UCD School of Electrical, Electronic and Communications Engineering

EEEN10020 Robotics Design Project

RoboRugby Final Report

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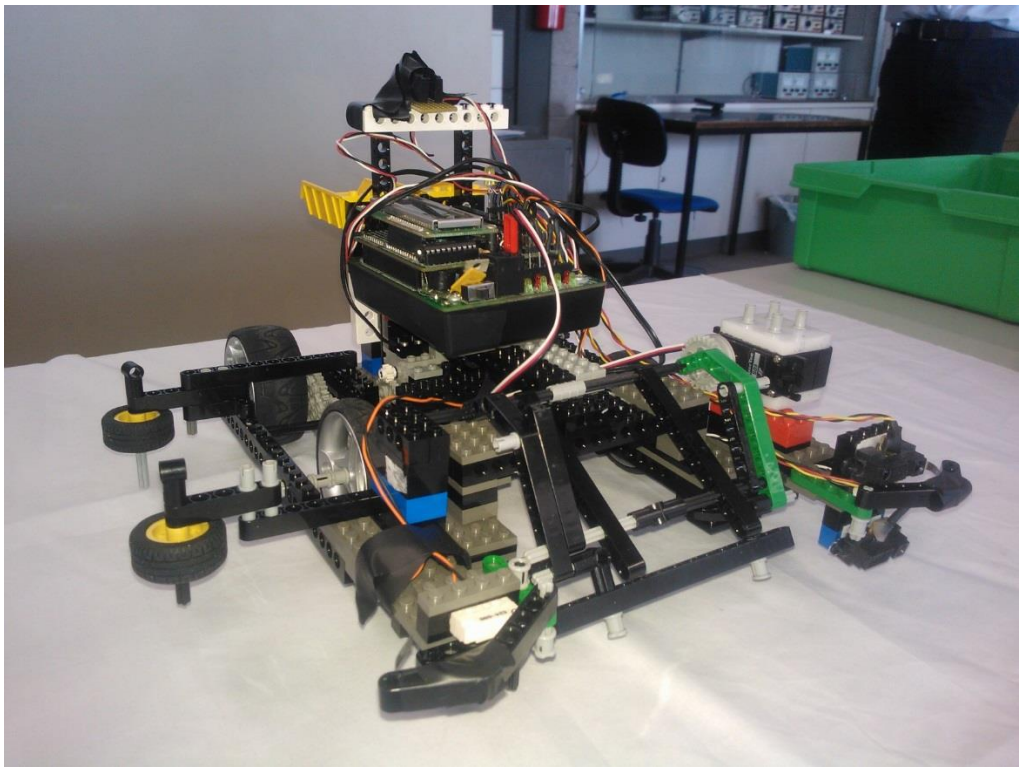
Team Name: Bot the Builder

Declaration of Authorship

I declare that all material in this report is my own work, except where there is clear acknowledgement and appropriate reference to the work of others.

Signed: . . . . . Date: . . . . . .



All images in report from Clodagh Dunne. Competition code to be submitted by Aaron Collier.

Introduction

This report will discuss the performance, design and strategy of 'Bot the Builder', as well as focusing on my individual role in the team. I will attempt to highlight my own contribution to the robot as well as describe how Aaron, Clodagh and myself worked together over the course of the Robotics Design Project Module for 2014, ultimately leading up to our performance in the Siemens RoboRugby Competition of 2014.

Strategy

During the Ranking round in week 10 we used quite a simple dead reckoning strategy in an attempt to collect quite a number of the balls on the table as well as clear out our own scoring zone (time 7:30). However, Murphy's Law prevailed, and for the first time ever, and since, when we ran said strategy we managed to capture balls in our scoring zone resulting in a net score of -3. We attributed this to our collision sensors being triggered to early and in doing so the robot believed that it was further along in its' strategy than it actually was. This did however give us the opportunity to make a few mechanical switches to our robot, i.e. the addition of the guide wheels on the right hand side and the servo instead of the harvester mechanism, which both worked perfectly in the RoboRugby tournament.

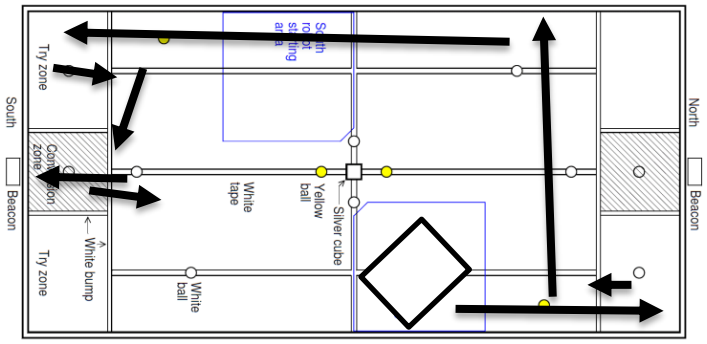
As we could not get the servo to rotate the desired amount or with the desired force to throw the balls over and obstacles, is walls, blockers etc., we decided to remove that part of our strategy. As we now knew that we were going to be playing against teams that use walls/ obstructions, "Iron Curtain" and "Reign of Error" respectively, we came to the conclusion that our strategy would need to be manipulated.

From watching "Iron Curtain" in their practice sessions on the table, and in the ranking round, we noticed that our best bet to defeat them was to use their 'strength' against them . For this we wrote an extremely simple strategy, 'Strategy 2' in our code, in which our robot drove directly for our home beacon, proceeded to clean out our defensive zone, and then drive head on into "Iron Curtain"s curtain and rotated it before it had the chance to score any points in our defensive zone. We also noted that had they deployed their defensive strategy, that should our robot have cleared our zone effectively, we would have also won as a result of tiebreak rule f. as we would have carried an extra yellow ball into our scoring half of the table.

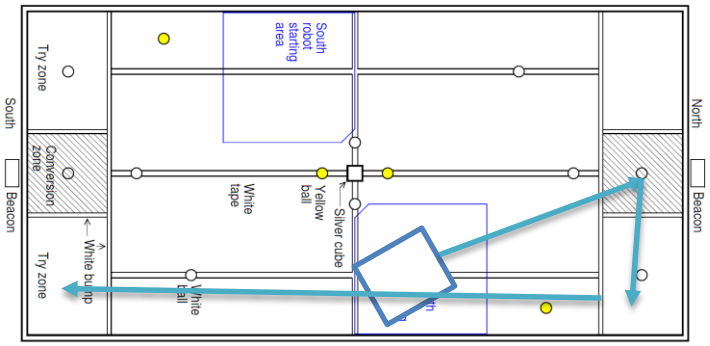
Our main strategy, 'Strategy 1' in our code, remained the same as our interim report, without the section regarding the tipper. We decided to change the harvester for the servo type collector as this allowed us to drive through the centre of the table when searching for the beacon, without breaking our harvester or collecting the cube. We were also able to reduce the size of the robot increasing its' strength and maintain the same dimensions for our collection area.

In 'Strategy 1', we began by facing our defensive beacon and then turning and collecting the balls down the side of our defensive half, until a collision was detected. We then reversed out of the scoring zone, as the wheels continually got stuck on the bumps and we couldn't turn reliably, and collected the balls in front of the try zone and the yellow on the opposite flank of the table, again waiting for a collision. Following

this we drove then this flank collecting balls until we collided with the bottom wall and reversed and turned until the beacon was found. We drove forwards, as long as we could still see the beacon, and when our light detectors sensed grey and both our collision sensors were closed, we lifted the servo and deposited the balls we had collected. We then hunted for balls until there was only ten seconds left. At this time we once more found the beacon and returned to the conversion zone.



Strategy 1



Strategy 2

Analysis of Strategy

As regards to our ranking round strategy, we were let down by its simplicity. Having to rely on the fact that for the strategy to work we needed it to collide where we had planned each time was in hindsight a poor decision. However, as a result of a poor ranking round we were able to assume the title of underdogs and also were placed in the bracket against teams who we knew quite a lot about and so we were able to spend our time fine-tuning our strategy to beat theses robots.

(Time 1:00) Against "Iron Curtain" 'Strategy 2' worked exactly as we had planned. It managed to clear a white ball out of our defensive conversion zone and then reach the 'curtain' before it had deposited any balls into our defensive zone. Then it was just a matter of waiting out the sixty seconds as both robots span in the middle of the table. Had we beaten "Frank the Tank" we would once again have been paired against "Iron Curtain", and assuming that they would have deployed their defensive strategy we could have showed how we had also planned for this by winning on the tie-break rules, also assuming that our robot cleared out our entire defensive zone.

(Time 7:18) Against "Reign of Error" 'Strategy 1' managed to clear all the balls out of our scoring zone then collect a few more before meeting our opponent before they had managed to enter our scoring zone with the balls. We were aware that this may happen even though it wasn't precisely planned. We also believe that had our robot gone onto finish out our strategy that we still may have won the game as we had collected more

balls and would have went on to collect a few to the centre of the table as well as the ball just in front of the conversion zone.

(Time 12:10) We had noticed how "Talk Nerdy to Me"s beacon blocker was extremely effective and so we were left with the decision of which strategy do we choose. We were very much aware of how our strategy was not designed to battle a beacon blocker. I felt that if we used 'Strategy 1', that we may have been able to collect enough balls and make it to the scoring half in time to collide with the opponent before they had made it down the table. Our robot would also have acted as a massive obstacle in their path and they may not have been able to score any of their collected balls. However, the counter argument that was made was that if we used 'Strategy 2' we would at least have the chance of scoring some points and we were then not dependent on the beacon. It was eventually decided that we would use 'Strategy 2' with the idea that scoring some points was better than scoring none. However our robots battery, despite us charging it, seemed still quite diminished from its previous two battles and so its turns and driving were sluggish. This resulted in the robot colliding with the walls before it was expected, as in the ranking round, and unfortunately spending the remaining 50 seconds of the match driving against the wall. We were disappointed that our robot gave such a bad showing in this game. I also do not believe that if we had used 'Strategy 1' that we would have won however I do believe the score would have been more respectable. "Talk Nerdy to Me" went on to win the tournament and as such it takes some of the sting out of the defeat.

(Time 24:54) Finally against "Frank the Tank" we were quietly confident of our chances of getting back into the business end of the competition once we got passed a robot we felt our strategy would do well against. Everything had been going swimmingly as far as our programme was concerned and we had collected quite a considerable amount of balls in our collection area. Unfortunately the robot released them before reaching the scoring zone and having had a distance sensor get knocked so as it was reading the wrong values our robot spent its last moments in the competition spinning helplessly in the centre of the table. We are all fairly certain that due to the difference in light levels between the lab and the auditorium that our robot believed that the white line that he was on was grey and so he released the balls to the centre of the table, however had he noticed it was white and not grey we would, I am certain, have managed to deposit the balls in the try/conversion zone and win the match. If we had done so we once again would have faced "Iron Curtain" and who knows where we may have finished up.

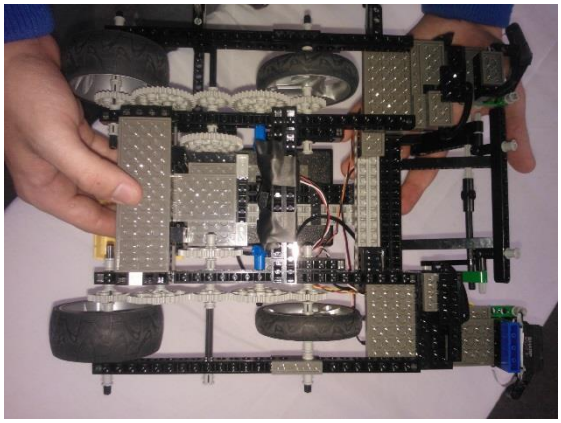
In hindsight, we realise that a start-up sequence which includes calibration of the robot, as used by "Scorpion" and "Erin Jaeger", would have helped us immensely in the competition.

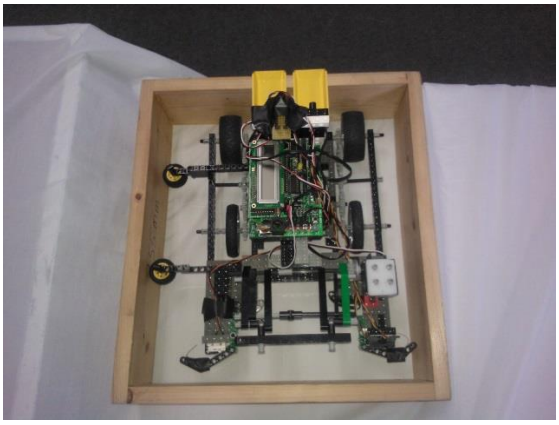
1. Firstly we would never have released the balls to the centre of the tables vs "Frank the Tank" and would have continued in the competition.
2. Secondly on the day of the competition we noticed our robot was overcharged and so our turns were larger than expected, this is why we return to our starting position instead of driving down the side of the table as expected. Aaron and myself did send time running the battery down on the day of the competition however with a start-up sequence there would have been no need for that and our robot would have been faster, sharper and stronger as a result.
3. Finally, against "Talk Nerdy to Me", our turns would have worked correctly and we would have score four points instead of zero giving us a more respectable result of 12-4.

In conclusion, I believe strategically we were one of the stronger teams in the competition. Our robot was designed to battle against other robots not just by itself and in doing so got us to a respectable position in the competition however with a start-up sequence which included a re-calibration of the robot we would have done much better.

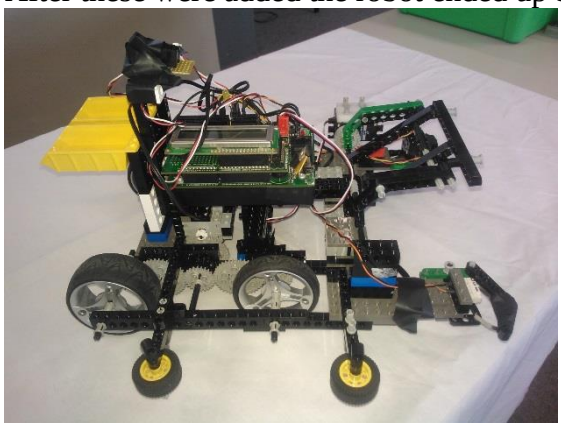
Robot Design

We decided early on that we wanted a fast robot that could hold a lot of balls. With these considerations in mind each person was asked to come up with a design, or aspects of a robot that they individually would like.



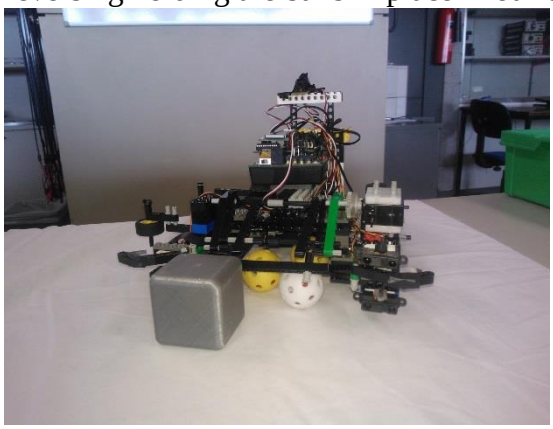


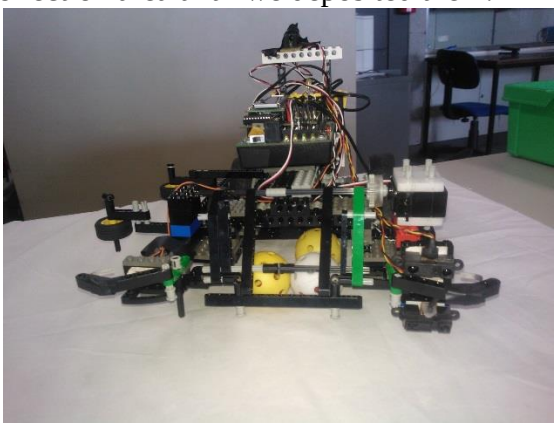
Both Clodagh and I wanted four wheel drive as we thought it would increase turning and the speed of our robot. From trial and error we came up with a design that ran five gears, resulting in a 5-1 ratio, along the side of our robot and then boxed in at either side to ensure that another robot or a ball could not disturb them. Due to this the underside of our robot became quite wide in order to allow space for the wheels, gears and motors all to fit comfortably. After the ranking round we identified the need for guide wheels on the side of the robot to ensure the right hand collision switch was not hit prematurely. After these were added the robot ended up being 320mm in width.



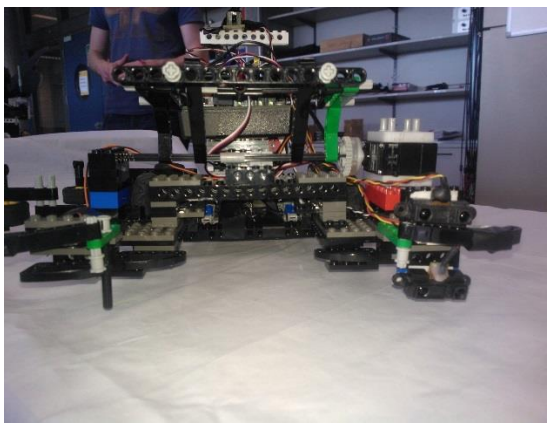
We initially had a harvester mechanism at the front, which was something we all agreed on adding to collect the balls, however this made the robot extremely long and flimsy at the front as well as forcing us to avoid the cube. As a result of this we always had a backup plan to switch the harvester to the servo ‘trapper’ but only changed this after

noticing that we were paired against “Iron Curtain” and “Reign of Error” in our first two games as we knew that both their ‘curtain’ and ‘blocker’ respectively would ruin our harvester. Changing allowed us to attack the cube without collecting it and also reduce the length of our robot, to 330mm, as well as strengthen it at the front. The servo stayed up whilst driving allowing the balls in but keeping the cube out. It closed on turning and reversing holding the balls in place in our collection area until we deposited them.





The servo was placed on the left hand side of the robot and so were the distance sensors. The servo was secured using the 2x5 lego plates with the holes in them as this was the easiest way to secure it to the body of the robot. We tried building up a wall and sticking the pegs into it however this didn’t work for our servo results for opening and closing and was less secure than the chosen solution. To combat this extra weight the handyboard was placed slightly right of centre to balance the robot for steering. It was also placed in the middle of the front and back wheel axes to improve turning. The collision sensors were the foremost parts of the robot with the light sensor in the undercarriage of the robot at the back of the collection area. The collision sensors were made by getting one of the bent peams of lego and securing it to the robot at the source of the switch and then securing the switch to it with tape. This increased their reliablity and sensitivity. The distance sensors were place on the left as there was no place in the centre to put them. A 1x16 piece of lego was used as a barricade to keep the balls from wrecking the gears and as a place to add the light sensor. It was also used for binding the robot together with the pegs and beams. We added curved pieces to the underside of our robot to guide balls into the collection area. The entire back of the robot was bound together as well as where the handyboard was situated however we were not able to bind the front as we were trying to keep this area open for collecting balls.



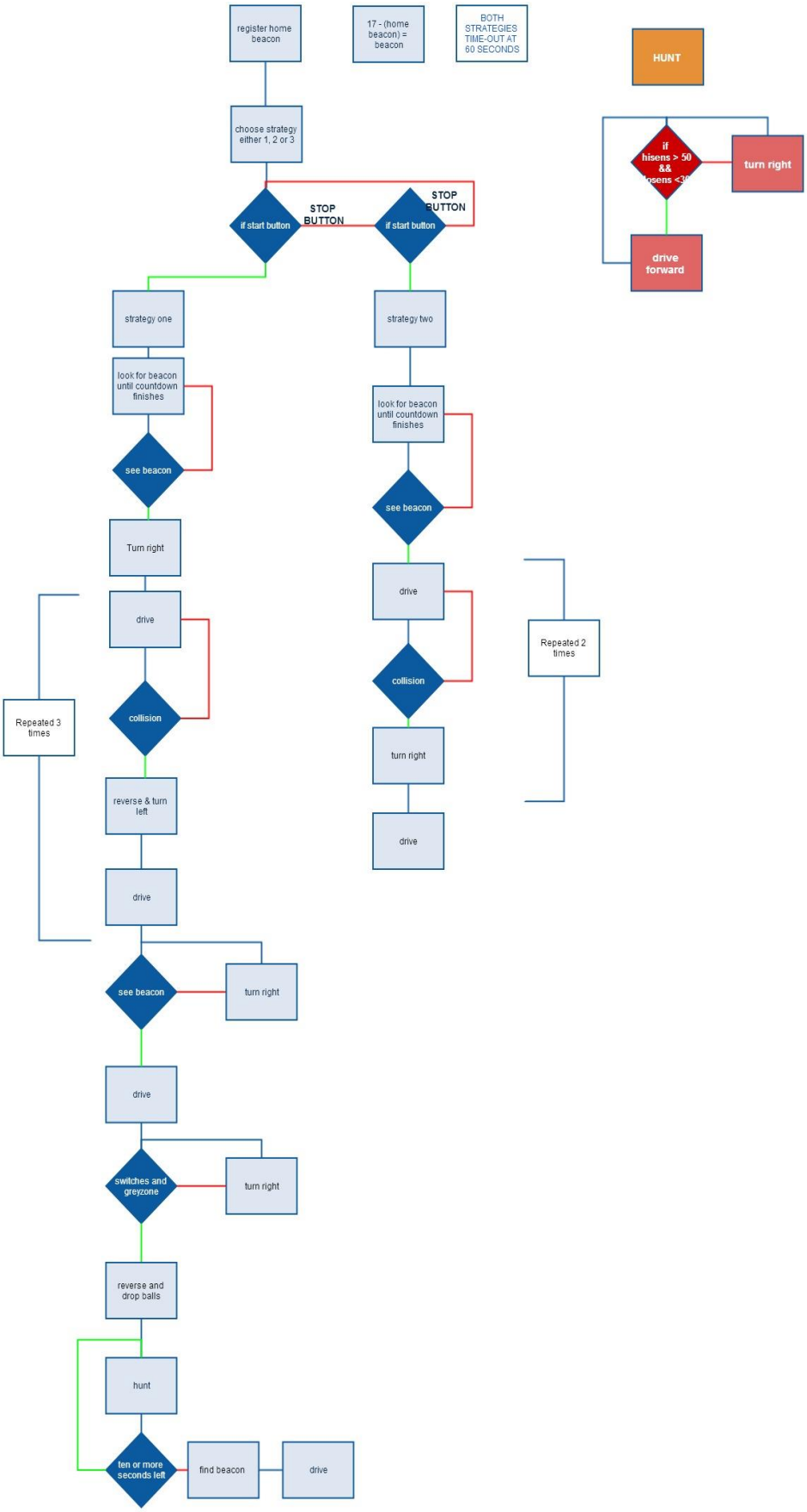
Analysis of Robot Design

Looking back our design worked extremely well, allowing us to move quite quickly as well as collect a considerable amount of balls, 8 at capacity, in our collection area. We experienced some problems with sagging in the robot due to the weight of the handyboard and if we had more time we would definitely have sorted that problem. Our four-wheel drive worked extremely well however we had some difficulty with meshing sometimes and this would have been sorted be running a beam up beside them, to secure them in place, if we had more time. The servo worked extremely well at collecting and retaining the balls as well as pushing away the cube, and the addition of the guide wheels to the right hand side proved a great success. All in all I believe despite a few minor structural issues which would have been easily fixed had we had the time the robot was soundly built to perform our strategy.

Software

Our programme used the start-up software given then gave the option of two strategies. You choose between strategies by pressing the 'START' button if it was the strategy you wanted and by pressing the 'STOP' button if you wanted the other strategy. There was a 60 second countdown which when reached shut down the robot once either strategy was deployed and had got past the countdown stage.
In 'Strategy 1' the robot completed its' 5 second countdown before turning right. The guide wheels prevented the collision sensors from being pressed. The robot the drove using the guide wheels until the collision sensors were pressed. It then reversed out of the try zone and turned left collecting the ball in front of the conversion zone and on the far side of the table before the collision sensors were pressed again. It again turned left and headed down the table until it collided with the bottom wall, in the process hopefully collecting the ball on that side and using the guide wheels. It then reversed and turned until it could see the beacon. Once it saw the beacon it drove towards it. If it lost the beacon it searched for it again. If the light sensor read grey and the collision sensors were both pressed the robot reversed and raised the servo depositing the balls, servo was changed by changing it from servo_up to servo_down two predetermined values. The servo was in the up position whilst driving and the down position when turning/reversing. After this the robot reverses and turns looking for balls, i.e. ball seen if hi_sens > 50 and lo_sens <30. During testing we calibrated it so that it could see balls up to 20cm away. If there was only ten seconds left on the timer the robot stopped hunting and searched for the beacon by tuning around. Once it had found it, it drove home.
In 'Strategy 2' we waited for the 5 second countdown to finish. Once it did as it was facing the beacon it drove until it detected a collision, collecting the ball in the conversion zone in the process. It then turned right and drove until it recognised another collision, collecting the ball in the try-zone. Finally it turned and drove for the remaining time blind to turn "Iron Curtain"s 'curtain'.

The differences from the ranking round were that we were now using the servo instead of the motor to drive the harvester. Also we added both the find beacon and hunting parts of our strategy to the code. As well as this we had the option of choosing an additional strategy which was 'Strategy 2'.


register home beacon
17 - (home beacon) = beacon
BOTH STRATEGIES TIME-OUT AT 60 SECONDS
HUNT
choose strategy either 1, 2 or 3
if hisens > 50 &&
turn right
drive forward
if start button
STOP BUTTON
if start button
STOP BUTTON
strategy one
strategy two
look for beacon until countdown finishes
look for beacon until countdown finishes
see beacon
see beacon
Turn right
drive
drive
collision
collision
Repeated 3 times
Repeated 2 times
turn right
reverse & turn left
drive
drive
see beacon
turn right
drive
switches and greyzone
turn right
reverse and drop balls
hunt
ten or more seconds left
find beacon
drive

Analysis of Software

We understood from the beginning of the module that we were not the strongest programmers in the room and so we relied more on our tactical nous than on the programming. In saying that I believe that for our strategies even though our code was simple, for the most part it was effective. We did not want to complicate the programming by running too many loops at the one time and so we usually focused on one task and completing it before moving on to another. We had a minor hiccup in regards to the beacon however once this was sorted the rest of our software worked quite well. Had we found the problem sooner we would have been able to perfect our hunting programme, which only notice the balls sometimes, as well as add in a more sophisticated start-up sequence which would include calibration settings.

Project Management

I wrote out our team's plan of action for the weeks following the interim report, however we all had an input into who did what for the coming weeks, as well as designing our team banner.
Seeing as it had been my idea to involve the tipper, and Aaron and Clodagh were sceptical as to its ability to work, I oversaw mostly the mechanical side of the robot as well as finding out strategies of other teams and devising strategies to combat them. Aaron and Clodagh took charge of the code but I chipped in where possible with that part. I did not want to spend my time also sitting looking at the code while they wrote it as I thought this would be a waste of valuable time so I spent most of my time testing different aspects of the robot and finding out the optimum positions to start the robot. By default I was nominated to position the robot during the competition too as I knew its start positions.
Aaron wrote the majority of the code. The only bits he didn't write were slight alterations made in the labs like times for turning etc. which whoever closest to the computer did. He spent a lot of time at home writing it up to save time in the labs for fine-tuning.
Clodagh helped in the labs with both the code and the mechanical side. She also did some recon on other teams strategies whilst we were in the labs.

Following the plan we managed to achieve most of our goals each week however due to an error in the code, which we all failed to spot, we ended up getting caught up trying to get our find beacon function to work which delayed us a lot. Had we noticed this earlier we would have been able to perfect a pre-start sequence with a calibration setting that would have greatly helped our robot.

Performance of the team

I felt we worked quite well as a team with each person eventually fitting into their respective roles. Both Aaron and I tried to make the most out of the extra lab sessions and lectures and we all spent time discussing different aspects of the competition in a Facebook chat we created for the module.

We were all quite friendly before the project and still are now however that did make it a bit more difficult when coming to final decisions as we didn't wish to hurt anyone's

feelings. We were democratic about decisions and offered everyone a vote to decide how we would proceed when conflicts arose.

I do feel however that both Aaron and I did the majority of the work for the project. We both attended every lecture and tried to make as many extra lab sessions as possible, stating in the chat that we were going to attend them. This left us sometimes having to explain some of the details explained in the lectures to Clodagh, as well as having to decide a few of the minor details about the robot, when we were nearing the competition date, without her and then informing her later.

As a result of this I would attribute a large percentage of the work done to both Aaron and I, with Clodagh helping mainly during the Wednesday lab sessions.

Aaron	37.5%
Clodagh	25.0%
Fergal (myself)	37.5%

Suggestions

What would you do differently if you were starting again?

If I were to start RoboRugby again I would definitely like to do more with the code. I enjoyed that part quite a lot and we got our best result in the earlier labs (week 2) when I wrote the code however as we moved on in the modules I spent more of my time with the mechanical side of the robot. I would also make a plan for the lab sessions involving our own robot much earlier as I feel we worked best when we had a list of objectives to achieve.

What advice would you give to a student starting RoboRugby next year?

During the test labs at the beginning of the module start sketching and planning a robot around what you need to do and what works well for you. Attend the lectures as they're very helpful and don't be afraid to ask for help when you get stuck. Also if you can do the majority of the code at home and then take it in and test it, this saves a lot of time. Something that helped us a lot was a diagram explaining where we had put sensors and motors, etc. on the handyboard so that we could keep track of them.

What could we do to improve the project or the module?

Allow teams to add one or two extra pieces to the robot that are not in the kit.
Increase number of labs towards end of the module.
Award a percentage for attending lectures and tutorials.
Advertise module more in Computer Science courses as this would probably increase standard of coding and robots in general.

Conclusion

In this report I have outlined “Bot the Builder”s performance in the RoboRugby competition this year, as well as described the strategy, design rationale and performance of Team 10 over the course of the Robotics Design Challenge module.