COMPUTER CONTROLLED ANTENNA SYSTEM

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With the advent of relatively cheap and small computers on the market, digital techniques have become very attractive for application to the servo and control systems of large antennas. A small dedicated digital computer can be used to perform an automatic checkout and readiness verification of the servo system. In addition, the computer can be used to replace certain pieces of existing hardware. Such a system has several advantages: reliability and consistency of operation, minimization of turnaround time between satellite passes, fast identification of component or subsystem failures or misadjustments, and in the case of new antenna procurements, substantial savings on special equipment requirements. Digital techniques have been evaluated at GSFC's Network Test and Training Facility using the 40-ft data acquisition antenna and the Sigma V computer. Figure 1 shows the programs that have been written for the monitoring and automatic checkout of the antenna servo system.

During normal operation of the system, the computer monitors critical quantities such as power supplies, oil temperatures, and axis velocity. Abnormal conditions are flagged to the operator, and if conditions warrant it, direct action is taken by the computer.

The antenna operator can call for a startup program. This program automatically brings the antenna up to operational status by properly sequencing the various switching functions.

A readiness test program can be called which is intended as a short prepass check of the servo system. This program checks power supplies, interlocks, the hydraulic system, and the servo amplifier. As a final test, a step function is applied to the antenna, and its transient response is evaluated according to a predetermined performance index. If all of these tests pass satisfactorily, the antenna is declared operational. If not, the operator is informed of the particular problem and is given the choice of operating the antenna in a degraded mode or of calling for the complete test program, which will help in further pinpointing the problem.

The complete test program checks for items such as tachometer gain and ripple, error sensitivity, synchro operation, friction, low speed performance, and hydraulic leakage and finally generates a diagnostic message to the operator. This program can also be called during the performance of routine maintenance because many tests of this program coincide with tests required by standard maintenance procedures.

Figure 2 shows the tracking loop for an antenna as it exists at a STADAN tracking site. The antenna structure is driven by a hydraulic drive system, and the tachometer, receiver, and encoder provide feedback signals from the structure. The tracking loop is closed via the servo amplifier and the receiver or the antenna position programmer, depending on the operating mode selected. Offline, the PB 250 computer is used to generate prediction data, and a scan generator is provided which aids during the satellite acquisition phase.

All of these devices, with the exception of the antenna structure and its sensors, are special-purpose equipment ranging in size from one chassis to several racks. The functions of these devices have been replaced with a program on the same computer. Test results indicate that the digital system has a performance that is equal to or better than the performance of the existing system.

With the use of the computer approach, a third mode has been added to the antenna: the augmentation mode.

This mode permits operation in the program mode with the addition of a correction factor derived from the receiver which is passed through a low-pass filter and integrator (Figure 3). Thus, the antenna is driven by a signal with high signal-to-noise ratio, as it would normally be during program mode operation, but improved pointing capability is provided by the introduction of the average receiver output.

In the lower half of Figure 3, the response of the augmentation mode is shown at a time when the antenna was tracking Nimbus 3. First, autotrack performance is shown; then, the operator switches to program mode. (Note the offset in this mode caused by a combination of antenna misalignments and prediction error.) Then, the augmentation mode is selected, and the error goes to zero after an overshoot.

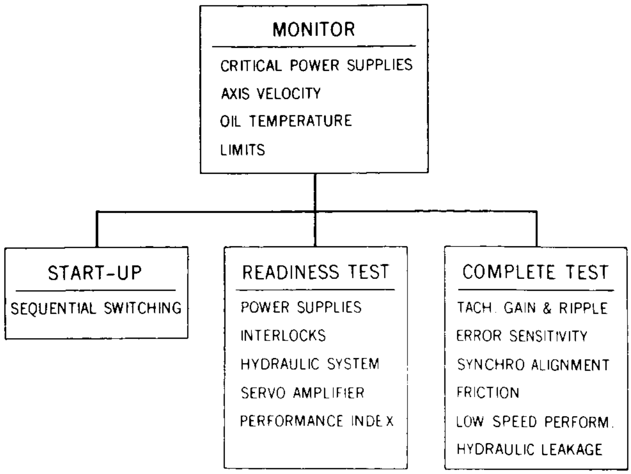

Figure 1–Program for the monitoring and automatic checkout of the antenna servo system.

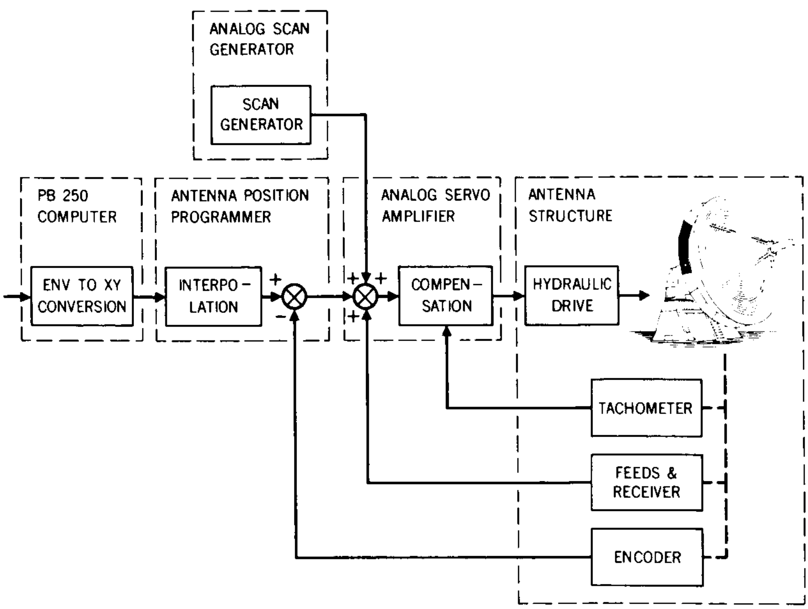

Figure 2–Tracking loop for a typical STADAN antenna.

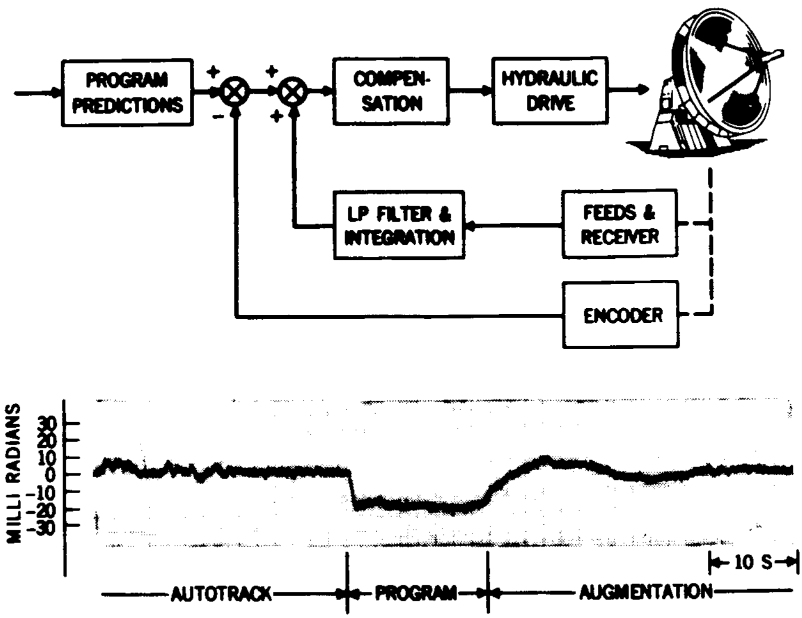

Figure 3—Configuration of the tracking loop with augmentation added and the response of this loop (tracking error versus time).