

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 A05
Semester	Fall 2019 Circle: Either <u>Intermediate (ECE4011)</u> or Final (ECE4012)
Project Abstract (250-300 words)	The goal of the project is to design and program an autonomous race drone: a quadcopter that is able to autonomously pilot itself through professional drone racing courses. The drone will perform image processing onboard using a GPU-enabled embedded computing platform, the NVIDIA Jetson Nano. It must be able to compute a path to the goal and adjust the path in real time as it senses its local environment and detects and prevents collisions. There are several controllers that are already enabled with this capability. For example, Georgia Tech's own AutoRally research platform uses a model predictive controller to plan paths for off-road autonomous rally cars. The controller, called Model Predictive Path Integral, samples thousands of stochastic and achievable trajectories and averages them to obtain one reliable and optimal path. Model predictive controllers are highly parallelizable and thus well suited for real-time control using the discrete GPU on the Jetson Nano. Along with path planners, we need fast and accurate perception sensors. Our initial design calls for a camera module, but we may have to add a LIDAR module if the camera fails as a source of localization information. We expect to encounter challenges in accurately processing sensor data given the (desired) high speeds of the drone; this is why it is important to have a discrete GPU-enabled computing system on board the drone to process information. We will initially focus on implementing the autonomous collision avoidance and path planning, but succeeding while reaching speeds of around 30 to 40 mph is the main objective. The algorithms and technologies necessary to achieve our goal of high speed autonomous drone racing are applicable to many autonomous systems as evidenced by the interest from Lockheed Martin and their Alpha Pilot Competition.

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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. RTPS (Real-Time Publish Subscribe) protocol that allows Pixhawk and ROS to seamlessly communicate without translation layer 3. The USB standard will be widely used along with UART connections, for data networking and RX/TX
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 up to 4 stereoscopic cameras (data acquisition and computation speed) 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 according to most human pilots since finishing the race is more valuable than finishing first in most cases. 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. <i>Complete if applicable; required if team includes CmpE majors.</i>	Since we will be working with third party sensors to guide the maneuvering of the drone, our embedded software must be able to appropriately interface with the motors and added camera modules. We expect 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. As mentioned in our abstract, the innately high speed of the drone will require equally 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