Report 2

Selected Strategy for the Research

For this research, a quantitative strategy is used to develop and evaluate an improved star detection algorithm for spacecraft attitude determination. The focus is on obtaining objective and measurable results through quantitative data analysis techniques.

Here is the follow diagram of the research plan:

1. **Literature review**
    a. Conduct a comprehensive review of existing literature on star tracker systems, traditional star identification algorithms and advancements in deep learning algorithms.
2. **Problem Identification**
    a. Identify the limitations of traditional star identification algorithms such as their processing speed and susceptibility to failure under challenging conditions.
3. **CNN algorithm design**
    a. Research about the CNN algorithms that will be most effective for detection of the constellations and stars that was taken from star tracker.
    b. Specifically, it is planned that transfer learning will be used for a better model.
4. **Dataset Collection**
    a. Collecting the dataset from open-source space simulators such as Stellarium and Celestia.
5. **Algorithm Training**
    a. Train the CNN-based star detection algorithm using the collected dataset.
    b. Implement optimization techniques to enhance its performance such as data augmentation, regularization, and hyperparameter tuning.
6. **Evaluation and Analysis**
    a. Evaluate the performance of the algorithm by measuring accuracy, precision, recall and other relevant metrics.
    b. Compare the results with traditional star identification algorithms to get the improvement achieved by the proposed approach.
7. **HIL Testing**
    a. Conduct HIL testing if the environment is suitable. The purpose of this testing approach is to integrate the physical hardware components of the system with the simulation environment to achieve real-time interaction and analysis.
8. **Performance Optimization**
    a. Explore additional optimization techniques to further improve the accuracy and efficiency of the spacecraft attitude determination algorithm.
    b. Consider strategies such as network architecture modifications and advanced training methodologies.

Data Collection Strategy

The dataset used in this research consists of star and constellation images obtained from publicly available sources. Especially data from planetarium software like Stellarium and space simulator platforms like Celestia are utilized. These platforms provide a rich and diverse collection of star images including different constellations, brightness levels, and celestial objects. The simulated dataset used in this research consists of a total of 15,000 images. To train and evaluate the algorithm effectively, I will divide these images into three sets: a training set, a validation set, and a test set. The training set will contain 12,000 images, the validation set will have 2,000 images, and the test set will consist of 1,000 images. However, storing the entire dataset requires a large amount of storage space. Therefore, I will only store a small portion of the dataset in the GitHub repository. Here is the link:
https://github.com/ADA-GWU/guidedresearchproject-xRedik/tree/main/data

Data Cleansing Approaches

No specific data cleansing procedures were conducted for this study. The dataset used for training and evaluation was obtained from space simulators and they provide noise-free and accurately mapped star data. However, it is known that real star trackers may introduce noise during the detection process. To account for this, a technique will be used to simulate noise by incorporating false stars into the simulated images. This approach aims to enhance the model's adaptability to real-time detection scenarios using star trackers and ensure its robustness in handling potential noise factors.