Micromouse Webinar
An overview to design and build a Micromouse
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A Micromouse is a small robot vehicle that is able to navigate its way through an unknown maze. It is autonomous, battery-operated and self-contained, encompassing computer technology, robotics and artificial intelligence. The main challenge for the Micromouse designers is to import the Micromouse with an adaptive intelligence which enables exploration of different maze configurations, and to work out the optimum route with the shortest run time from start to destination and back. In addition, the Micromouse must reliably negotiate the maze at a very high speed without crashing into the maze walls.

The annual IEEE Region 1 Student Conference hosts the Micromouse Competition. The objective of the competition is to build a Micromouse that can negotiate a specified maze in the shortest time. This on-line webinar will introduce the design and development of the hardware and software of a Micromouse. The take away will be the fundamental knowledge with best practices and design strategies to build a Micromouse, and be really for the 2016 Region 1 Micromouse Competition.
Introduction
- What is Micromouse?
- Video – An International Micromouse Competition
- Soon’s and others Micromice
- Maze and Micromouse Specifications

Micromouse Design Overview
- Performance
- Hardware Design (Sensor, Motor Drive, Micro-Controller, Power Supply)
- Software Design (Maze Solver Algorithm, Search Algorithm, Movement)

Micromouse Competition
- IEEE Region 1 Student Conference
- APEC (Applied Power Electronics Conference)

Micromouse Simulation Tool

Questions and Sharing Design Ideas
Introduction
What is Micromouse?

- A small microprocessor-controlled mobile robot which is capable to navigate its way in an unknown maze.
- Micromouse is autonomous, battery-operated and self-contained, encompassing computer technology, robotics and artificial intelligence.
- Main challenge is to import the Micromouse with an adaptive intelligence that enables exploration of different maze configurations. Then, to work out the optimum route with the shortest run time from start to destination and back.
- Micromouse must reliably negotiate the maze at a very high speed without crashing into the walls of that maze.
Soon’s Micromouse

- Built when at High School
- Name: ZAP
- 1991 International Micromouse Competition Champion at Hong Kong
Soon’s Micromouse

- Built when in 1996
- Name: Pinocchio
Soon’s Micromouse

- Built when at Vicor Corporation
- Name: VI-Mouse
- Most reliable micromouse at APEC 2001 International Micromouse Competition
IEEE Spectrum first introduced the amazing micromouse in 1977

The amazing micromouse: see how they won

The major difference between the Express and the Special was in their forward speeds: the Express had stepping motors with four times the torque used on the Special. Top motor speeds of 2.07 cm/s for the Express vs 0.52 cm/s for the Special were made possible. In addition the motor drive circuitry for the Express was strengthened so handle the increased load of the new motors, and the Special’s gear train was entirely eliminated.

Some of the hardware used on the Special—for example, interconnection logic—was eliminated by the use of IC devices that were exclusively from the Z-800 family of components. The Express was based on the Z-800 microprocessor, as was the Special. This represented only a slight modification of the earlier electronic circuitry in the Special (Fig. 2). A distinguishing feature of the Special was that it looked like a real mouse. Everything else—the optical-sensor arrangement, battery supply, and the high-level software—was the same in the Express as in the Special.

The micromouse contest involved a long course taken by the mouse. Both mice passed through the maze on their first run, employing paths and mapping nodes (or three-way crossing) into their memories. Both solved the maze as much of their second and third tries, resolving the shortest possible maze course, from entrance to exit.

Doing it with logic

Not all micromouse at the finals contained microprocessors. Dudley and Mushka, two Canadian entrants, managed to solve the maze with simple logic (Fig. 3). Both had been built from the same basic design, and each solved the maze in as little as 252 and 247 s, respectively. Dudley was entered by David Schettini of N.C. Watters, Ontario, and Roger Sanderson of the University of Waterloo, Mushka, which won the runners-up prize, was entered by Bob McPherson of Hamilton, Ontario, and John Diller of the Athabasca University, Alberta.

The original design for Dudley and Mushka (Fig. 4) utilized a 1-bit microprocessor, a Model Z800 microchip with 8 k b of memory, a peripheral interface adapter, and three infrared transducers. The mice were no device could provide the mouse with leaving the maze to the parameters of the micromouse machine, which was a modified version of the Moonlight Special, a machine that had demonstrated its learning process at previous time trials of the course as well as at finals.

Roger Allan
Associate Editor
New Generation Micromice
Current Generation Micromice
Maze and Micromouse Specification
Maze Specifications

- Maze comprises 16 x 16 of 18cm x 18cm unit squares
- Walls are 5cm high and 1.2cm thick
- Side walls is white color, and the top shall be red or white color
- Outside walls enclose the entire maze
- Maze floor shall be made of wood and finished with a non-gloss paint
- Start square is at one of the 4 corners of the maze
- Destination is at the central square space (4 squares)
- There must be at least one wall touching each pole
Maze Specifications (continue)

- 16 x 16 squares
- 18cm x 18cm unit square
- Maze Wall
  - 5cm High
  - 1.2cm Thick
Micromouse Specifications

- A self-contained mobile robot
- Not leave anything behind while negotiating in the maze
- No combustion energy sources
- Must not step over, climb over, scratch, or damage the walls during exploring in a maze.
- Dimensions shall not greater than 25cm in length or width. But, there is no height limit.
Micromouse Design
Micromouse Performance

Performance can be measured by
- Reliability
- Speed
- Intelligence

Speed conflicts with reliability
- High speed creates instability

Proper motion control
- Enable micromouse to run at higher speed without losing much on the reliability
Main Components

- **Hardware**
  - Micro-Controller
  - Motor Driver with Motor
  - Sensor
  - Battery Pack
  - Chassis, Wheels

- **Software**
  - IDE (Integrated Development Environment)
  - Acceleration Profile Generator
  - Simulator
  - Program Loader
Micromouse Sensors

- Type of Sensors
  - Infra-Red Emitter/Detector
  - Digital Compass
  - Accelerometer
  - Bumper Switch
  - Rotary Encoder (wheel position)
  - Rangefinder
  - Sonar
Micromouse Sensors

Way of Sensing Walls
- Top Down
- Side
Micromouse Sensors

- Way of Sensing Walls
Micromouse Movements

- **Basic Moves**
  - Forward
  - Right Turn
  - Left Turn
  - U-Turn
  - Slow down and Stop

- **Advance Moves**
  - Diagonal Run
  - V-Turn
  - J-Turn

- **Movements**
  - Exploring, Fast run
Sensors Position for Movement

Infra-Red Sensors
Micromouse Motors

- Type of Motors
  - Stepper Motor
  - DC Motor
  - Servo Motor
  - Brushless Motor

- Each micromouse should have at least 2 motors
Navigation Algorithm

- Micromouse must be able to keep track of its position.
- Micromouse also need to remember all the junctions. At dead end or old path encountered, the mouse shall select a junction that will lead to a new path.
- To make use of the exploring rules more effectively, a maze will be divided into several exploring sections. Each section uses different rule to explore.
- When reached the destination, the micromouse will decide whether to come back for a fast run or just continue exploring.
- A weight is used by the sorting program to determine whether the micromouse is more favorable to forward move or left and right turns.
Software (continue)

- **Maze Solving**
  - To search the shortest path from Start square to Goal for the fast run.

- **Main Control**
  - Micromouse to make decision on the next move in the maze.
  - Avoiding Crash

- **Motor Control**
  - Micromouse movements

- **Sensor Control**
  - Acquiring Walls information
  - Store data for maze sorting
  - Sensor sensitivity calibration
Available Micromouse Kits

http://www.rev-ed.co.uk/docs/KIT110.pdf
http://www.robotstorehk.com/micromouse/RS-AIRAT2.html
Micromouse Development Plan

Hardware

- CPU Board
  - Select Micro-Controller
  - Learn about the Micro-Controller
  - Design CPU circuit (PCB Layout)
  - Wiring and Soldering
  - Testing CPU

- Sensor Board
  - Select Sensors
  - Determine Sensors Location
  - Design Sensor Circuit (PCB Layout)
  - Wiring and Soldering
  - Testing Sensor Board
Micromouse Development Plan

Hardware
- Motor Driver Board
  - Select Motor
  - Design Motor Driver circuit (PCB Layout)
  - Wiring and Soldering
  - Testing Motor Drive Board
- Power Supply
  - Determine Power and Voltage requirements
  - Select Batteries
  - Testing Power Supply
- Chassis
  - Mounting Motors and all PCBs with interconnection
  - Wheel and Gears
Micromouse Development Plan

Software

- Familiar with Micro-Controller Language (C Language)
- Maze Solving Algorithm
- Shortest Path Algorithm
- Search Algorithm
- Motor Control Coding
- Sensor Control Coding
- Test and Debugging
Region 1 Student Conference 2016
Conference Highlights:
Undergraduate Student Paper Contest, Student Ethics Competition, T-Shirt Design Competition, Micromouse Competition, Workshops, Award Ceremony and Dinner, Networking Opportunity, Meet IEEE Leaders and Industry Professionals

To register:
https://meetings.vtools.ieee.org/m/37907
2015 Region 1 Student Conference - the highlights
Micromouse Competition

- The objective of the competition is to build a robot which can negotiate a specified maze in the shortest time.
- First Place: $800, Second Place: $500, Third Place: $200

Eligibility:

- The entrant must be an undergraduate student at a school in the Region at which there is an IEEE Student Branch at the time of entry at the Branch contest.
- A Student must complete and submit an application for membership in IEEE prior to entry in the contest.
2015 Region 1 Micromouse Competition - actions
2015 Region 1 Micromouse Competition - more actions
2015 Region 1 Micromouse Competition
- Micromouse
2015 Region 1 Micromouse Competition
- more Micromouse
2015 Region 1 Micromouse Competition - winners

1st Place
(Run time to Goal = 14.97 sec)

Mercury Micromouse

University of Massachusetts Amherst
- Justin Marple (Team Leader)
- Rohan Kapoor
- Aaron Lucia
2015 Region 1 Micromouse Competition - winners

2nd Place
(Run time to Goal = 48.76sec)

MegaMouse Micromouse

University of Buffalo
- Kyle Thompson (Team Leader)
- Mack Ward
- Joe Materski
- Jimmy Mazur
- Tomasz Pietruszka
2015 Region 1 Micromouse Competition - winners

3rd Place
(1st Closest to the Goal)

Chester Micromouse

University of Buffalo
- Mike Szymkowski (Team Leader)
- Matt Spitzer
- Maxim Solomonyuk
- Nazia Hasan
- Carly Schulz
- Kevin McMahon
2015 Region 1 Micromouse Competition - winners

4th Place
(2nd Closest to the Goal)

Minute Micromouse

Suffolk University
- Frank Calderon (Team Leader)
- Michael Wall
2015 Region 1 Micromouse Competition - winners

5th Place
(3rd Closest to the Goal)

Squeak Micromouse

Roger Williams University
- Ethan Daniels (Team Leader)
- Taylor Winnick, Nicole Marmo
- Nicholas Benoti, Kyle Lourens
- Kristi Perreault, Aidan Bradley
- Kelsey Cintorino
2015 Region 1 Micromouse Competition - special award

Funny Award

Monmouth University
- James Blessing (Team Leader)
- Abdul Muhsin Al-Kandari
- Nico Flora
- Alex Kristensen
- Veronica Granite
2015 Region 1 Micromouse Competition
- the judges

Alvin Joseph, Green Mountain Section
Bala Prasanna, Region 1 Treasurer $$$
Bob Pellegrino, Region 1 Southern Area Chair
Anthony Wan, Future IEEE Member
Dave Harame, Green Mountain Section
Rob Vice, Region 1 Young Professionals Coordinator
Thank you

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2015 Region 1 Student Conference
Micromouse Competition Chair
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2012 Region 1 Student Conference at Hartford CT
2012 Region 1 Micromouse Competition at Hartford CT

[Images of the first and second place Micromouse competitors]

http://www.youtube.com/watch?v=DuG-WF9yT5c
2012 Region 1 Micromouse Competition at Hartford CT
2011 Region 1 Micromouse Competition at Boston University
2011 Region 1 Micromouse Competition at Boston University
2011 Region 1 Micromouse Competition at Boston University
2006 Region 1 Micromouse Competition at University of Maine

1st: The College of New Jersey

2nd & 3rd: Suffolk University

4th: Fairleigh Dickinson University
Region 1 Micromouse Competition