How to be Successful at Botball
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1.0 Introduction

Over the past five years, the Cedar Brook Academy Botball team has learned quite a bit about how to be successful at Botball. The goal of this paper is to describe what helped us to win the 2007 International Competition and place third at the 2008 Greater DC Regional Competition against some of the best teams in the world.

2.0 – Software Libraries and Using Sensors

One of our greatest strengths is that we have a large, reusable code base. Since we are a small team, this saves us valuable time in programming our robots. Every year, we have focused on adding additional functionality to our code base. The first libraries that we developed were the Camera Library and Object Search Library[1]. The second set of libraries was the Navigation Library[2] and Position Library[3]. Figure 3 shows how our libraries are related to each other.

2.1 – The Camera Library and Object Search Library

The camera is a large versatile sensor. It can be used to sense both close and far objects. No other sensor can cover the area that the camera can. The Object Search Library encapsulates our years of experience with the camera. Though powerful, it needs careful coding to make it useful. The library contains functions to center the robot on an object, to check if there is an object right in front of the robot, to see if there are any scoring objects in view, to move the robot to an object, and many more functions.

To give an example of why writing a library for the camera functions is useful, one must look back to the 2005[4] and 2006[5] game boards. Figure 1 is one of the two targets used on the 2005 game board. Figure 2 is one of the two colored targets used on the 2006 game board. Our strategy in 2005 was to knock Botguy and the orange ball from the penthouse, find them using the camera, and deliver them to the yard from anywhere on the board. It was important that the robot was able to locate the yard using the target as an identifier. In this case, it was an orange rectangle with a green square within it. This allowed us to score Botguy and the green balls. The key was to identify an orange object with a green square, which is significantly smaller than the orange target, that is inside the orange and to the right (Figure 1). The reason we had to identify these specific parameters is that we don’t want to go for the wrong target. If we instead only looked for orange, the robot would go for the closest orange object in its vicinity, whether or not it was actually on the game board. Identifying that the green is significantly smaller than the orange and is inside and to the right of the center insures that we are looking at the target.

When writing this code, it would seem that it would only be able to be used for the 2005 competition, but the 2006 target was similar. The main difference was that the two colors were different and their shapes were somewhat different. So, we only needed to modify the parameters for the color models, and we deleted the code to determine where the odd color was at in relation to the main color. (green being odd, orange being main) This took less than an hour to change and test the code.

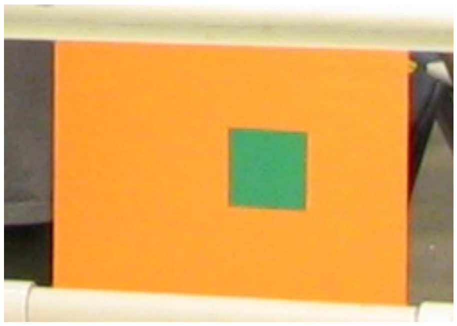


Figure 1.

Figure 2.

2.2 – Navigation Library and Position Tracking Library

The second set of libraries is the Navigation Library and Position Tracking Library. The Position Library keeps track of the robot's position and direction using the Back EMF output, while the Navigation Library contains functions for precise movement that is governed by the position data from the Position Library. These functions are discussed in our previous conference papers, entitled "Position Tracking Using the XBC"[3] and "Navigation Using Position Tracking"[2].

These two libraries have been vital to our team's success in the past three years, and it has made coding very easy. The benefit of making these two libraries is that they can be used every year. For position tracking, it is only necessary to adjust for the wheel distance and the diameter of the wheel. The best example was in 2006 where there were different colored balls that needed to be placed in their respective homes. The library made the code simple. It was as simple as telling the robot that after obtaining a ball, go to a point in front of the home that corresponded to the color of the ball, turn towards the home, drive into position, and drop off the ball. Though the code was not completely solid because it was still in developmental stages, it worked well enough to serve its purpose.

2.3 – What about those sensors?

Along with the mostly neglected camera, sensors are not effectively used by the vast majority of teams. It seems that every year, the majority of the teams will use no sensors on their robot. For example, one year at our Regional Tournament we won the judge's choice award for best use of sensors for using only three sensors! Amazing, right? Not if you use them in a useful way. Sensors can be the difference between winning and losing if they are properly used. Just like the Camera, other sensors such as the range finder and IR (Top Hat) sensor are extremely valuable. They can help eliminate errors in navigation, and help the robot decide what to do when something changes on the game board. See Section 3.3 for a story on how sensors helped us in the 2007 International Tournament.

3.0 – Strategy: How to think

One of the largest problems with any team is determining an effective strategy. How do you want to think when it comes to determining the strategy? This section explains how your team should approach this crucial part of the game.

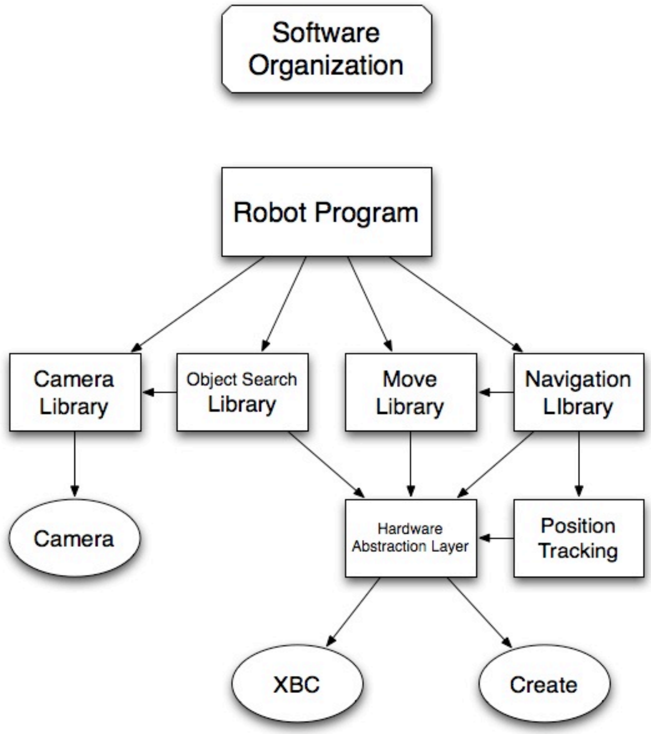


Figure 3.

3.1 – Points

The first question that should be asked is, "Where are all the points at?" Most of the game boards in past years have a cluster of points, or objects that represent large points. In some years, a large number of points are where both teams can get at and the first one to control them usually wins. In 2005 and 2006, Norman High School was very effective at controlling these points. Their robot from 2006 illustrates this (Figure 4). The balls were the cluster of points, and obtaining them was the key to winning. See the 2006[5] Game Board to see the position of the scoring objects. So, a winning strategy focuses on controlling these points. In the 2007[6] and 2008[7] games, the points are more decentralized. An effective strategy in this case requires a team to reliably score a lot of points and try to find a defensive method to hinder the opponent's scoring. Every year, KIPR also gives out a scoring chart showing where all the points are located. In 2005, the team that obtained Botguy and placed him in his home won almost every time. Our strategy to go after Botguy as quickly as possible led us to a good placing in the 2005 National Competition. In 2007, the majority of the points were concentrated in the center of the tables. So the key was sorting the scoring objects to score major points. The only problem is that you can't score a lot if you don't move quickly.

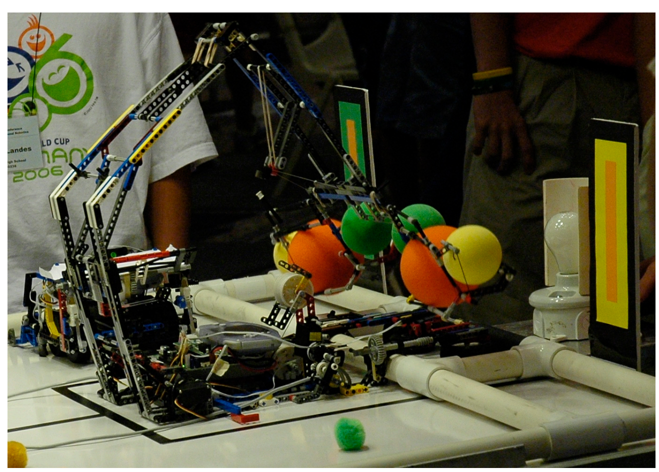


Figure 4.

3.2 – Speed is the Key

If your robot isn't moving, then it isn't scoring. The key to scoring a lot is speed. A lot of teams will have one robot exit the starting box while the other waits. Once the coast is clear, and ten seconds or more have passed, the other robot starts to move. Ten seconds can be crucial in a match between two good teams. Success comes in innovative ways, and for us it has involved going over the PVC pipe in the starting box. In 2007, we essentially had both robots go in opposite directions at the same time. One robot went out of the front of the starting box, and the other out of the back over the PVC. This allowed both robots to be scoring in different parts of the table at the same time. This year, we had one robot go over the PVC into the solarium to get to the bridge quickly. At the 2008 Greater DC Regional, the top three teams all crossed over the PVC to get to the bridge quickly. This proved without a doubt that speed is essential to winning.

3.3 – Playing Defense

A good defensive strategy coupled with reliable scoring can give a team the upper hand. How can you protect yourself from the other team, and how can you limit the other team's scoring potential? Good defensive strategies generally are focused on denying the other team the ability to score points.

To give an example, in 2007, our strategy was to move the yellow bin on the opposing team's board to a position where it would be impossible for the other team to score any points. In Figure 5, our robot is to the left moving the yellow bin. This move lowered the other team's scoring potential by 30 points, and it also caused problem's with the other team's navigation. If a robot ran into the moved bin, it would cause the robot to go off course. This caused our opponent's robots to collide in multiple matches. Doing this also meant that we didn't have to be the highest scoring team. Rather, we were able to focus on reliably scoring more points that the other team's maximum scoring potential.

Knowing that other teams probably would attempt to disrupt the bins, we compensated by relying on our sensors. Sure enough, four other teams out of the field of sixty-five had robots that moved a bin. But it just so happened that they only moved the green bin to the middle as opposed to the side like we did. In one of our matches, a team moved our green bin to the described position. However when our robot turned to drop off what it had in it's claw in the green bin, it knew that the bin was right in front of it because of a range finder sensor and camera. Thus it was able to compensate and complete the round.

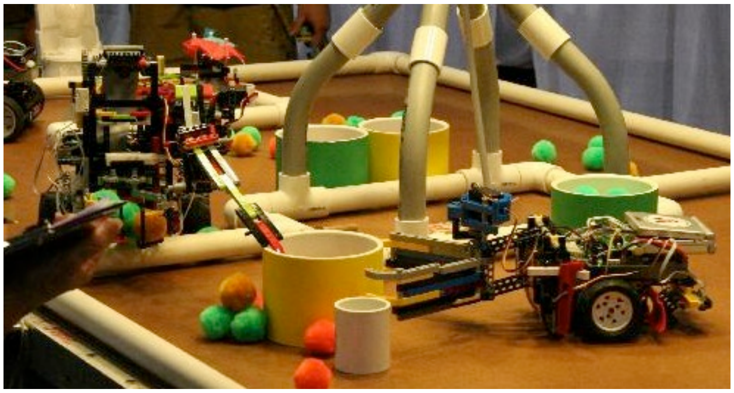


Figure 5.

3.4 – Don't Show Your Hand

Just like in Poker, you don't want to show your hand too soon. At the 2007 Tournament, a lot of teams practiced their double elimination strategy during the seeding practice rounds. After seeing this, other teams started developing counter strategies. Which resulted in none of those teams reaching the top ten. We kept our defensive strategy under wraps as long as possible by making our arm that moved the green bin look like a crude lava blocker (Figure 5). Many teams asked what the arm was for, but no body caught on. This tactic resulted in no one developing an effective counter against us. Give your opponent as little time as possible to learn how to counter your strategy. This is especially important at GCER, where there is two days to practice and to counter. So basically, don't show the world what you can do before you need to.

3.5 – Reliability

Making your robots reliable is very important. If your robot doesn't perform consistently, then your team will probably not win. Always make your robot reliable in all the tasks it does. One of the best examples of reliability was our 2007 defensive robot that moved the bin. It never failed in either practice or a match. This is because we evaluated why the robot failed when an error occurred. The rules for the 2007 game had a 45 second time limit before you could touch the other team's table surface, but you could be above the opponent's table before that time. Essentially if the robot failed during a match, we would be disqualified. Making a mistake was not an option. By the time we reached Hawaii, our navigation functions were very accurate and we had sensors to check for error. The main point here is that every time a robot fails, the cause of failure should be examined. The end result should be refined code, sensor usage, and even structural changes.

4.0 – Intelligence Gathering

One thing that can greatly help a team is intelligence gathering. This part may be the easiest thing to do that can help. Learn whatever you can about other teams. This knowledge can help you either to counter to strategies or provide ideas to improve your robots.

4.1 – Imitation is the Sincerest Form of Flattery

Just like another team might have come up with the same idea, another team may have come up with a better design for the same concept that you have. Sometimes an idea from a previous year can be used for the current year's design. One of the best robot designers, who is currently at MIT, would wander around practice tables for ideas. He would engage the other teams to understand how their robots worked. For the 2008 competition, we wanted a faster and stronger lift that would hold the claw parallel to the table. We realized that we've run into this model on the competition board and in real life.

Figure 6.

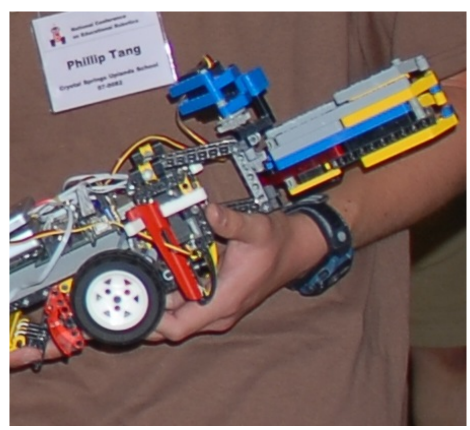


Figure 7.

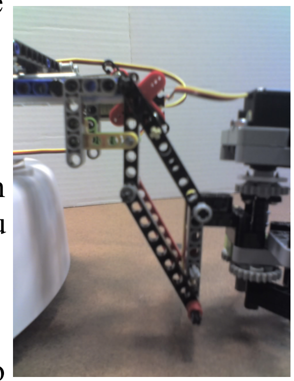
Figures 6 and 7 illustrate the examples that we used to build our own robot in Figure 8. Figure 6 is a picture of a basketball hoop design that is widely used. Figure 7 is a picture of the 2007 Crystal Springs Uplands robot. It used the same design, and it was a very effective scorer.

4.2 – Learn How Many Points other Teams are Scoring

If you're one of those teams aiming to win it all, it is imperative to know how many points the other teams are scoring. Scores are usually not posted on tournament results, so the only way to find out is by doing some research. By studying pictures of other teams, you can usually judge how many points another team could potentially score. Maximum possible scores can be calculated by determining what their robots can do. Sometimes, teams talk about their scores online or scores are published in the news. Knowing this, you can adjust your strategy.

4.3 – On Site Intelligence Gathering

Figure 8.



Any information that cannot be obtained on the Internet can also be obtained at the regional competition. One thing that can really help out is forming a scouting sheet that has each team's names, how much they score, and any other notes. By this time, experience should give you an idea about major details such as bridge crossing and tribble gathering. So sections could be made to categorize this information. A lot of times, team members might not have anything to do during the seeding rounds. So you can send them out with these sheets to take notes on what other teams do. If you have at least three team members out doing this, you're sure to have notes on every team. That way when the double elimination rounds come, you'll know what they're capable of doing, instead of hoping they don't do anything that could hinder you. Figure 9 is an example of a scouting sheet.

Team Name	Score	Notes
Cedar Brook Academy	89	They cross over the PVC into the solarium and knock over the bridge. Beware of a collision with our robots.

Figure 9.

5.0 – Summary

These guidelines have made our team a very successful team for the past many years. We hope that this information will help benefit your team and all teams for years to come.

References

[1] Myers, Ethan, Myers, Wesley. "The Object Search Library." Proceedings of the 6th Annual Conference on Educational Robotics 10 July 2007

[2] Myers, Wesley, Myers, Ethan. "Navigation Using Position Tracking." Proceedings of the 6th Annual Conference on Educational Robotics 10 July 2007

[3] Myers, Wesley, Myers, Ethan. "Position Tracking Using the XBC." Proceedings of the 5th Annual Conference on Educational Robotics 7 July 2006: 157-163.

[4] Anonymous, "Botball 2005 Teacher's Workshop Game Review," KIPR, 2005

[5] Anonymous, "Botball 2006 Teacher's Workshop Game Review," KIPR, 2006

[6] Anonymous, "Botball 2007 Teacher's Workshop Game Review," KIPR, 2007

[7] Anonymous, "Botball 2008 Teacher's Workshop Game Review," KIPR, 2008