

MSC Physics Sem – IV Experiential Laboratory: Project Proposal –I

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"Design and Optimization of a Lens-Based Diffraction-Limited Earth-Observing Telescope for Low Earth Orbit(LEO) Applications by Zemax OpticStudio Simulations"

Abstract

This Experiential Laboratory Project focuses on the design of a lens-based Earth-observing telescope optimized for Low Earth Orbit (LEO) at an altitude of 500 km. The system is specifically designed to resolve ground features with a fixed Ground Sampling Distance (GSD) of 5m or 10m, operating in the visible spectrum (400–700 nm). The telescope aims to achieve diffraction-limited imaging, evaluated through Modulation Transfer Function (MTF) analysis, to ensure high-resolution and precise data capture.

Key design parameters include the calculation of aperture size and focal length to balance resolution and light-gathering capabilities, ensuring the system meets the desired GSD. The f-number ($f/\#$) is optimized to control light intensity and depth of field while maintaining compatibility with the detector's pixel pitch, which is determined based on Nyquist sampling criteria. The telescope's swath width is carefully considered to provide efficient ground coverage while maintaining imaging fidelity.

Image quality is analysed using wavefront error (WFE) metrics to ensure diffraction-limited performance. Additionally, MTF graphs are used to validate the system's ability to resolve fine details at the specified resolution. This project combines theoretical calculations and Zemax OpticStudio simulations to develop a practical optical system for Earth observation applications, contributing to advancements in space-based remote sensing technologies.