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AN OPTIMUM SURVEILLANCE RADAR FOR ATC

HERBERT G. WEISS

Massachusetts Institute of Technology
Lincoln Laboratory

SUMMARY

The role of surveillance radar will change as the evolving ATC system relies more heavily upon cooperative beacons, but radars will still remain as an important system element. Today's radars have major limitations for an automated ATC environment because they report unwanted targets (ground, bird, and weather clutter) and because they are expensive to operate and maintain. In addition, to minimize ground clutter, radars are usually sited relatively close to the ground and consequently their performance is not adequate to detect small, distant, low-flying aircraft.

By exploiting today's digital technology and by using a completely linear signal processing system, it is now possible to obtain a major improvement in MTI performance. The Lincoln Laboratory has demonstrated a 48-db clutter improvement factor on a 15-rpm scanning S-band ASR-type radar. This clutter rejection capability is about 20 db greater than exhibited by radars now in the field (see Fig. 1). By selection of more appropriate radar parameters, still greater fixed clutter and weather rejection can be achieved.

The advent of low-cost, high-speed digital components now permits the implementation of a coherent, optimum signal processor (one that is matched to the target and clutter spectrums). This type of processor can eliminate both the zero-blind speed and second-time-around problems as well as the need for staggered prfs. It provides digital target reports indicating the range, azimuth, and radial velocity of the target in a narrow bandwidth format which can be sent over a standard telephone line. Two representative digital processors are shown in Figs. 2 and 3.

By combining this digital processor with a digital step-scan cylindrical antenna (Fig. 4), which is not as complex as a phased-array, the spectral width of the clutter can be reduced and the processing simplified. In addition, this non-mechanically scanning antenna should have very high reliability and, if it is implemented at UHF or L-band, a large effective aperture can be obtained with relatively few elements (low cost). Adequate accuracy can be preserved with monopulse processing. At these longer wavelengths, the weather and bird clutter will be reduced and circular polarization will not be necessary (see Fig. 5). Pulse compression may be used to obtain the required average transmitter power at a relatively low peak power. The performance of the coherent digital processor is sufficient to obviate the need for very short-pulse systems. In addition, since the antenna does not rotate, it can be somewhat larger than the typical ASR antenna, and this permits further reduction in transmitter power.

In summary, our studies and experimental work indicate that a simple radar with impressive performance can be developed which would be well matched to the ATC task. It would incorporate the following features:

- A receiver processor that is linear over a wide dynamic range.
- An optimal digital processor with adaptive thresholds.
- Wavelengths longer than S-band.
- A switched cylindrical array antenna with monopulse processing.
- A lower peak power transmitter due to the more efficient processing, larger antenna and pulse compression.

While experience is lacking, this class of radar should have reduced operating and maintenance costs because of the extensive use of digital techniques, the low peak power transmitter and the absence of a mechanically-scanned antenna. Since the adaptive detector adjusts the gain and thresholds to the environment, there are no "knobs" on the radar which require adjustment and the radar performance is much less influenced by site-dependent characteristics.

This work was sponsored by the Federal Aviation Administration.

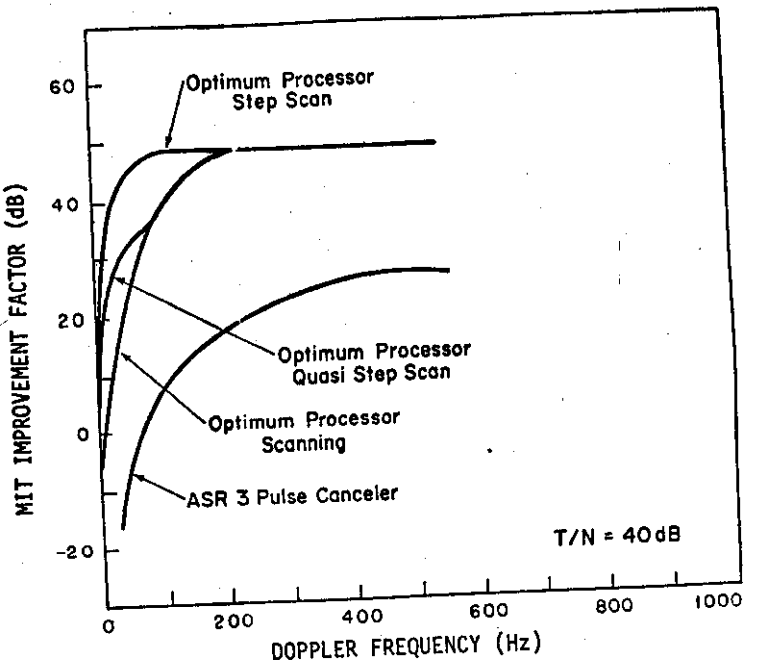

Fig. 1. Comparison of Processors at S-Band.

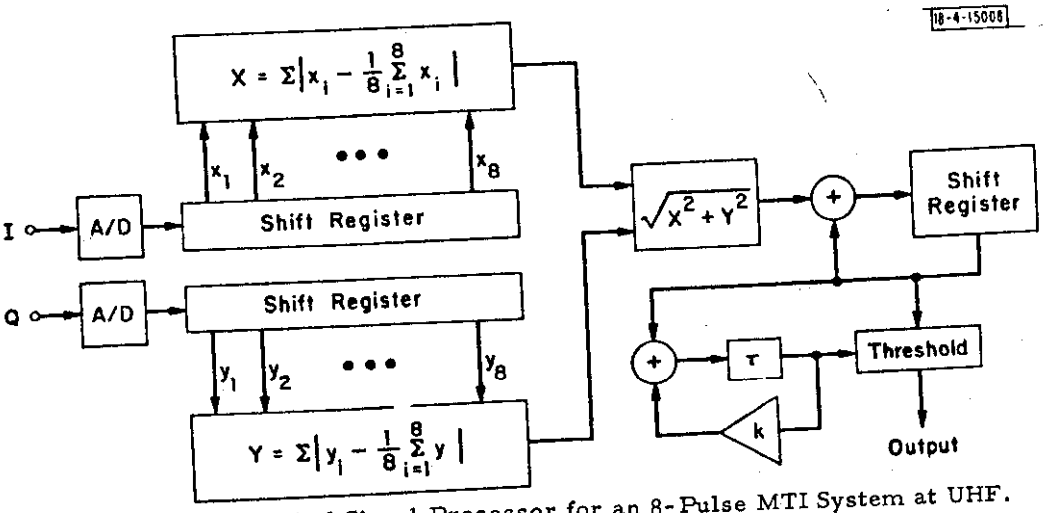

Fig. 2. Simple Digital Signal Processor for an 8-Pulse MTI System at UHF.

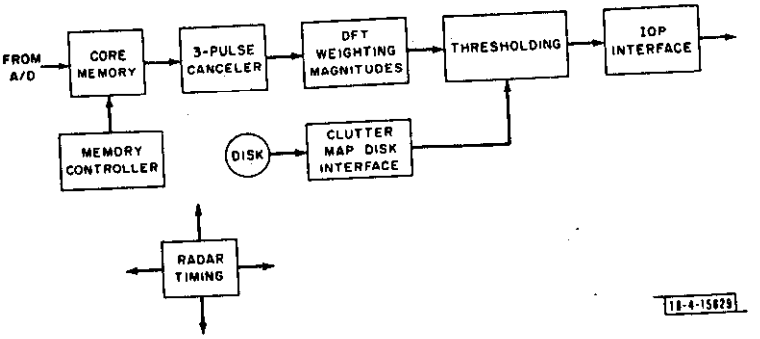

Fig. 3. An S-Band ASR Digital Processor.