
Windows Embedded Robot Challenge

Competition Rules

November 2, 2007, Version 0.1

Objective

Each competitor will be supplied with a robot kit, Windows Embedded CE development tools, and the Microsoft Robotic Studio. In order to win the competition, the robot must be programmed by each competitor to solve a complex line maze, using Windows Embedded CE and the Microsoft Robotic Studio. The competition is divided into three Stages with progressively more complex mazes. One half of the total number of competitors in each round will advance to the next stage according to the fastest average recorded time.

The remainder of this document provides details on the construction of the maze, how the competition will be administered, and a description of the robot hardware provided for this competition.

Terminology

This section contains terms used throughout this document to describe certain aspects of the competition.

Table 1: List of Terms Used to Describe the Competition

Term	Definition
Match	A robot's attempt to solve a maze
Match Time	The duration of time when the robot moves from the Starting Tee to the Finishing Circle, plus any penalties.
Match Distance	The distance measured for a robot unable to reach the Finish Circle within the specified time limit. This distance is calculated by measuring the shortest distance between the Finishing Circle and the path traveled by the robot while exploring the maze.
Stage	A competition which is conducted using a particular maze
Starting Tee	The configuration of a line marking the beginning of the maze
Finishing Circle	The solid white circle which marks the end of the maze
Signs	The image which describes the best direction to turn to continue toward the Finishing Circle
Arena	The area reserved for the material upon which the maze is drawn
Stinger Pen	The designated holding area where all robots must be located prior to the beginning of each new Stage

The Maze

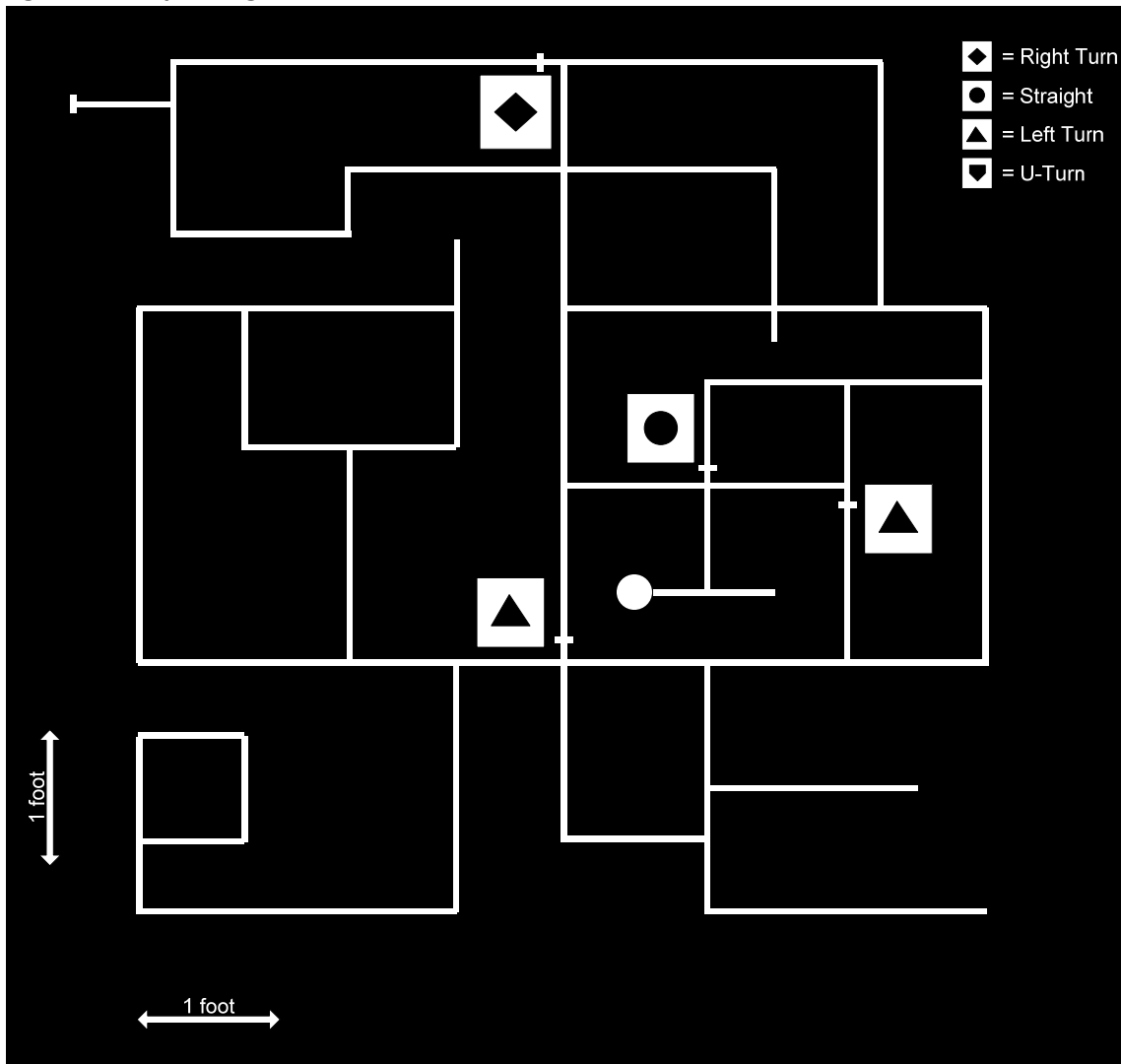
Each maze will consist of a series of intersecting white lines on a black background. At various points throughout the maze Signs will be posted in the form of specified shapes printed in black on a white background. These signs may be used by the competitors to determine the best direction to turn (left, right, forward, or u-turn) to continue toward the end of the maze.

The mazes used in the competition will be constructed using the following guidelines:

- All lines will be one half inch wide, white lines on a black arena, no larger than 8 feet by 8 feet
- No line will be closer than 6 inches from the edge of the arena
- All lines will intersect at right angles
- The end of the maze will be marked by a solid white circle 3 inches in diameter, known as the “Finishing Circle”
- The beginning of the maze is marked by a 1.5 inch wide tee, known as the “Starting Tee”
- The location of a sign is indicated by a 1.5 inch line crossing 2 inches before the location of an intersection in the maze.
- All parallel lines will be no less than 3 inches apart
- All intersections will be a minimum of 2 inches apart.
- Dead ends will be indicated by a line which simply terminates
- Overall maze complexity is measured by the number of intersections and end points it contains. A maze with more intersections and end points is, therefore, considered more complex, than one with fewer intersections and end points.

An example maze of the complexity that will be used in Stage 2, appears below. Additional sample mazes appear in the Competition Handbook.

Figure 1: Sample Stage 2 Maze



It is important to note that the mazes in all stages will contain white lines that connect to form enclosed areas. Robots which attempt to solve the maze by applying the typical right-hand or left-hand rule are likely to get caught traversing the same enclosed area over and over again.

Every effort will be made to construct the maze to be flat and level, but it is possible that irregularities in the surface of the maze will appear at adjoining sections. It is also possible that lines will not be perfectly straight and intersections not occur at precise right angles. Each competitor must test their robot in such an environment to be certain that their maze solving algorithm can accommodate these irregularities.

Competition Stages

The competition will consist of 3 distinct stages, each with progressively more complex mazes. Stage 1 of the competition will begin with the total number of registered competitors. One half (rounded down to the nearest whole number) of the competitors in Stage 1 with the highest average Match Time will

advance to Stage 2. Half of the competitors in Stage 2 with the highest average Match Time, will advance to Stage 3. The top three average Match Times in Stage 3 will win the competition with first, second, and third place awards.

The maze for each Stage will be concealed until the beginning of the Stage has been declared by the Competition Judges. Prior to the beginning of a particular Stage, all robots must be placed in the designated location in the competition area, called the “Stinger Pen”. When the Stage begins, each competitor will have the opportunity to examine the maze for defects (smudges, surface irregularities, etc.). Any issues a competitor has with the maze, must be brought to the attention of the judges at this time.

When a Stage is in progress, no contact with the robots will be permitted until it is called to the maze arena to begin a Match. No modifications of any type, including changes in software or maze solving strategy, will be permitted while a Stage is in progress. The use of external interfaces such as a switch, sensor, or actuator for any other reason than to start the robot at the beginning of a Stage, is not permitted. *After a competitor has completed all of their Matches for a particular Stage, they may perform any desired software modifications or robot maintenance (limited to fixing faulty robot hardware). This will allow a competitor to improve their maze solving algorithm with each successive Stage.*

Competition Matches

Robots which qualify to participate in a given Stage, will be called by their registered name in alphabetical order when the Stage has begun. The competitor must then carry their robot from the Stinger Pen to the maze Arena, and place some portion of the robot body over the Starting Tee. The competitor must then start the robot and allow it to attempt to autonomously solve the maze. The robot will be allowed two consecutive Matches in the currently active Stage.

Each robot will be given no more than three minutes to find its way from the Starting Tee to the Finishing Circle. Timing for a Match begins when the robot starts moving, and ends when any part of the robot touches the Finishing Circle. The robot may continue to explore the maze after touching the Finish Circle, but it must cease to move prior to the three minute time limit. If a robot which has touched the Finishing Circle continues to move after the three minute time limit, it will be given a 30 second penalty. Each match will receive a score equal to the time required to touch the Finishing Circle, plus any penalties. This score is called the “Match Time”.

At the three minute point in the Match, if a robot has failed to reach the Finishing Circle, it will be stopped manually, and the shortest distance measured from the Finishing Circle to the point along the patch traveled by the robot, will be measured. This distance is called the Match Distance and will be recorded instead of a Match Time (described above). The Match Distance will be used to rate the performance of the robot if it is unable to score a Match Time. The Match Distance will then be used at the end of the Stage to rate the performance of the robot if the total number of robots that have scored a Match Time is insufficient to advance to the next Stage.

The robot must not leave the maze while a match is in progress. A robot is considered to have left the maze when no part of its body is over the line it is currently traveling along. If the robot does leave the maze, the Match will be manually terminated and no score will be recorded for the Match.

When both Matches have been concluded (either manually, or because the robot has solved the maze) the score will be calculated by averaging the Match Times, from those Matches for which a Match Time was recorded. The Match Distances will be averaged for those matches where a Match Distance was recorded.

The winners of Stage 1 and Stage 2 are calculated by selecting half the competitors with the lowest average Match Time score. The lowest average Match Distance score is used to select any additional competitors if the number of Match Time scores is less than half of the number of competitors for the particular Stage. The next Stage will begin with those competitors who qualify even if their total number is less than half that of the previous Stage.

Robot Hardware

All hardware required to build the robot for this competition will be provided. The robot hardware may not be altered or removed in any way, and must be constructed as specified in the documentation provided with the robot (or made available [online](#)). No additional sensors or structural modifications to the robot are permitted. The robot must leave no trails or markings on the maze, and must be completely autonomous and self contained.

The robot provided for this competition is comprised of the following:

- [Stinger CE Robot Kit with Line Following Sensor](#)
- Batteries [TBD: battery type]
- Web Cam [TBD: web cam type, either Microsoft LifeCam NX-6000 or Logitech QuickCam Pro 5000, supported by this [driver](#)]

The [eBox 2300](#) provided in the robot kit, is a Single Board Computer (SBC) which acts as the robot's primary controller. The eBox communicates with a low level controller called the [Serializer](#) (also included in the kit) via an RS-232 cable. The eBox 2300 will act as the host for a Windows Embedded CE 6.0 image which must be created by the competitor using Visual Studio 5.0. See the Robot Software section for more information on the software provided with the kit and how it must be used in the competition.

Robot Software

The robot's SBC must run a custom Windows Embedded CE 6.0 OS image, created by the competitor. The custom CE 6.0 OS image must include the .NET Compact Framework and the Microsoft Robotics Studio (MSRS) runtime version 1.5. The maze solving algorithm must be developed by the competitor and must be written as an MSRS application.

Prior to attending the competition all competitors must provide their Windows Embedded CE 6.0 build.log file. The deadline for uploading the build.log file along with the URL will be provided later, after the robot kits have been shipped to the competitors.

Various MSRS sample services have been developed specifically for this competition including a sample line following algorithm, and a Sign recognition algorithm. Information on these services, and on additional references for MSRS 1.5 and Windows Embedded CE 6.0, are listed in the Competition Handbook. The Competition Handbook also contains information on one possible strategy for maze solving that can be implemented using the sample MSRS services provided.

[TBD: This Competition Guidebook document will contain a How-To for getting started with the kit, in terms of where to locate any additional references. It will also contain details on how to use each of the sample MSRS services provided and at least one additional sample Stage 3-level maze (more complex than the one provided in this document).]

Competition Administration

Additional information on this competition can be found at this website:

[TBD: Website for posting competition announcements, registration, and venue information.]

Please review the Competition Guidebook for a list of forum sites that may be used to submit questions on the various development tools supplied in the robot kit.

The competition will be run with two mazes operating simultaneously for each of the three Stages. The entire competition will last from 3 to 4 hours. Please refer to the competition website listed above for deadlines and information on the competition venue.

End of Windows Embedded Robot Challenge Competition Rules