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Dynamic measurements at THz frequencies with a fast rotary optical delay line

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For several years, THz spectroscopy and imaging have been applied to many different fields. However, some burdens still remain in its commercial generalization, particularly for the industry sector. One of these difficulties lies in the acquisition time. In a typical THz time-domain spectroscopy system (THz-TDS), the THz pulse is sampled in time by the means of a micrometer linear delay line. This operation is highly time-consuming, often on the minute scale. We design and fabricate a fast rotary optical delay line (FRODL) consisting of two curvilinear reflectors directly connected to a rotating motor. The optical delay is linear with the rotation angle of the FRODL. The optical input and output are separate and stable to avoid the use of other moving components. We present an experimental implementation of such FRODL. The FRODL surface is made with a CNC machine. We fabricated four blades on the same disk to increase by four the total scan rate. We tested the FRLODL with speeds up to 48 Hz (192 Hz maximum). The motor and the electronics were limiting this speed. The total delay was experimentally evaluated to 100 ps. As a first application, we present contactless monitoring of spray painting process and thickness real-time evaluation of the thickness of the paint layer. As a second application, we present the simultaneous detection and thickness characterization of fast moving objects.

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

Co-authors: Dr MARKOV, Andrey (École Polytechnique de Montréal); Dr QU, Hang (École Polytechnique de Montréal); Prof. SKOROBOGATIY, Maksim (École Polytechnique de Montréal)

Presenter: GUERBOUKHA, Hichem (Ecole Polytechnique de Montreal)

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