Faculty of Engineering
ENGG1000 19T3
Soccer Droids
Test Report

Soccer Droids Test Report

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Team 20

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Faculty of Engineering
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Table of Contents

Faculty of Engineering
ENGG1000 19T3
Soccer Droids
Test Report

Introduction

Design Challenge

The main challenge of this projects is to design and build a soccer droid which can autonomously locate, identify and track the tennis ball and score for goal and the game.

Firstly, the robot should follow a series of instructions which includes finding the tennis ball in a specific area, moving back and forth on the ground, kicking off the ball to the goal gate precisely, tracking and following a moving ball, detecting the environment issues nearby such as the light condition, and at last, programming an artificial algorithm to win a droid game.

Besides, there are also some limiting factors which should be considered. For instance, the maximum mass of the robot should be less than 1.1 kilograms, the size should fit in a 220mm cylinder and the total budges should be less than 120 dollars. Also, the droid should be started manually but running autonomously without any remote control.

Executive Summary

This report will focus on the design of the droid prototype, the final test of the defending stage, the improvement of the robot design and finally, the appendices in the report. The first part, prototype design, is based talking about the morph chart design and selection, the first build of the prototype and final version after serval fixed and changed. The second part, the defending test, is talking about the program algorithm for the defending function, the challenges and opportunity in the preliminary, and future improvement after the final test. The third part is that potential robot improvement in the aesthetics of appearance. Last but not least, the appendices used in this report.

Faculty of Engineering
ENGG1000 19T3
Soccer Droids
Test Report

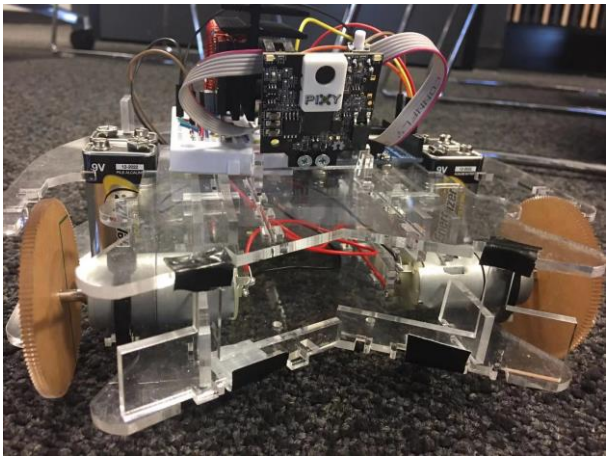
Prototype Design

The different components of the robots are decided and assembled through the morph chart below. The morph chart method can provide the advantage and disadvantage of selections for each feature. Also, once entered the build stage, the morph chart can be considered as a sketch.

All Features	All options		
Method of Movement	Wheels	Belt	Air Propulsion
Shape	Cylinder	Box	Other
Camera Height	High	Middle	Low
Speed	Fast	neutral	Low
Construction	Mixed	Wood	Acrylic
Ball Launcher Type	No Launcher	Solenoid	Continuous Motor
Display Feedback	No Feedback	LEDs	Letter Display
Circuit Implementation	Breadboards	Custom PCB	Mixed
Camera Rotate	No Rotation	Rotate	
Camera Depth	In Front of Robot	Middle of Robot	Back of Robot
Mode Input	No Mode Input	Switches	
Power Source	Battery Pack	Single Battery	Multiple
Motor Vertical Mounting	Below Plane	Centre to Plane	Above Plane
Wheel Depth Mounting	External to Robot	At Edge	Inside Robot
Number of Motored Wheels	2	3	4
Front Indent Area	No Indent	Flat Indent	Concave Indent

Finishing all the concept and the sketches of the robots, three different technical teams begin to use what they're good at to build the prototype. Finally, the final prototype of the soccer droid has nearly completed in week 8. The prototype is shown below.

Faculty of Engineering
ENGG1000 19T3
Soccer Droids
Test Report



The main structure of the droid is made with plastic by laser cut. Each component would stick and assemble inside the plastic shell. There are two main wheels with motors at each side in the front of the robot to support the droid rotate and move, and a smaller wheel, installed at the end of the robot to maintain the balance. Four battery pack at the center area of the robot to provide the power, and Arduino microcontroller at each side to compile and run the program. Finally, the pixy2 camera is set at the top of the robot with a particular angle.

Compared with the traditional robot, this design has combined the aesthetics of curves and symmetry, and the concave in front of the droid “control” the robot from sliding and easily pass the test.

Faculty of Engineering
ENGG1000 19T3
Soccer Droids
Test Report

Test No #4 – Defending test

In this test, I will focus on the defending part, which is the robot should wait when the ball is out of the distance, strike when the ball is getting closer and return to its initial position.

Client Specification

The droid should be able to intercept the moving tennis to the goal and go back to the initial places to prepare for the next interception. The main challenge of this test is that the pixy2 camera needs to detect the position of the tennis ball precisely and calculate the distance correctly and quickly. Also, the droid should be well-functioned in a different environment. For instance, the droid itself should adjust the brightness of the light autonomously due to the signature been detected by its colour. Sometimes the light condition will become too warm, then the tennis ball would be hard to recognize by the camera and cause the robot acts wired and without logic. What's more, the robot still needs to return to its original place after striking the ball.

Test Procedure

Before the final test, the battery of the droids has been replaced with a brand new one and the signature of the ball has been updated for better performance. However, some accidents just happened without anyone's expectations during the test procedure. The first test was completed the program instruction, waiting for the ball get closer and go strike for defending, perfectly. In the second test, the robot found the tennis ball which is in the striking area, look forward the ball but somehow just stuck. Our team became nervous and confused about the wired appearance of the droid which never happened before.

Defending test			
Time	Move	Test #1	Test #2
6/6	6/6	6/6	3/6

Testing Results

In the end, half of the marks were lost for test #2. Considering the other four tests left, our team starts to check what is wrong in the droid and prepare for the next test. Luckily, the problems were founded and fixed on time, and the droid passed all the test left, which helps our team get a third high score in twenty teams. The problems which reduce the robot cannot work functionally is that the lines connecting between the left wheel and left motors were loosed and lead to the left wheel was totally out of control. Unfortunately, this situation never happened during either build or practice test, so one of the challenges being engineering is that we are always facing some unexpected challenges and need to solve them in limited time.

Evaluation of Performance

There are multiple methods to enhance the performance of the robot to defend, some of them are much complicated, and some of them is simple to code but still effective. For example, one of the strategies, which I also added in the competition, is to upgrade the original program from single, straight-line defence, to multiple, range defence. The bonus competition is an excellent way to show up the intelligence level of droid's performance. When the origin coding strategy, which is used to pass the defend test, was extended to the two-dimensional field, currently the droid can always turn towards the ball, go strike when the ball is closer to my gate, and finally move back to the goalkeeper position and wait for next strike.

What's more, compared to other team's robot, our robot has higher torque in wheels, which helps our droid has an advantage when body fighting with other robots. For instance, when the opponent's droid moving towards our gate with the ball, our robot should go straight towards their droid and prevent their droid from moving any further due to stronger motivation.

Also, sometimes the light condition will affect the detection of the signature of the ball and lower the performance of the droid. This is because the pixy2 camera detects the object by its colour, and the brightness of the colour will strongly influence the result. After dozens of tests and attempts. Finally, the errors caused by the camera has been weakened due to the classification program.

Faculty of Engineering
ENGG1000 19T3
Soccer Droids
Test Report

Design Improvements Part 1 (using SWOT analysis)

Strengths

- Higher torque provides higher power
- Aesthetics
- Great defense ability
- easy to disassemble and assemble
- four batteries to provide the power

Weaknesses

- low rotation speed
- hard to adapt in new environment

Opportunities

- easily beat other droids in body fighting
- the defense range could cover nearly 150 degree

Threats

- hard to handle with agile and small droid
- sometimes the droid will leave the goalkeeper position to chase the ball far away from the gate

Design Improvements Part 2 (Analysis the Artificial Intelligence of the current droid)

Artificial Intelligence of the Droid should be Improved

After the prototype designed and built, the droid already can move forward and backward, rotate with its centre. Then the droid was tested to detect and chase a following tennis ball, and analysis the environment nearby, select the useful information and code a preliminary AI prototype. However, sometimes the behaviour of the droid seems silly. For example, when the droid competes with other droids for goal, the current Artificial Intelligence does not perform well due to much more complicated environment to analysis, which might cause the droid acts silly such as moving straight to the opponent's gate when the other droid is in front of it.

Analysis

The best solution to enhance the Artificial Intelligence of the droid is to mimic the behaviours of the professional soccer player in the premier league. Excellent players could make the best decision immediately by observing the position of the ball and opponents. That is exactly what the droid should learn. However, the robot cannot think independently on its own (or not in this project). Above all, the Artificial Intelligence should be realized through the classification of the code design.

Recommendations

To get better performance when fighting with other droids, the robot should become smarter when handling a complicated situation. Luckily, through the classification of different possible situations in the pitch and using the program to simulate this production, the robot will get a better performance in the competition. For instance, currently, the robot cannot switch the attacking mode or defend mode autonomously, which will cause the droid cannot make the best decision at that moment. Luckily, by detecting the position of the ball, opponent's robot and the gate, an algorithm to change the current game mode can be added by focusing on the distance from the ball to itself, and the ball to opponent's robot.

Appendices

Swot analysis website:

https://www.swotanalysis.com/

pixy2 API for Arduino:

https://docs.pixycam.com/wiki/doku.php?id=wiki:v2:full_api

The tutorial of interrupt in Arduino:

https://www.arduino.cc/reference/en/language/functions/external-interrupts/attachinterrupt/