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Author: Mr. Ankur Singhai  
KaleidEO Space Systems Pvt. Ltd., India

Mr. Akash Yalagach  
KaleidEO Space Systems Pvt. Ltd., India  
Dr. Manoj Varma Sri Vatchavai  
Germany

TOWARDS HIGH-FIDELITY EARTH IMAGING: AN INTEGRATED HARDWARE APPROACH TO  
MOTION COMPENSATION AND SUPER RESOLUTION**Abstract**

Earth observation (EO) image quality is often constrained by high ground speeds and short sensor integration times required to minimize motion blur. Traditional systems address this using Time Delay Integration (TDI) sensors. This paper presents a hardware-focused approach to enable longer exposure times by compensating for relative ground motion, thereby improving both Modulation Transfer Function (MTF) and Signal-to-Noise Ratio (SNR). The system employs digital TDI through frame capture synchronization and motion compensation, eliminating the need for specialized TDI sensors. A prototype was developed and flight-tested on a gyro-stabilized aerial platform equipped with an Inertial Measurement Unit (IMU) and interfaced with the aircraft's Flight Management System (FMS). Despite limitations in super-resolution validation due to gyro-induced RMS errors, the system demonstrated notable image quality improvements. This work highlights a promising direction for high-performance imaging in future space-based EO missions.