

Applications and Analysis of Fourier-Transform Infrared Spectroscopy Measurement Techniques

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I. ABSTRACT

Fourier Transform Infrared (FTIR) spectroscopy reconstructs spectral information by analyzing interference signals generated in a Michelson interferometer. In this project, we design and implement a **near-infrared FTIR measurement** platform based on a 1030 nm laser source, aiming to understand the complete FTIR workflow from interferogram acquisition to frequency-domain reconstruction.

We construct and align the interferometer, develop a **LabVIEW-based motorized scanning system**, and implement a **MATLAB FFT reconstruction process**. Experimental measurements confirm stable interferograms, accurate spectral reconstruction, and high repeatability under different scan conditions. The results demonstrate that the implemented system provides a **reliable and reproducible platform for near-infrared absorption and transmission measurements**.

II. RESEARCH METHODOLOGY

(1) **System Architecture:** A 1030 nm Yb:YAG laser is directed into a Michelson interferometer composed of a 50:50 beamsplitter, a fixed mirror, and a motorized movable mirror, forming a stable two-arm interference path (Fig. 1).

(2) **Motorized Scanning:** A stepper-motor translation stage is controlled by a custom LabVIEW interface, ensuring synchronized mirror displacement and data acquisition through automated scanning (Fig. 2).

(3) **Photodetection:** The recombined beam is detected using a photodiode (PD), amplified, and digitized for further processing, capturing clean time-domain interferograms.

(4) **Signal Processing:** Interferograms undergo baseline correction, smoothing, and FFT-based spectral reconstruction using MATLAB, converting time-domain data into accurate spectra.

(5) **Simulation Verification:** MATLAB simulations validate interferogram formation and guide parameter choices such as step size and scanning window, providing reference conditions for experimental tuning (Fig. 3).

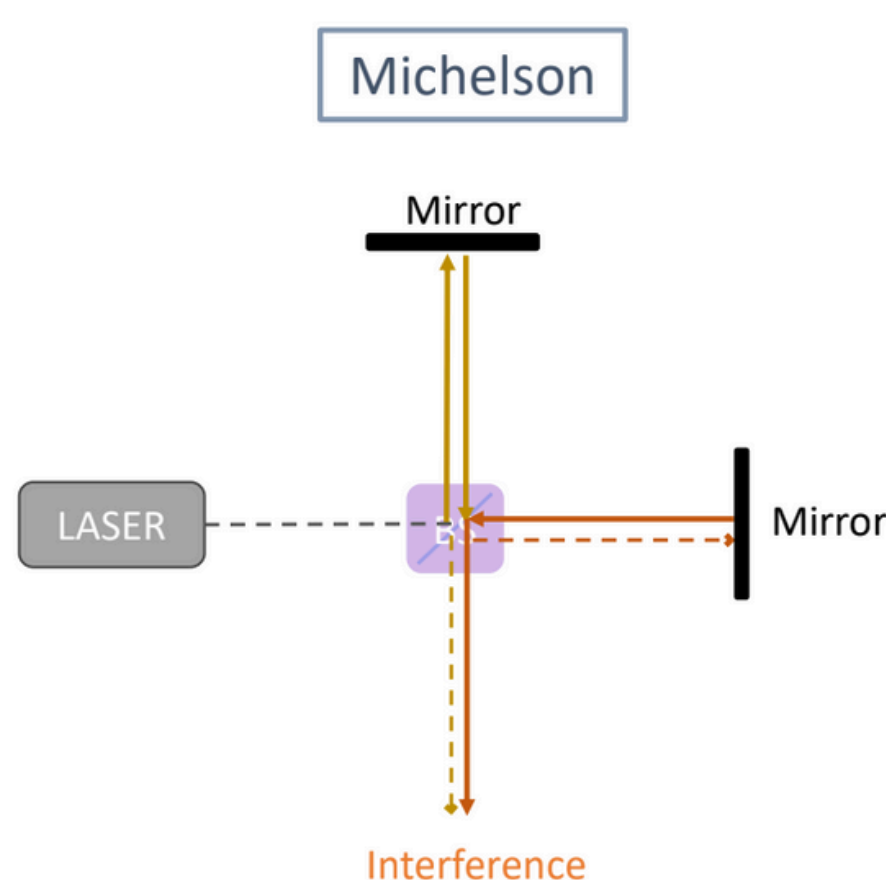


Fig. 1 Michelson interferometer

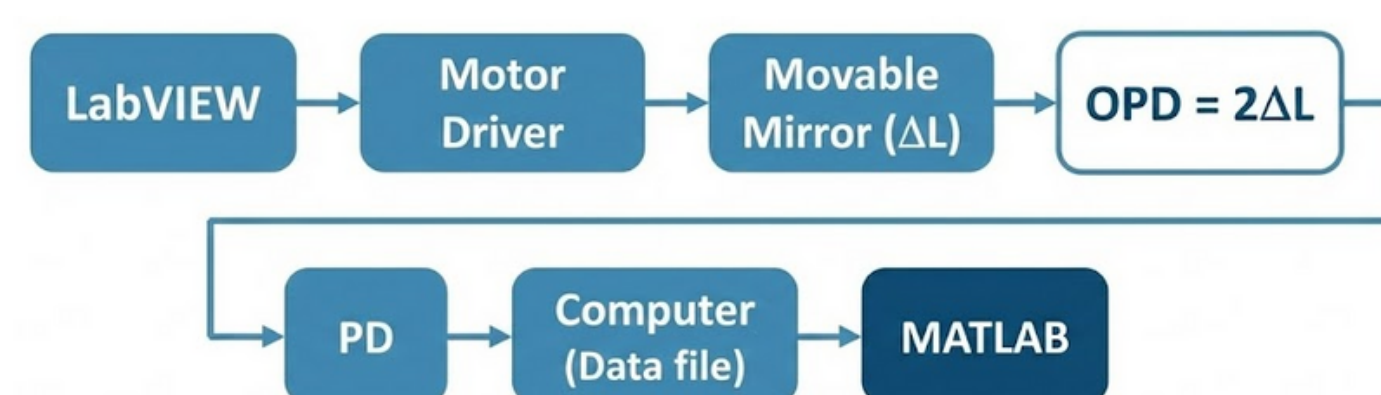


Fig. 2 LabVIEW-Controlled Motorized Scanning and Data Acquisition Workflow

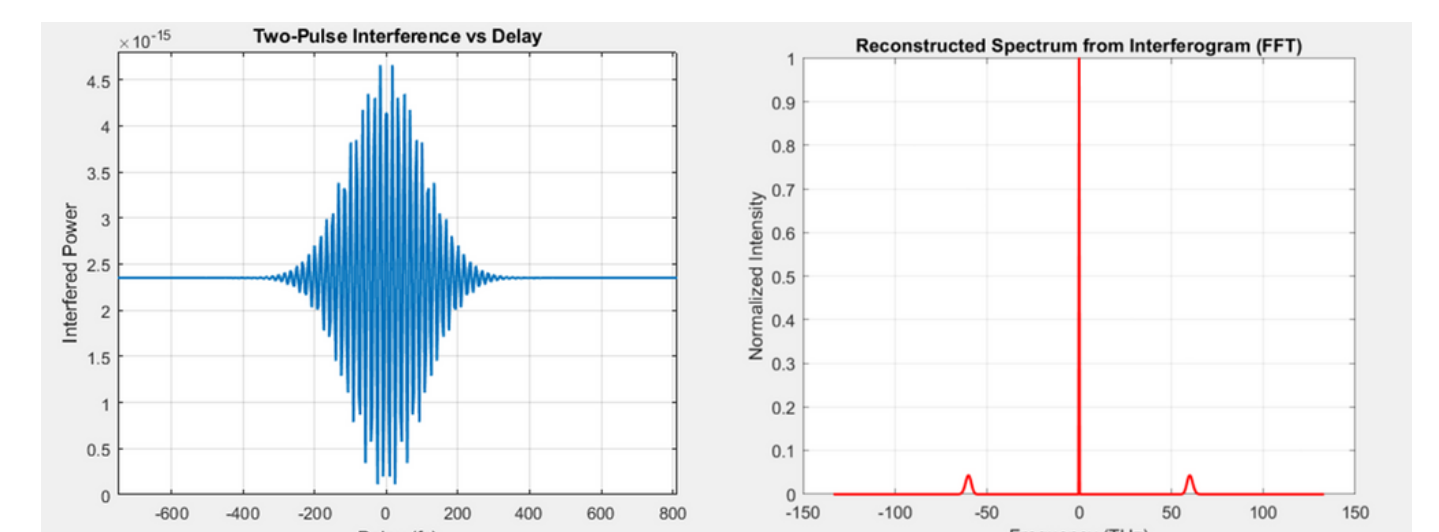


Fig. 3 Interferogram and FFT-Reconstructed Spectrum (Simulation)

III. EXPERIMENTAL RESULTS

Our FTIR system successfully reconstructs near-infrared spectra using a **1030 nm laser**, **motorized OPD scanning**, and **PD-based detection**. The raw spectra confirm correct optical alignment, while Transmittance Spectra results show **stable and repeatable absorption features** under different scan step sizes. After FFT reconstruction, the final absorbance spectra exhibit **clear, consistent spectral structures**, demonstrating that the proposed system achieves **reliable interferogram acquisition**, improved SNR through averaging, and **accurate spectral recovery** across the full measurement range.

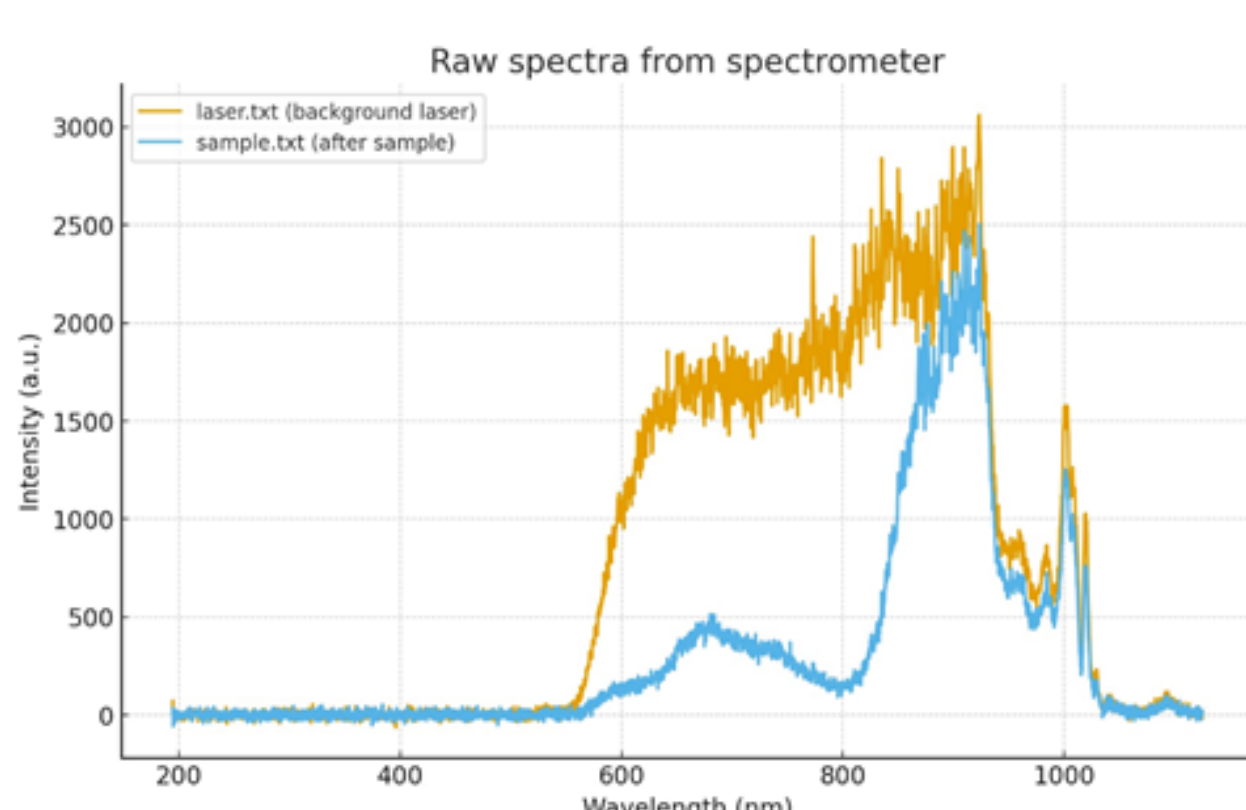


Fig. 4 Raw Spectra Verification

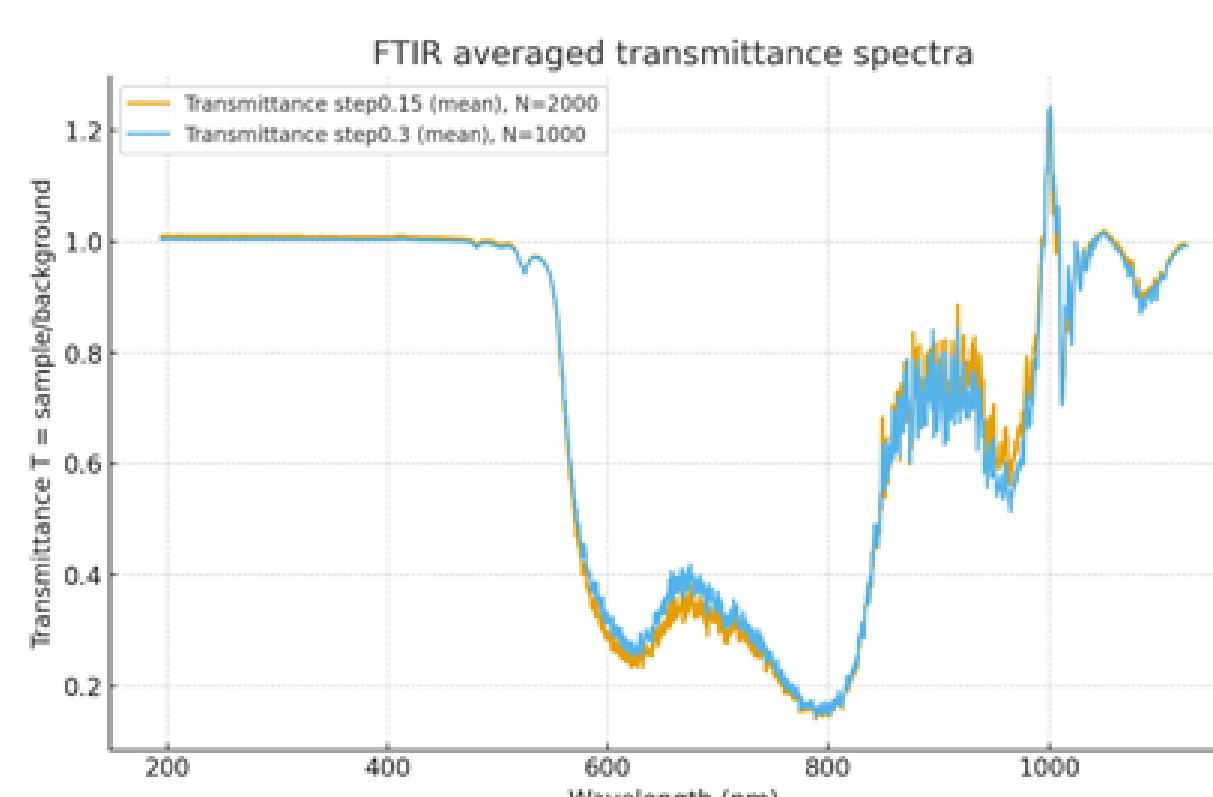


Fig. 5 Transmittance Spectra

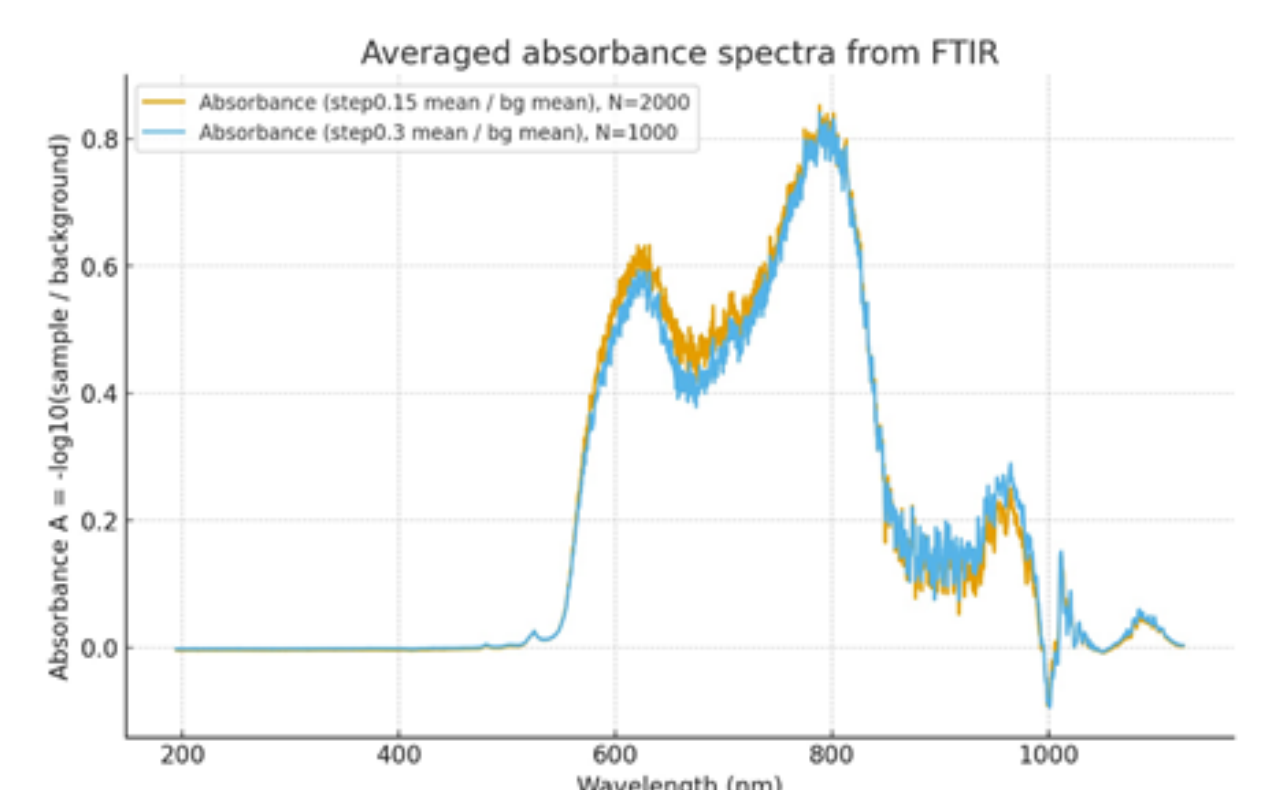


Fig. 6 Absorbance Reconstruction (FFT)