

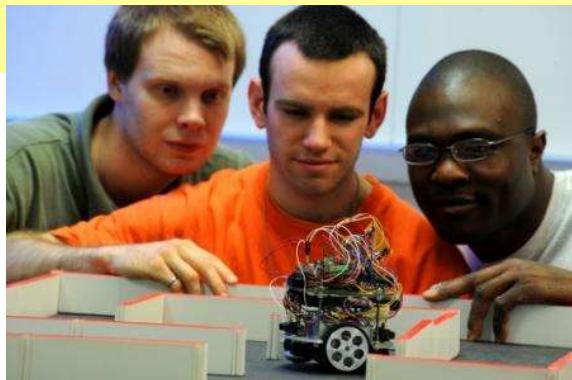


Introduction of Micromouse

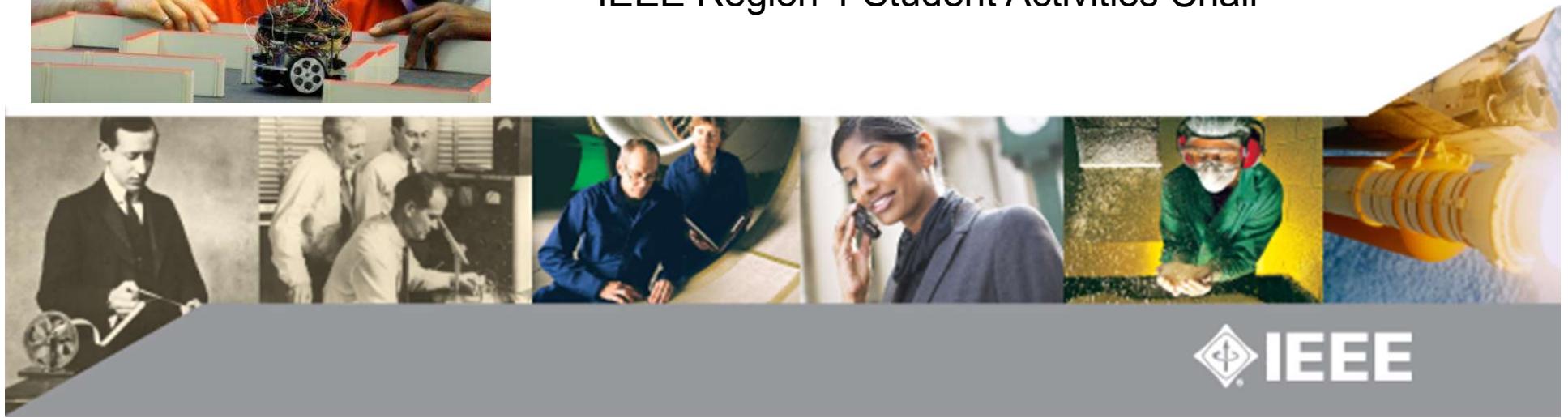
An overview to design and build a Micromouse

Zoom Session

January 25, 2023



Soon Wan
IEEE Region 1 Student Activities Chair



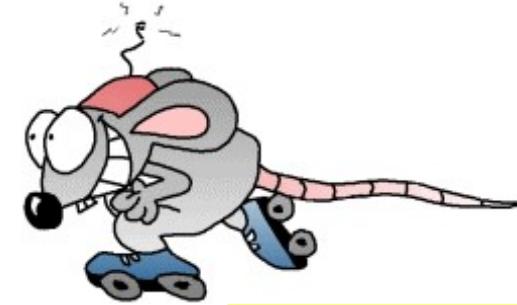
Abstract

- 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 Zoom Session 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 next 2023 Region 1 Micromouse Competition.

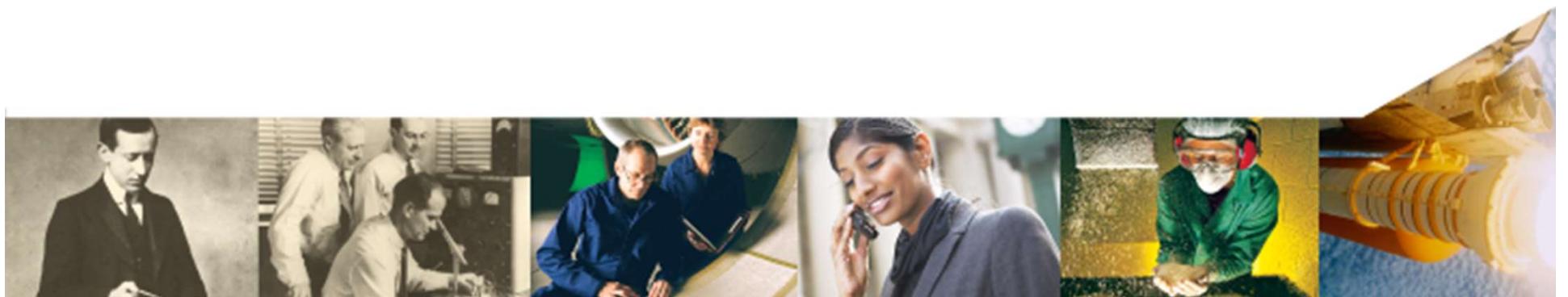


Presentation Outline:

- Introduction
 - What is Micromouse?
 - 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

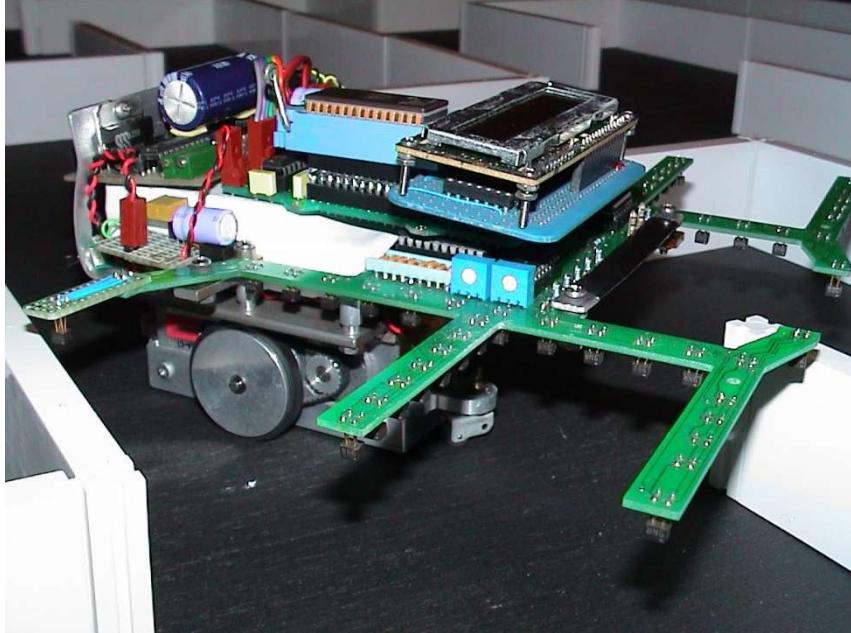
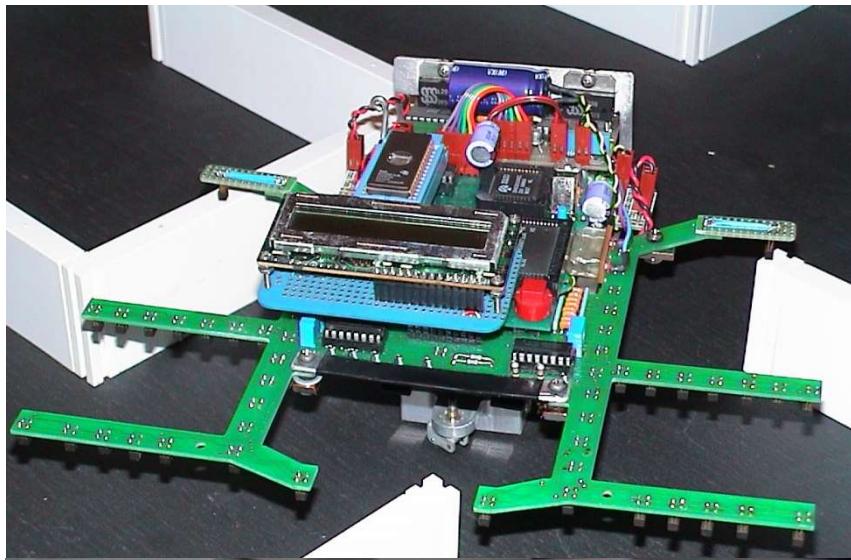


What is Micromouse?

- 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.



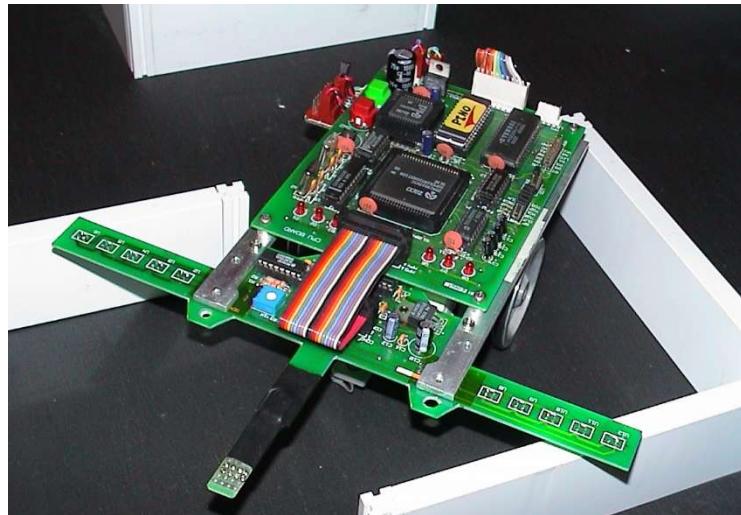
Soon's Micromouse



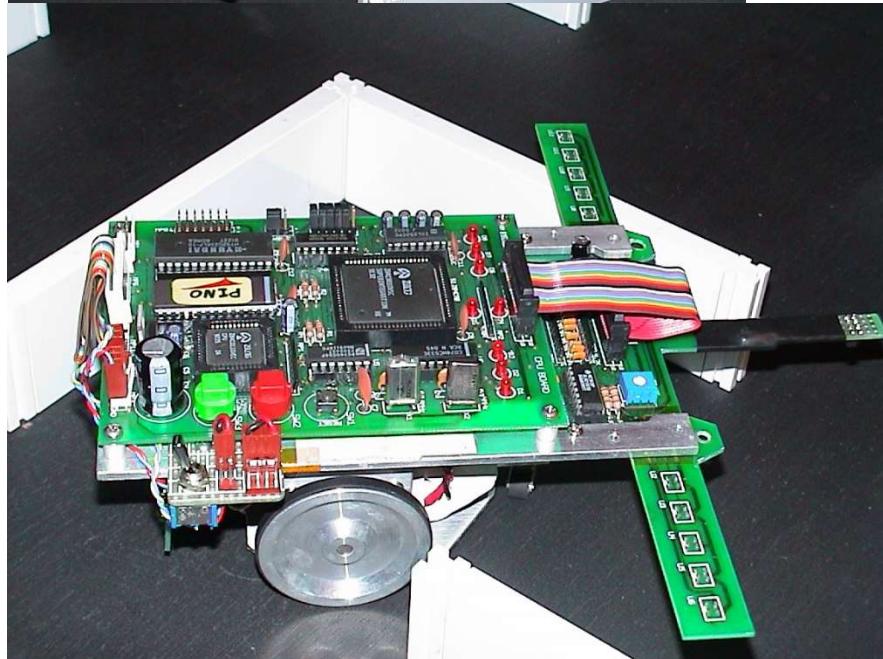
- Built when at High School
- Name: ZAP
- 1991 International
Micromouse Competition
Champion in Hong Kong



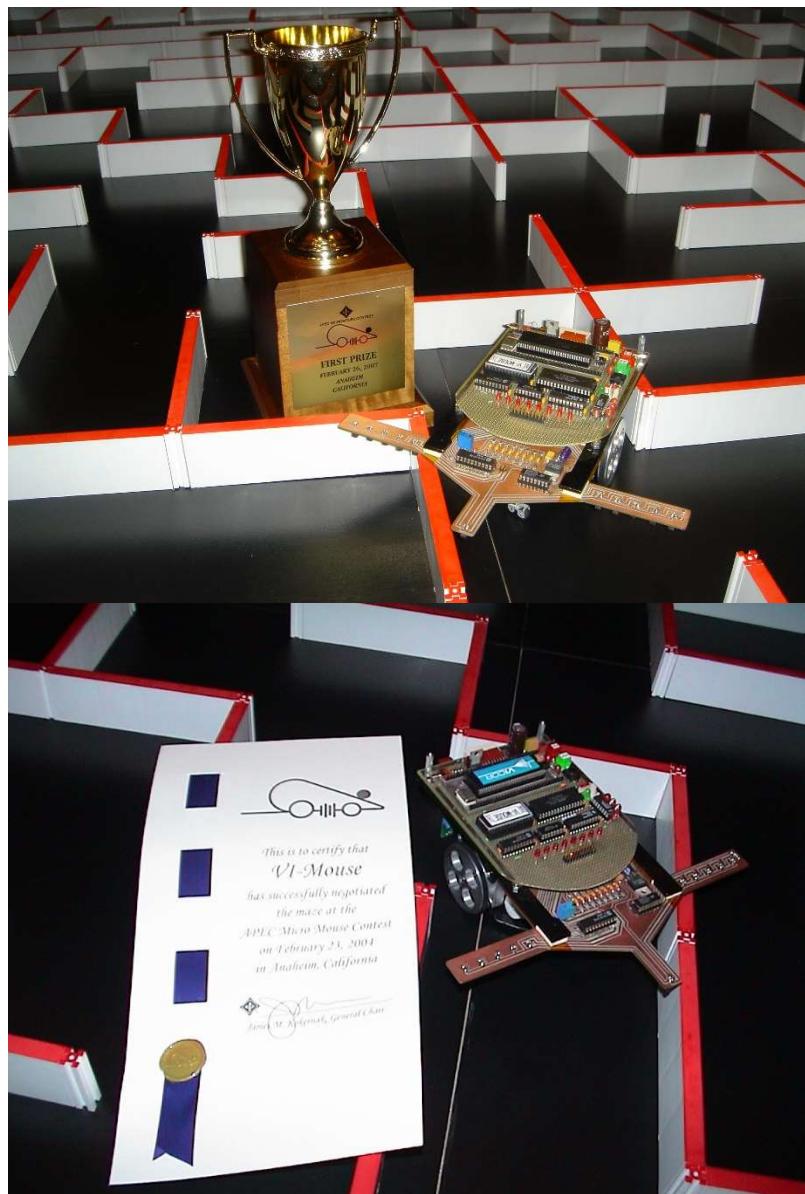
Soon's Micromouse



- Built when in 1996
- Name: Pinocchio
- 1996, 1997, 1998, 1999 IEEE Region 1 Micromouse Champion



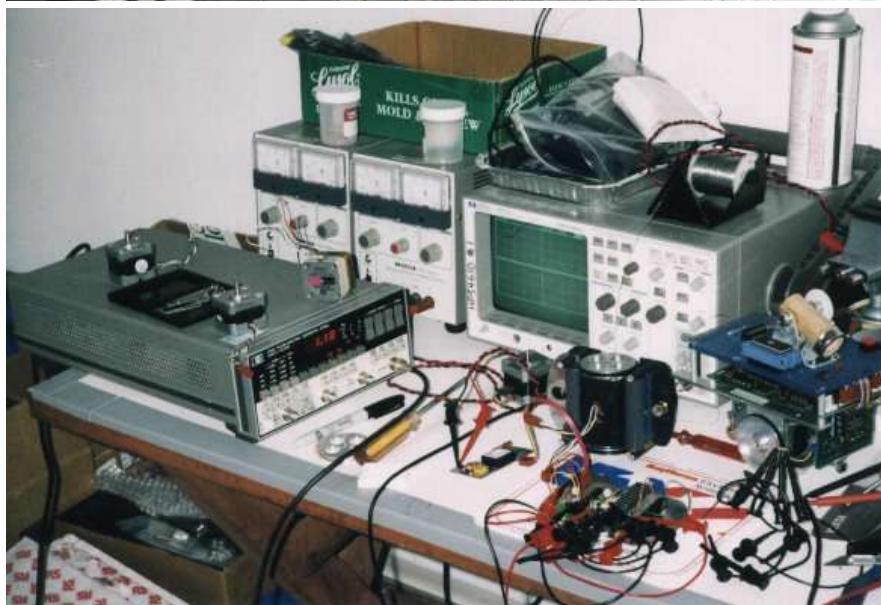
Soon's Micromouse



- Built when at Vicor Corporation
- Name: VI-Mouse
- Most reliable micromouse at APEC 2001 International Micromouse Competition

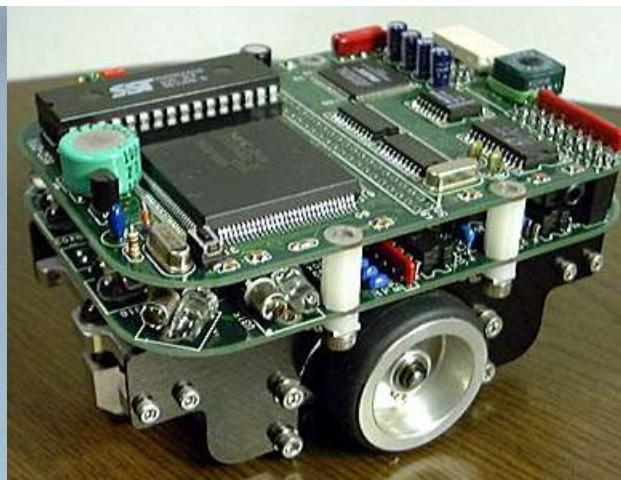
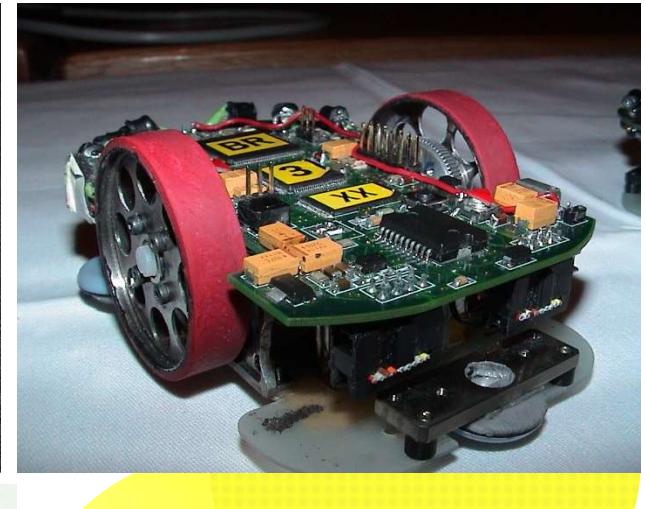
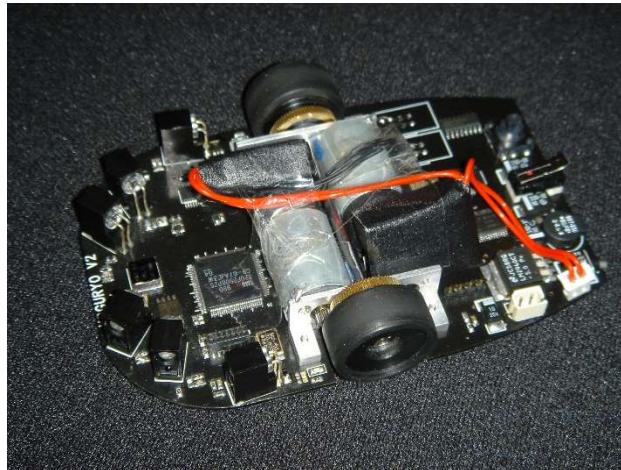
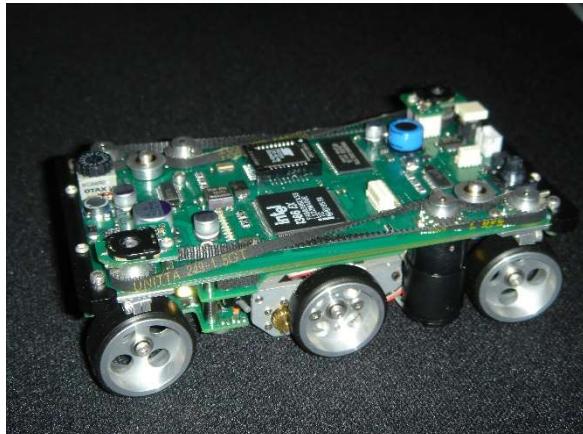


Soon's Micromouse Activities

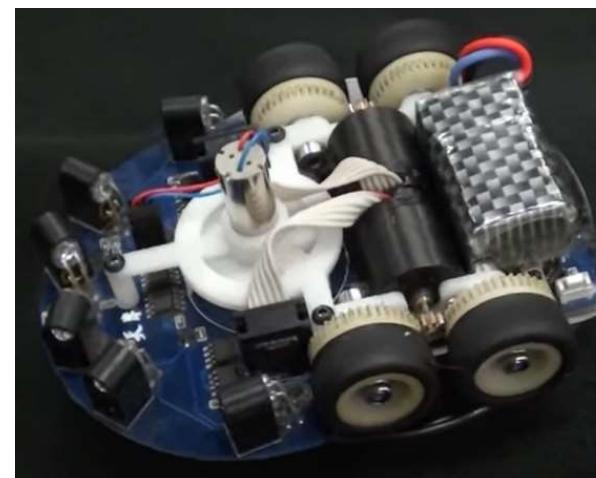
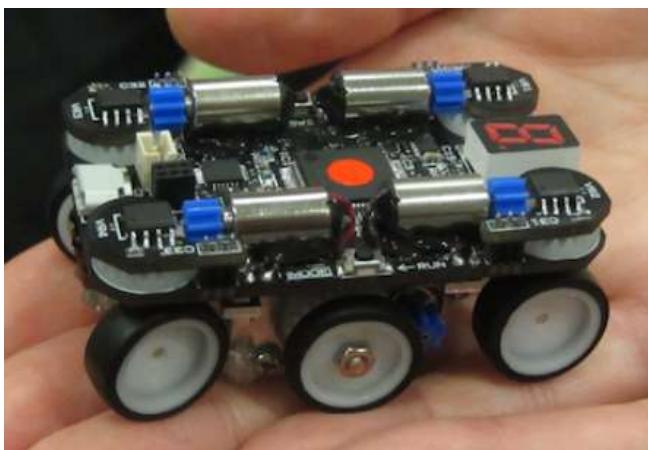
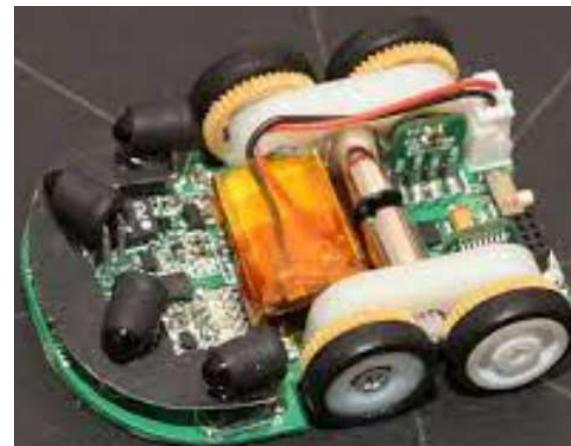
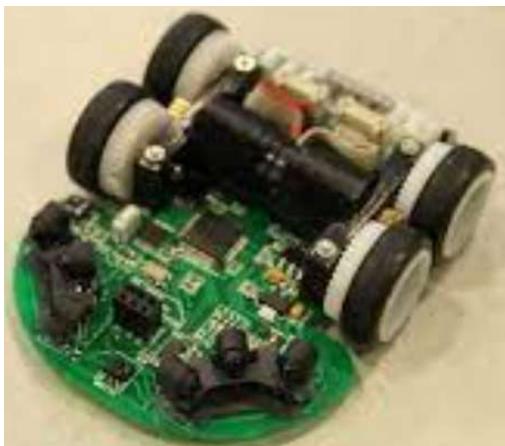


Micromouse Workshop

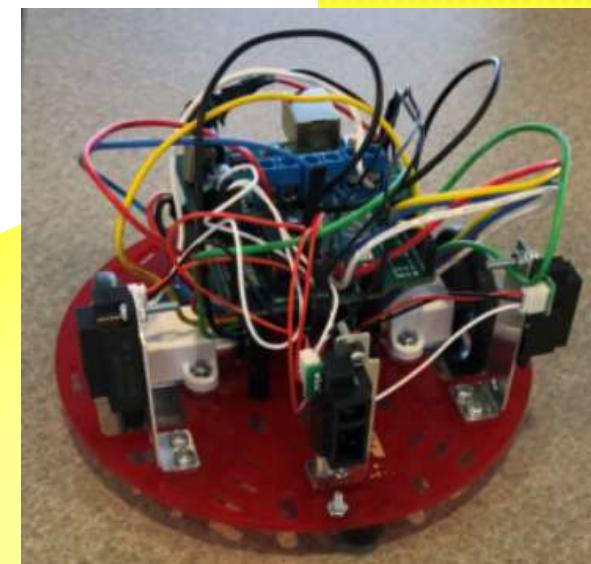
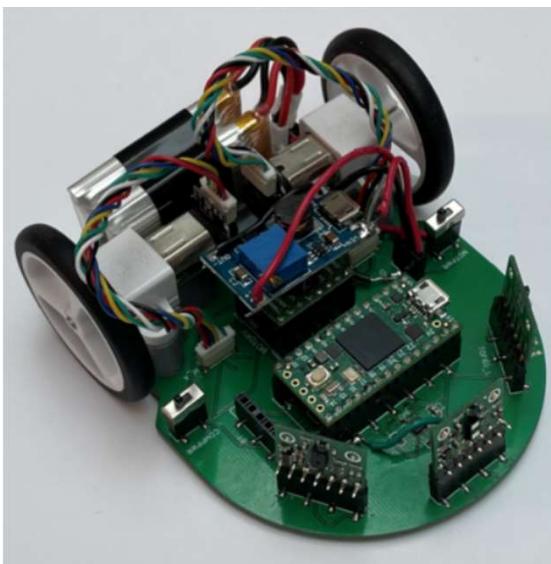
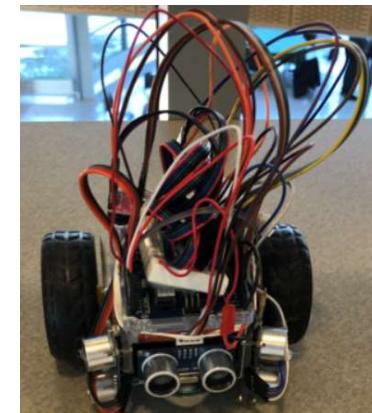
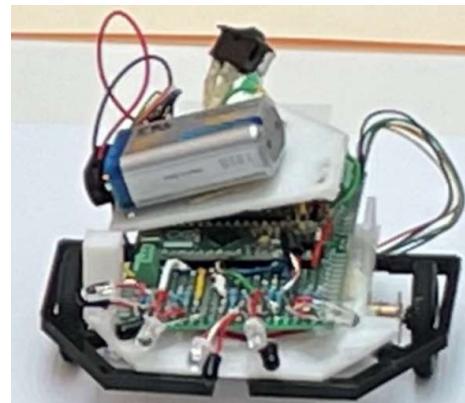
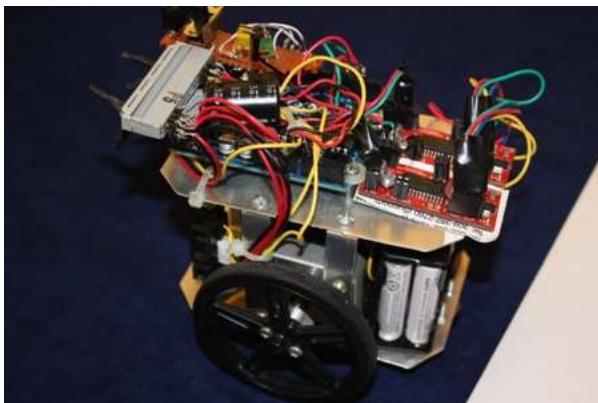
2000-2010 Generation Micromice



Current Generation Micromice



Region 1 Micromice

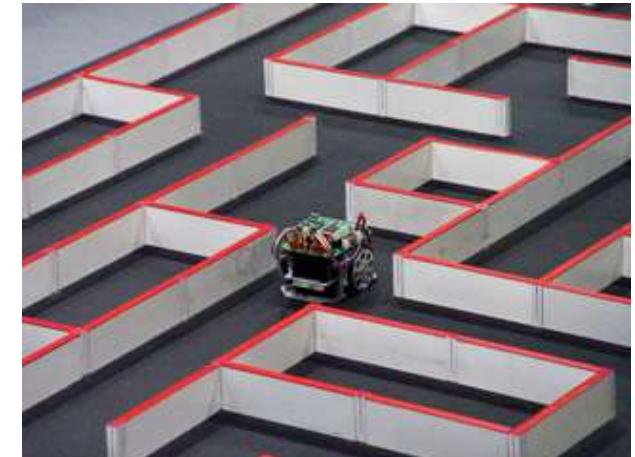


Maze and Micromouse Specification

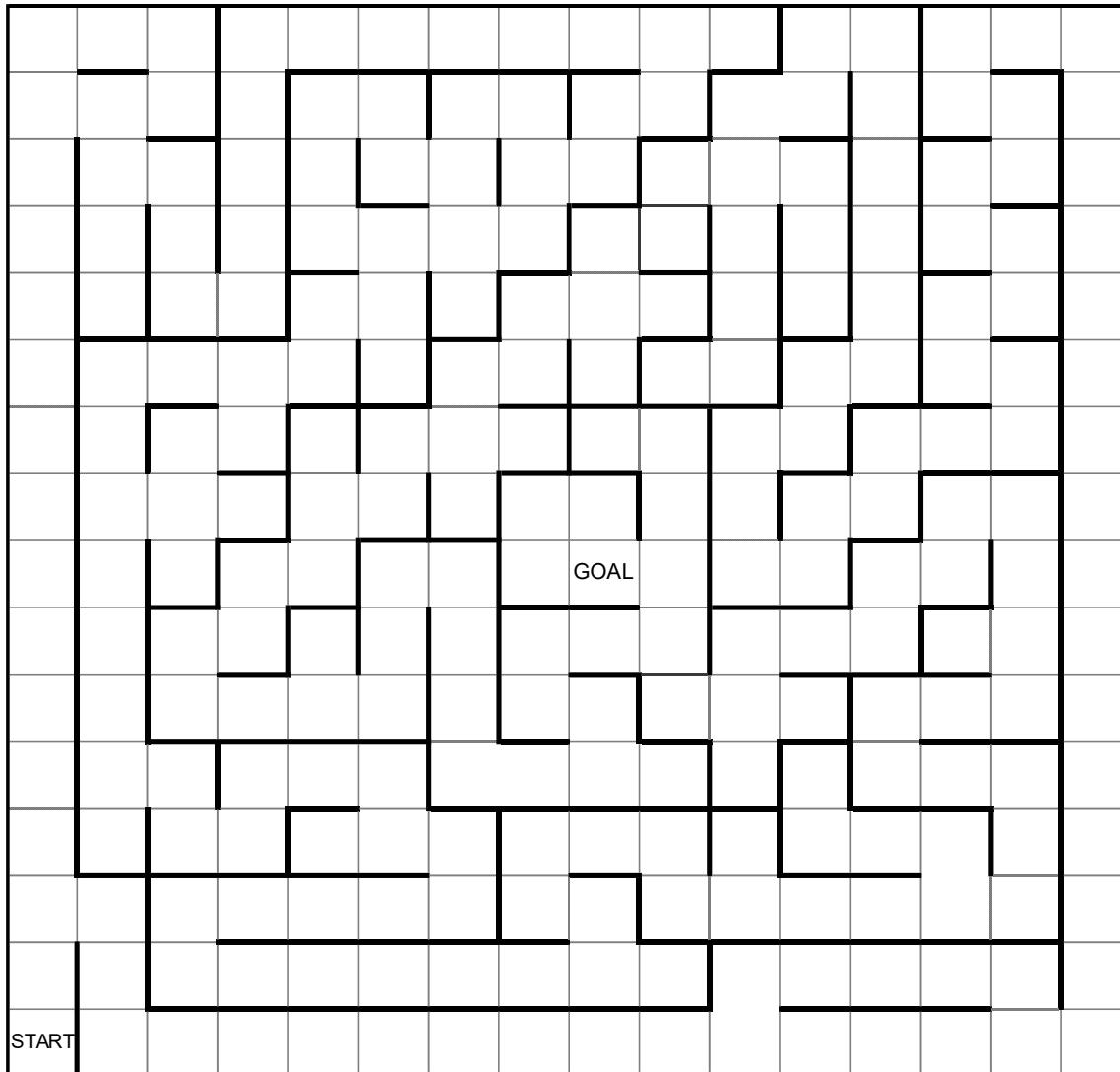


Maze Specifications

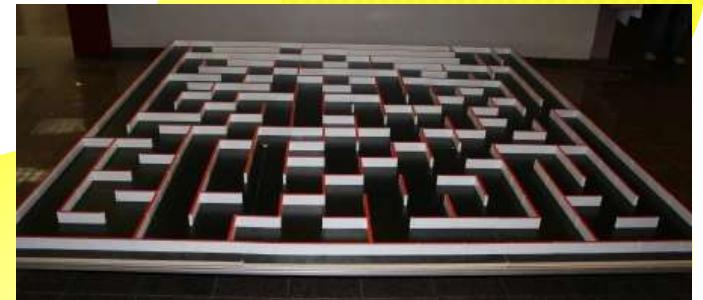
- Maze comprises 16 x 16 of 18cm x 18cm unit squares
- Walls are 5cm high and 1.2cm thick
- Side walls is white color, and the top shall be red or white color
- Outside walls enclose the entire maze
- Maze floor shall be made of wood and finished with a non-gloss paint
- Start square is at one of the 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



Maze Mapping

START = 0x00

GOAL1 = 0x77

GOAL2 = 0x78

GOAL3 = 0x87

GOAL4 = 0x88

WEST

NORTH

EAST

START

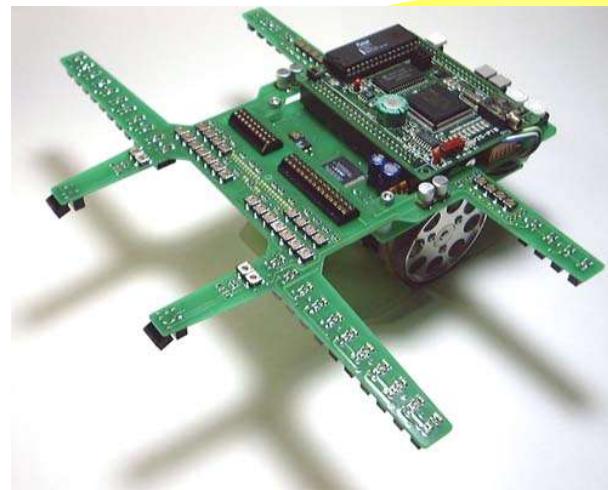
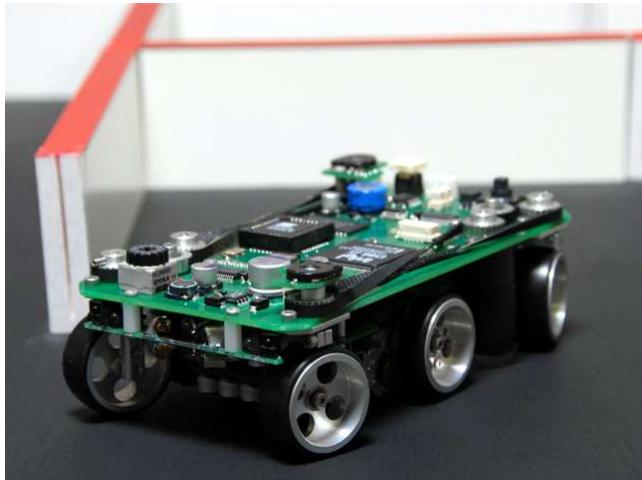
SOUTH

0F	1F	2F	3F	4F	5F	6F	7F	8F	9F	AF	BF	CF	DF	EF	FF
0E	1E	2E	3E	4E	5E	6E	7E	8E	9E	AE	BE	CE	DE	EE	FE
0D	1D	2D	3D	4D	5D	6D	7D	8D	9D	AD	BD	CD	DD	ED	FD
0C	1C	2C	3C	4C	5C	6C	7C	8C	9C	AC	BC	CC	DC	EC	FC
0B	1B	2B	3B	4B	5B	6B	7B	8B	9B	AB	BB	CB	DB	EB	FB
0A	1A	2A	3A	4A	5A	6A	7A	8A	9A	AA	BA	CA	DA	EA	FA
09	19	29	39	49	59	69	79	89	99	A9	B9	C9	D9	E9	F9
08	18	28	38	48	58	68	78	88	98	A8	B8	C8	D8	E8	F8
07	17	27	37	47	57	67	77	87	97	A7	B7	C7	D7	E7	F7
06	16	26	36	46	56	66	76	86	96	A6	B6	C6	D6	E6	F6
05	15	25	35	45	55	65	75	85	95	A5	B5	C5	D5	E5	F5
04	14	24	34	44	54	64	74	84	94	A4	B4	C4	D4	E4	F4
03	13	23	33	43	53	63	73	83	93	A3	B3	C3	D3	E3	F3
02	12	22	32	42	52	62	72	82	92	A2	B2	C2	D2	E2	F2
01	11	21	31	41	51	61	71	81	91	A1	B1	C1	D1	E1	F1
00	10	20	30	40	50	60	70	80	90	A0	B0	C0	D0	E0	F0

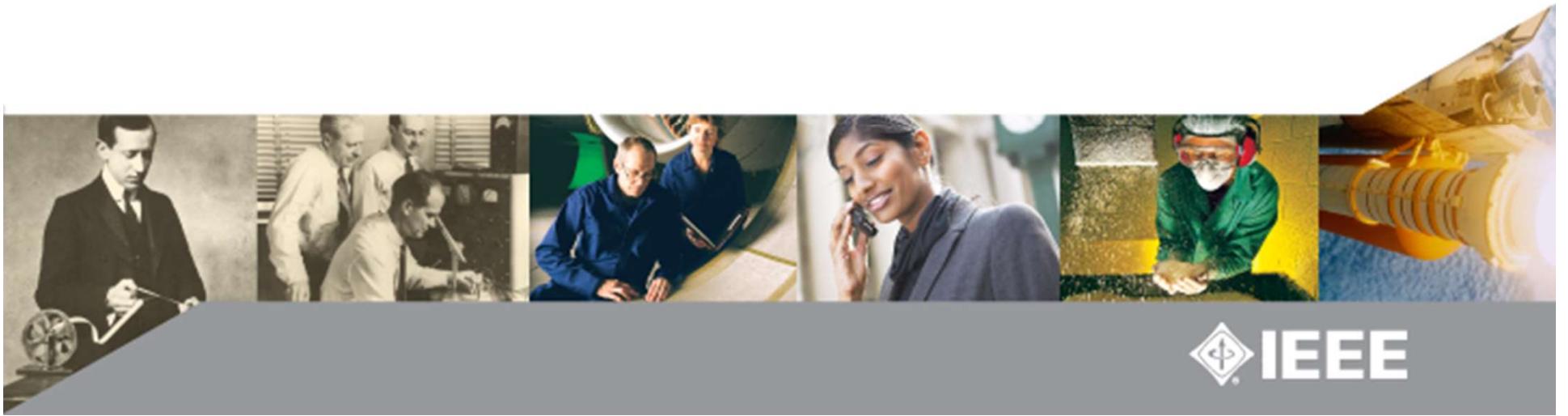


Micromouse Specifications

- 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



IEEE

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



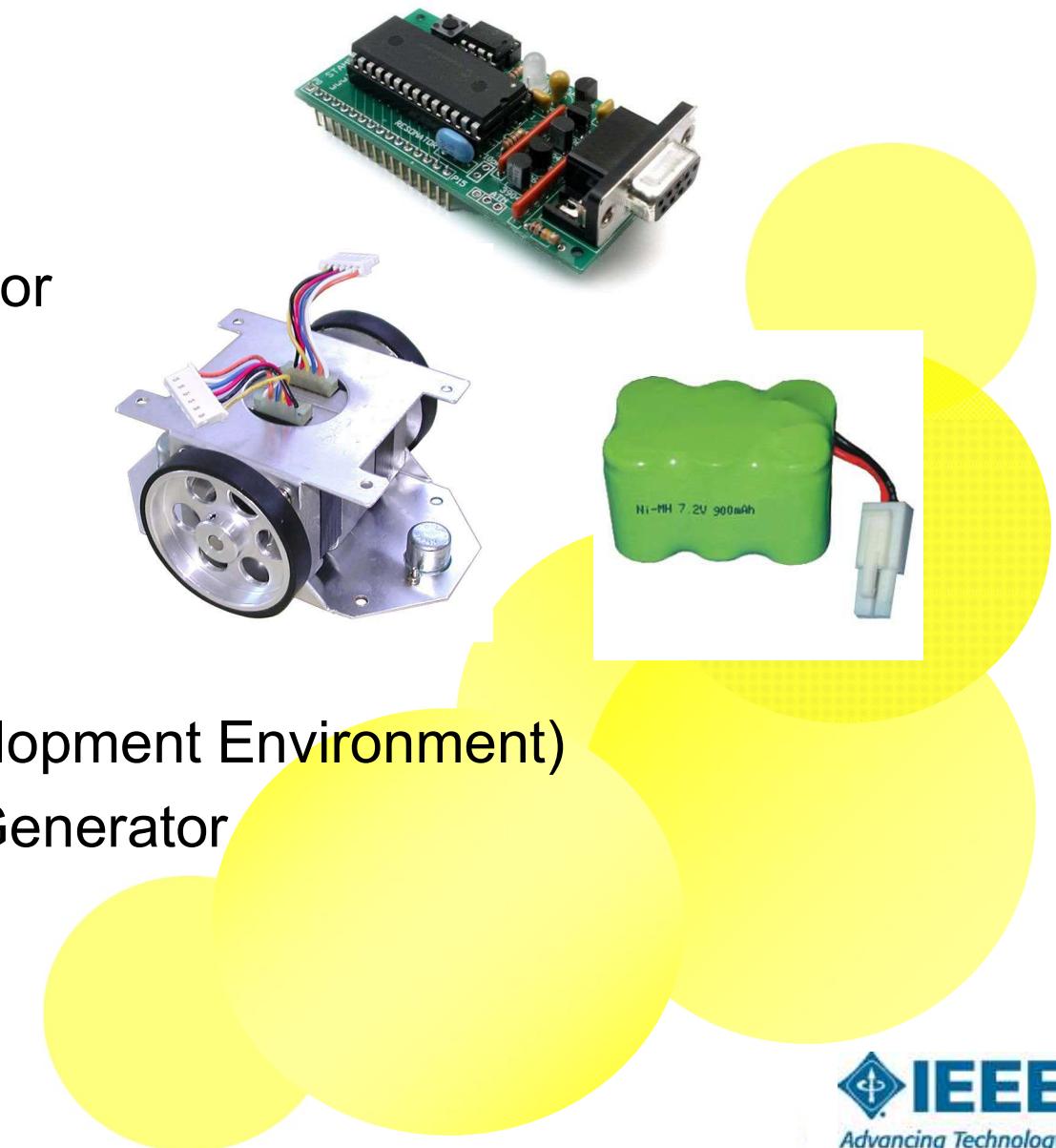
Main Components

■ Hardwares

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

■ Softwares

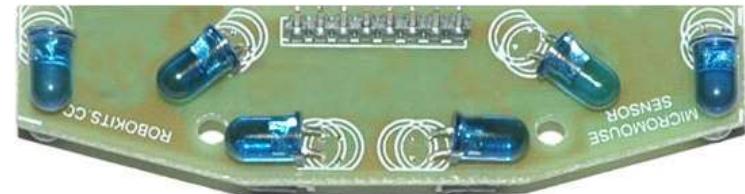
- IDE (Integrated Development Environment)
- Acceleration Profile Generator
- Simulator
- Program Loader



Micromouse Sensors

□ Type of Sensors

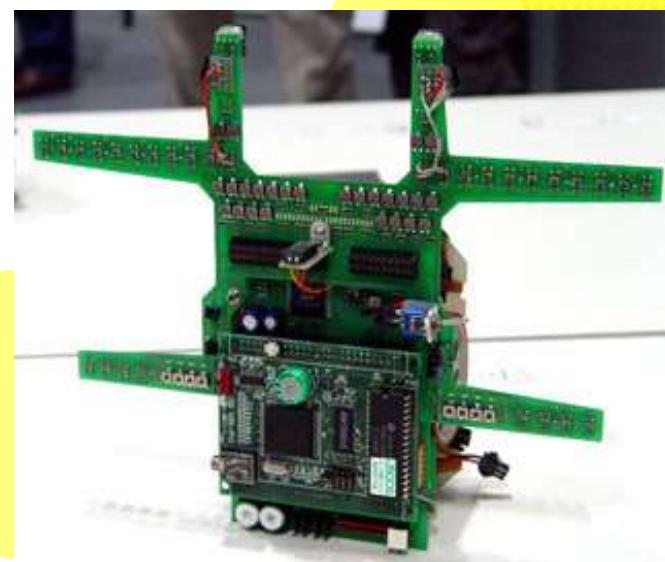
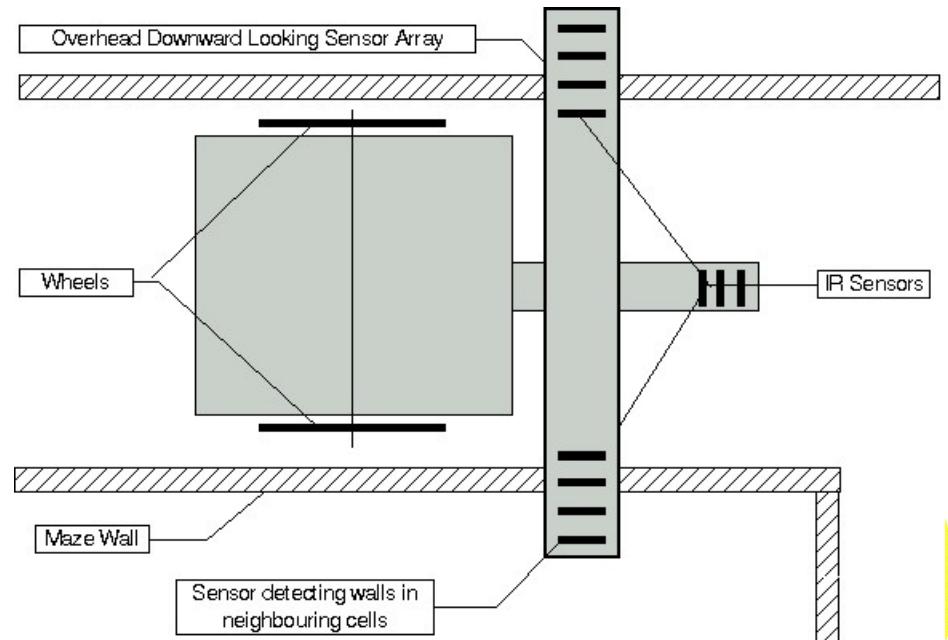
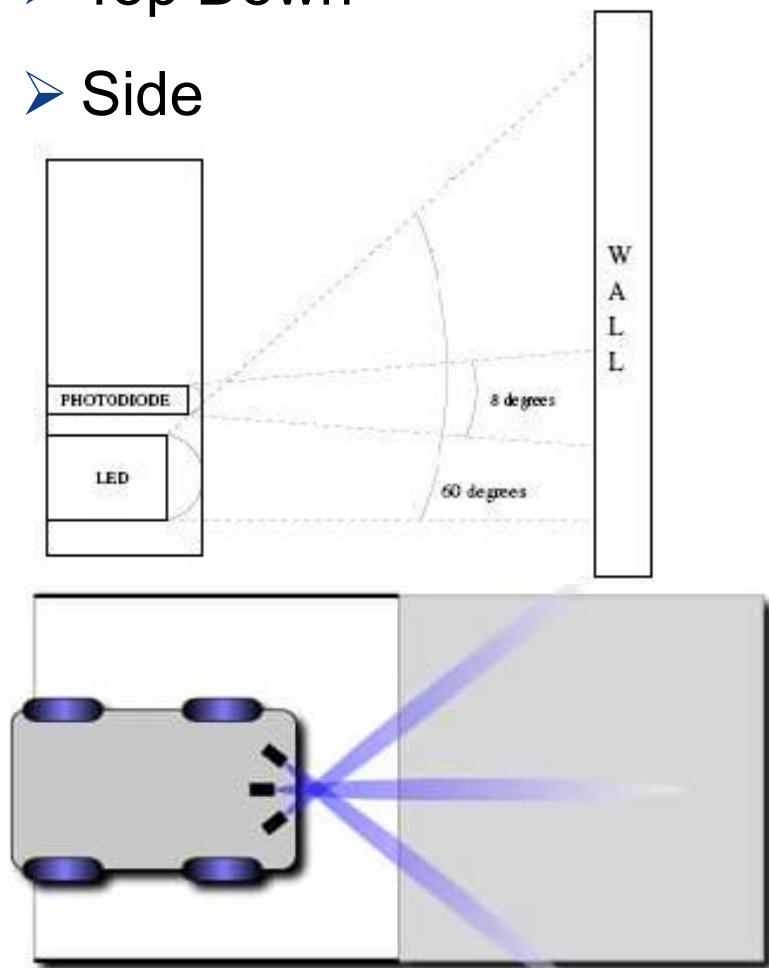
- Infra-Red Emitter/Detector
- Digital Compass
- Accelerometer
- Bumper Switch
- Rotary Encoder (wheel position)
- Rangefinder
- Sonar



Micromouse Sensors

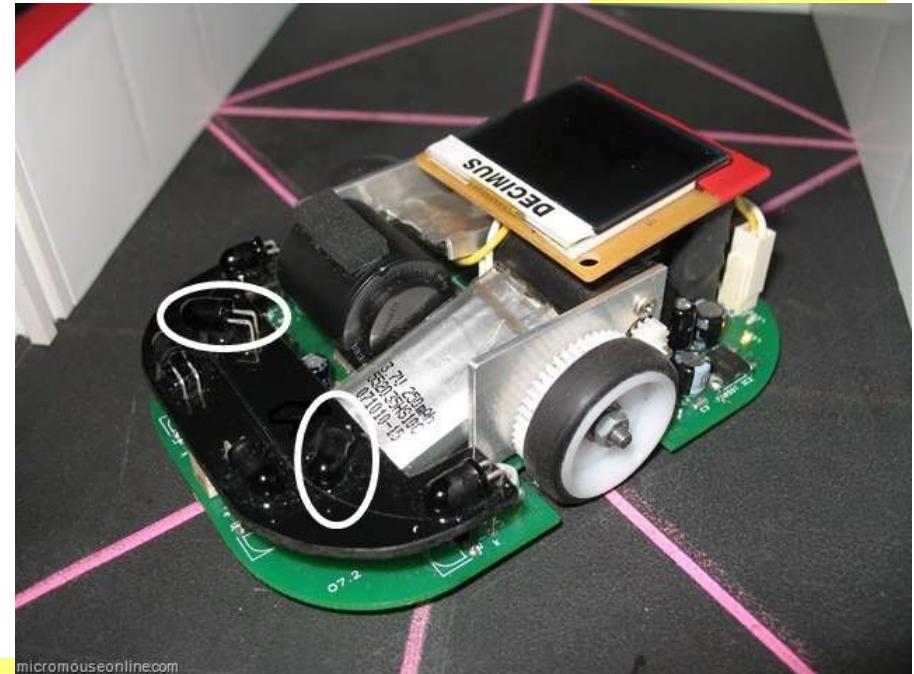
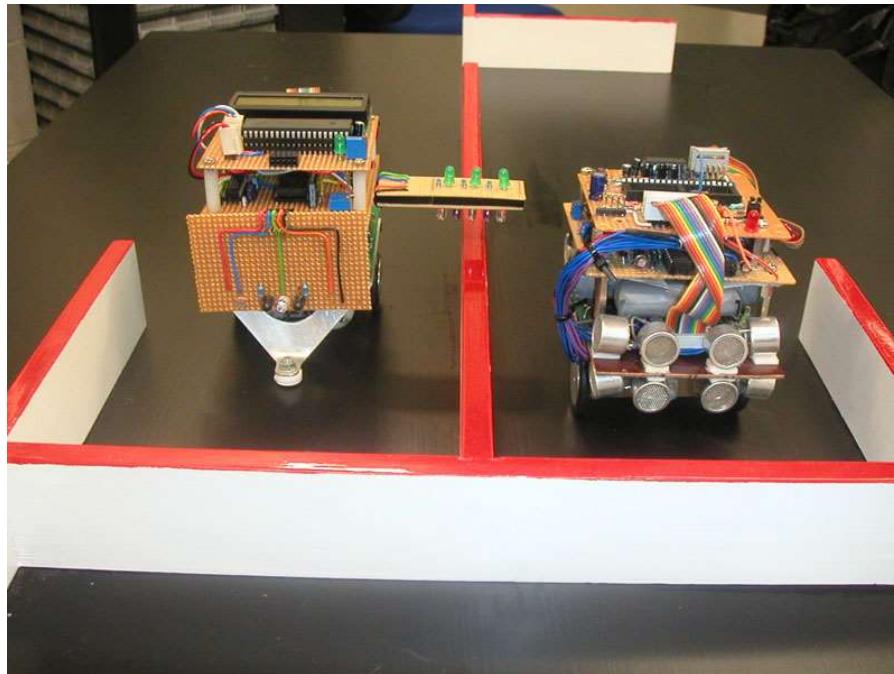
■ Way of Sensing Walls

- Top Down
- Side



Micromouse Sensors

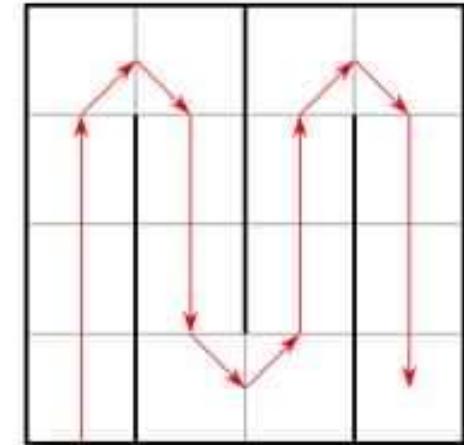
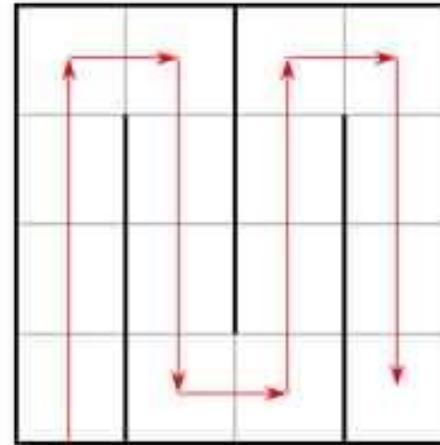
■ Way of Sensing Walls



Micromouse Movements

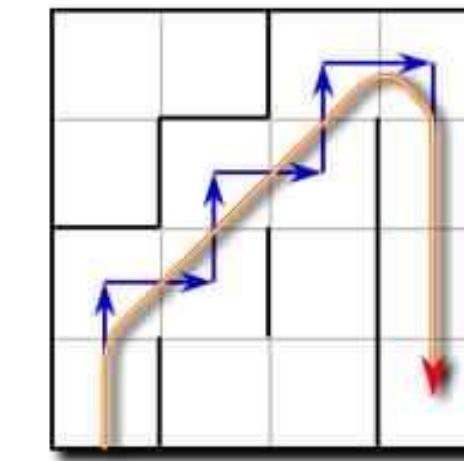
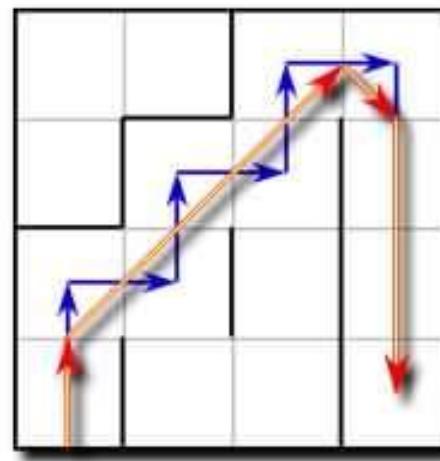
□ Basic Moves

- Forward
- Right Turn
- Left Turn
- U-Turn
- Slow down and Stop



□ Advance Moves

- Diagonal Run
- V-Turn
- J-Turn



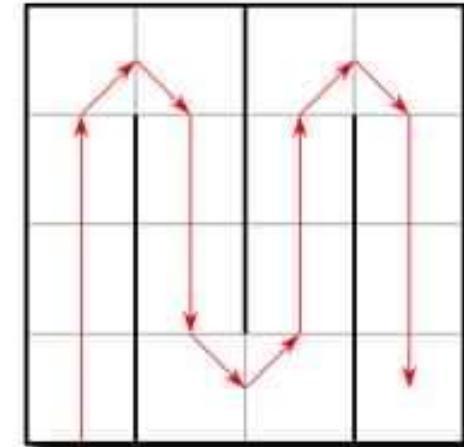
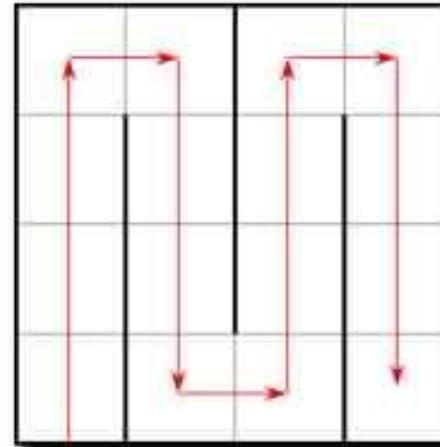
□ Movements

- Exploring, Fast run

Micromouse Movements

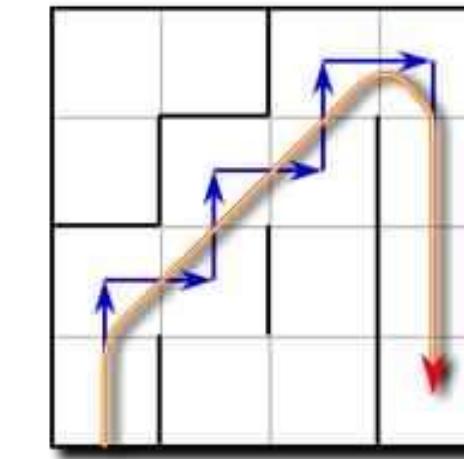
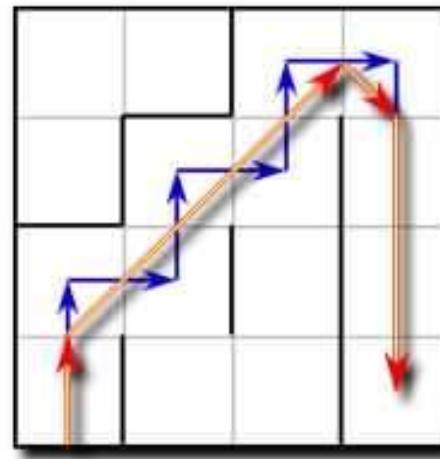
□ Basic Moves

- Forward
- Right Turn
- Left Turn
- U-Turn
- Slow down and Stop



□ Advance Moves

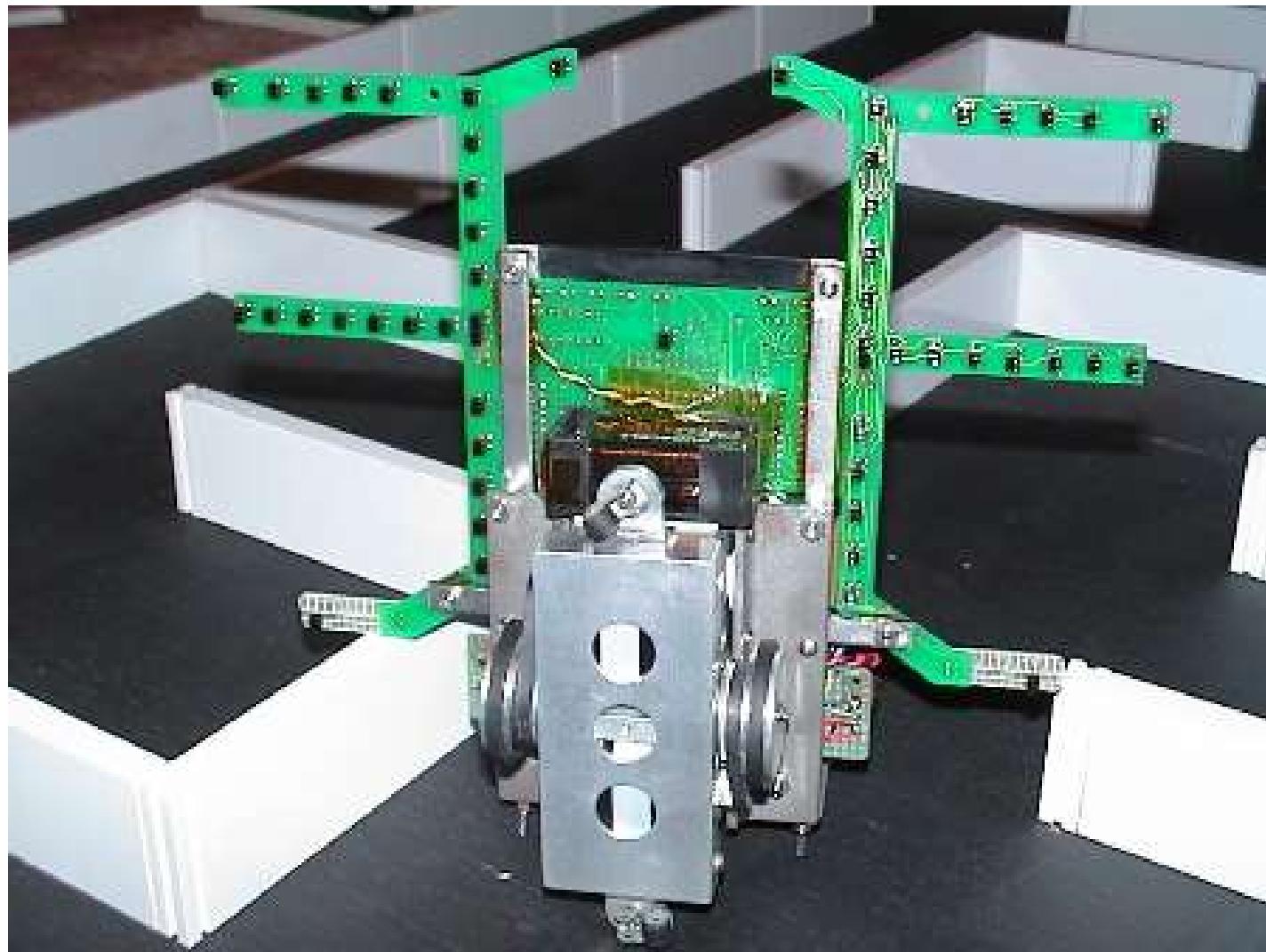
- Diagonal Run
- V-Turn
- J-Turn



□ Movements

- Exploring, Fast run

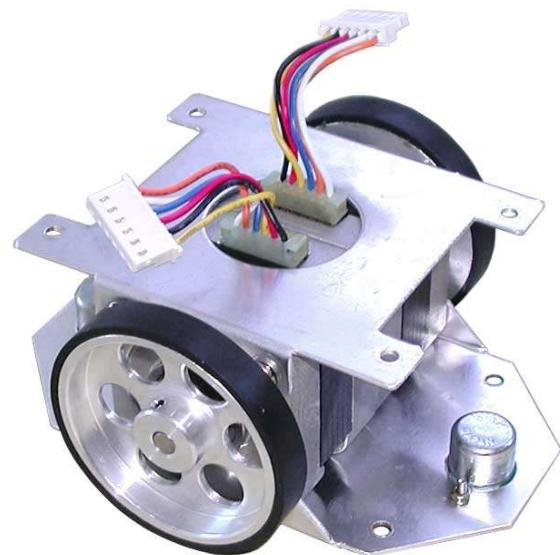
Sensors Position for Movement



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for Humanity

Micromouse Motors

- Type of Motors
 - Stepper Motor
 - DC Motor
 - Servo Motor
 - Brushless DC Motor
- Each Micromouse should have at least 2 motors



Software

■ Navigation Algorithm

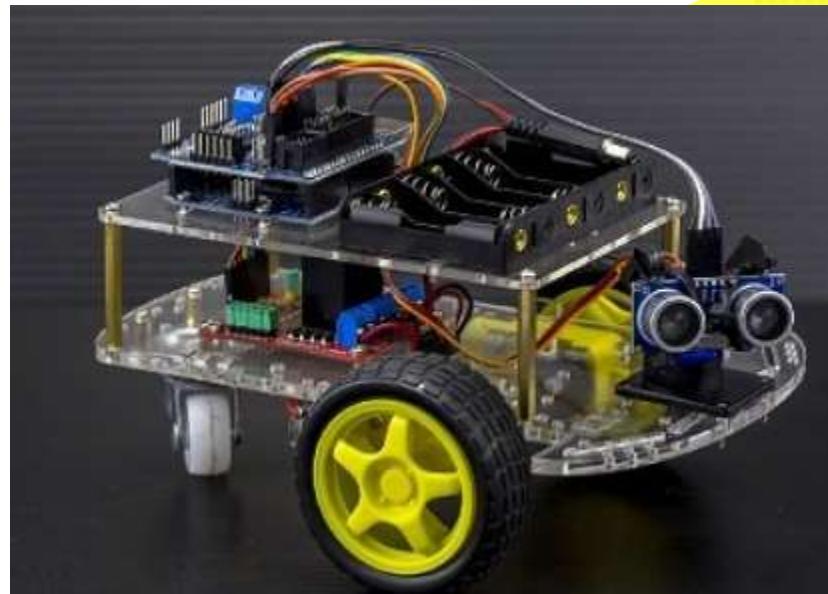
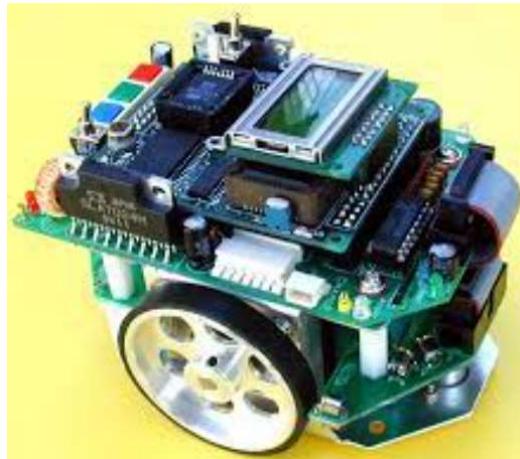
- Micromouse must be able to keep track of its position.
- Micromouse also need to remember all the junctions. At dead end or old path encountered, the mouse shall select a junction that will lead to a new path.
- To make use of the exploring rules more effectively, a maze will be divided into several 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

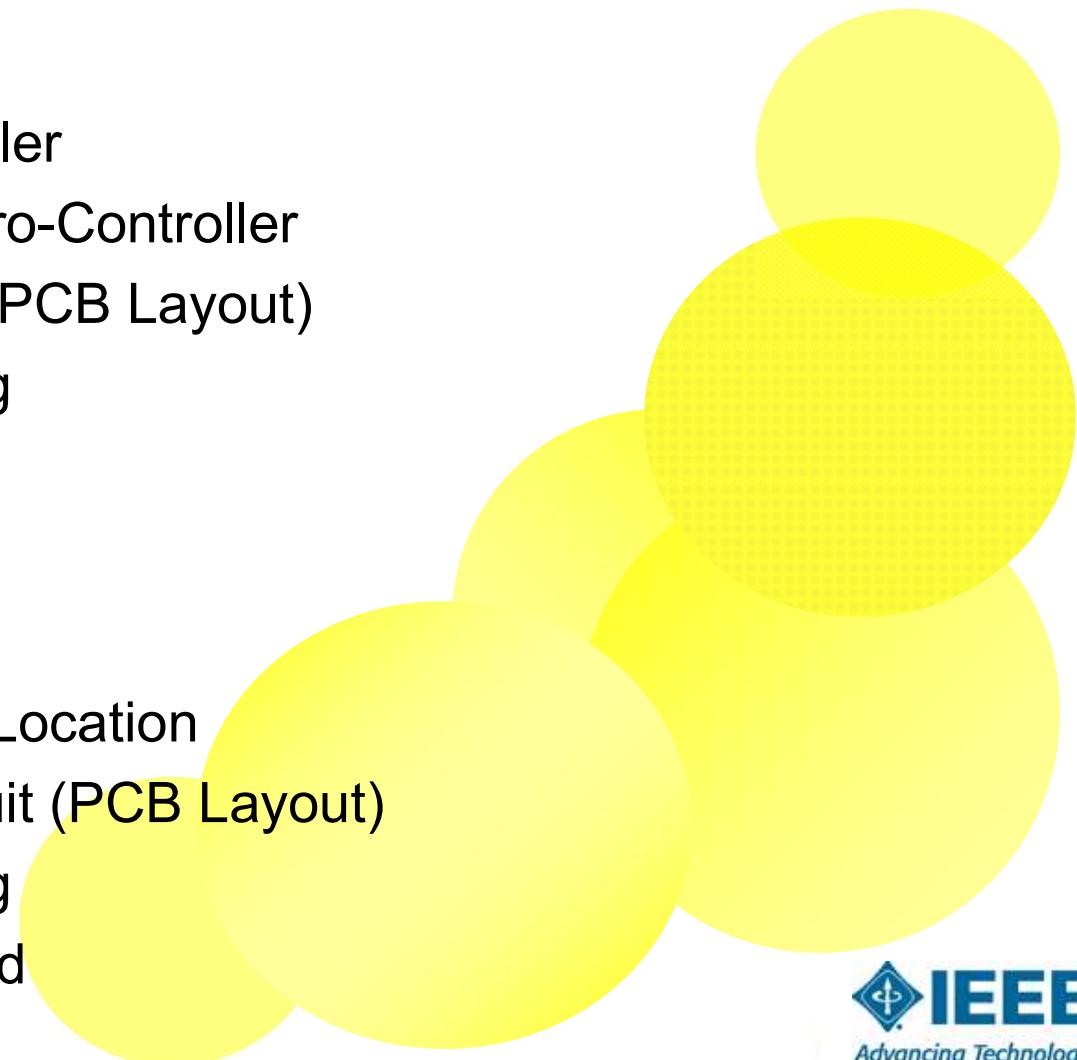
Available Micromouse Kit



Micromouse Development Plan

■ Hardware

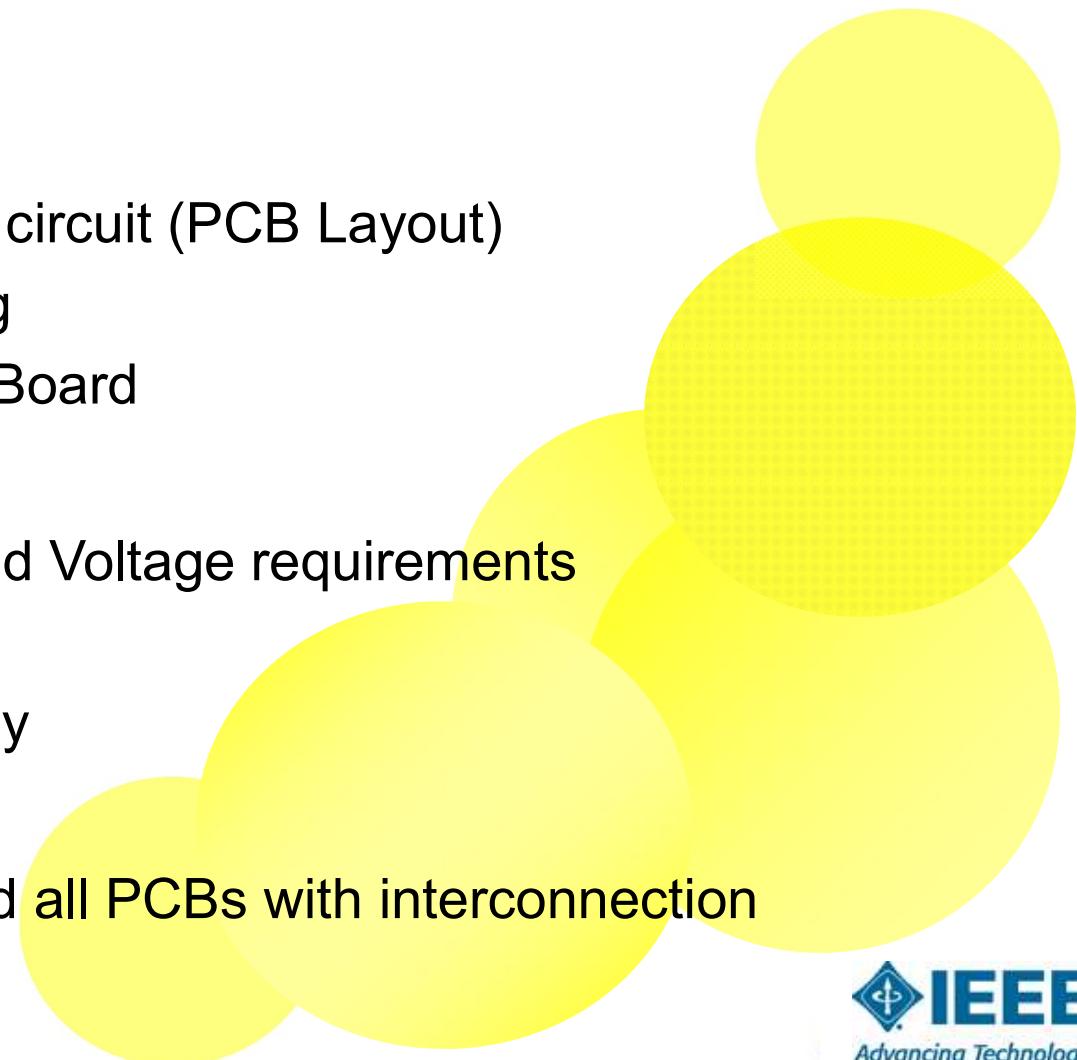
- CPU Board
 - ❖ Select Micro-Controller
 - ❖ Learn about the Micro-Controller
 - ❖ Design CPU circuit (PCB Layout)
 - ❖ Wiring and Soldering
 - ❖ Testing CPU
- Sensor Board
 - ❖ Select Sensors
 - ❖ Determine Sensors Location
 - ❖ Design Sensor Circuit (PCB Layout)
 - ❖ Wiring and Soldering
 - ❖ Testing 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

Micromouse Competition



2019 Region 1 Student Conference

- April 2019
- Conference Programs
 - Micromouse Competition
 - Micromouse Workshop
 - IEEE Student Branches Training
 - Student Paper Contest
 - Student Ethics Competition
 - T-Shirt Design Competition
 - Robotics Workshop
 - Keynotes Presentation



IEEE Region 1 Student Conference

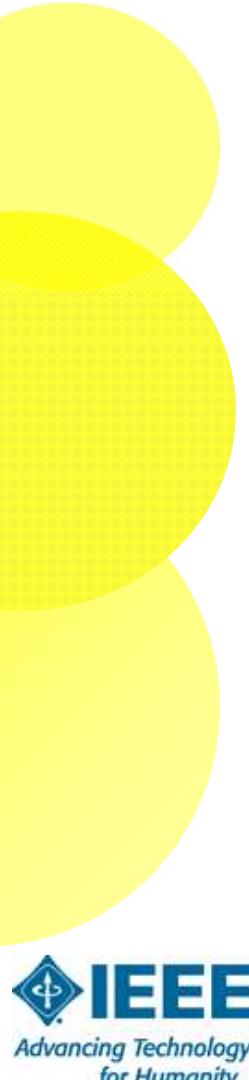
- Micromouse Competition
 - The objective of the competition is to build a robot which can negotiate a specified maze in the shortest time.
 - Cash Prizes
- Eligibility:
 - The entrant must be an undergraduate/graduate student at a school in IEEE Region 1 (Northeastern USA Region) - preferable there is an IEEE Student Branch
 - Must be IEEE Student Member



2022 Region 1 Micromouse Competition at Union College (April 9, 2022)



2022 Region 1 Micromouse Competition at MIT (October 1, 2022)



2023 Region 1 Micromouse Competition

- ❑ Long Island Micromouse
 - May 12, 2023
 - At NYIT, Old Westbury, New York
- ❑ MIT Micromouse
 - October 6, 2023
 - At MIT Cambridge MA



Question?



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