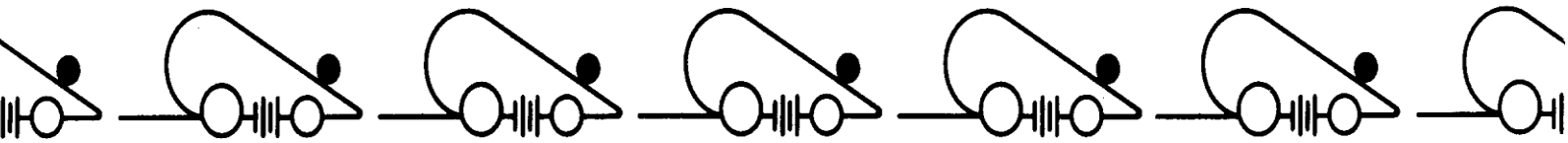


APEC 31th Annual Micromouse Contest

The goal of the contest is to design and build a robot that can navigate from the corner of a 10-foot square maze to the center in the shortest time. For most entrants the contest is divided into two phases, the search phase and the run phase. During the search phase the mouse determines at least one path from the start to the center and may seek additional paths in hopes of finding a faster one. During the run phase the mouse goes as quickly as possible from the start square in the corner of the maze to the center of the maze along the previously determined optimal path. Scoring is based on 1/30th of the time used to search the maze prior to the start of each run *(maze time)*, and the time of that run *(run time)*. If the mouse has not crashed or been manually restarted prior to the start of a run, a bonus of 2 seconds is subtracted from the score.

List of Contestants for APEC '17 Micromouse Contest

Mouse Name	Affiliation	Country
Zeetah VI	Harjit Singh, Pierre Hollis	United States
Brain	University of Pittsburgh	United States
EduMouse	Lunghwa University of Science and Technology	Taiwan
Fab 1	Derek Hall, Jim Chidley	UK
Patience 1C	Robert Scheer	United States
Hippo C	Lunghwa University of Science and Technology	Taiwan
Decimus 5α	Peter Harrison	UK
Green Giant 5.19V	Cal State, Los Angeles	United States
Exia Repair II	Naoto Hiramatsu	Japan
Diu-Gow 4	Lunghwa University of Science and Technology	Taiwan

Zeetah VII was designed and built by Pierre Hollis and Harjit Singh. The idea behind this mouse was to see how light we can make it. The mouse weighs in at 44 g. It uses an STM32F411 CPU with 512kB flash and 128kB of RAM, has 16MB of flash for logging, AD22425 analog gyro along with a BMX055 accelerometer/gyro (to compare the gyros), a 128x32 OLED display and 512 count encoders on the wheel. Power comes from two LiPo 70 mAh cells. The motors are MicroMo 1024S. The mouse measures 84mm x 74mm.

Brain is designed and built by students in the Robotics and Automation Society at the University of Pittsburgh. All components are mounted to a custom-designed PCB measuring 8cm by 10cm. The Brain uses a Teensy 3.2 development board, which includes an ARM Cortex M4 CPU running at 144MHz with 64kB RAM and 256kB flash. A mass of 140g is driven by four independent wheels. For control, the Brain utilizes a gyro, encoders on each motor, and four IR phototransistors. The hardware has demonstrated accelerations and velocities in excess of $12 m/s^2$ and 3m/s, but software control is limited to more modest speeds. The language is C++, and the build system is Teensyduino.

EduMouse was designed by Juing-Huei Su and Chao-Wei Chen for educational and experimental purposes. It uses observer-based sensor fusion algorithms to improve the encoder resolutions.

All the Taiwan teams are from the Embedded Control System Laboratory of the Department of Electronic Engineering at Lunghwa University of Science and Technology, which is organized and led by Professor Juing-Huei Su.

FAB 1 parodies the Thunderbird's pink Rolls Royce. It uses a STM32 processor running at 72 MHZ with 96k of RAM. It has 6 TSL262R sensors and 100mAh LiPo batteries. The total weight of 100g is driven by six powered wheels, allowing the mouse to accelerate and decelerate at much higher speeds. The two centre wheels are mounted 0.5mm lower than the others, allowing uncompromised high speed cornering. It measures 115mm(L) x 75mm(W) x 22mm(H).

Patience 1C is the first micromouse from Robert Scheer. As a newbie, the goals for this project were limited to basic functionality using simplification of fundamentals. Motto for this project is "A little Patience goes a long way." The format is 2-wheel, classic size. Wheel & motor mounts are CNC milled 7075AL. Fixed wheel shafts are CNC turned 7075AL. Wheel rims are CNC milled Acetal. Wheel bearings are off-the-shelf Acetal gear hubs rotating on aluminum, ie without ball-bearings. Search and speed-run speed is 0.8m/s, while accel/decel is $7m/s^2$. Turns are limited to left and right 90deg pivot turns.

Hippo C was designed and built by Huan-Jie Liao in 2016. He is currently a graduate student at Lunghwa University of Science and Technology. Hippo C is equipped with a vacuum fan to increase friction while turning. The fan and fan body were made by a CNC machine. A boost switching power circuit is used to provide a stable voltage input to the DC motors. Yu-Chih Lin is a partner of Huan-Jie Liao. Hippo C came in second at the APEC micromouse contest in 2016.

Decimus 5α is a classic (full size) micromouse by Peter Harrison from the UK. Using the common four-wheel drive layout, this revision has a top speed in excess of 5m/s. The use of 3D printed parts has greatly simplified the mechanical design and construction of this mouse. Sensor alignment in particular is much easier with IR absorbing, 3D printed mounts. Decimus 5α has demonstrated repeatable turns at nearly 2g of centripetal acceleration and straight-line accelerations of up to $15m/s^2$. The ARM cortex M4 processor is an STM32F407 with 1Mbyte of flash and 192kbyte RAM. Running at 144MHz, it performs all the navigation, solver and control functions using floating point throughout while still only taking up less than 10% of the available processor power. Improvements to the searching and pathfinder algorithms attempt to find the most effective route by taking into account the mouse dynamics and the need to search as fast as possible. A comprehensive software re-write is under way which, it is hoped, will improve reliability and turning performance as well as paving the way for a port to new hardware.

Green Giant 5.19V (vacuum design) is designed and built by Luzhou Ye (Green Ye) a student at Cal State LA. The technical information is in a table on the next page.

Exia Repair II has 6 infrared sensors and a suction fan which is made with a 3D printer. This allows it to be more stable in a fast run. The suction fan can create 270g of force with 50% output. I have not measured it at maximum output. Exia has some new features which it did not have at MM2016 in Japan.

1. It is able to accelerate in known sections of the maze during searching.
2. It has a much faster algorithm to determine the route.

Diu-Gow 4 was designed and built by Xin-Han Cai in 2015. He is currently a graduate student at Lunghwa University of Science and Technology in Taiwan, working on a master's degree. Diu-Gow 4 is equipped with a vacuum fan, made by a 3D printer, to prevent skidding in high-speed turns. Because of the vacuum fan, Diu-Gow 4 turns about 25 percent faster than his previous micromouse Diu-Gow. Diu-Gow 4 won first place in the All Japan micromouse contest in 2015, 2016. Jiu-Hung Hung is a partner of Xin-Han Cai. The technical information is in a table on the next page.

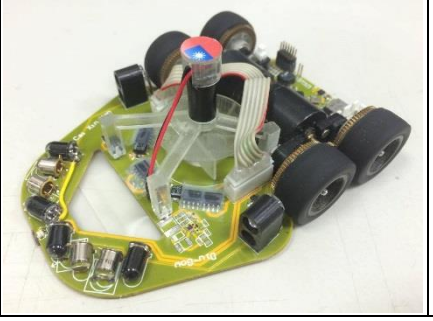
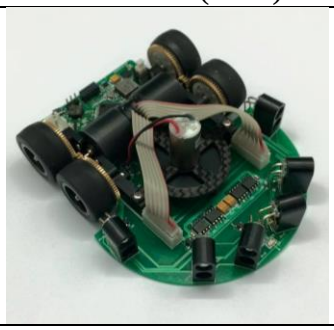
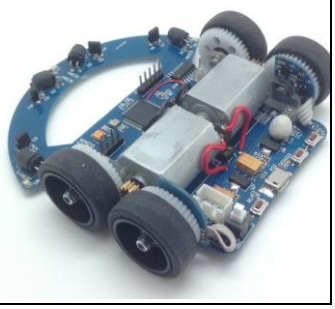
The maze design for this year's contest was prepared by Mr. Gerado Molina. He has designed the mazes for all the recent APEC contests. He has a "Maze Solver" app on the App Store if you are interested.

Technical information for Patience 1C

Designer	Robert Scheer
Dimensions	76W x 95L x 25H mm
Weight	77g

MCU	STM32F405RG @168MHz
Gears	50:12 mod.4
IR	SFH4550/TEFT4300 x4
Motors	Faulhaber 1516T006SR with IEH2-4096 encoders
Motor driver	1x DRV8835 drives both motors
Battery	2S LiPo 150mAh 20C 11g
Gyro	LY3200

Technical information for the Lunghwa University of Science and Technology entries

	Diu-Gow 4	**HIPPO C**	**EduMouse**
Length/Width	105mm/79mm	99.6mm/79mm	100mm/89mm
Height/Weight	40 mm/ 100g	31.14 mm/ 110g	24mm/~110g
Drive Motor	1717T006SR + IE2-512 x 2 Vacuum motor : Maxon RE8	1717T006SR + IE2-512 x 2 Vacuum motor : Maxon RE8	JD20-L002A229-1 x 2
Tire size	Diameter : 21.5mm, Width : 9mm	Diameter : 21.5mm, Width : 9mm	Diameter : 24mm, Width : 9mm
Gear ratio	60:16	60:16	45:9
CPU	Renesas RX62T	Renesas RX62T	dsPIC 33EPMU806
Flash ROM	32KB	32KB	128KB
On chip RAM	16KB	16KB	64KB
Wall Sensor	OSRAM SFH4550 x 6 TOSHIBA TPS601A x 6	OSRAM SFH4550 x 6 TOSHIBA TPS601A x 6	OSRAM SFH4550 x 4 TSL262 x 4
Gyro	Analog Devices ADXRS620 STM LY3100ALH	Analog Devices ADXRS620	MPU6500
Top/turn speed	4.1m/s, 120~200cm/s	3.8m/s, 120~180cm/s	1.5m/s, 50cm/s
Display	RGB x 2	RGB x 2	RGB x 2
Power Source	Lithium Polymer 120mAh2S(7.4V)	Lithium Polymer 120mAh2S(7.4V)	Li-Polymer 240mAh 2S(7.4V)
Picture			

Technical information for the Green Giant 5.19V

Name: Green Giant 5.19V	Designer: Luzhou Ye (Green Ye)
Dimension:H:37mm W:75mm L:100mm	Weight 116g / Nominal suction force:58.4g/W
Gear Ratio 60:16 M0.3 / wheel D:22mm W:9mm	Battery: 300mah 45C LiPo 2S1P (7.4V)

MCU: STM32F405RG at 168MHz with 16MHz internal RC		Memory: MCU built-in 192KB ram and 1MB ROM
IR Sensor: SFH4550 X 6 + TEFT4300 X 7		MEMS: MPU-6500 X 1 @ 20Mbps for SPI
Motor: 1717T006SR with IE2-512 X 2		Fan Motor: CL-0820-17 X 1
Internal Power Regulation: LMZ21701(5V) + TPS73633EP(A3.3V1) + LMZ10501(2V) + MCP1700 X 2 (A3.3V2&Bluetooth)		
UI: HCMS-2903 LED display X 1 + LED x 18 + Button X 2 + Buzzer X 1 + Bluetooth 4.0 (DA14580)		
Fan Power Supply: buck converter to 3.3V, 3A max (TPS82130)		
Motor Power Supply: boost converter to 11.88V, 10A Max (TPS61088)		
Motor Driver: UCC27524 (Driver) X 2 + DMHC3025LSDQ-13 (H-Bridge) X 2		
Fan Driver: UCC27524 (Driver) X 1 + RF4E070GN (Low Side N-Mosfet Drive) X 2		
Max Speed: 5m/s	Max Acceleration: 18m/s^2	Max Turn Speed: 1.7m/s(90v) 2.1m/s(90L) 2.0m/s(45) 1.8m/s(135&180)

Technical information for Exia Repair II

Robot Name	Exia Repair II
Designer	Naoto Hiramatsu
Team Name	Mice Busters
Length/Width	94mm/74mm
Height/Weight	40mm/115g
Drive Motor	FAULHABBER 1717-003SR+IEH2-4096 *2
Motor Driver	TB6614FNG
Vacuum Motor	MAXON DCX-10S
Tire Size	Diameter: 24mm, Width: 8.5mm
CPU	Renesas RX631
Gyroscope	Invencense MPU6500
User Interface	Button + Buzzer + 5*LED
Power Source	LiPo 200mAh 2S(7.4V)|
Infrared Emitter	SFH4550 *6
Infrared Sensor	ST-1KL3A *6