

## MEMS in Action: RoboCup Nanogram 2009

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From June 29 through July 5, 2009 teams from around the world participated in the International RoboCup competition, held in Graz, Austria. In addition to humanoid robots playing soccer on turf fields, “companion” robots demonstrating their ability to help around the house, and rescue robots traversing complex terrain looking for simulated disaster victims, there were MEMS-scale robots competing on fields the size of a grain of rice.

Instead of sitting in stands cheering, the spectators were watching TV monitors as the robots performed under the eye of a microscope. These robots are actually untethered MEMS devices. The researcher wanting to fabricate a functioning microrobot faces, in a single package, all of the technical challenges faced in the production of functional MEMS devices including power distribution, friction, and communication.

This nanogram demonstration was organized by the National Institute of Standards and Technology (NIST). NIST provided a number of universities from around the world with starter kits that included standard operating environments and IC interfaces for microrobot operation.

The microrobots were asked to meet a series of progressively more difficult challenges. Root mean square scoring of multiple event trials focused this year’s competition on *microrobot reliability*. The first challenge was the two-millimeter dash. Figure 1 is a series of images of the ETH robot performing the two-millimeter dash.

The second challenge was the slalom drill. The microrobot was tasked with traveling across the playing field with a number of obstacles placed in its path.

The final challenge was the ball-handling drill. The microrobot was given a playing field with a number of obstacles and a number of balls and tasked with placing as many balls in the goal as possible in a two-minute period.

Through the “Nanogram” microrobotics events, thousands of participants and visitors to RoboCup 2009 were exposed to the capabilities of MEMS devices, many of them for the first time. In addition to the competitions, visitors viewed continuously running demonstrations and video. Figure 2 shows some future MEMS engineers looking at robots at the ETH table.

Highlighting the challenge faced by the competitors, four of the teams, who were expected to participate in RoboCup 2009, dropped out at the last minute, citing

inability to successfully perform the specified tasks or cost associated with traveling to Austria.

The two remaining teams performed well, with year-over-year advances showing progress in key technical areas: the ETH Zurich team overcame previous limitations on their robots' reliability when starting up from a dead stop, and the team from the U.S. Naval Academy (USNA) demonstrated continuous operation for over 5 minutes. Figure 3 shows images of the USNA robot in action. In addition, a new world record was set for the two-millimeter dash at 326 milliseconds.

Although both teams did not fully share the technical successes, the RoboCup nanogram achieved the goal of introducing the spectators and many of the other participants to the challenges and capabilities of MEMS devices. In addition to the RoboCup attendees, this event was relayed to the wider MEMS community by one of the authors of this article (Allen) through the MEMS Industry Group blog ([MEMSblog.wordpress.com](http://MEMSblog.wordpress.com)).

NIST is now deciding how to continue its microrobotics outreach in 2010. All of this year's teams, including those that did not attend, have expressed intentions to participate next year. In addition, NIST has received, from about 10 other universities, expressions of interest in participating in future microrobotics competitions.