ECE4011/ECE 4012 Project Summary

Project Title	Autonomous Racing Drone
Team Members (names and majors)	Max Rudolph, EE Dave Patel, CmpE Eddie Stevens, CmpE Michael Bermudez, CmpE Nye Najieb, CmpE Rishov Sarkar, CmpE Suhani Jain, CmpE
Advisor / Section	Dr. Hasler / Section L8A
Semester	Spring 2020 **<u>Final (ECE4012)</u>**
Project Abstract (250-300 words)	In this modern age of autonomy, robotics has become more ubiquitous in society and our everyday lives. For instance, autonomous package delivery is beginning to become viable technologically and legally. These drone systems need to be reliable, safe, and, most importantly, fast. For this reason, we were originally designing an autonomous racing drone that can navigate a course without the interaction with a human pilot. After COVID-19, the final goal of the team switched from delivering a fully autonomous race drone to a proof of concept that would showcase the possible autonomy of a drone. Due to the switch to remote learning, we had to convert our project to have more simulation-based deliverables. Our project has laid the groundwork for a fully autonomous drone in the future. This report discusses the simulated deliverables that we built; these deliverables include various disjoint pieces of software such as computer vision scripts, velocity control algorithms, and a drone simulator. The software we have written acts as a proof of concept for the autonomy of the drone. Finally, we can also deliver the physical drone complete with hardware to use the NVIDIA Jetson Nano as the compute unit and Pi Cam as the vision unit. The bulk of our cost consisted of the hardware required. In total, we needed $575.92 for drone parts and compute units. We were able to use the several documented successes of autonomous drones navigating a course in order to give inspiration and ideas to our own work. Although we encountered many hiccups due to COVID-19, we were able to make ample progress in designing our autonomous quadcopter.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	1. During testing, public flights must follow FAA regulations: can't fly around people/vehicles, can't fly over 400 feet, weight over 250 grams must be registered. 2. The MAVLink protocol will be used to issue commands to the flight controller. We can remotely send flight commands to the Pixhawk via a laptop ground station using the Jetson Nano as the communication medium. Likewise, we can directly connect the ground station to the flight controller and utilize the MAVLink protocol for commands.
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	1. Drone must be able to navigate course without offboarding data (100% edge computation) 2. Drone will use the NVIDIA Jetson Nano and a camera module (future designs could include up to 4 stereoscopic cameras, but data acquisition and computation speed must be considered) 3. Flight times around 5 minutes (effective power management)
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	1. Accuracy vs. Speed Going as fast as possible will result in less time to do calculations and detect potential collisions. Accuracy is more important than speed since finishing the race is more valuable than finishing first in most cases. A bad collision could also result in excessive damage to the drone and come at high cost; we would like to avoid this as much as possible. 2. Weight vs. Efficiency Higher weight will result in less flight time and wider turns. The lowest weight possible without sacrificing accuracy (fewer cameras / cheaper motors) is most desirable as this will lead to longer possible flights.
Briefly describe the **computing aspects** of your projects, specifically identifying **hardware-software** trade offs, interfaces, and/or interactions. *Complete if applicable; required if team includes CmpE majors.*	Since we worked with third party sensors to guide the maneuvering of the drone, we expect that our embedded software is able to appropriately interface with the motors and added camera modules. We took advantage of the dronekit simulator in lieu of being able to run our program on the drone, but since it emulates a real drone, the same code could be used to interface with the autopilot module and camera. Future projects could apply our highly parallelizable vision algorithms to take advantage of the dedicated GPU on-board the Jetson Nano and use CUDA C/C++ to launch parallel threads across the 128 compute cores of the Jetson Nano. The speed of the drone requires fast hardware and software to process the data. The 3D camera must be fast enough to provide real-time image data while the software must be constantly ready to interpret the data and adjust the motors accordingly.

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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: Rishov 2. Communications Lead: Max 3. Hardware Lead: Eddie 4. Software Lead: Nye 5. Team Coordinator: Suhani 6. Design Lead: Dave 7. Research Expert: Michael