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DEVELOPMENT OF HIGH RESOLUTION SURFACE RADAR SYSTEM USING LASER DIODE

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INTRODUCTION

It is necessary to detect the positions of airplanes and to identify the types of airplanes on runways and taxiways for safety airport operation. Nowadays, millimeter wave radar systems called ASMI (Airport Surface Movement Indicator) are employed in airports. It is possible to detect the positions of airplanes, however, is impossible to identify the types of airplanes with traditional radar systems. Therefore, air traffic controllers must identify the types of airplanes with the naked eyes. Air traffic controllers are tired out because of this reason. So, they demand development of a new radar system that is able to foretell the danger of collision.

It is an aim of this study to built a new Radar System that has high range resolution and high bearing resolution as a prototype model. Laser Diode that is given attention in points of high speed pulse response and high directional beam is used in this prototype model. The echo pulse signal from the model airplanes B747 and B767 that are scaled one to two hundred on 1000/200 meter ahead are detected with the measuring device built as a trial. A performance of the prototype model, a comparison between ASMI and the prototype model, and the results of comparative observations B747 and B767 are reported.

SURFACE LASER RADAR SYSTEM

Fig. 1 shows the block diagram of Surface Radar System using Laser Diode (SRL) built as a prototype model. SRL can scan 360° in horizontal. As the system detects a start signal clock counter is started and a fire signal from pulse generator is transmitted to the laser diode at the same time. Then a pulsed laser beam is sent to the air through the collimating lens. The echo signal comes into the photomultiplier through the receiving telescope. The received signal that is detected by the photomultiplier is amplified by the amplifier. The echo part of this amplified signal is distinguished from the noise part of that through the threshold level setting circuit. The echo signal is converted digital signal through A/D converter and stops counting at the same time. Bearing detection system is formed by resolver and R/D converter. Then a computer reads range data, bearing data and a peak level of the echo signal. Fig. 2 shows vertical and horizontal beam pattern on 1000/200m ahead.

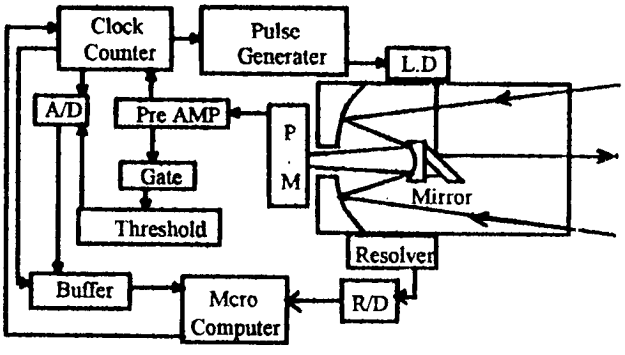
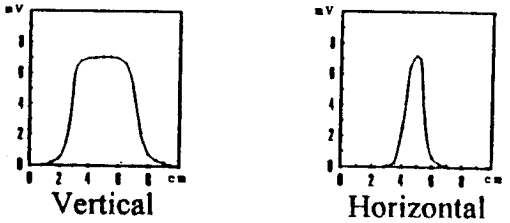


Fig. 1 Block Diagram of SRL



Vertical Horizontal

Fig. 2 Vertical and Horizontal beam pattern

COMPARISON BETWEEN SRL and ASMI

Table 1 shows the performance of SRL and ASMI. Range resolution of SRL is 2.3 times as accurate as that of ASMI. And Bearing

resolution of SRL is 17.4 times as accurate as that of ASMI. Fig. 3 shows the scanning illustrations of SRL and ASMI on 1000/200m ahead. SRL can come in practical replacing 20 mW pulse peak power with 2.2 KW. Pulse peak power of SRL is 0.074 times as strong as that of ASMI.

Table 1 Performance of SRL and ASMI

	SRL	ASMI
Wave length	780 [nm]	1.22[cm]
Pulse Peak Power	2.2 [kW]	30 [kW
Pulse Width	8.6 [ns]	20 [ns]
Distance Resolution	1.3 [m]	3 [m]
Bearing resolution	0.0286[rad]	0.5 [deg]

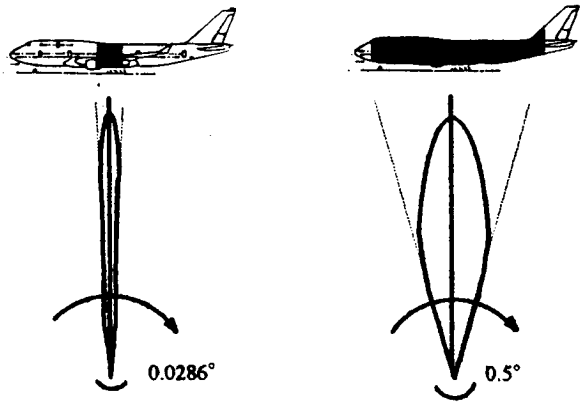


Fig.3 Scanning illustration

EXPERIMENT

Fig. 4 shows the method of experiment. The model airplane is detected from the front or the side. Measured echo patterns show the properties of airplanes, in other words, the positions of engines, the number of engines, the lengths of airplanes and the width of airplanes. Fig 5, 6, 7 and 8 show the external appearances and the measured echo patterns of airplanes.

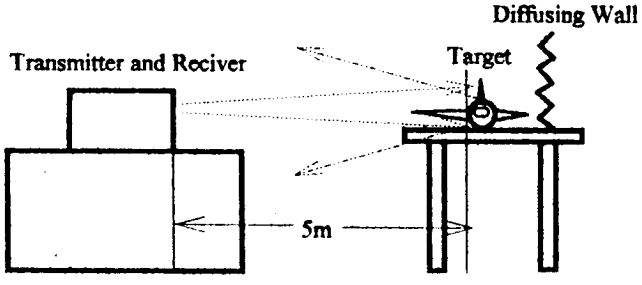
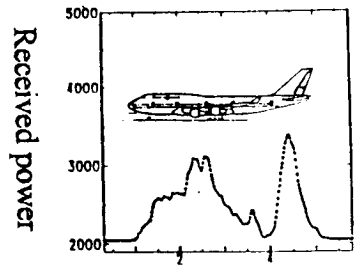
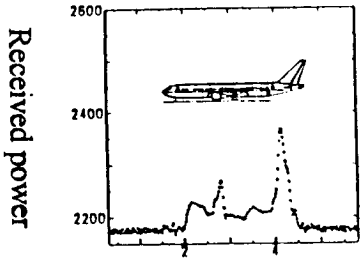


Fig. 4 Method of experiment



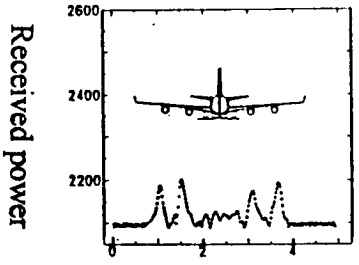
Horizontal angle

Fig. 5 B747 Side



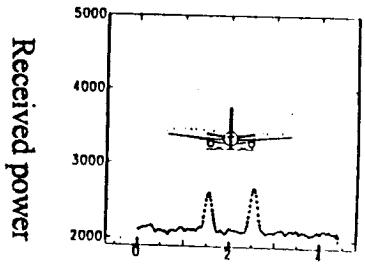
Horizontal angle

Fig. 6 B767 Side



Horizontal angle

Fig. 7 B747 Front



Horizontal angle

Fig. 8 B767 Front

CONCLUSIONS

It is possible to identify the types of airplanes with SRL. SRL can come in practical replacing 20 mW pulse peak power with 2.2 kW. Nowadays, laser diode maximum power is only 10 W, however, such a weak power is supplemented by arranging 220 laser diodes. From now on, SRL would be improved to identify the moving airplanes and to use in bad weather. Algorithm to identify the types of airplanes will be established in the future.