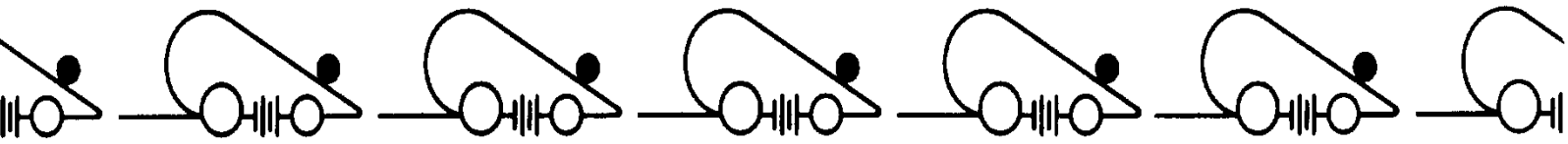


APEC 31th Annual Micromouse Contest

The thirty-first annual APEC MicroMouse Contest was held at the Tampa Convention Center in Tampa Florida on March 27th, 2017. A total of 12 mice were on hand for the contest, including 6 foreign entries. Diu-Gow 4 from Lunghwa University of Science and Technology in Taiwan came in first with the best score as well as the Fastest Run, and also won the Best Student award. Hippo C from Lunghwa University of Science and Technology in Taiwan came in second. Decimus 5α came in third. All the contestants are listed in the table below together with their best score.

List of Contestants for APEC '17 Micromouse Contest

Mouse Name	Affiliation	Country	Score
Diu-Gow 4	Lunghwa University of Science and Technology	Taiwan	9.442
Hippo C	Lunghwa University of Science and Technology	Taiwan	11.931
Decimus 5α	Peter Harrison	UK	15.008
Green Giant 5.19V	Cal State, Los Angeles	United States	17.917
Zeetah VI	Harjit Singh, Pierre Hollis	United States	20.157
EduMouse	Lunghwa University of Science and Technology	Taiwan	20.180
Exia Repair II	Naoto Hiramatsu	Japan	52.097
Patience 1C	Robert Scheer	United States	60.960
Brain	University of Pittsburgh	United States	105.201
Jerry	University of Texas in El Paso	United States	
Deceptimouse	University of Texas in El Paso	United States	
Fab 1	Derek Hall, Jim Chidley	UK	

Cash prizes were awarded again this year. Diu-Gow 4 received US$500 for first place, US$500 for the best student entry, and US$150 for the fastest run. Hippo C received US$250 for second place. Decimus 5α received US$125 for third place.

The contest was held on Monday night after the exposition so that everyone at the conference could attend. New this year, stadium seating to handle about 200 attendees was located on either side of the maze. The traditional aerial view of the maze was projected on a large screen behind the judge's table. The scoring system superimposed the timing information on the overhead view of the maze, so that everyone could see it in real time. The contest venue was located in the exhibit hall very near to the exhibits, making it easy for attendees to migrate over to the contest when the exhibits closed. The picture below shows the venue as the contest was just getting under way. The contest was run on a maze imported from Korea.

Gerardo Molina prepared the maze design once again. APEC has developed a reputation for very difficult and long maze designs. This year's design had two main paths to the center. The green path plus the red path was 108 squares. Most mice took this path. The green path plus the blue path was 109 squares. Two mice took this path, including the winner.

APEC 2017 MicroMouse Contest Venue (photo courtesy of Juing-Huei Su)

The table below contains a list of the scores for each mouse that was able to solve the maze. The score is based on 1/30 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 had been manually restarted prior to the start of a run *(touched)*, a penalty of 2 seconds was added to the score.

Scores for All Completed Runs of each Mouse

Mouse Name	Run No	Run Time	Maze Time	Penalty	Score
Diu-Gow 4	1	25.916	0	0	25.916
Diu-Gow 4	2	7.405	61.100	0	9.441
Diu-Gow 4	3	6.535	103.360	2	11.980
Diu-Gow 4	4	6.218	142.796	2	12.978
Hippo C	1	43.863	0	0	43.863
Hippo C	2	9.642	68.662	0	11.930
Hippo C	3	6.648	119.367	2	12.626
Hippo C	4	6.412	165.473	2	13.927
Decimus 5α	1	35.645	0	0	35.645
Decimus 5α	3	9.287	111.621	2	15.007
Decimus 5α	4	8.890	158.722	2	16.180
Green Giant 5.19V	1	23.972	0	0	23.972
Green Giant 5.19V	5	11.013	147.116	2	17.916
Zeetah VI	1	50.978	0	0	50.978
Zeetah VI	3	13.894	127.903	2	20.157
EduMouse	1	80.849	0	0	80.849
EduMouse	2	15.914	127.978	0	20.179

EduMouse	3	15.605	206.508	2	24.488
EduMouse	4	15.077	272.333	2	26.154
EduMouse	5	11.888	342.952	2	25.320
Exia Repair II	1	52.097	0	0	52.097
Patience 1C	1	87.534	0	0	87.534
Patience 1C	2	53.601	160.765	2	60.959
Brain	1	111.871	0	0	111.871
Brain	3	96.307	206.824	2	105.201

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.

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.

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.

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.

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.

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.

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 $12m/s^2$ and 3m/s, but software control is limited to more modest speeds. The language is C++, and the build system is Teensyduino.

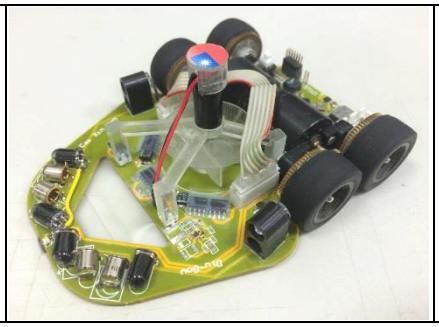
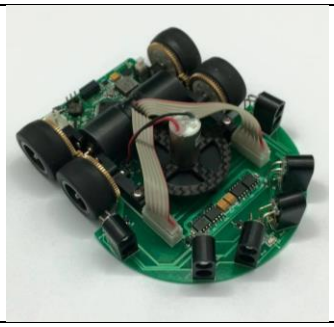
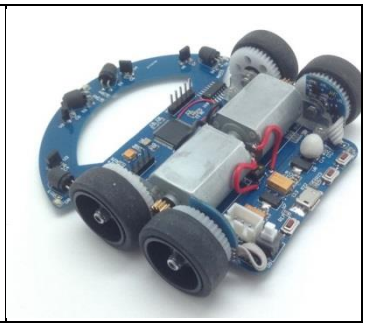
Jerry was designed and built by students at the University of Texas in El Paso

Deciptimouse was designed and built buy students at the University of Texas in El Paso

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).

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 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 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

Best Score = 9.442 seconds
Fastest Run = 6.218 seconds