Development and Evaluation of Ground-Based L-band SAR System

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Abstract—Application of synthetic aperture radar (SAR) data are being widely used for commercial and military purpose because the SAR can support acquiring images regardless of the weather and time conditions. Also, center frequency of the SAR is determined depending on its purpose such as resource exploration, disaster monitoring, national defense, and etc. In this paper, we adopt L-band SAR system for land observation and design and develop the prototype of ground-based L-band SAR system. The SAR system consists of PC, chirp signal generator, RF transceiver and antenna. The signal acquired by outdoor experiment is measured by oscilloscope and analyzed using MATLAB. The results of outdoor experiment show that the developed ground-based SAR system meets design requirements. Also, the acquired data is evaluated by impulse response function (IRF). We have a plan to improve the ground-based SAR system to the automobile SAR or Inverse SAR applying the results of this paper.

Keywords—Ground-based SAR; L-band; earth observation; prototype; IRF

I. INTRODUCTION

Synthetic aperture radar (SAR) which uses microwave can observe an object or a terrain regardless of the weather and light condition. Also, the SAR is on-boarded a car, unmanned aerial vehicle (UAV), satellite, and etc[1]. The center frequency of the SAR is determined by the purpose and is selected, for example, L-band (1-2 GHz), X-band (8-12 GHz), Ku (12-18 GHz), etc. In this paper, we adopt L-band SAR system for land observation and present the prototype of ground-based SAR system. The ground-based SAR system consists of several modules. First, chirp signal generator (CGN) generates chirp pulse signal. Second, RF transmitter modulates and amplifies generated signal. And then, antenna transmits chirp pulse signal and receives reflected signal. Fourth, RF receiver converts reflected analog signal to digital data. Finally, the converted data is printed to oscilloscope and stored to PC. After outdoor experiment, we verify the SAR system using impulse response function (IRF) method.

II. METHODOLOGY AND IMPLEMENTATION

For verification of ground-based SAR system, it is necessary to look for place of experiment. We select the schoolyard of Ajou university which reaches 60 m of straight-line distance. We experiment twice at day and night. After the first experiment, we complement the SAR system and try the second experiment at the same place. Fig. 1. represents the observation environment of the ground-based SAR.

Fig 1. Observation environment of the ground-based SAR
is chirp pulse signal, for evaluation of the SAR system. We load the two signals using MATLAB and use corr(A,B) function. The reason that we choose the IRF method is that this methodology can show the performance of the SAR system and to measure the distance between radar to target\cite{2}\cite{3}. Also, system performance is evaluated by calculating peak to side-lobe ratio (PSLR) and integrated side-lobe ratio (ISLR). PSLR means the distance between peak of main-lobe and peak of first side-lobe and is represented in dB scale. Also, ISLR means the power difference of main-lobe and side-lobes. Main-lobe and side-lobes are occurred as a result of the IRF analysis. Usually, the requirement of the SAR system is set up below to -13 dB of PSLR and ISLR, respectively\cite{4}.

III. FINDINGS

After two attempts, we find the problems of the SAR system and the experiment. First, the RF module and the antenna are interfered in each other. The attenuation of the IRF values result from this problem. Second, the distance of experiment is too short in comparison with pulse width. Long pulse width causes that the reflected signal is buried in the transmit signal. Solving this problem, we decrease the pulse width 30 \( \mu \)s to 5 \( \mu \)s and 2.4 \( \mu \)s. Furthermore, we have a plan to additional experiment at open area.

IV. CONCLUSIONS

We have built the ground-based L-band SAR system and measured outdoor experimental result. Based on the measured data, we have found that current system needs to be fine tunning in pulse width of chirp signal and RF module. Therefore, we are working on improving system hardware and signal parameters.

Finally, we will carry out third experiment and make the observation images of open area soon.

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REFERENCES