Original research article

Research on a “flash” ladar without cooling system working under the temperature field of fast flying platform

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\begin{abstract}
The “flash” ladar is a focal plane array (FPA) imaging system, which can supply the 3D-range and 1D-intensity imaging with high quality and frame rate. The high-speed flying platform needs a low-power-consumption and miniature ladar system. To meet this requirement, we proposed a “flash” ladar using an alexandrite laser without cooling system and an APD as a receiver, which can be miniaturized and working normally for a short time under the temperature field (60–80 °C) of fast flying platform. Through the testing, a maximum detection range of 6 km, a spatial resolution of 1 degrees and a range resolution of 2 cm have been obtained.
\end{abstract}

1. Introduction

The “flash ladar” is a promising imaging system as its high spatial resolution and frame. It can supply the 3D-range imaging and 1D-intensity imaging \cite{1,2}. Furthermore, as a focal plane imaging system, it can supply the target image one time during one laser pulse, which has greatly improved the imaging frame \cite{3,4}. Therefore, it is suitable for the fast flying platform.

The fast flying platform needs a ladar not only the high frame but also the high laser pulse energy and miniaturization \cite{5}. Due to the solid laser, the volume is increasing with the laser pulse energy. To remove the cooling system of the laser is an effective approach to reduce the weight and volume of ladar system. The key solution is to find a laser which can be working normally under the temperature field of the fast flying platform (60–80 °C). To meet the requirement of the application of terminal guidance, only several minutes for the ladar working is enough. As a kind of high power tunable laser, the alexandrite laser has been chosen because it has the ability of working normally under the higher temperature field (could be nearly 250 centigrade) \cite{6–9}. With a quartz xenon pump of 12 J, 25 Hz, the alexandrite laser can be working for over 7 min under the temperature field of 60–80 °C.

The wavelength of alexandrite laser is nearly 750 nm, which belongs to invisible range \cite{10,11}. So that this ladar system is easy for hidden compared with the green laser. A silicon based linear avalanche photodiode (APD) array detector can be chosen because of its high responsivity of 700–800 nm \cite{12,13}.

In this paper, a “flash” ladar system based on an alexandrite laser without cooling system and a Si In-APD as a receiver has been manufactured which can be working normally under the temperature field (60–80 centigrade) of the high-speed flying platform.
platform. Through the indoor experiment, a spatial resolution of 0.4° and a range resolution of 2 cm have been obtained. With the simulation, a detection range of 6 km can be extrapolated.

2. A “flash” focal plane imaging ladar without cooling system

A “flash” focal plane imaging ladar without cooling system is designed, which consists of an alexandrite laser, an 8 × 8 silicon based linear APD detectors, optical system and Field Programmable Gate Array (FPGA) control circuit.

As is shown in Fig. 1, the alexandrite laser sends a beam to illuminate the imaging area through the emission optical system. Then reflected light from the target in the region could be received by the APD detector through the receiving
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