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Utilization of Infra-Red in Radar System

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Abstract: The field of this paper is radar and more particularly, infra-red imaging radar. Currently, microwave radar systems provide terrain following capability, permitting all-weather, day/night low level flight aircraft operation at extremely low altitudes and relatively high speeds. However, at low altitudes, for example, below 50 meters, many flight applications require a substantial obstacle avoidance capability in addition to terrain following. Since obstacle detection requires extremely high resolution that is not practical with microwave radars. So Infra-red Radars are necessary for better flight application.

Keywords: Infra red Radars, Microwave Radars.

Introduction:

In conventional microwave radar systems, electromagnetic radiation from a power oscillator is directed by a transmit/receive switch, through an antenna onto a scene-to-be-imaged. The radiation reflected by targets within the scene is collected by an antenna and directed through the transmit/receive switch into a mixer where it is heterodyned with microwave radiation from a local oscillator. The heterodyned signal is then electronically processed to extract range, velocity and reflectivity information for the targets. Accordingly, it is an object of the present invention to provide an improved radar system which simultaneously provides range and moving target identification information. Another object is to provide an improved radar system providing capability of terrain and obstacle avoidance and in addition, target acquisition and identification. Yet another object is to provide an improved radar system which simultaneously provides active and passive imaging. It is a further object to provide an improved radar system having a closed-loop fire control capability.

Description of the Preferred Embodiment:

The system includes an infrared laser and associated controllers which are adapted to provide a succession of transmit pulses having a relatively high intensity spike portion followed by a relatively low intensity quasi-CW portion. An optical system directs the transmit pulses to a target scene and collects infrared radiation reflected from the scene. The collected radiation is imaged on a heterodyne detector array together with a locally generated reference infrared beam. A range network is responsive to signals from the detector array to provide signals representative of the range of objects in the target scene. A moving target indicator network is responsive to signals from the detector to provide signals representative of the velocity of objects in the target scene.Apart from this it also includes an infrared transmitter laser, an array of optical detecting elements and an associated optical system for directing the beam from the laser to a target scene, and for collecting reflected portions of that beam and imaging those portions on the detector array. A signal processing network is coupled to the detector array. A local oscillator laser and an associated optical system are adapted to image a reference beam from the local oscillator laser on the detector array. The transmitter laser is selectively operable in a pulsed mode or a continuous (CW) mode. A controller is adapted to control the operational mode of the laser transmitter so that the transmitted beam includes at least one pulse having a spike portion and a CW portion. In response to signals generated by detector array from received reflections of the spike portions of the transmitted beam, the signal processing network generates data representative of the range and reflectivity of objects in the target scene. In response to signals generated by the detector array from the CW portions of the transmitted beam, the signal processing network generates data representative of the velocity and reflectivity of objects in the target scene. In alternative configurations, the system may further include conventional active and passive radiation imaging networks which may be operative simultaneously with the MTI and ranging networks.

Input Data/ Structure:

Conventional infrared radar systems also transmit electromagnetic radiation but rather from a transmitter laser typically, the laser radiation is directed by a transmit/receive switch, through a telescope and onto a target. The radiation reflected by the target is then collected by the telescope and directed through the transmit/receive switch and onto an optical detector. This detected radiation is heterodyned with radiation from a local oscillator laser. The heterodyned signal is then electronically processed to extract range, velocity and reflectivity information for the targets. The principle differences between the microwave and infrared radar systems are the wavelength of the electromagnetic radiation employed (microwave versus infrared), and the specific devices which perform the necessary radar functions (e.g. magnetrons versus lasers, antennas versus telescopes, and the like). In view of the wavelength difference, infrared systems generally offer higher resolution, while microwave systems generally offer better performance in bad weather. Infrared laser airborne radar systems have recently been developed for use as bad-weather, day/night, obstacle avoidance systems on tactical aircraft involved in close air support missions. See for example Hull, R. J., Marcus, S. "A Tactical 10.6 um Imaging Radar", Proc. 1978 National Aerospace and Electronics Conf. (IEEE, Dayton, Ohio, May 1978). In such systems, there are two modes of operation. In a target acquisition (or obstacle detection) mode, a CO_2 laser generates a continuous wave (CW) infrared beam. This beam is shaped into a fan beam and projected through a telescope and directed by a pointer scanner mirror assembly onto the ground in front of the aircraft. A combination of the aircraft's forward motion and a horizontal rocking motion of the pointer-scanner mirror assembly provides a line scan search of the area in front of the aircraft. The back-reflected radiation is collected by the telescope, and imaged onto a one-dimensional array of heterodyne detectors together with the beam from a local oscillator laser. The outputs from the heterodyne detectors are then Doppler-analyzed to provide a moving target indication (MTI). When a moving target (or obstacle) is detected, the pointer-scanner mirror is adaptively pointed in the direction of the target, and the transmitter laser is switched to an obstacle avoidance mode. In this second mode, the system operates as a laser-aided forwarded looking infrared imaging (FLIR) system. The laser is repetitively-pulsed, and a two-dimensional image plane scanner is activated. This second mode of operation provides a high resolution point-by-point raster scanned CRT image of the target for identification purposes. Range information from the reflected pulse delays are then used in conjunction with the azimuth-elevation information from the image and information from the aircraft's inertial platform to provide obstacle avoidance control signals for the aircraft. This form of system is also suitable for fire control. Although the latter form of prior art infrared radar systems does provide target range, velocity and reflectivity characteristics suitable for use in terrain avoidance and target acquisition and identification, the performance of such systems are substantially limited since such systems cannot provide both MTI and high resolution ranging operation at the same time.

Analysis/ Solution/ Description:

The system includes an infrared laser and associated controllers which are adapted to provide a succession of transmit pulses having a relatively high intensity spike portion followed by a relatively low intensity quasi-CW portion. An optical system directs the transmit pulses to a target scene and collects infrared radiation reflected from the scene. The collected radiation is imaged on a heterodyne detector array together with a locally generated reference infrared beam. A range network is responsive to signals from the detector array to provide signals representative of the range of objects in the target scene. A moving target indicator network is responsive to signals from the detector to provide signals representative of the velocity of objects in the target scene.

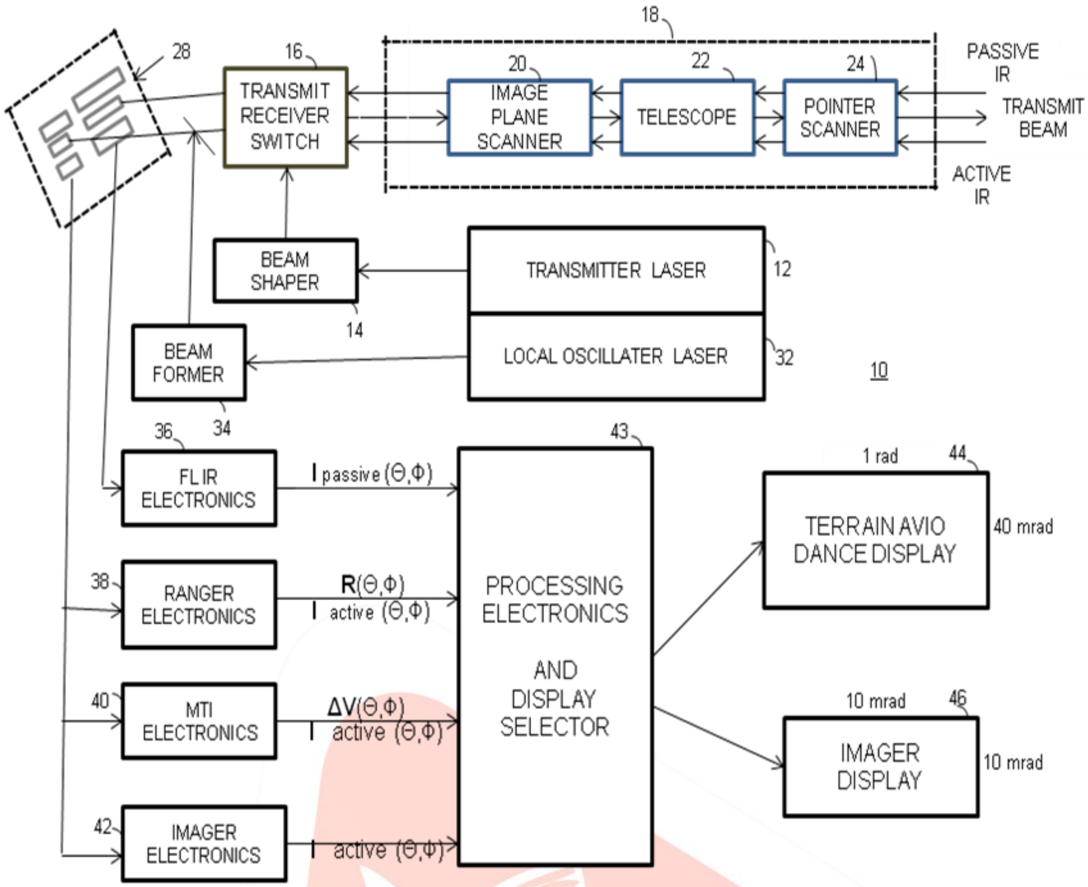
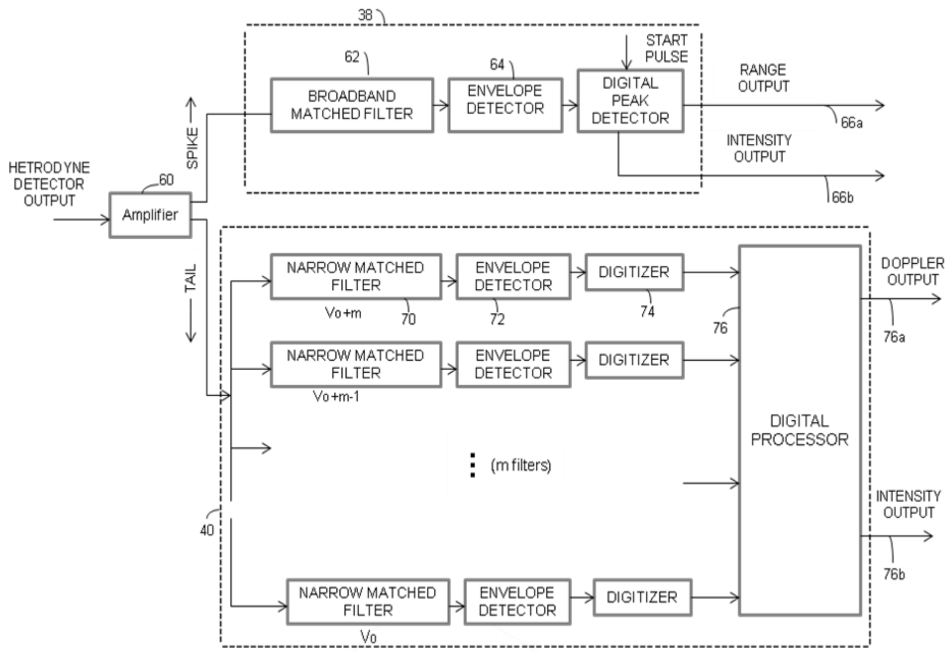


Fig - 1

1. An Infrared Radar System, Comprising:

LASER device for generating at least one infrared transmit pulse having a spike portion and a CW portion. A telescope and pointer scanner for transmitting said pulse to a target scene. Receiver device for receiving reflections of transmitted pulse reflected from objects in said scene, and for generating first signals representative of the received reflections of said spike portion, and second signals representative of the received reflection of said CW portion. First processing device responsive to first signals (Spike) for generating data representative of the range of objects in scene. Second processing device responsive to second signals(Tail) for generating data representative of the velocity of objects in scene.



2. A system according to claim 1 wherein said laser device comprises:

An infrared laser selectively operable in a pulsed mode or a continuous wave (CW) mode, and LASER control unit for selectively controlling the operational mode of laser to generate pulse for transmission.

3. A system according to claim 1 or 2 wherein said receiver device comprises:

An array of detector elements and associated units for imaging received reflections through detector elements, A local infrared laser and associated units for imaging a reference beam from local laser unit for received reflection through detector elements, Wherein array includes a first set of detector elements, each first set element being adapted to generate first signals(Spike), first signals being representative of the intensity of the received reflections of spike portion imaged thereon, and Wherein array includes a set of heterodyne detector elements, each heterodyne element being adapted to generate second signals (Tail), second signals being representative of the difference in frequency between said reference beam and the received reflections of said CW portion imaged there on.An array of detector elements, wherein each element includes at least one heterodyne detector cell, Imager electronics circuit for imaging received reflection on heterodyne detector cells, Local infrared laser and beam former for imaging a reference beam from local laser on heterodyne detector cells, Units for imaging received passive radiation on direct detector cells, and wherein heterodyne detector cells are adapted to generate said first signals(Spike), and direct detector cells are adapted to generate said second signals(Tail).

Final Results:

This paper will have the following capabilities which will positively help in overcoming the restraints of a Electromagnetic microwave RADAR.

(1) Search in wide angle (that is wide field of view, low resolution imaging) in either an active (reflected radiation) or passive (thermal radiation) mode.
(2) Capability of finding range of targets(Target Ranging).
(3) MTI operation by Doppler resolution of target velocities (allowing moving target indication to be performed).
(4) Target identification and acquisition (using narrow field of view, high resolution imaging) in both the active or passive mode.
(5) A Target designation to other associate systems.

Conclusion:

INFRA-RED RADAR when fitted on an aircraft will further enhance the safety and navigational capability of the aircraft. A microwave RADAR is unable to provide a high resolution image for better terrain avoidance system. This limitation of the microwave RADAR is now overcome by using an INFRA-RED RADAR. Terrain mapping can be done with a better result by using INFRA-RED RADAR for better planning and implementation of projects by the government. It can also be used for the geographical study of an area and for subsequent implementation of initiatives to be taken for infrastructure development. These are the few important aspects which can be fulfilled with a higher result out of the total lot of advantages and usage for INFRA-RED RADAR.

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