Preliminary Experimental Result of Optical Fiber Connected Passive Primary Surveillance Radar

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***Abstract* - This paper describes a new radar system concept using a radio-over-fiber (RoF). The proposed system is an Optical Fiber Connected Passive Primary Surveillance Radar (OFC-PPSR) which is based on the passive bistatic radar. Separated receiver unit uses scattered waves from aircraft and radar reference data. Radar reference data transmitted by RoF include radio frequency (RF) of transmitter unit and processing data such as rotating radar angle. In this paper, we present a principle of the OFC-PPSR and show experimental system which has been deployed in Sendai airport. We show the preliminary experimental result of the proposed system. It will be shown in the experimental result that the proposed system can detect moving aircraft.**

***Index Terms* — primary surveillance radar, multi-static primary surveillance radar, RoF, air traffic management.**

1. Introduction

An airport surveillance radar mainly consists of both a primary surveillance radar (PSR) [1] and a secondary surveillance radar (SSR) [2]. SSR using reply signals from an aircraft is the major surveillance system, and there are some applications. On the other hand, PSR plays an important role for backup and improving operation security. This is because PSR using scattered waves is an independent non-cooperative surveillance. However, no application systems are introduced to air traffic control.

Recently, multi-static primary surveillance radar (MSPSR) [3] has been expected to be used as the conventional PSR alternative. One of the interesting properties is to select appropriate signals, for example, present radar signal, digital terrestrial television broadcasting (DTTB), mobile communication (ex: 3G and LTE), GNSS and so on [4]. As one of them, we have been studying a new radar system for expanding the present PSR coverage. Our proposed system is an Optical Fiber Connected Passive PSR (OFC-PPSR). In this system, the radio-over-fiber (RoF) technology is applied.

In this paper, the proposed surveillance system is introduced. Firstly, the system concept and principle of OFC-PPSR is described. And then, the experimental system deployed in Sendai airport is shown. Finally, we show experimental result. It will be shown that the OFC-PPSR detect aircraft.

2. Optical Fiber Connected Passive Primary Surveillance Radar

This section describes the system concept of OFC-PPSR. The proposed system uses an application technology of optical fiber. Since the present PSR has a transmitter unit combined with a receiver unit, the receiver unit easily obtains the information of transmitted signals. On the other hand, passive bistatic radar has a separated receiver unit from a transmitter. Therefore, the original signal processing is needed. Hence, we consider a radar system which has a receiver unit connected by the optical fiber for taking radar information. In order to directly send the radio signals, we employ the RoF.

Figure 1 shows a system concept of the proposed system. The receiver unit consists of two antennas, a preamplifier, a down converter, a signal processing unit and a RoF receiver unit. On the other hand, a transmitter unit of RoF is located at radar site. The RoF transmitter is connected to the RF monitor and TTL terminals of control unit. The TTL terminals provide various radar information such as rotating angle, the transmitted timing and so on. RF signals and radar information transmitted by RoF are used at receiver side as reference data. The OFC-PPSR receiver unit computes aircraft positions by using scattered waves and reference data. In addition to that, the system can be also estimated target positions by directed waves in case that the RoF is not used.

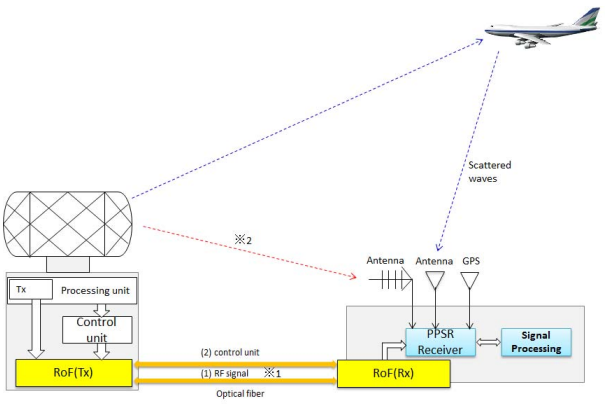

Fig.1. Principle of OFC-PPSR.

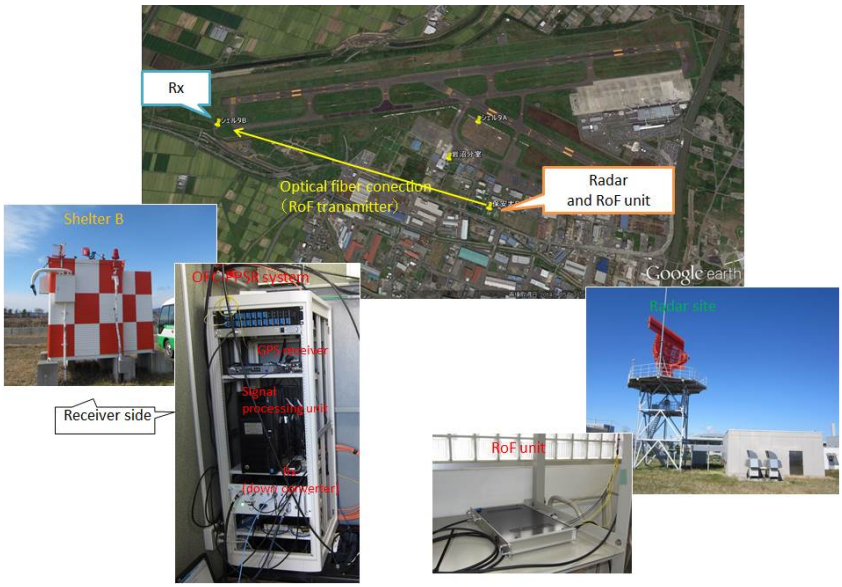

Fig.2. Experimental environment.

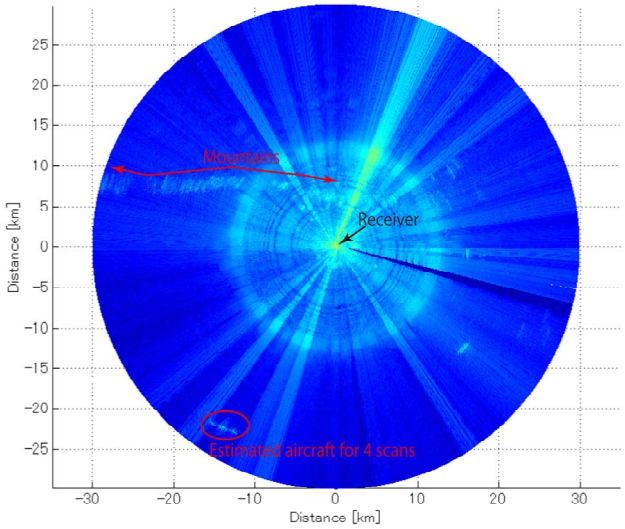

Fig.3. Experimental result.

In order to simplify the radar signal processing, we employ the RoF technology which uses the optical amplitude modulation. Accordingly, the OFC-PPSR receiver unit receives RF signals without large attenuation. However, corresponding to the length of optical fiber, signal delays occur. To modify the delay, the length of the optical fiber is measured in advance.

3. System Deployment and Experimental Result

A prototype system has been deployed at Sendai airport in Japan. Figure 2 shows an experimental environment. Radar and a RoF transmitted unit are located at southern part of airport. The RoF transmitter unit collects radiated RF signals and send RF signals to the optical fiber.

The OFC-PPSR receiver unit is located near runway end. The PSR emits both short pulses with 1us and long pulses with 80us. Long pulses are modulated by FM chirp. The signal processing unit analyzes both pulses, separately.

Figure 3 shows an experimental result of long pulse. This data was obtained for 4 scans (=16sec). The figure shows the mountains at the upper side. A moving aircraft is also shown at the lower side.

4. Conclusion

In this paper, we proposed the new radar system concept by using the RoF. The characteristics of the proposed system are to directly carry RF signals to separated receiver unit. The receiver unit uses the scattered waves from aircraft and original radar information. Aircraft positioning is carried out by the principle of passive bistatic radar. An experimental result performed at Sendai airport was shown. It has been shown that the proposed system detects the moving target.

Experimental data shown in this paper does not use special signal processing. We need to study the accuracy of the proposed system and to consider some applications of radar signal processing. They will be future works.

Acknowledgment

The work was supported in part by a Grant-in-Aid for Young Scientists (B) (16K18072) from the Japan Society for Promotion of Science.

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