UCSB CS 189A
Capstone Vision Statement (Aerospace)

Project Name: AeroCube Position Detection Embedded System

Team Name: Your Fire Nation

Team Lead: Eric Swenson

Team Contact Information

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Problem Statement

Picosatellites require the positional information of neighboring picosatellites to maintain their formation. Because picosatellites don't have the power or systems to send and receive the information from earth, they must handle everything onboard. The plan is to use the onboard cameras to identify and determine the relative attitude and orientation of other picosatellites within the area.

The problem is not solved due to the constant trade-offs between balancing the physical resources for communication capacity and optical sensing capacity. However, it appears that the fuzzy relative position approach may be used to address the problem.

Proposed Solution & Constraints

The developed software should correctly identify and differentiate satellites, and calculate traits such as relative attitude or pose and range; range is the least significant of these traits as other sensors exist to estimate range.

Constraints on the outcome include limited latency, minimized power consumption, useful identification range and accuracy, and being able to identify relative attitude and orientation.

Initial Project Milestones

Initial project milestones revolve around specifying hardware-based physical constraints such as power consumption, identification marker properties such as size, shape, color, structure, durability, and other physical properties. This also includes the properties of the image sensor such as pixel count, viewing angle, exposure dynamic range, pixel pitch, sensor sensitivity, and various physical optical properties of the module. These will be utilized in conjunction with more structured and well-defined scenarios for the use of the camera module, physical error case possibilities such as damage or obstruction to the image sensor.

To begin working, the team must setup development environments for Ubuntu 14.04 Linux development on an ARM A57 CPU and CUDA development with CUDA 7.0 for use with the maxwell based onboard GPU. This likely revolves around the use of JetPack 2.2.

The software design should follow implementation patterns that satisfy the following requirements: (1) possibility of total failure is eliminated, (2) resource consumption is minimized, and (3) the software is optimized for CUDA processing.

Prototyping will begin by using CUDA processing on a test data set. Once successful, prototyping will proceed to image data, which should be more complicated than the original test data set. The next step would then utilize machine learning with CUDA processing, most likely using Caffe. The final step would be to prototype a training set for machine learning with CUDA processing.

Solution Design & Articulation

The solution will revolve around developing software for the Jetson TX1 platform that will implement computer vision and deep learning capabilities for picosatellites. Aside from the Jetson TX1 platform, the solution will also include working with 3D-printed models of AeroCubes. The AeroCubes will come with visual identifiers to facilitate recognition and therefore shape the design of the solution. The technologies we will use are:

- Nvidia Jetson TX1 Development Kit
- Nvidia CUDA for application acceleration
- cuDNN for Cuda-accelerated deep learning in conjunction with Caffe
- JetPack 2.2

The process model that we will use to achieve our milestones will be an Agile development cycle. The team will have daily scrums to facilitate healthy team communication and minimize blockers, and will work in two-week long sprints to organize the size of the goals and deliverables. The codebase will be stored on a public GitHub repository, and issues will be tracked on Pivotal. Team communication online will be managed on a Slack team.