Senior Design Project Description

Company Name	*Actev Robotics*	Date Submitted	*05/11/2020*
Project Title	*Radar Obstacle Detection System* **(ACTEV_RADAR)**	**Planned Starting Semester**	*Fall 2020*

Personnel

Typical teams will have 4-6 students, with engineering disciplines assigned based on the anticipated Scope of the Project.

Please provide your estimate of staffing in the below table. The Senior Design Committee will adjust as appropriate based on scope and discipline skills:

Discipline	Number	Discipline	Number
Mechanical	2	Electrical	2
Computer	2	Systems	
Other ( )			

Company and Project Overview:

Actev Robotics is a high-tech startup company originally founded in Silicon Valley but relocated to Mooresville, NC in January 2019.

Actev is developing a modular mobility platform for autonomous mobile robots (AMRs). This enables AMR companies to build their robots on a platform that is safe, reliable and cost-effective. Companies can focus their precious engineering resources on differentiating robot functions, not on mobility platform (aka drivetrain) development. Pictured below are a typical mobility module stack and a complete mobility platform including charging dock.
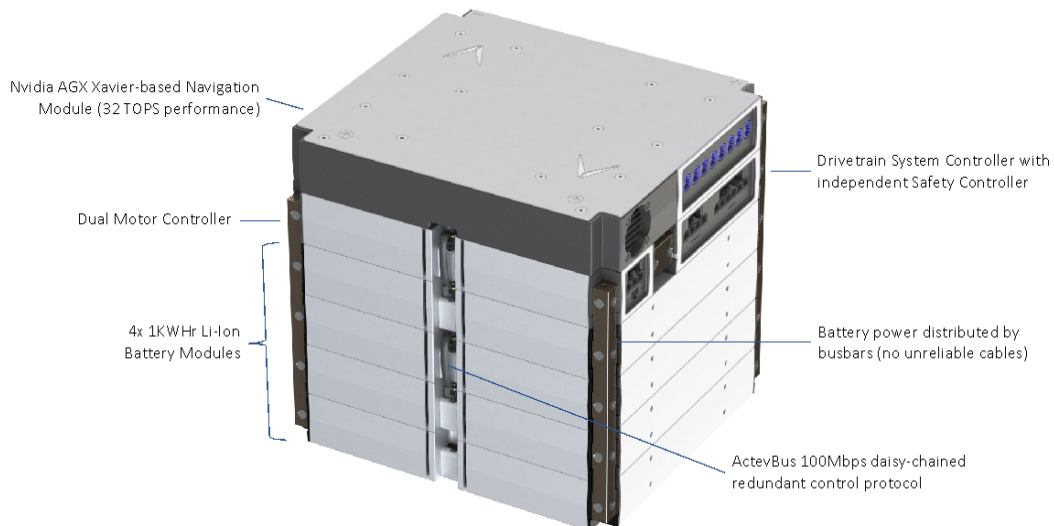
COVID-19 Opportunity

When the COVID-19 pandemic struck, Actev sensed an opportunity to build a complete AMR product based on our own mobility platform. This product has the potential to provide significant health benefits and also create a very successful business.

UV-C ultraviolet light disinfection systems have become very popular in hospitals. In sufficient doses, UV-C has proven very effective at killing all forms of pathogens (including COVID-19). Actev plans to apply this disinfection technology to another large market – hotels.

Before this pandemic, travelers seldom wondered if the prior occupant in their hotel room was contagious and how well their room was disinfected by housekeeping. In the future, hotel guests will want confidence that their rooms were properly disinfected. Hand wiping and spraying disinfectants is only moderately effective at killing pathogens on surfaces (proven by diligent hospital personnel), but the combination of disinfectants + UV-C is shown to be very effective.

To meet this need, Actev is developing a Pathogen Disinfecting Robot (PDR) that will autonomously navigate within hotels using elevators and opening guest room doors. This PDR will use intense UV-C light to disinfect guest rooms after housekeeping has finished, as well as disinfecting public places such as lobbies, restaurants and fitness centers. Safety is the top priority, so avoiding collisions with hotel guests (including unpredictable children) is crucial. This is challenging in busy public environments such as hotels.

The PDR's vision and LiDAR navigation sensors can identify obstacles within their field of view. However, these sensors are unable to detect obstacles in close proximity to the PDR (e.g., a kid jumping in front of the robot). For close-range obstacles another type of sensor system is needed to augment the vision and LiDAR sensors.

Project Focus

The focus of this project is development and testing a radar sensor system and demonstration platform to detect objects near the PDR and permit collision avoidance. The radar sensors will be small (about the size of a silver dollar), and an array of ten sensors will be positioned around the perimeter of the PDR several inches above the floor level. A set of small cables will daisy-chain interconnect the modules and the PDR's Safety Controller using the CAN Bus protocol.

With a sensing range up to two meters, the radar sensors can detect nearby objects and permit the PDR to stop before a collision occurs. Because multiple sensors will simultaneously detect most objects, obstacle location can be approximated and permit the PDR's Navigation Controller to safely maneuver around many obstacles.

Project Requirements:

The top-level objective of this project is to create a working radar sensor system and a demonstration platform that validates its ability to detect objects prior to collision.

Actev Deliverables

Listed below are items that Actev will provide the UNCC team at the beginning of the project:

- 12 radar sensor PCB assemblies, each including a radar transceiver and an ARM Cortex M4F-based microcontroller (without enclosures or firmware)
- Schematics and other relevant documentation for the radar sensor
- Materials for constructing interconnecting CAN Bus cables

Because Actev's offices are located in nearby Mooresville, we are able to meet regularly to provide guidance and advice to the team.

Team Responsibilities

As described above, Actev will supply radar sensor prototype PCBs, but the UNCC team will be responsible for creating a working system using these boards. Listed below are the team's responsibilities:

- Defining the partitioning of functionality between embedded firmware running on the sensor and software running on the connected host computer.
- Developing embedded signal processing and communications firmware to run on the sensor's ARM Cortex M4F microcontroller.
- Developing software running on a notebook computer that is attached to the interconnecting CAN Bus. This software will collect sensor data and calculate the position of objects. Object positions (and possibly object type) should be displayed on the notebook.
- Mechanical design of a plastic sensor enclosure (using SolidWorks) suitable for injection molding. 3D printed enclosures must be fabricated to house prototype sensors.
- Construction of a manually moved rolling platform to simulate a robot base to which sensors will be attached. This platform should also include a mechanical brake controlled by the notebook PC to stop platform movement before a collision occurs.

- Motorize the rolling platform so it can move under its own battery power and either stop or navigate around obstacles.

The team is expected to procure the necessary notebook PC, microcontroller programming adapter, CAN Bus adapter, CAN protocol analyzer and rolling cart materials.

Expected Deliverables/Results:

- Demonstration of a rolling platform (robot simulator) containing some form of computer-controlled brake that can detect objects and stop the platform before a collision occurs.
- Displaying the distance and position of any detected object on the notebook computer. Optionally, it may be possible to also characterize the type of object (e.g., wall, suitcase, person).
- 3D printed sensor enclosures based on a design suitable for injection molding.
- Fully documented embedded firmware and host software source code.

Disposition of Deliverables at the End of the Project:

Actev expects to eventually take possession of the hardware at some date after the Expo, but the timing is negotiable. Electronic deliverables (software and mechanical designs) should be transferred soon after the Expo.

List here any specific skills, requirements, specific courses, knowledge needed or suggested (If none please state none):

- Computer languages anticipated are C, C++, Python
- Interest in robotics