The BYU Robot Racer senior project for Electrical and Computer Engineering students focuses on designing vision and control modules for an off-the-shelf RC vehicle to drive itself through a visually marked course using on-board vision processing. The project poses challenging and open-ended technical problems for our students.

In 2008 and 2009, competing vehicles were timed as they traversed a racecourse marked by vertical pylons of one of two solid colors. During competitive runs, vehicles operated autonomously using only onboard equipment which consisted of a FPGA based computer, various on-board sensors, and a camera. Teams often stream vision and state information from their vehicles to their base-station computer to provide visibility into the actions of the onboard control and vision systems.

Each racecourse was determined by the physical placement of pylons and a course description file – taken in combination. The course description file specified a sequence of heading changes; each such change is the number of degrees that the vehicle must turn at the current pylon to face the next pylon, assuming it has approached the current pylon on a direct line from the previous one. In practice, a reasonable approximation of turning angles was sufficient. By convention, each course was set up as a loop, so that the course description may be repeated from the beginning when the end was reached. A wide variety of interesting courses were set up quickly and easily by placing a small number of pylons and creating a short course description.

In 2010, we want to try a new “capture the flag” competition in which trucks are divided into two (or more) teams and work together to move the “flag” to their respective bases. The same trucks that were used the previous year will be equipped with a game system that allows them to shoot a laser at other trucks and detect incoming shots. The game systems communicate with each other to determine who has the flag.

This is the concept drawing for the game system.

The rules of the game are:

1. If a truck on another team has the flag, a truck can steal it from him with a successful “kill shot”.
2. If a truck is hit by a “kill shot”, it becomes disabled, and if it has the flag, loses it to the shooter. When disabled, a truck can still move, but cannot shoot kill shots and cannot hold the flag.
3. A truck that is disabled may be re-enabled by receiving a “revive shot” from a team member, or by shooting a successful “revive shot” to its own base.
4. A truck that has the flag can pass it to a team member or the base with a successful “pass shot”. Passing the flag to the base scores a point and a new match begins.

The game system on every truck has a laser, a light detector, a zigbee wireless modem, status lights, and a microprocessor. Shots are made by moving the truck to point the laser at another truck or base and then sending a message using light pulses. If the target truck or base receives a well-formed message, then it has been “hit”. Message types are “kill shot”, “revive shot”, and “pass shot”. If a truck receives a shot, it relays that fact wirelessly to all trucks in the game so that the game state can be correctly updated. The state of each individual truck is displayed by a light that can be seen from all directions that encodes whether or not the truck is enabled (alive) and whether or not the truck has the flag. This state, as well as another light indicating the team to which the truck belongs, can be read using the on-board visions systems of other trucks as well as by human spectators.

We are currently developing this game system.

Rules of the Game

There are two flags, one for each team. Initially flags start at the home bases. Objective is to get your opponent’s flag to the your own base (and to stop opposing team from doing the same). The bases are placed about 50 feet apart.

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| --- | --- | --- | --- | --- |
|  | Team Member | Opposing player | Your base | Opposing base |
| Kill shot | ---  (Alt. you are disabled, and if you have the flag, it goes to opposing base). | Disables the opposing player. If he has the flag, then you get the flag, (or alt. the flag goes back to your base). | ---  (Alt. you are disabled, and if you have the flag, it goes to opposing base). | --- |
| Pass shot | If you have a flag, the flag is passed to your team member. | ---  (Alt. If you have a flag, the flag is passed to the opposing team member.) | If you have the flag, it is passed to your base, and you win the match. (Alt. all players on opposite side are disabled). | If the base has a flag, you get the flag. |
| Revive Shot | If your team member is disabled, he is re-enabled. | ---  (Alt. If opposing team member is disabled, he is re-enabled.) | If you are disabled, you are re-enabled. | --- |