ECE4011/ECE 4012 Project Summary

Project Title	Project Hydra
Team Members (names and majors)	Michael Tatum (CompE) Hemanth Koralla (CompE) Priyansh Bhatnagar (CompE) Aneri Muni (EE) Vishnu Perumal (EE) Trevor Jones (EE)
Advisor / Section	Mick West
Semester	Fall 2018 Circle: Either **Intermediate (ECE4011)** or Final (ECE4012)
Project Abstract (250-300 words)	A flight recorder, or a black box, is an electronic recording device placed in an aircraft to facilitate the investigation of aviation accidents and incidents. The flight recorder is fitted with an underwater locator beacon (ULB) or underwater acoustic beacon (UAB). Once immersed into water, a built-in "water switch" activates the beacon by closing an electric circuit, and the beacon starts emitting its "pings"; the battery power should be sufficient for at least 30 days after the activation. The disappearance of Malaysia Airlines Flight 370 demonstrated the limits of the contemporary flight recorder technology, namely the need for the ULB's range and battery life to be extended. Current beacons are typically supplied with electrical power by a lithium battery, thus giving them a limited lifespan. This makes recorder retrieval, a time sensitive mission. It would be more efficient and, in some cases, safer to send robots instead of divers for such missions. The goal of our project was to develop a swarm robotics system of autonomous underwater vehicles (AUVs) that would aid in search and retrieval missions for flight recorders. Each robot, called a Hydrabot, in this system contained a camera and IR transceivers for sensing and communication with their neighbors, respectively. Each Hydrabot cost approximately $300 to build and three were built. The Hydrabots demonstrated the consensus algorithm underwater by identifying their neighbor and moving towards it until all the Hydrabots met in the center. This demonstrated the ability of decentralized control algorithms to command swarms of AUVs in an open environment. These prototype tests were used to present the project's applicability to real-world problems, such as the search and retrieval of a flight recorder.

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List **codes** and **standards** that significantly affect your project. Briefly describe how they influenced your design.	Codes and standards affect the project include the following: ● **SPI**: synchronous serial communication interface specification used for short distance communication with sensors ● **I²C**: multi-master, multi-slave, packet switched, single-ended, serial computer bus to interface with sensors ● **GPS**: space-based radionavigation system used to send location information about the black box location ● **USB-C**: universal serial bus to communicate with microprocessor ● **IR:** SONY Protocol (850 nm)
List at least two significant **realistic design constraints** that applied to your project. Briefly describe how they affected your design.	● **Time**: Ability to make multiple robots ● **Waterproof**: The case of each bot that houses the components needs to be airtight and completely waterproof ● **Pressure**: Must take into consideration the changing pressure with depth of a tank → pressure changes in the ocean ● **Sensor Range**: Must take into consideration the radius of the sensors when searching for objects in open water. ● **Weight**: The heavier the robots, the more power needed to move them ● **Size**: Could limit searching hard-to-maneuver areas ● **Battery Power**: Should be able to perform search for 1 hour
Briefly explain two **significant trade-offs** considered in your design, including options considered and the solution chosen.	● **Communication-based vs. Sensing-based Identification**: Using the piCamera to identify neighbor Hydrabots was successful, but IR communication may be more reliable for this task ● **Driving mechanism**: Buoyancy vs thrusters for propelling the vehicle. Buoyancy-based propulsion represents a significant increase in range and duration compared to vehicles propelled by electric motor driven propellers and thus can carry out extended missions. Adding motor thrusters is easier and less time consuming process, therefore we will be adding 3 thrusters, one for depth control and two for direction.
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.*	<u>Tradeoffs</u>: ● **Microprocessor limitations:** ○ Speed, Heat, RAM (8-bit vs. 32-bit), Power Requirement ○ These limitations will affect the way we program due to code efficiency and other software constraints. ● **Operating System:** ○ Windows: More support, robust, expensive, uses more CPU resources ○ Linux: Robotic Operating System, open source, free, lighter

	Interfaces: ● **Inputs:** ○ Color output from neighboring robots ○ IR transmitter output from neighboring robots ● **Outputs:** ○ Thrust commands (speed, direction, propulsion) ○ Color output ○ IR transmitter output Interactions: ● **Swarm algorithm (connected using IR and color detection)**: ○ Each robot only interacts with its designated neighbor(s) ○ Prevents complete shutdown when one member does not function ○ Graph theory: Rendezvous problem ● **USB or RS-232 (or other)**: Serial communication with microprocessor when programming