TECH TIME

Helpful tips for the Avionics Technician

B Y A L I N G L E

The Rate Based (Turn Coordinator/Accelerometer Stabilized) Autopilot

Last month the operation of the position based (gyro stabilized) autopilot was described. It uses a gyro horizon with reference pitch and roll outputs for position sensing and rate. We now turn to an alternate method of controlling an aircraft that utilizes a Turn Coordinator and an accelerometer for position sensing and rate. Meggitt Avionics / S-Tec manufactures many models of rate based autopilots and one of Bendix/King's current models, the KAP-140, utilizes similar technology. Figure 1 is a block diagram of a rate based autopilot and may be referenced for this article.

The Turn Coordinator is a key component in the roll axis sensing. It differs from the conventional Turn and Slip indicator by having its gyroscope inclined at 45° from level so that it can sense both yaw and roll movements of the aircraft. The output of the autopilot Turn Coordinator is typically a null in straight and level flight with increasing or decreasing DC voltage with respect to the aircraft's direction of turn or roll angle.

The rate based autopilot, utilizing the Turn Coordinator, has several advantages over its "gyro horizon" counterpart. One is reliability. The gyro horizon's rotor must spin at a higher RPM to maintain stability and therefore has a tendency to wear out sooner. With position based autopilots, when the horizon fails, you often have also lost your autopilot. Under instrument conditions, this can place a great workload on the pilot. Another advantage is the ability of the Turn Coordinator to always turn the aircraft at standard rate (typically 3° per second) regardless of airspeed. At high speeds this may equate to 25° of roll but reduce to 13-14° at maneuvering speed. A position based autopilot set for 25° of roll bank does so regardless of airspeed, making some slow speed intercepts awkward.

For the sensing of pitch, the rate based autopilot does away with the gyroscope entirely. It has a static sensor for altitude control but utilizes an accelerometer for pitch rate. The accelerometer, by definition, is a second order rate device. That is, it measures the rate of change of vertical velocity, which is in turn the rate of change in position (altitude). The accelerometer also may be used to limit both the pitch rate and the "G" forces experienced by the aircraft. An attitude based autopilot computer on the other hand derives pitch rate directly from a change in the gyro horizon's position. It can directly sense this position and disengage when an excessive attitude is attained or when the derived rate from the change in attitude exceeds a given threshold. Generally, the position based autopilot can fly an aircraft with greater precision in the high altitude and high airspeed environment. But for the majority of General Aviation aircraft, the rate based autopilot provides a safe, efficient and relatively inexpensive alternative.

From Figure 1, we see that the rate based autopilot is similar to the position based autopilot in many ways. The Turn Coordinator provides all roll and yaw attitude information while the accelerometer and static sensor, built into the computer, provide pitch information. These autopilots are typically simpler because no Air Data Computer or gyro horizon is necessary. Their operation, however, is similar to the position based autopilot with altitude preselect, flight director and yaw damper options, gain scheduling during an approach, aural and visual indicators, etc.

In future installments, we will look more thoroughly into the operation of the Turn Coordinator, static sensor and accelerometer to better understand the symptoms of their failure.

Next Month: More autopilots

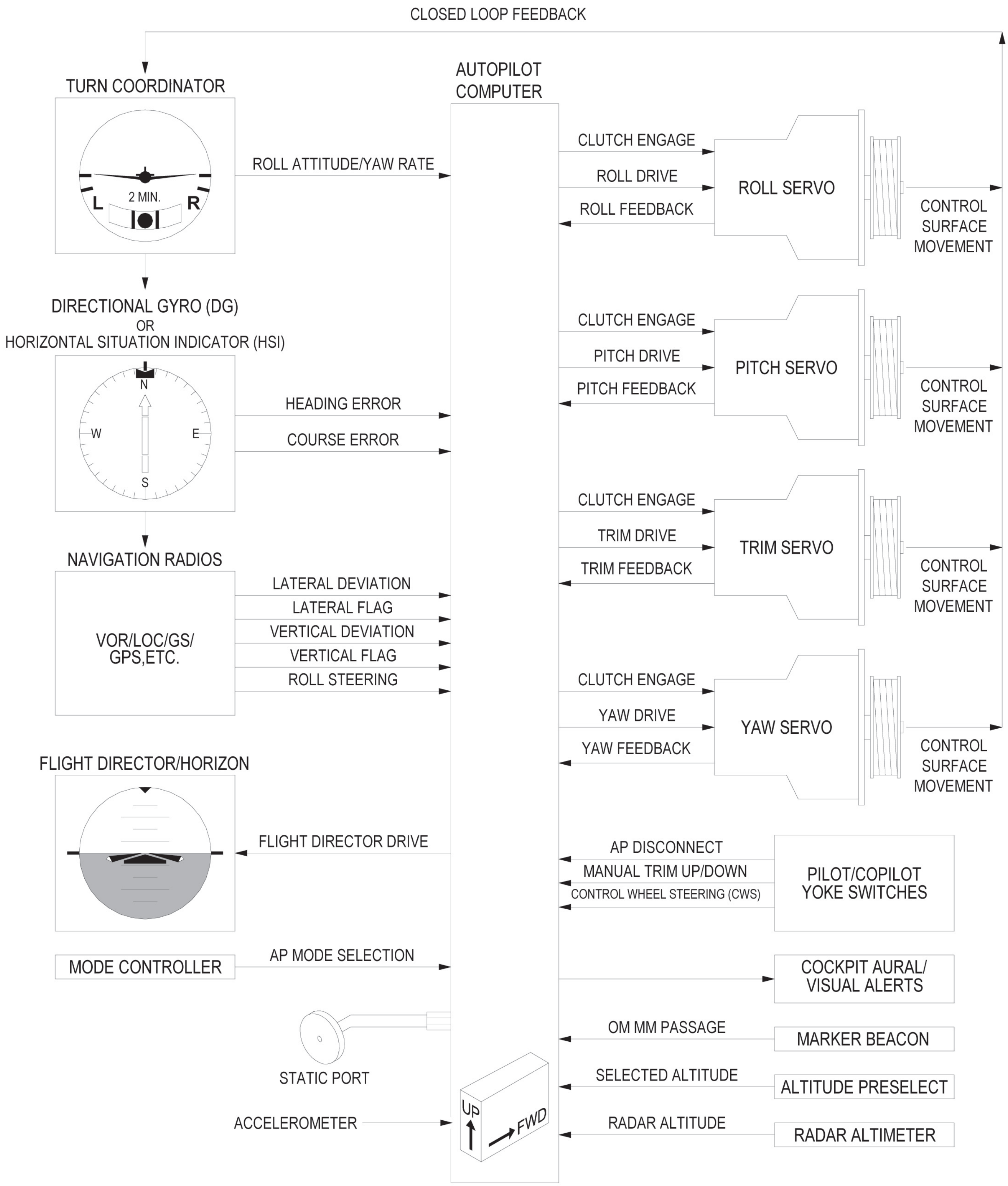

Figure 1 Rate Based (Turn coordinator/Accelerometer) Autopilot Block Diagram.