TECH TIME

Helpful tips for the Avionics Technician

BY AL INGLE

The Position Based (Gyro Stabilized) Autopilot

Last month we explored the basic control surfaces of an airplane and their associated aerodynamics. From our previous studies of the development of the gyroscope and closed feedback loops, we can now examine the position based, gyro stabilized autopilot. Figure 1 is a block diagram of a representative system. Due to the wide variation in aircraft types and autopilot options, the comprising elements may be separated and mounted throughout the aircraft or integrated with one another. The terminology depicting a particular mode of operation may also vary between manufacturers, however, most autopilots perform the same basic functions i.e. fly selected heading (HDG), fly VOR radials and GPS bearing to waypoint (NAV), maintain a given altitude (ALT), etc.

Figure 1 shows the block diagram of an autopilot with the fundamental feedback loops for three dimensions, and will be referenced for this article. Spinning gyros are fixed (responsive) in two dimensions, therefore, an aircraft with a Yaw Damper will require a second gyroscope. The pilot selects a mode of operation and the AP computer senses (depending upon its complexity) attitude, yaw, altitude, airspeed and NAV location as required by that mode of operation. Offsets from optimum conditions produce drive signals to the associated servos that move aircraft control surfaces. The result may be a change in aircraft attitude, yaw, altitude, airspeed and/or Nav location. These changes are sensed by the AP computer, which processes the change as a rate to satisfy the mode condition selected by the pilot. Remember that the autopilot computer is performing simultaneous processing in four dimensions. There is a lot going on inside these boxes. For example, the Honeywell KCP 220 AP/FD computer, found in the Pilatus PC 12 and other aircraft, has *four* microprocessors.

There are numerous input signals necessary to properly position an aircraft throughout the entire flight regime. First and foremost is the Gyro Horizon. It senses attitude and the computer will always limit the pitch and roll angles to a safe level as determined by its certification. Typically, this is standard rate in Roll (3° per second rate and 25° bank) and +/- 10° in pitch. These limits override any incoming signal errors. Modern autopilots will automatically disengage if they are unable to maintain prescribed roll and pitch limits.

Other inputs are selected heading and course errors. Note that autopilots do not need to know the aircraft's magnetic heading, only the amount of heading or course *error* there is. The altitude transducer may be internal to the computer or external, or include pitot and/or temperature functions which is then called an Air Data Computer (ADC). The altitude preselect is a function of this subsystem and reduces the pilot workload by automatically leveling the aircraft at a predetermined altitude.

When executing approaches, Radar Altimeters and Marker Beacon Receivers can change the autopilot gain for optimum performance.

Autopilots share universality in the pilot's ability to disengage or manually trim an autopilot from the yoke. Also, depending upon certification requirements, there are visual and aural warnings of an autopilot disconnecting. Most important are safety features built into servo engagement mechanisms. Virtually every autopilot servo is engaged with a solenoid spring loaded to the disengaged position. Removal of primary power through multiple means available to the pilot physically removes the servo from the flight controls. Because nothing is failsafe, there is a back up clutch that can be overridden by the pilot. Don't be afraid to use it.

Next Month: Rate Based Autopilots

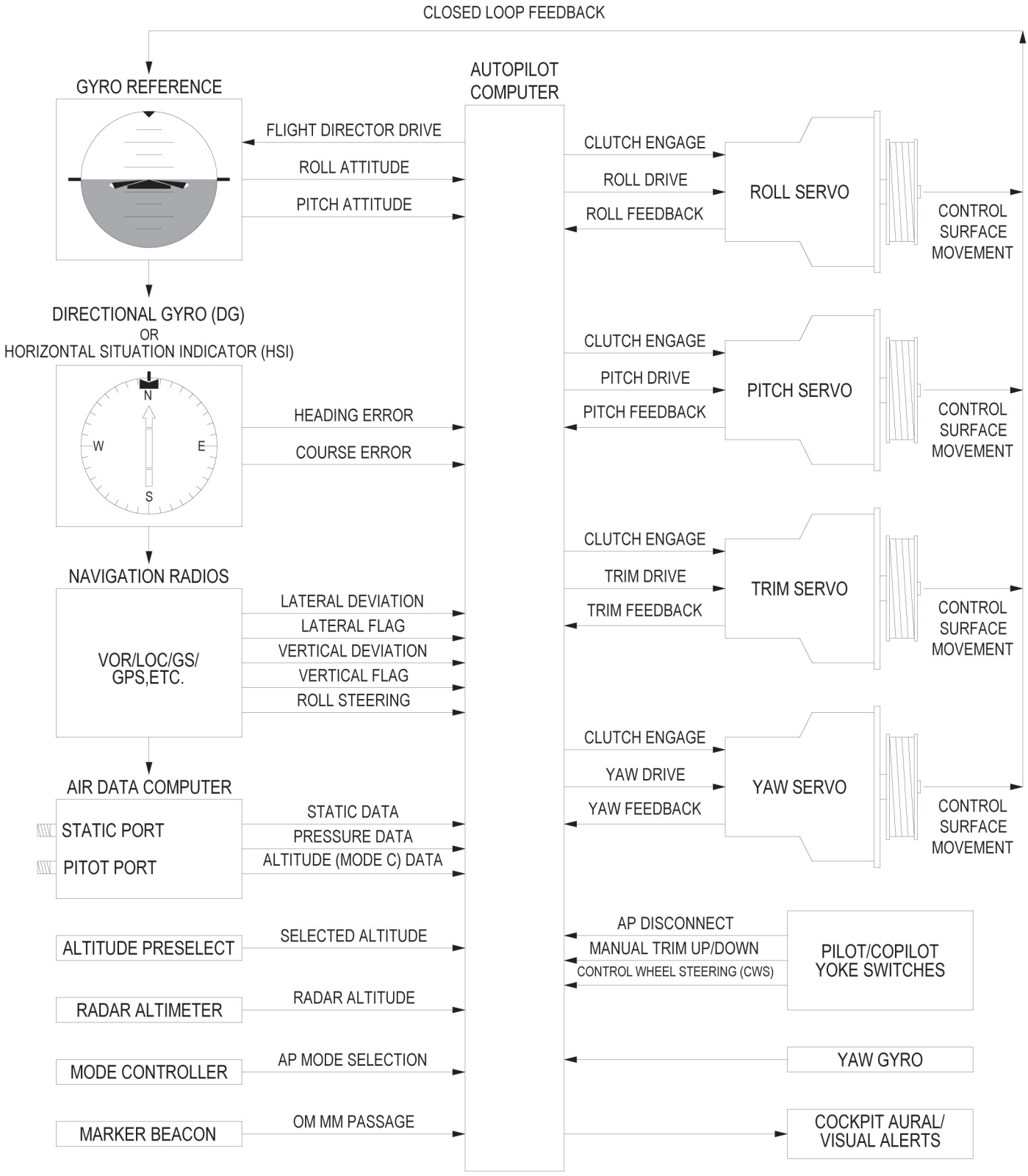

Figure 1 Position Based (Gyro Stabilized) Autopilot Block Diagram.