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Ground Name: VIASAT AMEND Machine Learning

## Sensor Input for Satellite Tracking Software

### Introduction

Satellites provide the foundation for a large-scale array of global communication. They transmit valuable data and communications. The key issue is the ability to continuously receive and decode this information on a large scale. Many satellite communication devices exist; the most prominent being GPS communications within standard cellular devices. However, larger communications can mean larger receivers, including ground satellites the size the basketball fields. Therefore, ground receivers on large scales must be movable to best align with communications from low-orbit satellites for minimal-noise, maximum bandwidth communication to occur. A machine learning algorithm will be used to achieve higher accuracy, with a goal to be within one-tenth of a degree. However, the first step is to define sensors to be used to define the system's input information.

### Commercial Applications

Satellite tracking is a widely used technology. The first consideration is to use tracking features readily available on the market to define ground receiver positioning goals. Many companies offer a variety of tracking features, including LeoLabs providing LeoTrack: a service companies and universities subscribe to globally to track their satellites' orbits [2]. Knowing the location of the specifically low-orbit satellites to track is fundamental to a functional tracking system. However, majority of satellite tracking and positioning beyond these services are, although inexpensive, inaccurate with large error ranges. For example, the latest GPS tracking chip to be manufactured for smartphones have accuracy within 30 centimeters [3]. The specific system needed for VIASAT amend will require accurate tilt to within one-tenth of a degree. These technologies are not sophisticated enough for this specific commercial need. Therefore, commercial trackers for purchase are not helpful, except for subscription services to companies with more sophisticated technology and undisclosed techniques to track positioning.

### Motion sensors & Feedback

The first step in any control system is understanding the end position goal. The next is to understand the current state of the system. The motion of ground receivers must be tracked precisely.

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Fortunately, recent advancements have made high-power control system tracking more accurate, including TI developing new integrated DSP control chips with the highest clock rates, pushing control timing into the nanoseconds [4]. However, these chips are designed for robotics and automation, which is a smaller scale than the large ground receivers in question for this project.

These sensors will be useful for live time control systems where time intervals are crucial for accuracy. Most motion tracking devices on the market for high-power systems do not have the timing of these chips to process. Basic current and load tracking for motors can be done cheaply, within the hundreds of dollars range [5]. However, these systems export new data in the milliseconds, whereas nanoseconds is the end goal for high fidelity control systems. Even more advanced and expensive tracking methods may not be best suited for this application [6]. Machine learning can play a pivotal role in both the sensing and timing aspect: predicting future motions while also predicting satellite orbit trajectories means calculation no longer needs to be live, but can be preplanned. The most widely available, and rapidly growing, machine learning input sensors for motion tracking are for tracking humans [1].

This is mostly due to the ongoing anti-terrorism tracking, as well as at-home use, for example X-Box. [1]. Deep learning motion tracking has been available for years and is only becoming more advanced. Commercial software products are available for use to track any type of object the software package can be trained for, as well as open-source software. A leading example is TensorFlow, which offers an open-source, free platform as well as trainings and integrated APIs [7].

Conclusion:

All technologies on the market discussed can be both valuable resources and potential competitors for this project. VIASAT AMEND is unique in that no company specifically offers ground-level receiver motion control systems to track specific low-orbit satellites. This is a project that will incorporate many technologies into a single pipeline. Therefore, technology independently developed for this project will be at competition with the corresponding technologies discussed, yet these existing technologies may also be exploited and integrated into the VIASAT AMEND pipeline as well.

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