

Real-Time Imaging System Using Parabolic Reflector and Detector Array

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Abstract

In this letter, a real-time imaging system using parabolic reflector is presented. The system is designed at 10 GHz to mimic THz real-time imaging system. In the proposed imaging system, a 10 GHz power is concentrated at the focal point of the parabolic reflector, and it is received by 8×8 detector array placed at the focal point. The received input power is rectified into dc output voltage by each detector. Finally, dc voltage in each detector is read by computer in real time and displayed using different colors depending on the level of dc voltage. The detector array design and experimental results of real-time imaging are presented showing that the proposed system can be used for a real-time THz imaging system design.

Keywords: detector, imaging, rectifier, rectenna, THz.

1. Introduction

Recently, THz imaging systems have been introduced in some publications [1-2]. In most systems, parabolic reflectors and lenses are used to illuminate the target object by THz power source, and the power reflected from or penetrated into the object is detected by detector array to construct image of the object. In this work, real-time THz imaging system is proposed using parabolic reflector and detector array without lens. To mimic the THz system, a 10 GHz system is designed and measured to verify the operating principle of the proposed system.

2. Real-Time Imaging System

Fig. 1 shows the experimental setup for the proposed imaging system. The reflected power from the object is represented by the signal generator which

is connected to a horn antenna. The input power radiated with the horn antenna is reflected by parabolic reflector, and is concentrated at the focal point of the parabolic reflector. The 8×8 detector array placed at the focal point receives and rectifies the reflected power into dc voltages at each output port of the detector pixels. In this condition, if the direction of the horn antenna is changed in real-time, the pixel reveals highest output voltage is changed also in real-time. Therefore, the real-time image can be made. The output voltage is read by data acquisition board, and real-time 8×8 output image is displayed on monitor after imaging process. The input power generated by signal generator is 10 dBm, and is radiated to parabolic reflector with a horn antenna which has gain of 20 dB. The parabolic reflector has 72 cm of focal length, and gain of 30 dB.

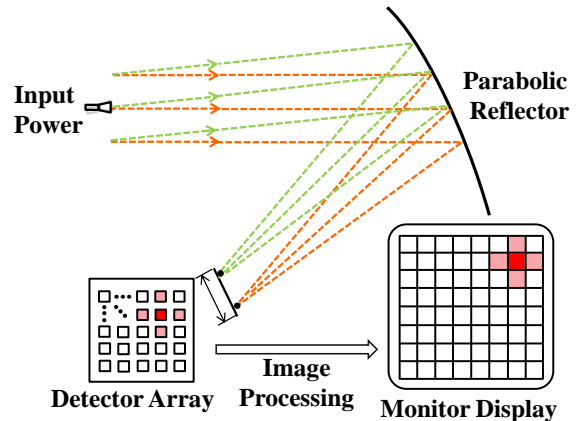


Fig. 1 Experimental setup for proposed real-time imaging systems.

3. Detector Design

A single detector, which composes 8×8 detector array, is designed at 10 GHz using a patch antenna and rectifier. The reflected input power is received by the patch antenna, and dc voltage is generated by the

rectifier. The designed microstrip patch antenna has size of $9.5 \times 9.5 \text{ mm}^2$, gain of 6 dB, and -15 dB of return loss.

The rectifier circuit is composed of a diode, quarter-wave open stub for rejection of even harmonics, and radial stub for rejection of third harmonics. According to simulation results, dc voltage of 300 mV is detected at the input power of 10 dBm. The fabricated rectifier circuit shows dc voltage of 150 mV at the same input power. The size of a single detector is $18 \times 18 \text{ mm}^2$. Fig. 2 shows the measured output voltages of single detector (rectenna) as a function of input power.

The 8×8 detector array was fabricated on a Teflon substrate having thickness of 62-mil and a dielectric constant of 2.2. The gap between each detector is chosen as 2 cm, a length between half-wave and full-wave, to reduce mutual coupling between patch antenna [3]. Fig. 3 shows photographs of fabricated single detector and 8×8 detector array.

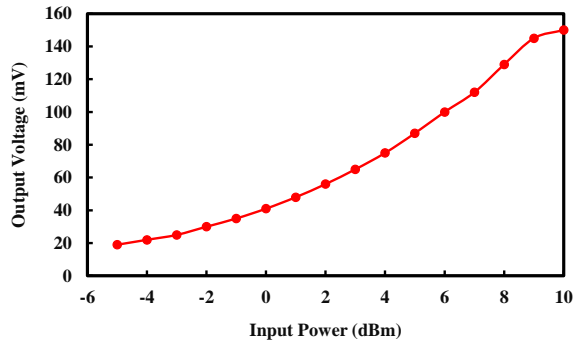


Fig. 2 Measured output voltage of a single rectenna (detector).

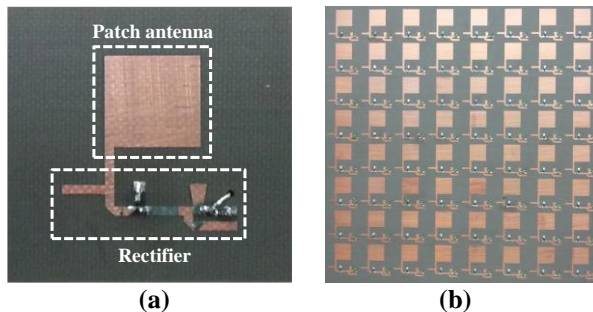


Fig. 3 Photographs of the fabricated (a) single detector and (b) 8×8 detector array.

4. Experimental Results

Output dc voltage of each detector was measured by the DAQ board with 64 channel and read by the computer. Total scanning time for 8×8 array was 194

ms which is short enough to construct real-time image. The dc voltage of the detector is processed by Matlab and displayed with different colors, where each detector constitutes a pixel. Fig. 4 shows output image displayed on monitor. The pixel with lighter red implies higher output voltage. The maximum measured output voltage is 120 mV. The proposed system shows that the pixel with highest dc voltage can track the direction of the input power source, describing real-time imaging.

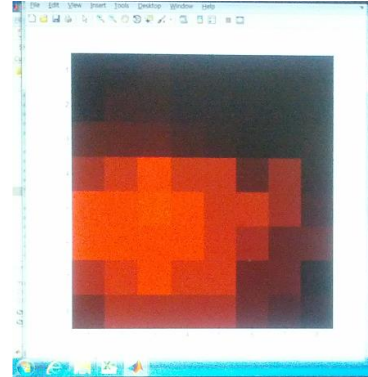


Fig. 4 Output image displayed on monitor.

5. Conclusion

In this letter, we proposed a real-time imaging system using parabolic reflector and detector array. The design of the system was presented at 10 GHz. The experimental results show that the proposed system can be used for a THz band real-time imaging system design.

Acknowledgements

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References

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