Interim Report

Title: CNN based star tracker for high-precision spacecraft navigation

Author: Farid Guliyev

Introduction:

This interim report provides an overview of the progress made in developing an improved star detection algorithm for spacecraft attitude determination using convolutional neural networks. The objective of this research is to address the limitations of traditional star identification algorithms by leveraging the power of CNN-based approaches. The proposed algorithm aims to enhance accuracy, efficiency and robustness in detecting constellations and stars from sky images obtained from space simulators.

Progress Overview:

The research follows a quantitative approach which focuses on the development and evaluation of the CNN-based star detection algorithm. The selected research strategy includes literature review, problem identification, CNN algorithm design, dataset collection, algorithm training, evaluation and analysis, HIL (Hardware-In-the-Loop) testing and performance optimization.

The dataset consists of 15,000 simulated sky images sourced from space simulators such as Stellarium and Celestia. These images are divided into training, validation, and test sets to facilitate the development and evaluation of the algorithm. The collected dataset, while noise-free and accurately mapped, will be augmented with simulated noise to enhance the model's adaptability to real-time detection scenarios.

Statistical analysis focuses on evaluating the performance of the CNN model through relevant metrics such as accuracy, precision, and recall. Comparisons will be made with traditional star identification algorithms to assess the effectiveness of the proposed approach.

Visualization techniques are employed to examine the input and target images, providing insights into constellation appearance and the Milky Way's role in determining

constellation positions. These visualizations highlight the potential impact on the CNN model's performance.

Conclusion:

This interim report highlights the progress made in developing an improved star detection algorithm using CNN for spacecraft attitude determination. The research is conducted with a quantitative strategy, utilizing simulated sky images from space simulators. The data collection strategy involves a division of the dataset into training, validation, and test sets. Statistical analysis and visualization techniques are employed to evaluate and understand the performance and capabilities of the algorithm. The next steps include further evaluation, HIL testing, and performance optimization to enhance the algorithm's accuracy and efficiency. The research aims to contribute to advancements in star tracker systems and their applications in spacecraft control.