FAMU/FSU College of Engineering

Department of Mechanical Engineering

<u>Restated Scope/Plan</u>

Team 10 Autonomous ATV

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Problem Statement:

CISCOR currently has multiple robotic platforms used in research ranging from bio-inspired legged walking robots to four wheel skid-steered robots. Some of these platforms are able to function outside on limited terrain types. This induces a need for a vehicle that is able to traverse many types of difficult terrains. Thus, the ATV was a clear choice for a platform to automate. Last year, actuators where installed onto the controls of the ATV. The task this year is to incorporate sensing and computer systems to interface with these actuators and develop the algorithms for autonomous motion.

- *Justification/Background:*

  Research into autonomous ground vehicles is growing rapidly. There is a need for vehicles to perform tasks without any physical interaction or human control. These tasks can range from dangerous search and rescue missions to civilian vehicles driving themselves through city streets. CISCOR is currently conducting research with autonomous mobile robots with emphasis on path planning and efficiency. This same type of research is desired with a more robust system that can handle difficult terrains and obstacles, as well as normal driving situations on a paved surface. For this reason, an ATV was chosen as the new platform to develop autonomous control.

- *Objective:*

  The main objective is to integrate a sensory system that will scan the surrounding environment. This data is then used to compute a trajectory for the ATV to perform waypoint navigation and road following autonomously. These sensors include Encoders, SICK laser sensors, IMU (Inertial Measurement Unit), GPS system for waypoint navigation, and possibly a stereoscopic camera. Problems including the overheating of the motor-drivers and an underpowered steering actuator will also be resolved. Waterproofing the sensors, encoders and actuators must also be done to ensure all-terrain capabilities. To assist with safety, a way to shut down the ATV remotely will be developed. A kinematic model of the system will also be developed to implement the autonomous control. All of the objectives will be finished by April 2014

- *Methodology:*

In order to deliver a fully functioning autonomous ATV by the end of April many important milestones need to be met. This will be done by assigning each student a specific task for them to work on for a majority of the project. The team consists of 3 mechanical engineering students, 3 electrical engineering students and one computer science student.

The first step will be for the mechanical engineers to develop concepts for the new steering system, computer cooling system, wheel encoder mounting, and laser/GPS/IMU sensor mounting. At the same time the electrical engineers will begin to research communication protocols for the sensors and become familiar with ROS (Robot Operating System) and QNX operating system. The next step will be the rapid prototyping and mathematical analysis of the mechanical systems. This will require careful wiring of the power and communication between the sensors, actuators and the computers. A kinematic model of the ATV will then be developed and used to create the high level control law for autonomous motion.

The last step will be to manufacture and test all necessary mechanical components for sensor mounting and implement the computer cooling system. Also the C coding for communication, data acquisition, and trajectory computation will be fully developed for waypoint to waypoint navigation and road following.

- *Expected Results:*

At the conclusion of senior design in April it is expected that the ATV will have all necessary sensors installed and communicating with the computers and data acquisition systems. The waypoint following will be as accurate as civilian GPS allows. The ATV will be able to traverse the environment safely without flipping and damaging itself or the surroundings. The onboard computers will also have functioning software to allow the ATV to move autonomously and reliably.

- *Constraints:*

There is a budget of approximately 1500.00 USD set aside for building material. Most of the sensors and computers are already purchased. A large hurdle to overcome will be scheduling time for all team members to work on the project at specific times. Each student has a separate and unique schedule that needs to be taken into account. The largest constraint on this project will be time. There are many objectives to complete and all of them must be met by the end of April 2014.

- *Updates:*

For the spring 2014 semester an additional member was added to the team. Nahush is a computer science student that will help with writing driver software and control algorithms. As of now, our major objectives have not changed. No additional requests or changes have been issued by our sponsor, CISCOR.

One issue that arose was our plan to manufacture the snorkels for the cooling system. It will be solved by implementing the FSU-FAMU COE 3D printer rather than laser cutting plastic and bolting the baffle parts together. The 3D printer will create the snorkel and baffles as one piece without further work. This will allow for a better waterproofing seal and shorten the manufacture time and effort drastically.

The primary parts list is complete and the parts will be ordered during week 3 of this semester. This has no major impact on our milestones. A more detailed description of these milestones are found in the Gantt Chart.

There have been no changes to the electrical or computer systems. Our team is slightly behind schedule with code and algorithm development but this will hopefully be rectified with the addition of our new team member.

- *Deliverables:*

-Work Breakdown Structure (WBS)

The following is a work breakdown structure of each task than needs to be completed and the dates when the tasks are to be completed. A less explicit WBS is shown visually in a Gantt chart below that also includes task dependencies.

<u>Week 2-4:</u>

- Part procurement
- Finalize mechanical designs
- GPS communication and testing
- Laser communication and testing

<u>Week 5-8:</u>

- Part manufacturing
- Initial installation
- Initial part testing
- IMU communication and testing
- Bi-Directional communication with ROS and QNX

<u>Week 9-11:</u>

- Finalize part installation
- Final part testing
- Autonomous algorithm development and testing

Week 12-16:

- Finalizing autonomous algorithms
- Final testing

Team 10 Autonomous ATV (GOLIATH)

ACTIVITY	Start date	End date	Percent complete
Part Ordering			0%
Updated Plan/Specs			0%
Finalize Mechanical Designs			0%
GPS Communication/Testing			0%
Laser Communication/Testing			0%
Webpage Update			0%
Part Manufacturing			0%
Initial Installation			0%
Initial Part Testing			0%
IMU communication/Testing			0%
ROS/QNX Communication			0%
Midterm 1			0%
Midterm 1 Presentation			0%
Finalize Part Installation			0%
Final Part Testing			0%
Autonomous Code			0%
Autonomous Code Testing			0%
Midterm 2			0%
Midterm 2 Presentation			0%
Operational Manual			0%
Finalize Algorithms			0%
Final Testing			0%
Manu/Reliab Report			0%
Walkthrough			0%
Open House			0%