ECE4871/ECE 4872 Project Summary

Project Title	Viasat AMEND - Machine Learning Team
Team Members	Shreyas Mhasawade – Computer Engineering Tyler Cole – Computer Engineering Chris Rothmann – Electrical Engineering Mikias Balkew – Electrical Engineering Adrija Bhattacharya - Electrical Engineering
Advisor / Section	Xiaoli Ma / D1A
Semester	Year/Semester: **Fall 2021** Circle: **Intermediate (ECE4871)**
Project Abstract (250-300 words)	Tracking satellite trajectories is a critical step for ensuring stable global communication and accurate data transfer between ground and low orbit satellites. One of the primary purposes of highly accurate tracking is to ensure ground dishes are pointed in the exact direction necessary to maximize Gain-to-Noise Temperature. Thus, a predictive tracking system is needed to steer ground dishes with a minimum accuracy of one tenth of a degree. This project specifically focuses on taking various inputs from a wide range of scenarios and training a machine learning algorithm to predict PID parameters based on previous orbit trajectories. This project is the continuation of a previous team's work. This specific team will utilize machine learning (ML) techniques to efficiently produce control system parameters of an improved RF simulation model that can be used with Viasat systems. There is also a hardware team that will aim to improve upon existing models. Both teams will work in close conjunction with one another. The project involves using the existing Simulink model, which was left behind by the previous team. As the project progresses, the hardware team will focus on increasing the fidelity of the model, and the ML team will be consumers of the improved model. The ML team will then develop and utilize scenarios representative of the ground station functionality to generate data with the Simulink model. This data will be used to automatically populate a database that serves as an input to an advanced ML algorithm. The ML model will analyze the data being fed into it and will predict necessary corrective actions from the parabolic dish's position. Ideally, this analysis will allow the team to effectively produce accurate PID parameters for the dish-satellite system and reduce angular position and tracking errors.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	FCC standard 15.209 regulates intentional emissions of RF energy (54 FR 17714). Although the auto tracking system will ideally not radiate any emissions, there is a chance that some RF energy is unintentionally emitted. Unintentional emissions are exempt from the standard, so it is unlikely that this standard will significantly affect the design. The team will also need to comply with the FCC part 25 standard which contains regulations on carrier frequency tolerance, power radiation, frequencies used, as well as the angle of antenna elevation (79 FR 8311). The limits will be more tolerant for ground stations pointed at near vertical angles, as the interference with other RF transmitters is less than if the stations were pointed more laterally. As our ground stations will likely operate at near vertical angles, the restrictions will be more relaxed, but will still need to ensure that we comply by the standard.
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	Response time: The ML algorithm takes in input data from RF circuits and then corrects the angular position of the dish. The required correction time is the response time, which has constraints. The algorithm will need to function correctly without taking too much time to generate its data. PID Parameters: The generation of accurate PID parameters that are going to be utilized to perform corrective actions within the RF model are critical in being able to maintain the accepted level of error tolerances specified by Viasat. Given the implementation of a ML algorithm, this design constraint inherently leads to improved corrections to the RF model.
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	One of the tradeoffs in this project, besides choosing the right machine learning toolbox to use, is modelling parameters vs system inputs. The existing AMEND model may need to be modified to provide the appropriate system inputs for the machine learning experiments. This could, however, increase the complexity of the modelling process and/or the physical hardware of the system. Another major tradeoff is DSP processing compared to latency. While additional signal processing could provide more accurate computations of angle errors signals, the higher processing time can increase the period of time between successive corrections of the base station dish.

Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** tradeoffs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	The ML team will need to use the existing Simulink model to generate data using scenarios representative of the ground station functionalities. The mentioned Simulink model will evolve as the project continues, since the hardware team will be adding features to it. The ML team will also create a database that can store the data that is generated with the updated Simulink model. This process of populating the database will ideally be automated, and that will be another computing goal. The generated data will then be fed into an ML algorithm, which will then analyze the data and use this information to train a model that can operate the ground stations with a lower root mean squared tracking error

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Leadership Roles (ECE4871 & Forecasted for ECE4872) (NOTE: ECE4872 requires definition of additional leadership roles including: 1.Webmaster 2. Expo coordinator 3. Documentation	1. Webmaster/ Git Coordinator – Tyler Cole 2. RF Insider – Mikias Balkew 3. Documentation/Viasat Coordinator - Shreyas Mhasawade 4. DSP insider - Adrija Bhattacharya 5. Expo Coordinator - Chris Rothmann

International Program: Global Issues (Less than one page) (Only teams with one or more International Program participants need to complete this section)	N/A