

2010 Advanced Robotics and Mechatronics Competition Official Rules

January 11, 2010

1 Introduction

The Advanced Robotics and Mechatronics (ARM) competition challenged teams of students and researchers to construct microscopic robots that would compete against each other in a series of agility drills. These robots measured a few tens of micrometers to one millimeter in their largest dimension and have masses ranging from a few nanograms to a few hundred micrograms. They are operated under an optical microscope and controlled by off-board electronics using visual feedback. To win the competition, a robots must be fast, agile, and capable of manipulating objects in the micro-world.

2 Components

2.1 Robots

Each player must fit within a bounding box measuring $1000 \times 500 \times 500 \mu\text{m}$ and must be capable of operation on the playing field without the presence of any physically connected wires or tethers.

2.2 Software

IRIS will provide a basic framework which allows for scalable functionality based on plugins. Existing plugins already include camera handling, file input and output, recording, and the like.

All teams are expected to write their own plugins for tracking and servoing starting from some basic plugin template containers. Other plugin templates illustrate the inner workings of data capture and display.

3 Tasks

The contest will consist of four exercises:

- The 1-Centimeter Dash
- The Slalom Drill
- The Sphere-Handling Drill

The first priority of the competition is to complete as many tasks as possible. In the event that the teams complete the same number of tasks, the team with the fastest dash times (in the most different mediums). The scoring process is not as complicated as it might seem at first. It is intended to encourage the completion of all tasks and to make the contest as realistic and as fair as possible. We are sorry if it reminds you of the federal tax code.

3.1 The 1-Centimeter Dash

In the 1-Centimeter Dash, each microrobot must sprint across the arena from a starting line to a goal. The micro-robot must begin with its entire structure behind the starting line, and it completes the dash when the first point on its structure crosses the goal line. Each team will be allowed 3 trials in any of the following materials (a minimum of 2 different materials must be selected): water, silicon oil, viscoelastic gel.

3.2 The Slalom Drill

In the Slalom Drill, the microrobot must move to all the points in a cube with a side length of 1.5 cm. Each team will be allowed three trials in different mediums (similar to the dash). A robot will be considered to be at a point when it is within 250 μm of the target point as provided by the control software.

3.3 The Sphere-Handling Drill

The Sphere-Handling Drill requires the micro-robot to push as many balls as possible into a 500 μm goal within a 3-minute time period. The team is allowed to select 1 preferred medium for all 3 trials. The micro-robot must begin the drill with its entire structure inside the 1000 μm starting area. A goal is scored when the entire ball is within the goal. The balls will consist of glass spheres approximately 200 μm in diameter. Each team will run two trials of the ball handling drill. A team receives 1 point towards the overall competition for each goal scored (2 for automated operation).

4 Competition

The teams will be randomly assigned numbers to determine the order in which they will compete in the contest. The competition will be divided into two separate time intervals. During the first interval, all single agent tasks will be performed. In the second time interval, the multi-agent tasks will be performed. Each team will be allowed 30 minutes setup time before each interval. All trials for each event must be then performed in the subsequent 20 minutes.

4.1 Initialization

Since the focus of this competition is upon the motion aspects of the micro-robots, competitors will be allowed limited possibilities for initializing the system. In events that require spheres, the judges will randomly position the balls on the field between trials.

4.1.1 Scoring procedure

Each successful (i.e. completed) slalom run or goal scored is counted as one point in the case of manually controlled tasks and two points in the case of automated tasks. The points are simply summed per tasks and then over all tasks. The winning team will be the one with the most points. In the event of a tie, the team with the fastest dash time (in the most different mediums) will win. Please see accompanying spreadsheet for a detailed scoring description.

4.2 Timing

Due to the potential speed of the individual events, teams are required to equip their control algorithms with a timing system. The source code for this will be reviewed by the contest judges before the competition. Along with this timer, an independent stop watch will be used to determine the time of each trial. If a discrepancy exists between the two, the resolution of this event will be left to the judges discretion. Timing will begin when the robot starts moving. In case of the robot sticking in place, each group will be allowed two “false starts” which are up to the judges discretion. In the event of a “false start,” the teams are allowed to repeat that trial.

5 Miscellaneous

All other items not directly addressed in this document are left to the judges’ discretion.