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Electrooptic technique to investigate the scattering phenomena in millimeter-wave band

Shintaro. Hisatake
Gifu University, Gifu, Japan

Abstract

Electric field visualization system based on photonics technology was presented to demonstrate millimeter-wave scattering phenomena inspection. The measurement system is a so-called spectrum analyzer type in which neither a reference probe nor a cable plugged to the RF source is required for amplitude and phase measurements. We demonstrate the visualization of the electric field scattered by a metal pole. Also, we visualize the scattered field is decreased by the absorber attached onto the metal pole.

1 Introduction

In the higher frequency region, such as millimeter-wave band and terahertz wave band, the spatial quality of the beam becomes more important than the microwave band. Highly accurate and precise measurement of the electric field distribution is an important key technology for the system optimization. Recently, we proposed and demonstrated an asynchronous technique based on an electrooptic sensing for electric field visualization at millimeter-wave and THz wave band [1,2]. The measurement technique is quite versatile to realize not only a near-field visualization and far-field characterization [3], but also the inspection of the propagation, diffraction, and scattering phenomena. In this presentation, we demonstrate the visualization of the scattered field distribution at millimeter-wave band.

2 Experimental set up

Figure 1 shows the measurement set up based on the asynchronous technique [3]. The system based on the two key techniques: non-polarimetric electrooptic (EO) frequency down conversion technique and frequency fluctuation cancelling technique. The RF signal to be measured is frequency converted to the microwave band based on the non-polarimetric EO frequency down conversion technique. We used two EO probe for the measurement and reference. The frequency fluctuation of the RF signal to be measured relative to the system is cancelled out in the frequency fluctuation cancelling part to map relative phase distribution of the field. The amplitude and phase data measured by the lock-in amplifier were transferred to a PC to visualize field distribution.

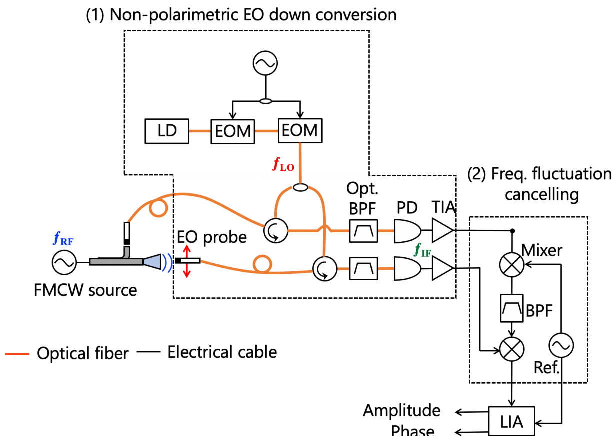

Figure 1. Measurement setup. LD: laser diode, EOM: electrooptic modulator, BPF: bandpass filter, PD: photodiode, TIA: transimpedance amplifier, LIA: lock-in amplifier.

3 Results

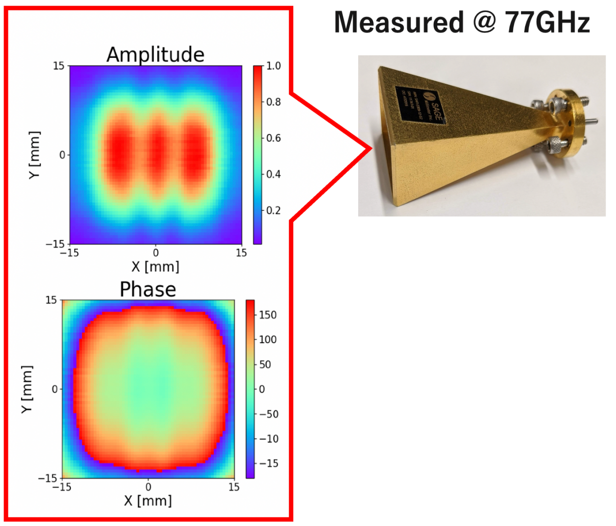

Figure 2. Near-field distribution of a standard horn antenna (WR-15). Measured frequency was 77 GHz.

Figure 2 shows measured near-field distribution (amplitude and phase) of the standard horn antenna. The measured frequency was about 77 GHz, which has been used for the car radar applications. The measured near-field distribution and far-field radiation pattern calculated from the measured near-field results agreed well with the simulated results.

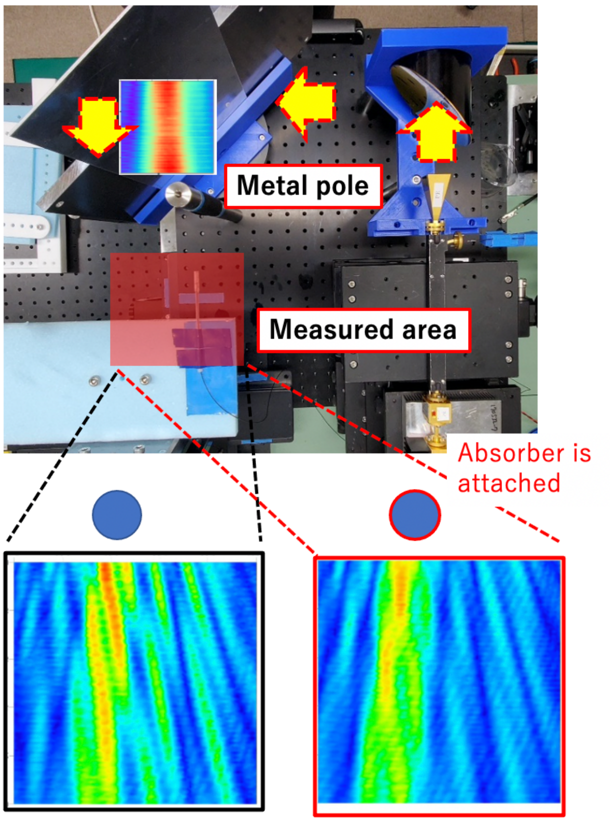

Figure 3. Visualized scattered electric field. The collimated 77 GHz beam was scattered by a metal pole.

Figure 3 shows measured distribution of the scattered electric field. The millimeter-wave (77 GHz) was emitted from the standard horn antenna (shown in Fig. 2) and collimated by an off-axis parabolic mirror. The collimated beam was scattered by the metal pole. We also measured scattered field after attaching an absorber to the metal pole. We confirmed that the visualization is effective way to quantitatively evaluate the effect of the absorber. The technique paves the way for the experimental investigation of various electromagnetic phenomena including propagation, diffraction, and scattering.

4 Summary

We demonstrated the visualization of the millimeter-wave distribution at 77 GHz. The technique reveals not only the near-field distribution of the antenna, but also the electric field scattered by any objects. We believe that the technique paves the way for the experimental investigation of various electromagnetic phenomena including propagation, diffraction, and scattering.

6 Acknowledgements

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7 References

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