

Demonstration of a real-time terahertz-wave radar based on a resonant-tunneling-diode oscillator

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Terahertz-wave radars have been gaining interest for potentially replacing microwave and millimeter-wave radars and offering better axial and lateral resolution due to larger bandwidths and shorter wavelengths.

For successful applications, including radars, a practical terahertz-wave source is critical. We believe a good candidate is the resonant-tunneling-diode (RTD) oscillator, a compact device that can generate continuous terahertz-wave outputs in the milliwatt range at frequencies up to 2 THz.

We previously reported [1] on a real-time subcarrier frequency-modulated continuous-wave (FMCW) radar based on an RTD source. At that time, only fixed targets could be ranged accurately. Here we report an improved radar that allows ranging of fast moving (at least 1 m/s) targets. This was achieved by synchronizing all the signals in the system, as shown in Fig. 1. With this improvement, not only the distance, but now also the speed of the target can be measured accurately, by taking two distance measurements at precisely spaced times.

We also demonstrate the real-time quality of our measurement system by rotating the radar beam in a plane and searching for targets at each angle, thus obtaining a two-dimensional map of the target field. A result is shown in Fig. 2. The total measurement time is limited by the mechanical rotation stage; for each angle the measurement takes only 25 ms. Other measurement parameters: RTD oscillation, 522 GHz; RTD output power, 10 μ W, frequency sweep period, 131 μ s, modulation frequency range, 3–9 GHz.

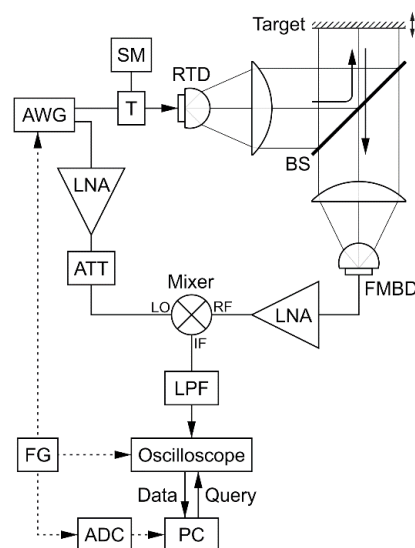


Fig. 1. Schematic of the experimental setup. AWG: arbitrary-waveform generator; T: bias tee; SM: source measure unit; BS: beam splitter; FMBD: Fermi-level managed barrier diode detector; LNA: low-noise amplifier; ATT: attenuator; LPF: low-pass filter; FG: function generator; ADC: analog-digital converter.

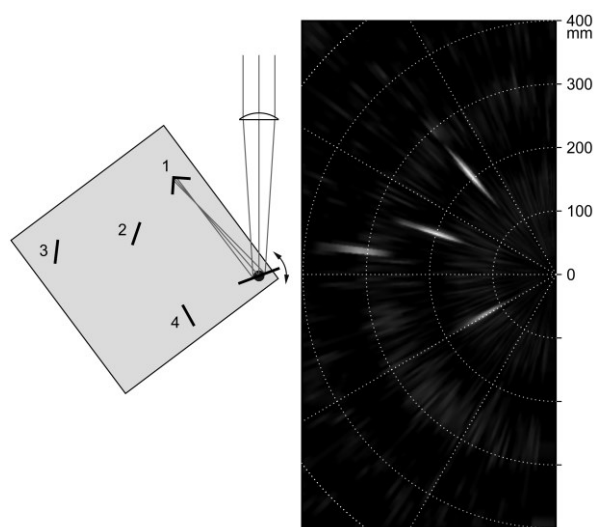


Fig. 2. Four targets (left) are scanned one-dimensionally with a rotating mirror. The radar reveals the targets' $R\theta$ positions (right).

[1] J. Ito, A. Dobroiu, S. Suzuki, M. Asada, and H. Ito, “Real-time distance measurement using a subcarrier FMCW radar based on a terahertz-wave resonant-tunneling-diode oscillator,” *IRMMW-THz*, 2021, doi: 10.1109/IRMMW-THz50926.2021.9567210.