

Project Sketch

JetRacer Soccer League with Advanced Sensor Suite

Date: 1/11/2024

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Project Background and Context:

This is the third consecutive year of the JetRacer Soccer League Project here at UW through the ENGINE capstone. We are given the previous years' iterations and work of the JetRacer cars and equipment and will have to add to their work. We want to utilize the onboard sensor suite to drive the RC cars to play a game of soccer autonomously. The goal of the project this year is to expand upon the existing hardware and software to improve the RC cars' situational awareness for higher-level play through sensor upgrades. Once we demonstrate a 1 vs. 0 soccer scenario in the physical world, we can then upgrade the cars and work towards a 2 vs 2 demonstration.

Project Objectives and Deliverables:

Objectives:

1. Build and enhance four JetRacer cars that will compete in a soccer environment.
2. Demonstrate existing capabilities and limitations.
3. Improve the sensor suite through hardware additions to the RC car.
4. Integrate the new sensor suite to improve the RC car capabilities and situational awareness.
5. Identify and work cooperatively with allies who try to help you score.
6. Identify and work against foes who are trying to score against you.

7. Identify objects while competing (such as a wall, ball, teammate, goal, and foe).
8. Design and use a simple soccer field for the vehicles to compete within which is reusable and may be transported.

Deliverables:

1. Videos of RC cars demonstrating each milestone.
 - a. Basic movement
 - b. Image recognition
 - c. Ball striking
 - d. Co-op and Versus capabilities
2. An open-source guide uploaded to GitHub that explains how to recreate the artificially intelligent agent(s) capable of playing soccer and contains build instructions for the soccer arena plus any support equipment.
3. Hardware: four JetRacer vehicles with operational sensors and software.
4. Hardware: a simple, reconfigurable, and easily transportable soccer arena.
5. Simulation and experimental data acquired throughout the project.
6. Control the laptop with all pertinent files.
7. Summary of the results of the work and objectives achieved.
8. Requirements verification testing data (including video of the JetRacers operating and competing).

List of Key Milestones and Tasks:

1. With existing 2GB JetRacers, re-demonstrate basic motion and image recognition
 - a. Improve basic motion to operate the vehicle in forward and reverse.
2. Perform a trade study to identify the optimal sensor upgrade
3. Identify materials needed to complete the project. Put together a Bill of Materials (BOM) including what is needed to make the soccer field and submit for purchase immediately after obtaining Lockheed Martin and University of Washington staff approval
 - a. TBD sensor upgrade
 - b. Soccer field materials – Goals will be provided
 - c. Note: LM will provide existing cars with JETSON NANO integration, control computer, charging equipment, etc.
4. Integrate additional sensor hardware
5. Integrate sensor feedback into the control algorithm
6. Demonstrate the goal-scoring capabilities of Jetracer with additional sensors
7. Demonstrate the real-world ability of JetRacers to play soccer.

Requirements from Sponsor:

1. Four JetRacers shall be built and maintained to meet the listed requirements.
2. The JetRacer(s) shall operate autonomously with the capability to manually override with a standard RC transmitter.
3. The JetRacer(s) shall demonstrate the ability to score a goal with the designed equipment autonomously.
4. The JetRacer(s) shall not pick up the ball.
5. The JetRacer(s) shall move the ball by striking it.
6. The JetRacer(s) shall be able to strike the ball in a controlled trajectory.
7. The official game ball shall be a size 1 soccer ball.
8. The size of the soccer field shall be 20' ft (L) x 15' (W), with +/- 1 ft tolerance in each direction.
9. The soccer field shall be transportable.
10. The JetRacer(s) shall identify and work cooperatively with an ally (marking distinction determined by students) to score a goal.
11. The JetRacer(s) shall identify and work against an enemy (marking distinction determined by students) trying to score in the opposite goal.
12. The allies and foes in the JetRacer Soccer League shall be visually distinguishable.
13. There shall not be an overhead camera used for this work. The individual vehicle feeds shall be used to dictate their action.

Rough Timeline:

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| • Demonstrate basic motion of JetRacer | 01/2024 |
| • Demonstrate JetRacer Image Recognition for soccer play | 01/2024 |
| • Trade study of possible sensor additions | 02/2024 |
| • Preliminary Design Review | 02/2024 |
| • Showcase vehicle scoring soccer ball in the goal in real-world | 03/2024 |
| • Add additional agents in the real world | 04/2024 |
| • Final Data Review | 05/2024 |

Learning Goals:

New knowledge we need to acquire to successfully complete our project:

1. Learn the software we will use for the ML, cameras, and LIDAR on the car.
2. How do LIDAR sensors work?
3. How do we implement the LIDAR sensor with the car?
4. What will indicate whether a car is attacking or defending?
5. What will distinguish which car has "possession of the ball"?
6. How do we direct the cars to hit the ball at a certain angle to get it into the goal?
7. How will cars detect where the sidelines and the goal are?
8. How will cars identify the ball and what it looks like on the field?
9. How will cars distinguish between teammates and the opposing team?

Mentor Comments:

No mentor comments from our mentor. We went over the document with him and he gave us most of the information for timelines, deliverables, and goals for both quarters.