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NASA TECH BRIEF

Ames Research Center

New Pulsing Technique May Improve Radar Ranging Systems

Conventional radar systems are pulsed at regular intervals by trigger signals derived from a time base generated within the radar itself. The time required for the burst of electromagnetic energy to leave the radar antenna and then return from a target is an indication of the distance between the target and the radar (i.e., the range). However, if outgoing pulses are triggered by the echo return of the previous pulse, the triggering frequency can be used to indicate target distance; the new method of operation has an output somewhat analogous to that obtained from Doppler radars and, thus, it retains all the advantages of these systems along with the range and sensitivity provided by pulsed systems.

The new pulsing technique is applied as follows: A radar is pulsed in conventional manner until a target is acquired and a return pulse is received. At this point, the radar is switched to a mode of operation whereby the radar is triggered by each echo pulse; the continuous series of pulses have a "ringing" frequency expressed by the formula:

$$F = C/2d$$

where F is the pulse frequency, C is the velocity of light, and d is the distance between the radar and the target; the range can be determined by measuring the pulse frequency. Of course, if the distance between the target and the radar is changing, the range rate can be determined by measuring the difference in time between any successive pair of pulses and comparing it with the interval between the next pair of pulses. The range rate can also be determined by measuring the rate of change of the pulse rate. If pulsing occurs at audio frequencies, the ear can detect a change in pitch.

Although the above equation indicates the pulse frequency can go from infinity at zero distance to zero at infinite distance, in practice, the measurement of range is set by the pulse frequency limits which state-of-the-art circuitry permits. If the pulse frequency exceeds the upper limit tolerated by the equipment or the operator, the outgoing radar or transponder pulse can be delayed by a certain time after the radar or echo pulse is received. In this instance, the ringing frequency is:

$$F = C/(2d + Ct_1)$$

where t_1 is the delay time introduced in the radar or in a transponder.

The ringing frequency can be reduced still further by introducing a delay in both the radar and the transponder; the frequency is:

$$F = C/(2d + C(t_1 + t_2))$$

where t_2 is the extra delay time.

Low-frequency pulses can be transferred into higher ringing frequencies by introducing additional pulses during the interval involved in a one-to-one exchange. For example, if a radar were ringing at 50 pulses per second, the transmitter could be made to transmit more than one pulse during the interval between echo returns; the new pulse frequency would always have to be an integral multiple of the basic pulse frequency. It may be necessary to code each sequence of pulses in order for the radar to distinguish echoes or transponder signals from pulses.

(continued overleaf)

Notes:

1. The technique can also be applied to laser ranging systems and to acoustic sounding devices.
2. No additional documentation is available. Specific questions, however, may be directed to:

   Technology Utilization Officer
   Ames Research Center
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   Reference: B72-10564

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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