AAAI Hosts the National Botball Tournament!

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■ Botball is a national program in which teams of middle and high school students design, build, and program small autonomous mobile robots to compete in a highly charged interactive (but non-destructive) tournament. Botball students learn to program in c, construct feedback and control loops, create electromechanical systems, and integrate it all together while they work on a team. Botball takes place in regional tournaments across the country and culminates in a National Botball Tournament traditionally hosted by the American Association for Artificial Intelligence at its annual conference. This program puts reusable equipment into schools and, at the Botball Teacher Workshops, trains teachers in robotics and the integration of robotics into their curriculum. Botball appeals to a wide variety of students and brings out the best in each, challenging them to solve real-world problems in a dynamic environment at their own level.

Ninety-four robots, working in teams of two, participated in this year's National Botball Tournament, sponsored by the American Association for Artificial Intelligence (AAAI) and held at the Seventeenth International Joint Conference on Artificial Intelligence. The robots, programmed in a multitasking dialect of c, exhibited standard AI behaviors such as target tracking, multiagent cooperation, and adversarial planning, all in an unpredictable dynamic environment. There were two unusual things about this group of robots, seldom seen at a professional conference: (1) all the robots worked and (2) none of the designers-programmers were old enough to vote.

Presented by the KISS Institute for Practical Robotics, a nonprofit educational organization, the Botball program uses the activities of robot building and programming to engage students in understanding the practical applications of science, engineering, and math. More and more middle and high school students are venturing into the complex world of AI as they program their robots to accomplish complex navigation and manipulation tasks.

Botball is a program for middle and high school age students. Teams register online in the fall at www.Botball.org, and the program takes place in regional Botball events across the country throughout the spring. Each regional program kicks off with a professional development workshop for teachers to give them an introduction to robotics, allow them hands-on experience with the Botball kit, and offer methods of using robotics to support curriculum in a variety of subject areas.

Each team receives a robot kit at the teachers' workshop. The 2001 kit contained two microprocessors (a handyboard and an RCX brick); a variety of customized sensors and motors, including servos, pneumatics, and LEGO construction materials; software; documentation; and other goodies. The processors are programmed in an interactive, multitasking version of c that allows the students to execute code fragments, as well as programs, encouraging students to dive right into programming and helping them to learn on the fly.

After receiving their kit, students have about six weeks to design and build two robots to play this year's game. Botball emphasizes a learn-by-doing approach, and robots are to be created completely by students. Adults can serve as mentors, but students do all the work. In addition to working on their robot, students also create their entry for the web site compe-

Figure 1. Participants Get Ready for a Botball Game.

Game begins when the lights go on; robots must start, stop, and steer without remote controls.

Robots have 90 seconds to score points by positioning their colored balls and tubes on the game board (1 point) or in the goal (2 points).

Goal points are doubled when the goal is moved onto a team's side.

Goal points are also doubled if a robot climbs into the goal.

If both goal conditions are met, the goal points are quadrupled.

Additional points are scored for placing an object on a post.

Scoring is determined by ball position at the end of the round.

*Figure 2. 2001 National
Botball Tournament Rules.*

tition at this time, designing a web site that displays their solution to a robotics-related challenge.

In the Botball 2001 game, robots scored points by positioning colored balls or tubes onto the game board or in the goal (figure 2). Bonus points were awarded if the team placed a ball or tube on a post. Teams had the opportunity to double or quadruple their points by moving the goal to their side or moving their robot into the goal. Such a challenge allows students to be creative in their solutions. Some robots follow search patterns or perform simple line following or obstacle-avoidance routines. Other teams use two robots to track targets using mechanical and computational solutions.

Whatever their approach, middle and high school students are solving real-world problems in a dynamic environment. Michael

Coblenz, a student from Thomas Jefferson High School for Science and Technology in Virginia, who is now a freshman at Carnegie Mellon University, described it this way: "Botball extends the hardware design to another level: software design. The resulting systems allow more advanced teams to use their skills more completely. For example, my team studied problems in software optimization, computer vision, sensor usage (including the difficulties imposed by noise and solutions thereto), control techniques, artificial intelligence (including autonomy), and other issues."

Each regional Botball tournament takes place about six weeks after the kickoff. Students bring their robots to the tournament (along with friends and family) to showcase their work in a highly charged, double-elimination tournament. Although it is not intended to be destructive, there is often lively interaction between opponents' robots. Fortunately, robots have a chance to show off their special talents in the seeding rounds, where they get to run unopposed just prior to the start of the double-elimination phase. Seeding round scores are figured into the formula for determining which robot is the overall winner of the tournament. Awards are given at the end of each tournament, including trophies for the best web sites, seeding rounds, double elimination, and overall performance.

Of all the Botball tournaments, clearly the grandest of all is the National Botball Tournament hosted by AAAI. AAAI gives travel grants to top teams from each regional; however, all teams are invited to participate in the national tournament. This year, 47 teams from 10 states traveled to Seattle to participate in two days of competition and to experience the AAAI Mobile Robot Exhibition. A full list of teams participating in the National Botball Tournament at AAAI appears in figure 3. The overall winner of the National Botball Tournament was team 2 from Foothill High School in San Jose, California (figure 4). The Double-Elimination Winner was Episcopal High School from Bellaire, Texas, and the seeding rounds were won by team 1 from Thomas Jefferson High School for Science and Mathematics in Alexandria, Virginia.

"The past decade has seen a revolution in robotics as AI techniques integrate with traditional control to achieve greater heights of autonomy in robotic function," says Jim Hendler, professor of computer science and director of the semantic web and agent technologies at the Maryland Information and Network Dynamics Lab at University of Maryland at College Park. "Botball teaches high school

Andrew P. Hill High School Team 1, *San Jose, California*
Andrew P. Hill High School Team 2, *San Jose, California*
Broad Run High School, *Ashburn, Virginia*
Cary Middle School Team 1, *Dallas, Texas*
Cary Middle School Team 2, *Dallas, Texas*
Episcopal High School of Houston, *Bellaire, Texas*
Episcopal High School of Jacksonville, *Jacksonville, Florida*
F.H. Peterson Academies of Technology, *Jacksonville, Florida*
Fletcher High School, *Neptune Beach, Florida*
Foothill High School Team 1, *San Jose, California*
Foothill High School Team 2, *San Jose, California*
Foothill High School Team 3, *San Jose, California*
Gabrielino High School, *San Gabriel, California*
Glen Burnie High School, *Glen Burnie, Maryland*
Gunderson High School, *San Jose, California*
Hampton High School, *Allison Park, Pennsylvania*
Hillsdale High School, *San Mateo, California*
Holy Trinity Episcopal Middle School, *Bowie, Maryland*
Independence High School, *San Jose, California*
Jordan High School, *Los Angeles, California*
MAST Academy, *San Diego, California*
Middlesex School, *Concord, Massachusetts*
Norman High School, *Norman, Oklahoma*
Norman Homeschool, *Norman, Oklahoma*
Oliver Springs High School Team 1, *Oliver Springs, Tennessee*
Oliver Springs High School Team 2, *Oliver Springs, Tennessee*
Rose-Hulman Explore Engineering, *Terre Haute, Indiana*
Sallisaw High School Team 1, *Sallisaw, Oklahoma*
Sallisaw High School Team 2, *Sallisaw, Oklahoma*
Schiller Classical Academy, *Pittsburgh, Pennsylvania*
South Vermillion, *Clinton, Indiana*
Tennyson High School Team 1, *Hayward, California*
Thomas Edison High School Team 1, *Alexandria, Virginia*
Thomas Edison High School Team 2, *Alexandria, Virginia*
Thomas Edison High School Team 3, *Alexandria, Virginia*
Thomas Jefferson High School Team 1, *Alexandria, Virginia*
Thomas Jefferson High School Team 2, *Alexandria, Virginia*
Thomas Jefferson High School Team 3, *Alexandria, Virginia*
Tilden Middle School Team 1, *Rockville, Maryland*
Tilden Middle School Team 3, *Rockville, Maryland*
U.S. Grant High School, *Oklahoma City, Oklahoma*
W.C. Overfelt High School Team 1, *San Jose, California*
W.C. Overfelt High School Team 2, *San Jose, California*
Wakefield High School, *Arlington, Virginia*
Wellesley High School Team 1, *Wellesley, Massachusetts*
Wellesley High School Team 2, *Wellesley, Massachusetts*
Woodrow Wilson Middle School, *Terre Haute, Indiana*

Figure 2. 2001 National Botball Tournament Participants.

students this new approach to robotics and prepares these motivated teens to become the AI students and researchers of tomorrow."

Already there is some crossover between Botball and the AAAI Mobile Robot Exhibition. In

Figure 5. Participants Work on Their Robots during the 2001 Botball Game.

First Place
Foothill High School Team 2
San Jose, California

Second Place
Episcopal High School of
Houston
Bellaire, Texas

Third Place
Wellesley High School Team 2
Wellesley, Massachusetts

*Figure 4. Top Finishers at the 2001
National Botball Tournament.*

addition to participating in Botball for a second year in a row, Mark Sherman, a high school student from California, exhibited a robot he built. "I wanted to participate in the exhibition because I saw what people did the year before and liked it. I don't like just watching, I want to do," says Sherman. "Participating gave me an opportunity to present my ideas to others." Sherman and his fellow Botball participants are the future of robotics and AI. With these bright students leading the charge, we have much to look forward to.[1]

Botball is presented nationwide by the KISS Institute for Practical Robotics, a private, nonprofit, community-based organization that works with all ages to provide improved learning and skills development through the application of technology, particularly robotics. In 2001, 181 participated in regional Botball tournaments.

What is KISS? It's a philosophy: Keep It Simple, Stupid. KISS Institute believes that high tech does not have to be overly complicated or intimidating. We want today's students to appreciate and enjoy being on the creative side of technology, so they are inspired to stay in the field, creating improved and innovative technology for us.

Note

1. For more information about Botball, please see www.Botball.org.

Cathryne Stein is the president and chief executive officer of KISS Institute for Practical Robotics, a national, nonprofit educational organization. Stein is also a cofounder of the organization. Under her direction, KISS Institute has developed several educational programs, including KISS Institute's Botball and Robots in Residence Programs, through which several thousand students have participated in some form of robotics activity. She enjoys teaching robotics to young students and has a particular interest in the factors surrounding girls and technology. Her e-mail address is cstein@kipr.org.

Darcy Schein has served as program manager for Botball at the KISS Institute for Practical Robotics for the past two years. She brings a background in communications and human relations to the organization along with six years' experience in nonprofit work. Her role is to oversee the operation and growth of Botball in the United States.

David Miller is the technical director of KISS Insitute for Practical Robotics as well as the Wilkonson Chair Professor for Intelligent Systems in the Mechanical Engineering Department at the University of Oklahoma. He received his Ph.D. in computer science from Yale University in 1985 and since this time has taught computer science at Virginia Polytechnic Insitute and State University, helped to develop Mars rover technology at the Jet Propulsion Laboratory, and helped found IS Robotics as well as the KISS Institute for Practical Robotics. He has worked with dozens of robots and thousands of students, teaching courses for kindergartners through Ph.D.s.