Then and NOW

ROBOT COMPETITIONS AND CONTESTS

by Tom Carroll

As long as there have been two people gathered together who have different ideas and skill sets, there have been competitions of some sort. The recent Summer Olympics was an extreme example of the world's finest who gathered together in China to prove who the best athlete in many categories was. Old records fell as younger or more experienced athletes swam or ran faster than ever before, jumped higher or further, or performed some series of athletic motions with more finesse than the others. An American swimmer walked away with a record eight gold medals.

We humans love to present our finest to the world in hopes that our country's competitors are better than anyone else. Robotics is no different as we are all proud of our coolest, fastest, meanest, smartest, or most destructive robot of all and want to show it to the world in some sort of competition.

In this year's April issue of *SERVO*, I touched upon some of the more popular contests such as the Seattle Robotics Society's Robothon, the Portland Robotics PDXBot robot competition (both of which have been postponed due to the need of leadership), the Robotics Society of Southern California's annual robot fairs, and a few of the national events. As I was more concerned with the exhibits by different groups, I really did not cover the complexities of these events and the many more held around the world.

I also had a few responses from readers mentioning that I did not cover their event or other events that were particularly noteworthy. I spoke with a few personally, and related that I can never cover the wide spectrum of any topic in modern robotics technology and I just try to cover a few unique aspects of a particular article's subject. This certainly applies to the many robot exhibitions and competitions as there are so many types of contests and competitions these days. In this article, I again will highlight a few of the more well known robotics contests in a bit more detail, but, this in no way represents the very best competitions. They just happen to be a few of the contests I know a bit more about.

Competition can be as simple as one neighbor watching another build a robot. That neighbor then decides that he can build an even better one, and so on. It can also arise in a school or university where two or more students build a robot that can "one up" another group of student's machine. Sometimes a competitive urge develops when a person watches a contest on TV or reads about one.

Some of the best competitions arise when sponsors decide to develop a contest with a specific set of rules and award prizes to the best in the contest. These can be a simple science fair at a local high school, a nation-wide series of contests such as FIRST, or even a government sponsored contest such as the DARPA off-road Grand Challenge or Urban Challenge with a first prize of $2 million.

Contestants benefit as do the sponsors who can use the winning technology to further enhance military or other government projects at a far cheaper cost than handing out research grants. I'm going to outline a few of the more widely-spread types of contests and, as I mentioned before, these are just a drop in the bucket of the many very interesting competitions around the world involving experimental, amateur, and downright unique robots.

The Seattle Robotics Society Robo-Magellan Contest

The varieties of entrants in robotics contests can vary from simple kit-built wheeled robots exhibited by elementary level kids in a local event to the million dollar autonomous cars and SUVs entered into the Grand Challenge series held in multi-mile desert and suburban environments.

I had the honor of being one of the judges for the Seattle Robotics Society's Robo-Magellan contest for several years, held at the SRS Robothon at Seattle Center. This contest was envisioned as an affordable alternative to these government sponsored contests and has spread to many robotics groups across the country. Entries are nothing short of amazing.

The robots that I've seen over the years range from a few pounds to maybe 30 or more, and sizes range from a small, remote-controlled car chassis to 18 inches long and 14

inches high, or so. They must weigh less than 50 pounds and fit within a four foot cube for the duration of the race. Some crawl away from the starting point at a speed slower than a stroll in the park and others race away at breakneck speeds. I've seen contestants running behind their speeding Robo-Magellan robot, barely able to keep up, with the safety tether in their hand ready for an emergency stop.

FIGURE 1. Robo-Magellan contestant.

Figure 1 (courtesy of SRS) shows a contestant holding the safety tether in the October 2006 competition. Wireless safety switches are admissible, but most contestants use a wired tether. In the early years, we had a bit of trouble with the GPS satellites being shadowed from the robots by a high wall or even the Space Needle, but this made the contest a bit more challenging when the competitors transferred navigation to odometry and compass navigation.

Newer and more sensitive receivers solved a lot of the GPS reception problems in later years. I never saw an entry that wasn't first class, though some did manage to get lost or stuck behind obstacles.

As stated in the rules set up by the SRS, "Robo-Magellan is a robotics competition emphasizing autonomous navigation and obstacle avoidance over varied, outdoor terrain. Robots have three opportunities to navigate from a starting point to an ending point and are scored on the time required to complete the course with opportunities to lower the score based on contacting intermediate points."

The 'chicken switch' tether I mentioned previously is allowed to disable the robot when it is deemed unable to continue or will run into a person or obstacle, but all control is autonomous and navigation is by GPS coordinates (no differential GPS to enhance the accuracy), visual cameras (to avoid obstacles and locate the 18" orange traffic cones), and on-board compasses.

The contest is held outdoors (for best GPS reception) and is usually on sidewalks, grass, and has some unique ramps and turns. The contests at the Seattle Center have always attracted a crowd of people who excitedly follow the robots around the course. Sometimes a person with an orange jacket or hat will confuse the robot so that it deviates from the course because it thinks it has seen the orange cone.

It's always fun to explain to the crowd just how intelligent the robots are and why they do certain things on the course, (which can be longer than 1,000 feet). Scoring is based on time, but points are also given for locating and touching all waypoint cones, so slower robots have frequently bested the speedier machines. Contestants are given the course coordinates just before the contest and are allowed to traverse the course themselves before their robot makes its run (a maximum of 15 minutes is allowed for each run). Other groups have used desert courses, woods, and strictly urban courses with only concrete and asphalt. To make the course more interesting, overhead trees, inclines, curbs, garbage cans, park benches, shrubs, and even streams have been included. Target cones are hidden from view at the starting points and at the waypoints. Go to **www.robothon.org/robothon/robo-magellan** for more detailed rules and information.

IEEE Micromouse Competitions

Running a maze with a robot has always been a draw and people have built robots to solve simple mazes since before the microcomputer age. In 1977, *IEEE Spectrum* magazine announced a 'micromouse' contest that would be held in New York in 1979. That gave time for the 6,000 initial entrants to design, build, and fine-tune their creations. Fifteen finalists were selected for the competition to be run in a 10' by 10' maze. The winner of this first contest was a simple, high-speed wall-follower that used no sort of 'intelligence' to seek its goal. These types of mice simply turn a certain direction when detectors locate the absence of a wall and continue turning in that same direction for the same reason, many times until they eventually (accidentally!) reach the goal. Rules were changed to eliminate these types of entries.

As the contest series gained popularity in the early 80s and groups around the world became interested in participating, the rules became more defined. 'Mice' appeared in all sorts of forms. David Buckley of the UK came up with Quester in 1981 — a large 8" by 7-1/2" by 5-1/2' micromouse that used a vision system to detect the maze walls and bump sensors when those sensors failed. (See Figure 2).

Buckley gained a bit of fame when Quester was featured in one of the earliest non-industrial robot magazines, *Robotics Age*. The First World Micromouse Competition was held in Tsukuba, Japan in 1985 and the top six winners were all locals. After a few sporadic contests in the US with low attendance and few

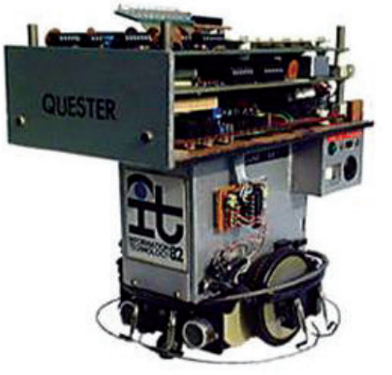

FIGURE 2. Quester from the UK.

entrants, the contest became quite popular and is now often held in conjunction with electronic business conferences, especially where IEEE attends.

What is a Micromouse?

A mouse must be self-contained and totally autonomous, no larger than 25 cm by 25 cm (about 10" x 10") and there is no limit on the height. It cannot, however, move over or damage the maze walls. The maze itself consists of a square pattern of 16 by 16 squares (18 by 18 cm each), with 5 cm high walls of 1.2 cm thickness. The entire maze is enclosed by an outside wall and the mouse is placed at an outside square and must find its way all by itself to four squares at the center of the maze.

This destination is so positioned that wall-hugging mice will be unable to locate it. Of course, the maze is set up ahead of time and hidden from view until just before the contest begins. The mouse has 10 minutes to complete the run from the start to the center four squares where there is a wooden goal post. Obviously, the fastest mouse wins. Figure 3 shows the maze at a contest at Cal State Chico. Note the detector protrusions over the walls in both Figures 3 and 4.

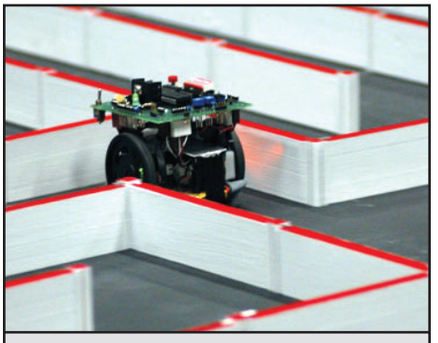

FIGURE 3. Micromouse maze at Cal State Chico contest.

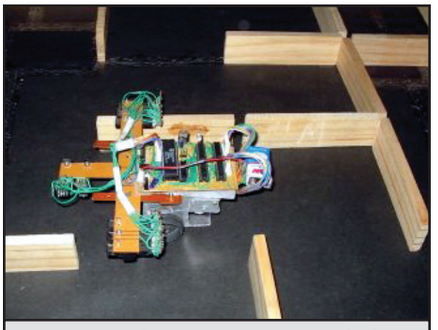

FIGURE 4. Micromouse maze variations.

One entry at a contest that I had the pleasure of judging back in 1988 at Wescon featured a very unique mouse. It could not have weighed more than 100 grams and had a pair of sensor arms made from PC board material that extended over the walls on both sides of the maze paths. I'm guessing that the arms had a series of IR photo transistors and IR LED pairs to detect the presence or absence of walls, and to keep the robot centered in the path. This little sucker would zip forward and stop at each 18 cm square, examine the walls present, and would then proceed or quickly turn a precise 90 degrees as required, and quickly step to the next square. It rapidly examined almost every possible square and found the center fairly fast.

The amazing thing was when the contestant placed the mouse back in the square, the mouse quickly sped to the center four squares by the absolute best route, sometimes making deliberate 45 degree turns to save time. Needless to say, it won first place.For rules, check out **www.ieee.uc.edu/main/files/sac2007/mm_rules.pdf.** There are many other good sites that have both rules and building techniques available.

FIRST — For Inspiration and Recognition of Science and Technology

I could not write about robot contests without mentioning the very popular FIRST competition that began back in 1992 with 28 teams competing in a New Hampshire high school gym. This competition series is the vision of one of my favorite robotic innovators, Dean Kamen, best known as the inventor of the Segway Transporter. FIRST competitions are for high school students across the US and other countries. NASA and other major US companies have been long-time supporters of these events.

One example of a challenge was one year teams competed against each other by controlling their individual robots to push and pass large rubber 'Trackballs' around the field of play. (Two of the five winning high school teams were sponsored by NASA centers.)

The mission and vision of the FIRST Robotics Competitions, FRC, is described this way, by Kamen:

"Our mission is to inspire young people to be science and technology leaders, by engaging them in exciting mentor-based programs that build science, engineering, and technology skills, that inspire innovation, and that foster well-rounded life capabilities including self-confidence, communication, and leadership."

BEST — Boosting Engineering, Science, and Technology

BEST is also a non-profit, volunteer-based organization whose mission is to inspire middle and high school age students to pursue careers in engineering, science, and technology through participation in a sports-like, science and engineering-based robotics competition.

Their vision is to excite the nation's students about engineering, science, and technology to unlock their imagination and discover their potential.

Final Results

I've only touched on a few of the more visible robotics contests. The many variations of BattleBots that was so popular a half dozen years ago on the Comedy Channel are still held across the world. Robot Sumo and other physical robot vs. robot contests are a mainstay of most robot organization's events. If any of these competitions sound the least bit interesting to you, I encourage you to go to any of the hundreds of websites for information and help your own group of robotics enthusiasts develop some super fun events in your home town. **SV**

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