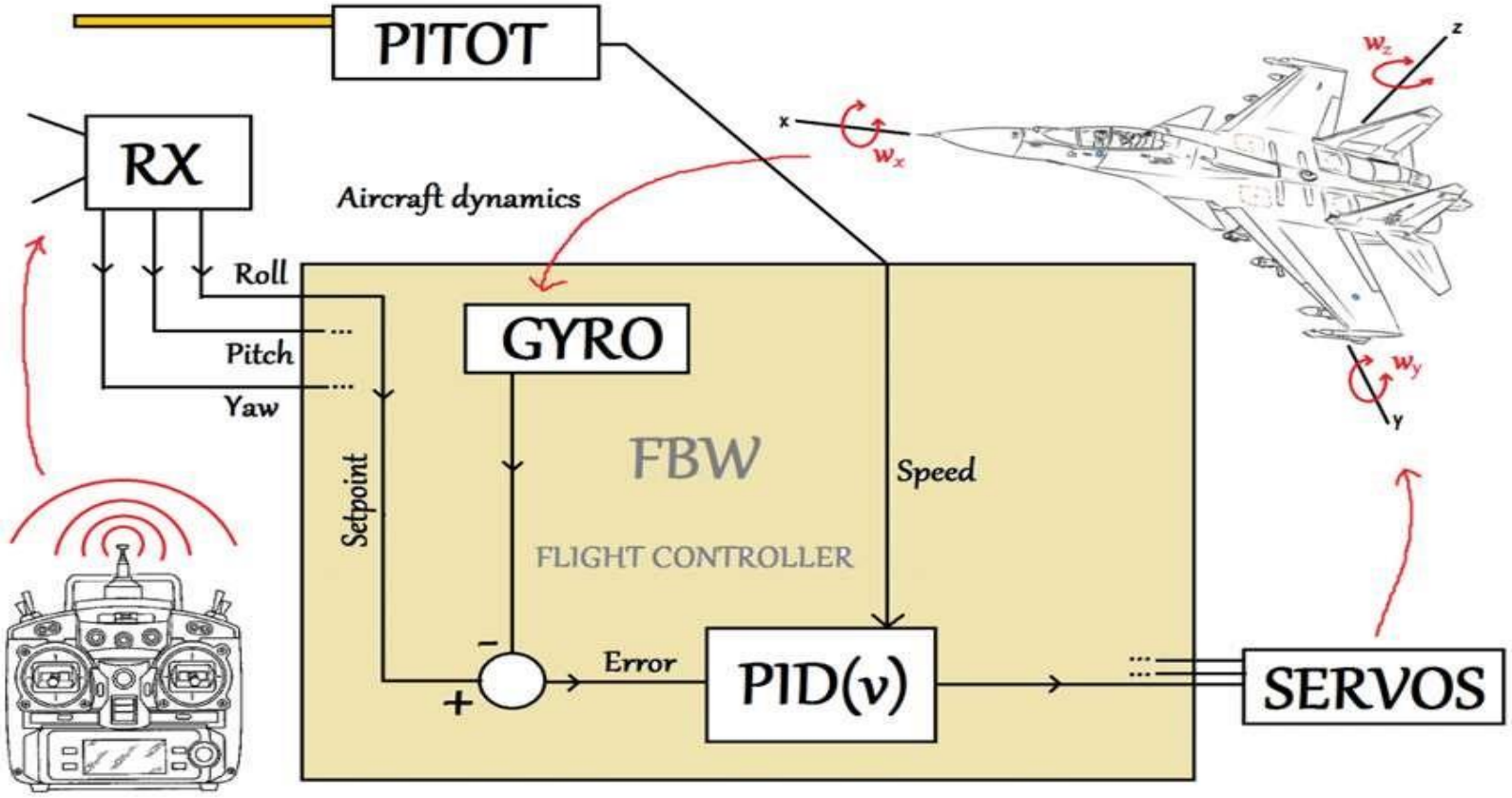


Figure 7

SIMPLE FEEDBACK MECHANISM IN FBW SYSTEM

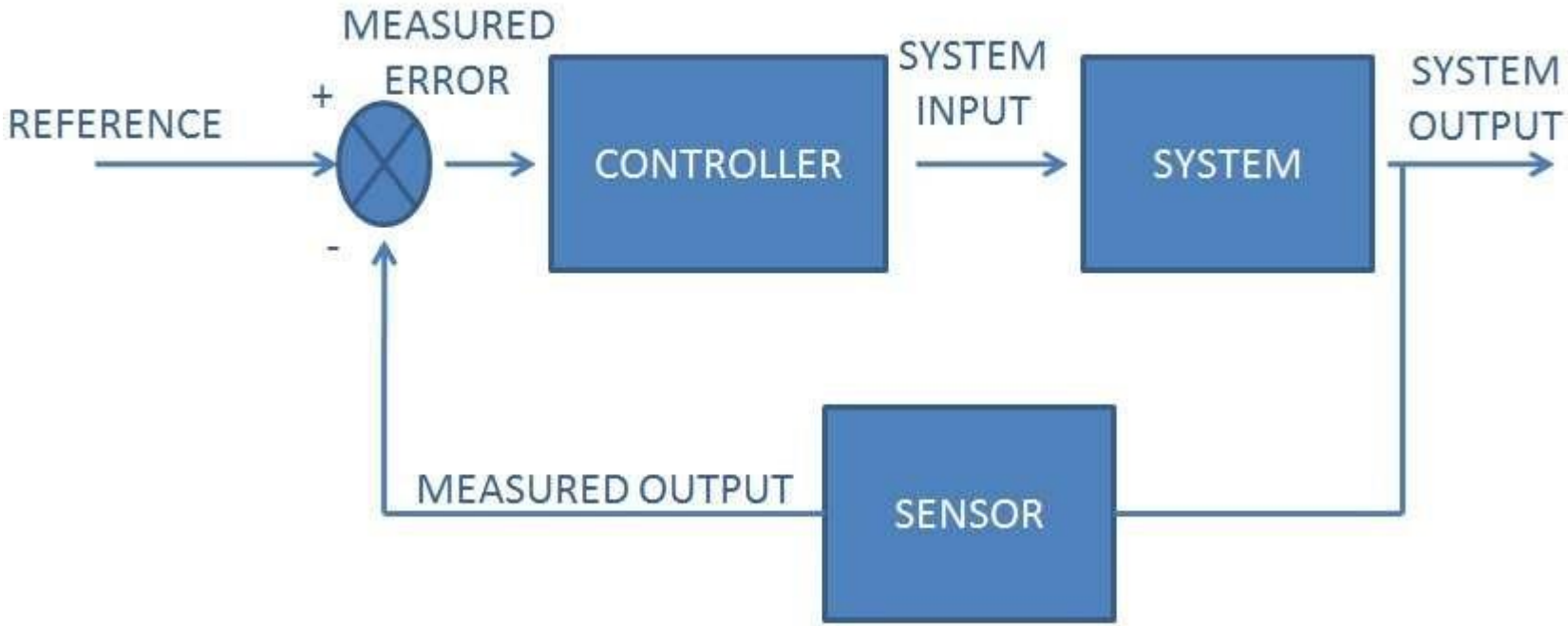


Figure 8

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 analog counterpart.
- 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 values.

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

ANY QUESTIONS ?