When Botball Live Isn't Live: Off-Season Educational Applications of Botball Live
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1 Introduction

In the 2011 Botball season, the Botball Youth Advisory Council announced and released the Botball Live project [1], which live-streams Botball events. While the project's stated goal is social in nature (students, parents, mentors, and supporters who can't be present at a tournament or GCER can see what happens), Botball Live has strong potential as an off-season educational tool as well. This paper will discuss some of these applications, provide examples of how we've used them, and offer suggestions for other mentors.

2 Methodology

Botball Live's most well-known functionality is live-streaming via Ustream or Justin.tv, but a lesser-known feature is that all matches are saved. Botball Live's first public release was the Greater DC regional tournament in 2011. However, the archiving and tagging system was not functional for that tournament.

Our next event was GCER 2011, which did attempt to archive videos. The original intention was to upload all matches to YouTube immediately after GCER concluded; due to technical problems, we have been unable to do this in a timely manner thus far. (Work on fixing these issues is ongoing at YAC.) We were, however, able to manually extract some matches with significant effort. For the first incarnation of this research, we had access to 30 alliance matches, 82 double-elimination matches, and 84 seeding matches, all from GCER 2011. (Of these matches, some were unusable due to timestamp issues.)

We sought help from three Botball teams: Whittier Middle School, Alcott Middle School, and Norman Advanced Robotics (all of the Norman, OK public school district). Jeremy is a mentor at both Whittier and Alcott, and is a former Norman Advanced student, so these seemed like natural choices.

Whittier Middle School is a seasoned Botball team with a long-time lead mentor, which focuses

on heavy recruitment and developing robots consistent with the KISS Principle. Alcott Middle School was in the process of rebuilding their Botball program, with a new lead mentor, and mostly new students. Norman Advanced Robotics is an experienced high school team with a focus on trying new things (in terms of both hardware and software) for educational benefit. Each team has won either a regional or international championship (though not for at least 3 years), but they had different styles, and therefore different interests in the Botball Live technology.

3 Strategy Lessons

Many Botball Live matches can be utilized to illustrate key strategic tips. The mentor or experienced student leader would typically show a sequence of matches to the students, to form a narrative as desired. Both Whittier and Alcott used this technique.

3.1 Sample Narrative: Los Altos Community Team

One example of a strategic narrative from GCER 2011 is that of Team 11-0453 Los Altos Community Team. Los Altos had an interesting method of interfering with their DE opponents' blocks. Showing students DE Match 104 (Los Altos VS Team 11-0501 teamaustria) [5] is a good way of introducing students to this strategy, particularly the fact that even though Los Altos's robot did not work perfectly, it was still effective. An example of a near-perfect run (and more effective, complete with collision) can be found in DE Match 112 (Los Altos VS Team 11-0148 Whittier Middle School Boys) [7].

Students can then be asked to imagine a way to defend against this strategy. After some discussion, DE Match 46 (Los Altos VS Team 11-0185 Rolla Regional Robotics) [3] can be shown. In this match, Rolla not only successfully prevents the attack on their blocks, but is able to manipulate Los Altos's robot into attacking its own block stacks. The point can be made that a simple blocking Create (which probably didn't take Rolla more than a couple days to program) was able to completely outthink a mechanically complex robot (which probably took Los Altos quite a bit of programming and testing time). This point can lead to discussion of the KISS Principle, as well as the need to be generally careful and attentive when it comes to strategy.

3.2 Sample Narrative: Norman Advanced Robotics

Another narrative can be found in Team 11-0113 Norman Advanced Robotics. Norman had a highly effective (100% success rate at GCER, as verifiable by inspecting the Botball Live archives) method of interfering with the opponent's first block stack, which can be demonstrated to students in DE Match 111 (Norman VS Team 11-0162 Explorer Post 1010) [6]. In the last few days before DE began, Norman modified one of their robots to attack the opponent's second block stack in addition. Not much testing was conducted on this modification, with the result that it caused a loss when the robot accidentally hit its own E-Stop button while extending an

arm past the CBC's touch-screen, as seen in DE Match 85 (Norman VS Team 11-0163 SIUE East St. Louis Charter High School) [4].

Students can at this point be reminded that Norman already had a 100% effective way to attack the first block stack, and a single two-block stack is worth zero points in Botball 2011 scoring, making the last-minute modification serve no practical purpose. Norman could easily have done far better at DE (or even won) had they not gotten greedy at the last minute. Teams who have a "feature freeze policy," under which no new features can be added close to tournament day, may wish to use this narrative to explain to new students why the feature freeze policy should be respected.

It is notable that some of the details of this particular narrative are only obtainable by talking with the team involved (Norman in this case). Many teams are willing to share these details after the tournament, so we don't consider this an issue. The situation is far better than it would be with no video. In addition, as videos are collected over time, most teams will have an example of a strategic narrative which includes their own team (which is in many cases better, since the message may have more value to the students if it involves their own team).

4 Reverse-Engineering

Reverse-engineering is an extremely valuable skill in engineering and technical fields. Botball Live provides ample footage of robots which provides reverse-engineering challenges of various types.
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4.1 Reproducing a Strategy

Teams who wish to gain experience in building or programming robots may choose an interesting strategy from a Botball Live video and attempt to reproduce that strategy from scratch. The choice of which strategy to reproduce can be made based on the team's building and programming skill level as well as the "cool factor" of certain strategies.

As an example, Team 11-0313 The Peddie School had an elaborate conveyor belt for ping-pong balls, as seen in DE Match 34 (Peddie VS Team 11-0164 Wahiawa Middle School) [2]. Attempting to reproduce this design would be a good challenge for experienced builders who want to try something new.

We haven't yet had a chance to try this technique.

4.2 Beating a Strategy

Teams who are interested in improving their strategic skills may choose a generally effective strategy from a Botball Live video and attempt to develop a strategy that will beat it. As with reproducing a strategy, the choice of which strategy to attempt to beat can be made based on skill

levels and a "cool factor," but with the notable difference that judging the skill level necessary to beat a particular strategy can be tricky.

As an example, Norman's block interference strategy (see Sec. 3.2) is an excellent candidate to try to beat, for two reasons. First, it was 100% effective in tournament rounds, so the ability to beat such a strategy would possibly yield improved tournament performance. Second, the strategy was only effective because teams generally used hardcoded locations for the blocks; the ability to determine on-the-fly where the blocks are located (via camera, rangefinder, or a mechanical method) is a useful skill to have in one's programming repertoire. Having the skill set (and foresight) to beat this strategy will most likely enhance future tournament performance.

We haven't yet had a chance to try this technique.

4.3 Adapting a Strategy

Many subsystems of robots can be reused in different situations. Reverse-engineering these subsystems and adapting them to new applications can be highly useful. It is very common for teams to look at their own previous robots for design inspiration; Botball Live enables teams to look at the whole world's previous robots for that inspiration.

As an example, Norman's secondary block interference mechanism (the one which attacked the second block stack; see Sec. 3.2) is probably reusable in other situations where physically driving near a target is undesirable due to collision risk (the concept was previously used by Cedar Brook Academy in 2007, winning them the International Championship). Teams who are able to utilize the experience of other teams will often have increased performance, both in scoring and reliability.

Norman is currently using this technique.

5 Strategy Evaluation

Botball Live can give teams practice at strategy evaluation. This can lead to better strategic decisions in tournament settings.

5.1 Practice at Scoring

Being able to roughly score a match by eye is a critical skill in Botball. It can tell you how you'll stack up against opponents after you watch one of their matches, and it can tell you if a judge has made an error in scoring your match. Teams can view a match, watching which scoring objects are scored, and guess on a score. After the guesses are tallied, the actual score can be viewed. Team members may consider having contests amongst themselves to correctly

score a Botball Live match. Difficulty of this task can be adjusted by allowing or disallowing team members from rewinding the match, or by imposing a time limit (e.g. the team members must tally the score within 15 seconds of the match ending). Difficulty can also be adjusted by the choice of match and team; a failed run (e.g. Explorer Post 1010 in DE Match 111 [6]) is often much harder to score than a successful run (e.g. Norman in DE Match 111 [6]).

This technique was loosely based on a suggestion from Barbara Rice of Alcott, but we haven't yet had a chance to try this technique.

5.2 Predicting Performance of a Strategy

Teams can be shown a video of a strategy, and be asked to predict how well the strategy will perform in different situations. These predictions can then be scored against the other videos of the same team's strategy in the same tournament, as well as the rankings in Seeding and D.E. One lesson that will likely be learned here is that predicting performance of any strategy in D.E. is much harder than predicting performance of a Seeding strategy, and that there is in fact a large amount of chaos in any Botball match (e.g. Norman's robot hitting its own E-Stop button; see Sec. 3.2) — 100% accurate predictions are near-impossible!

This technique was loosely based on a suggestion from Barbara Rice of Alcott, but we haven't yet had a chance to try this technique.

5.3 Evaluating Your Own Strategy

Teams can decide on a strategy as a group, and then watch videos of actual matches to decide whether their strategy would have fared well. This may lead to more concrete perceived implications for the team members, since they will have a stake in the strategy succeeding. In the event that the strategy doesn't fare well, discussion of what could have been done better is a logical next step.

We haven't yet had a chance to try this technique.

6 Recruiting

Whittier and Alcott have both used Botball Live recordings to impress potential students and improve recruiting. Whittier performed very well at GCER 2011, and used videos of their own matches to maximum benefit. Alcott was not present at GCER 2011, and thus used videos of other teams (most notably Norman, into which Alcott students feed).

7 Team Experience Level

We haven't thoroughly investigated this question, but we believe that teams with more existing experience will gain more from the reverse-engineering aspects of Botball Live, while teams with less existing experience will gain more from the strategic aspects. We would be interested to see some data on this point.

8 Impact of Video Quality

A question that has been raised is whether the quality of the videos has a significant effect on the videos' educational value, and if so, what the effect is. We don't really know what the answer is, but we have a few observations. Very low quality makes it hard to tell what is going on, particularly regarding scoring. Extremely high quality would likely make reverse-engineering simpler (students could copy designs more accurately with less work), which probably is detrimental to the educational value. Strategies which have been captured in more Botball Live videos are possibly easier to reverse-engineer (many matches at GCER 2011 were lost due to technical issues with Ustream, Twitter, and YAC's software), although there are only so many camera angles that will show up.

In practice, the quality of Botball Live videos will likely increase in the future, as YAC obtains better equipment. We think we will soon have the technical ability to do 720p video recordings, although we don't know when this will be ready for public consumption (almost certainly not in the 2012 season). Teams who specifically want low-quality videos have an easy fix if this happens: lower the quality in YouTube.

One other issue which is unambiguously annoying is the dead space surrounding the matches, which is not cut out of the videos. This is because at GCER 2011, the timestamps used to cut the videos were based on when we entered the team names at a table and when the scores were entered. We already have a better system in place for 2012, which uses the game lighting CBC's for near exact precision, meaning that the dead space issue will plague us no more.

9 Comments from Our Partner Teams

Whittier Middle School, Alcott Middle School, and Norman Advanced Robotics all sent us feedback about the use of the Botball Live videos. A selection is below.

"I think the team being able to see the videos helps them with every aspect of the game, e.g. planning and getting building ideas. It helps the kids tremendously seeing what other teams are doing; extremely useful, and the kids get excited."
-George Beaver, Whittier Middle School Mentor

"The students (the majority of whom were new to Botball), the volunteers, and sponsor all gained valuable knowledge and a deeper understanding of the program. It was particularly helpful to watch videos of the sample matches while having Jeremy there so we could ask questions."
-Gena Stejskal, Alcott Middle School Mentor

"We actually made an entire robot to test with based on videos posted online. Having videos of every match allows us to not only analyze the competition, but to inspire us with new ideas of how to build and program robots."
-Marty Rand, Norman Advanced Robotics Student

"We were able to use videos of our team to show potential sponsors some of our successes."
-Daniel Goree, Norman Advanced Robotics Student

10 Team Tracker Development

This research was conducted mainly by manually looking through 100+ matches, both on video and via a spreadsheet of the Botball Live metadata. We don't expect all teams to have this patience, so we are working on a way to make this data much more accessible. This is the Team Tracker. When the Team Tracker is made public on the Botball Community site (we're aiming for an initial release at GCER 2012, but we're not sure if we'll meet that deadline), it will allow anyone to search for matches based on metadata such as teams involved, scores, ranking, consistency, whether a team is a middle school or a high school, and whether a team is a rookie team or an experienced team. We hope that this will enable much more efficient usage of the Botball Live videos for educational purposes. (Note that this work is ongoing, and the GCER 2012 release, if it happens, will probably not have all of these features.)

11 Conclusion

We're hoping for some good discussion at GCER of these ideas and how they could be improved. If you're interested in using the Botball Live technology for your team, please let us know what you're trying and how it goes! Jeremy can be found at the Botball Community [8].

This research was facilitated by Charlie Bevers and George Beaver (mentors at Whittier Middle School), Barbara Rice and Gena Stejskal (mentors at Alcott Middle School), and Marty Rand and Daniel Goree (students at Norman Advanced Robotics). The Team Tracker is based on the ideas of Jake Hall (former mentor at Grandville Middle School and former Youth Advisory Council member). The research also would not have been possible without the other members of the Botball Live team: Abdullah Sahyouni and Elena Nadolinski of Z=MC^2, Stuart Brothers of Lockheed Martin Explorer Post 1010, Ronnie Ghose of Thomas Jefferson High School for Science and Technology , Wesley Myers of Cedarhouse Robotics, Peter Demirdjian, Kevin Quigley, and Austin Gillis of Malden Catholic High School, Andrew Mehta of Palm Desert High School, Nathan Bernard of Haverhill Robotics, Tj Brown of Southwest Covenant School, Rody Farrow of G-Mont87, and Vasiliy Pobedinski of St. John's School. And of course, Botball Live wouldn't exist without Steve Goodgame, Jamie Boiles, Matthew Oelke, Elizabeth Whitewolf, Logan Cox, Ivan Joe, and the other KIPR staff who have taken time out of their busy work schedules to facilitate the Botball Youth Advisory Council. Thanks to everyone who helped!

12 References

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