Video-processing facilities

ACHIEVEMENT of the essential clarity and unambiguity in a modern radar display is dependent on the subjection of the received radar echoes to one or a number of highly developed video processing procedures. The function of these is to eliminate unwanted returns and interference from the display picture.

The following facilities have been developed to a high degree of proficiency for use in Marconi radar systems.

Moving Target Indication (MTI)

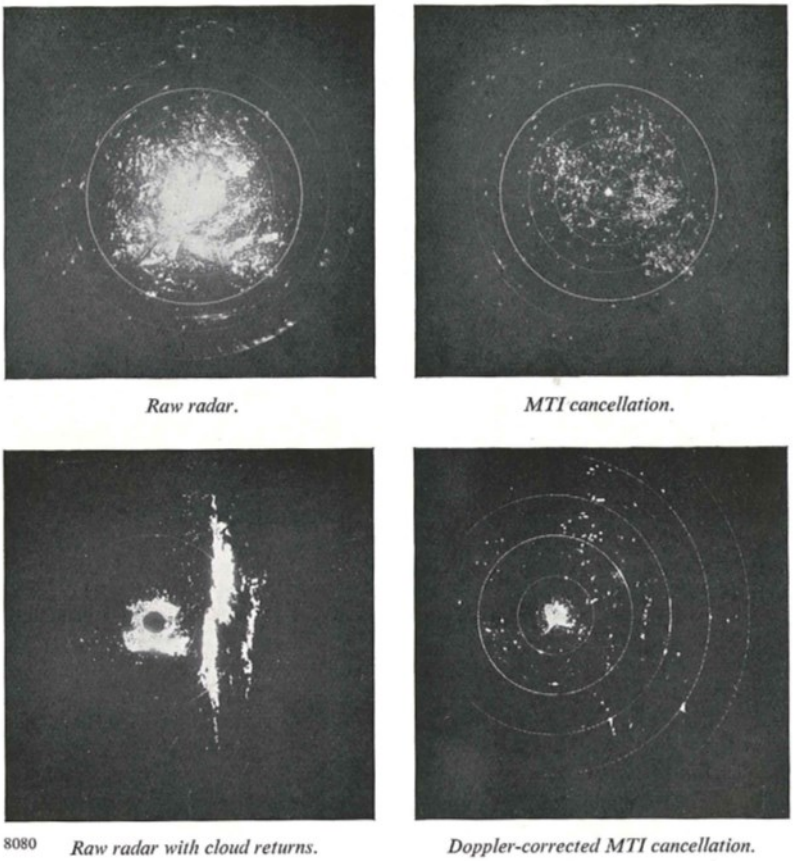
The MTI system, which is used most effectively with 25-centimetre radars, is an especially efficient version of the 'coho-stalo' technique, employing triple pulse cancellation.

A coherent IF reference oscillator (or 'coho') is phase-locked to the transmitted pulse and stabilized in frequency by a servo-controlled crystal local oscillator (or 'stalo') which also supplies the mixer of the receiver. The phase relationship of successive echo pulses to the reference oscillator is the basis of the system. In the case of stationary objects this phase relationship is unchanged from one echo-pulse to the next. For moving targets there is a change in phase between successive echo pulses, due to the change of range in terms of wavelength.

The echo pulses are fed, together with the coho signal, to a phase detector which produces pulses proportional to the phase difference. These pass to a cancellation unit in which one train of pulses is delayed and subtracted from the succeeding train.

Echoes from stationary objects, having suffered no change in phase, are cancelled and only those from moving targets remain. The feature of the Marconi system is that the cancellation procedure is repeated a second time (using a carrier of a different frequency and utilizing the same delay cell). This provides a 6 dB improvement in cancellation ratio upon the single-cancellation system.

After the cancellation the signals are detected and the video passed to the displays. A gating system can be included for switching MTI in and out over selected ranges, a 'clutter gating' system can also be incorporated whereby the clutter itself switches the system over to MTI signals, switching back to uncancelled signals in areas where there is no clutter.



Raw radar. *MTI cancellation.*

8080 *Raw radar with cloud returns.* *Doppler-corrected MTI cancellation.*

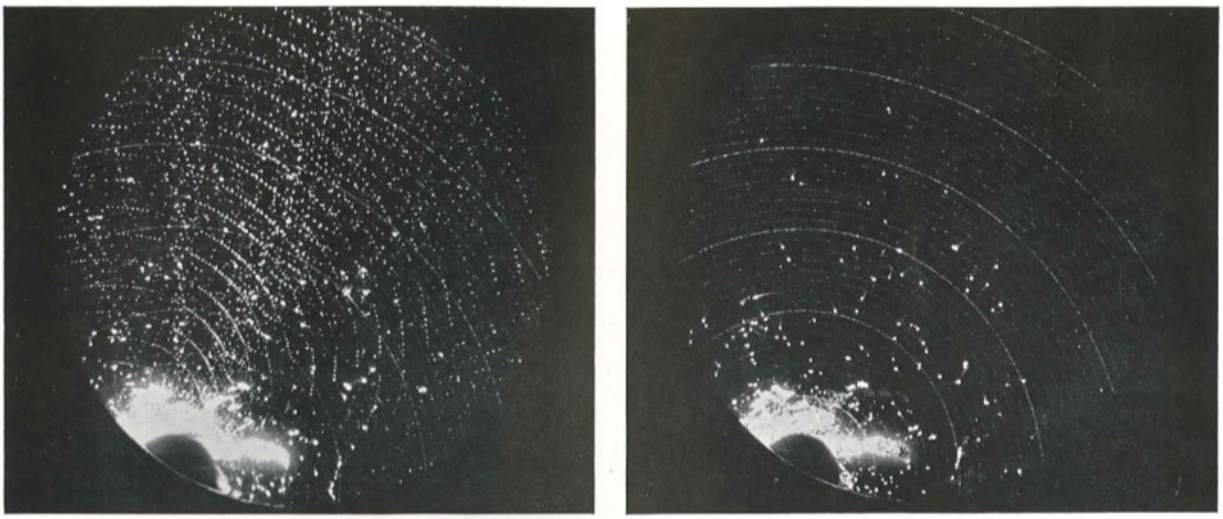
Display photographs (25 cm-band radar) illustrating the effectiveness of the MTI system for permanent echo cancellation (top) and for elimination of returns from moisture-laden clouds, using doppler correction (bottom)

The use of the MTI system may be extended to cancel out moving clutter (such as cloud and precipitation) by the introduction of doppler frequency correction circuits which can be adjusted so as to present the moving clutter to the MTI as permanent echoes.

The control of the anti-clutter facilities on a radar station would normally be exercised from a separate monitoring display console. The operator would be responsible for selecting the areas of clutter for doppler correction treatment. Any area of the display can be selected, and the area is marked up for observation and precise adjustment by the operator. The area size and shape is adjustable at will and facilities for the treatment of up to three such areas, all capable of separate doppler frequency correction, are included.

The combination of triple pulse cancellation with doppler frequency correction is a unique and singlularly effective means of clutter elimination.

The MTI equipment consists of 3 or 4 standard rack-cabinets occupying a minimum of floor area. One cabinet will normally be sited with the transmitter/receiver and the remainder with the display equipment at the remote operating position.



The display shown left illustrates the effect of pulse interference.
On the right is the same display with the interference suppressed, using the Type SM 300.

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Video pulse discrimination

An alternative and inexpensive way of dealing with clutter is by the use of a Video Pulse Discrimination Unit Type SM 900. This device which controls the video supplied to the display, discriminates between received pulses equal in length to the transmitter pulse and those of longer duration. Since clutter returns are normally several times the length of the transmitted pulse most of the clutter is avoided.

The Type SM 900 is a most useful aid where MTI has limited effect, such as in the 10-centimetre waveband. It can also be used in addition to gated MTI over the portions of the display where the MTI is switched off.

It will be seen that the unit also provides, in addition, a measure of protection against pulse jamming, since the pulse jamming technique usually employs pulses of as long a duration as possible.

The discrimination system is effective against both static and moving clutter and is not dependent on the number of strikes per target, the range, the beamwidth or any parameter other than the pulse length.

The Type SM 900 is a compact unit designed for desk or rack mounting.

Pulse interference suppression

A similar one-parameter anti-clutter device is the Pulse Interference Suppressor Type SM 300. This unit operates on the video responses in such a way that only those occurring at the pulse recurrence frequency of the transmitter are passed to the display system.

The unit has been used with considerable success against multiple secondary radar responses such as occur where the airborne equipment, being within range of several ground stations, causes responses to be received by other stations than the interrogating one.

Effective protection is also given against direct pulse interference from other radars on different pulse recurrence frequencies which, due to high siting, prove troublesome.

The Type SM 300 is a compact rack assembly.

Circular polarization

Elimination of precipitation returns can be greatly assisted by circular polarization of the radar signals. This is effected by fitting a circular polarization filter between the aerial feed system and reflector. The filter consists of a grid of slats at 45° to the plane of polarization of the feed.

The signals from the feed are split by the filter into two components. One component, normal to the slats, passes through the filter unaffected, *i.e.* under free-space conditions. The other component, parallel to the slats, is effectively in a waveguide, where phase-velocity is less than in free-space velocity. The dimensions of the filter are such that this component emerges from the filter leading 90° in phase on the unaffected component. The resultant of the two polarized waves, at right angles to each other and 90° out of phase, is a circularly polarized wave of predetermined screw-sense.

Reflection of a circularly polarized wave from a spherical or circular surface results in a reversal of screw-sense in the reflected wave. On re-traversing the polarizing filter, the reflected wave becomes plane-polarized again but is now at right angles to the radiating plane of the feed system and is thus not accepted. This is the effect upon returns from moisture droplets.

Irregularly shaped objects such as aircraft and ships give a plane-polarized reflected wave. After passing through the filter the reflected wave is circularly polarized, with one component acceptable to the feed system.

It can thus be seen that the energy received back from the desired targets using circular polarization is less than without polarization for the same transmitted power. The system is only practicable where some degradation in extreme range performance (due to the attenuation of transmitted and received signals by the polarization filter) is permissible, and is applied mostly with 3-centimetre radars.

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