Reviewer: Arzu Fatullayeva

Submitter: Farid Guliyev

Project title: CNN Based Star Tracker for High-Precision Spacecraft Navigation

The report proposes the use of a Convolutional Neural Network (CNN) for the star tracker sensor of a spacecraft, aiming to improve attitude determination and navigation. The author plans to gather data from open-source planetarium applications and real star images to create a reliable deep learning model. The implementation will be carried out using TensorFlow, and the model will be tested using the Hardware-in-the-loop (HIL) simulation method. The report highlights the limitations of traditional star tracking methods, such as susceptibility to errors caused by image noise and the presence of multiple stars in the field of view. These methods also require complex hardware and extensive databases, making them expensive and resource-intensive. The proposed CNN-based star tracker aims to address these challenges by leveraging deep learning algorithms to enhance accuracy, robustness, and computational efficiency.

Strong parts of the proposal which need to be highlight :

- Innovative Approach - The proposal to use a CNN for star tracking in spacecraft navigation represents a novel approach that could address the limitations of traditional methods. Leveraging deep learning algorithms has the potential to enhance accuracy, robustness, and computational efficiency.
- Cost-Effectiveness - By eliminating the need for complex hardware and extensive databases, the proposed model aims to provide a more accessible and cost-effective alternative to traditional star trackers. This could benefit space industry companies by reducing costs associated with star-tracking systems.
- The report demonstrates an understanding of potential risks associated with the implementation of a CNN-based star tracker. Identifying risks such as data quality, model generalization, and reliability in space environments shows a thoughtful approach to the project.

What can **be improved** after review:

- Data Collection - The report acknowledges the challenge of finding open-source datasets captured using a star tracker. It would be beneficial to provide a detailed plan on how synthetic datasets and real star images captured on Earth will be utilized to mitigate the lack of star-tracker-specific data. It would be beneficial to outline strategies for mitigating this issue, such as generating synthetic datasets that closely resemble real star images encountered in space.
- While the report mentions the importance of the model generalizing well to different star patterns and conditions encountered in space, there is no mention of specific strategies or techniques that will be employed to achieve this. Providing more information on how the model will be trained to handle variations and adapt to real-world scenarios would strengthen the proposal.
- Reliability and Robustness Testing - The report briefly mentions the need to ensure the CNN-based star tracker can operate reliably in various space environments, but it lacks specific details on how this will be achieved. Additional information on the testing procedures, such as exposure to extreme temperatures, radiation, and vibrations, would strengthen the proposal's validity.
- HIL Simulation: The author expresses uncertainty about completing the HIL simulation part due to logistical constraints. It would be advisable to explore alternative options or consider mitigating the risks associated with this particular aspect of the project. Addressing this concern and providing a contingency plan would enhance the feasibility of the proposal.

Overall, the report presents a promising proposal for utilizing CNNs in spacecraft star trackers. If successful, the model could provide cost-effective alternatives to traditional star trackers by reducing complexity, using a smaller database, and improving accessibility for space industry companies. Addressing the areas for improvement, such as data quality, generalization, reliability, testing, timeline management, evaluation metrics would strengthen the proposal and increase its chances of success.