**ECE4871/ECE 4872 Project Summary**

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| **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 |
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| **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 to 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 RF communication with minimal noise. Thus, a noise filtered, predictive tracking system is needed to rotate ground dishes with a minimum accuracy of one tenth of a degree. This project specifically focuses on taking variable inputs and training a machine learning algorithm to predict needed actions 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 create models 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 from 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 attempt to draw conclusions for the data. Ideally this analysis will allow the team to train the model to a point where it can successfully operate the ground satellite systems and reduce error in pointing and tracking. |

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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. 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. |
| 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.  Angle correction: The higher the signal processing power, the more accurate the computation that yields angle error signals which can be used for angle correction. However, there is only a certain point up to which DSP systems can be added (before computational limits and latency start becoming a major issue). |
| 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 movements 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 current model has both a fast and a slow version. The Machine Learning team will refine the “slow” model, that dictates how servo motors are tuned when displaced from their satellites.  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 change as the project continues, since the hardware team will be adding features to it.  The ML team will also create database that can store the data that is generated with the Simulink model. This process of populating the database will ideally be automated, so 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 to a lesser degree of error. |

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| Leadership Roles  (ECE4011 & Forecasted for ECE4012)  (NOTE: ECE4012 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 |