Functional Specification Document

Robot Soccer:

Cristiauto Robaldo

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Introduction

Background

Research and development in the field of robotics has lead to many improvements in the industries of manufacturing, transportation, construction, caregiving, and homemaking. It has also provided new forms of entertainment and sports. In particular, robot soccer has become a popular way for robot fanatics to showcase their passion for building robots, as well as a way to pit their own robotics skills against that of others.

Robot soccer is fairly self-explanatory: one team of robots plays soccer against another team of robots. The game is typically played on a much smaller scale, with smaller robots kicking around a smaller ball on a smaller field. In most cases, the playing arena is completely enclosed by walls. Some rules also differ from normal soccer, such as fouls, offsides, and goalies. The rules may vary from competition to competition.

There are several varieties of robot soccer, each with varying amounts of functionality and levels of autonomy. There are also multiple international standard-setting organizations for robot soccer, including Robocup and FIRA. These organizations host different tournaments throughout the year.

Project Description

Our team, Cristiauto Robaldo, is one of seven teams that will be competing in a robot soccer tournament for our senior project. The rules by which we and our classmates will be playing are loosely based on FIRA standards. Below are some of the rules that will govern gameplay (as of January 27, 2017):

- Robots must fit in a can with an 8-inch diameter and 10-inch height. All robots must be fully autonomous using on-board resources: other than start and stop directives, no information can be sent to the robots during play from human operators or from the team's basestation computer.

- The ball is a standard golf ball, with the color to be determined by majority vote. We can choose from any currently available ball. (The ball will not be painted or modified.)

- The field will be five feet wide by 10 feet long. The goals will be two feet wide and specially marked with a unique color. The sides of the field will be angled so that the ball cannot get stuck against the sides or in the corner. There will be six markers at the four corners and at centerfield. The markers will be three feet high, with three one-foot color sections. The colors will be arranged so that each marker is unique.

- Each team will be assigned one of two fixed colors for each game. All players on that team must be able to wear the assigned color, and that color must be clearly visible

from all angles at player height. All players on each team will be marked in the same way, so there will be no designated goalkeeper.

- Robots must be designed and operated in such a way that they do not damage other robots, the field, or human spectators. Kickers are not allowed to shoot the ball so hard that it damages other players. Robots are to avoid collisions. Any contact with a defender while in the defense area will be deemed a violation. Outside the defense area, causing substantial contact with an opposing robot will be deemed a violation. (Contact is considered substantial if it noticeably changes a player's orientation, position, or motion.) If the responsibility for contact is not obvious play may be allowed to continue.

- The offside rule will not apply.

- It will be deemed a violation if a robot drops parts on the field.

- Robots are not allowed to fix the ball to their body, or encompass the ball in any way that prevents access by other players. 80% of the area of the ball must be outside the convex hull of the robot, when viewed from the side at a perpendicular angle.

- No robot can use adhesives such as glue or tape for purposes of controlling the ball or constructing a dribbler. It is a violation to leave residue on the ball or the field. Dribbling devices that exert backspin on the ball (to maintain contact with the robot) are permitted, provided that the spin on the ball is perpendicular to the plane of the field.

See the following webpage for the most recent version of the rules:
http://rwbclasses.groups.et.byu.net/doku.php?id=robot_soccer:2016:rules

Project Requirements

While the intended users of this specific project are just ourselves, we determined customer needs with a theoretical customer in mind. And although we recognize that the hardware of our robot will not be mass produced, it is possible that our codebase will be used by future robot soccer competitors. Therefore, these customer needs include requirements for both hardware and software.

#	Customer Need	Interpreted Need	Priority
1	Team of robots can win.	Our team scores more goals than the other team.	High
2	Robot can play with a teammate.	Each robot has a distinct role, and knows the position, role, and orientation of the other.	Medium
3	Robot can shoot at the goal from a distance.	Robot has a kicker, and can position itself behind the ball facing the opposing goal.	Medium
4	Robot can block shots.	Robot can position itself between the ball and its own goal.	High
5	Robot can avoid obstacles and other robots.	Robot knows where other robots are, and can change its target destination to avoid them.	Medium
6	Robot can move with the ball.	Robot can position itself behind the ball, and can move without letting the ball slide away.	Medium
7	Robot moves smoothly.	Wheels allow for linear and rotational movement, and there are smooth transitions between states.	Medium
8	Robot is fast.	Robots moves quickly and, when possible, directly from its current location to a target destination.	High
9	Robot can implement different playing strategies.	Robot knows the game situation and its role, and can choose different plays accordingly.	Medium
10	Robot's playbook is easily expandable.	Code structure is modular, and new plays can be devised and added without breaking current functionality.	Low
11	Robots look good.	Robot has a nice encasing, and all parts are securely assembled and neatly organized on the robot.	Low

Project Specifications

In order to fulfill the qualitative needs of the customers, we have devised some quantitative specifications for our robots. Each metric is specifically determined to help meet at least one of the project requirements outlined in the previous section.

Metric #	Need #	Metric	Target	Unit
1	1	Difference between our team score and other team's score.	> 0	goals
2	2	Number of passes to a teammate per game.	> 2	passes
3	3, 4, 5	Difference between determined location of ball/ robots and their actual location.	< 5	cm
4	3	Distance between the target location of a shot and its actual location.	< 5	cm
5	4	Percentage of shots by opposing team that one of our robots blocks.	> 80	%
6	5	Amount of clearance our robot gives stationary objects when circumnavigating.	> 2	cm
7	6	When in dribbling mode, the distance between the ball and the dribbling robot.	< 3	cm
8	7, 8	Angular speed at which robot can rotate.	> pi	rad/s
9	7, 8	Linear speed at which robot can move.	> 0.5	m/s
10	9, 10	Number of plays run per game.	> 5	plays
11	11	Number of parts dangling off robot.	< 1	parts
12	7	Percentage of control overshoot when moving from one state to another.	< 1	%

Each customer need corresponds to one or more specification, which will be used as a performance metric to ensure that the customer need is satisfied.

These are tentative target metrics. As we begin simulating, building, and testing the actual system, we will update, delete, add, and recalculate target metrics as necessary.