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Extreme Compression in THz Fourier Imaging

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For many years now, terahertz imaging has been applied to many fields. In this work, we experimentally demonstrate THz Fourier imaging. We use a lens to generate the Fourier transform of a transmission object. Then, we measure the Fourier plane using a THz detector mounted on a 3D stage. First, we demonstrate that using the conventional inverse Fourier transform the image can be reconstructed for a single THz frequency. Temporal THz electric waveforms are detected by raster scanning of the Fourier plane. Then, temporal Fourier transform is applied to those points resulting in an image per THz frequency. Using the inverse Fourier transform algorithm, we can reconstruct the object at each THz frequency. Second, we show that using less than 2% of the original pixels, we can still reconstruct the object. The spatial frequencies being directly proportional to the THz frequency, the measurement of a THz spectrum creates a line in the k-space. Therefore, instead of measuring on a 2D grid, it is possible to measure only a 1D path along a circle to reconstruct the k-space. Here, we demonstrate that using only 1.6% of the points, we can reconstruct the object. This is a considerable improvement to reduction of the data points using compressive sensing theory.

Primary author: GUERBOUKHA, Hichem (Ecole Polytechnique de Montreal)

Co-authors: Mr NALLAPPAN, Kathirvel (polytechnique montreal); Prof. SKOROBOGATIY, Maksim (École Polytechnique de Montréal)

Presenter: GUERBOUKHA, Hichem (Ecole Polytechnique de Montreal)

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