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Real-Time Passive Coherent Microwave Imaging system Using a Disordered Cavity

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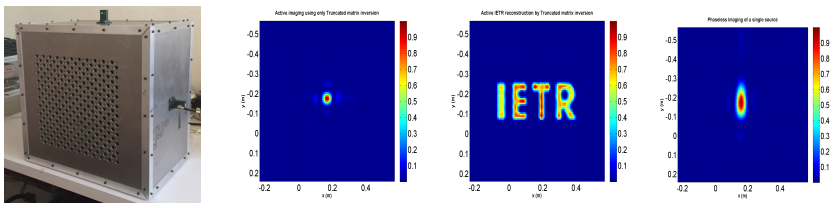
Extended Abstract

Traditional active imaging systems are based on the emission of a well-known waveform and the reception of signals by one or more antennas. To obtain high-resolution imaging systems, the number of antennas increases rapidly. MIMO configurations have been developed to limit this problem[1]. Nevertheless, each antenna has to be associated with an active device used for emission or reception of a signal. A recent interesting solution proposed to overcome this complex and expensive architecture is to use a leaky mixing cavity connected to a single or a few RF channels. The wave is randomized within the chaotic cavity and spectral degrees of freedom can be exploited to obtain a system for which the resolution is related to the aperture of the cavity instead of the number of antennas[2, 3].

Here we demonstrate that this computational imaging method can also be used for passive imaging of noise sources. We have designed a leaky cavity to operate over the frequency band of 8-12 GHz, covering the X-band. The size of the fabricated cavity shown in Fig. 1a is 50cm x 50cm x 50cm giving theoretically a number of 34000 modes within the frequency range from Weyl's law. A single output port is used in reception. The diameter of the holes is 1.25cm with a periodicity of 3cm, leading to an 11 x 11 array holes. We perform a near-field scan of the cavity to measure the transfer functions between the port and the near field of the cavity. Using a matrix formalism, the imaging of a distribution of sources outside the cavity reduces to a matrix inversion. We first show that this allow the location of a coherent source. The source is seen to be accurately located in Fig. 1b using a truncated SVD technique. Using synthetic data, we also demonstrate a good reconstruction of the logo IETR in Fig. 1c.

For imaging of a noise source, we compute the auto-correlation of the noise signal recorded on the port. In this case, imaging is similar to a phaseless problem. Using algorithm developed in [4], this can be overcome as seen in Fig. 1d. The results obtained in simulation as experimentally are very encouraging with regard to the totally passive detection of weapons or aiports scanners with a single sensor instead of an array of antennas.



(a) (b) (c) (d)

Figure 1. (a) View of the used cavity (b) Microwave active imaging of a point-size target (c) Active reconstruction of the logo IETR generated from synthetic data. (d) Passive imaging using the auto-correlation of the noise signal.

References

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