ORANGE MOUSE

The development of a multi-event schools' micromouse for 2018

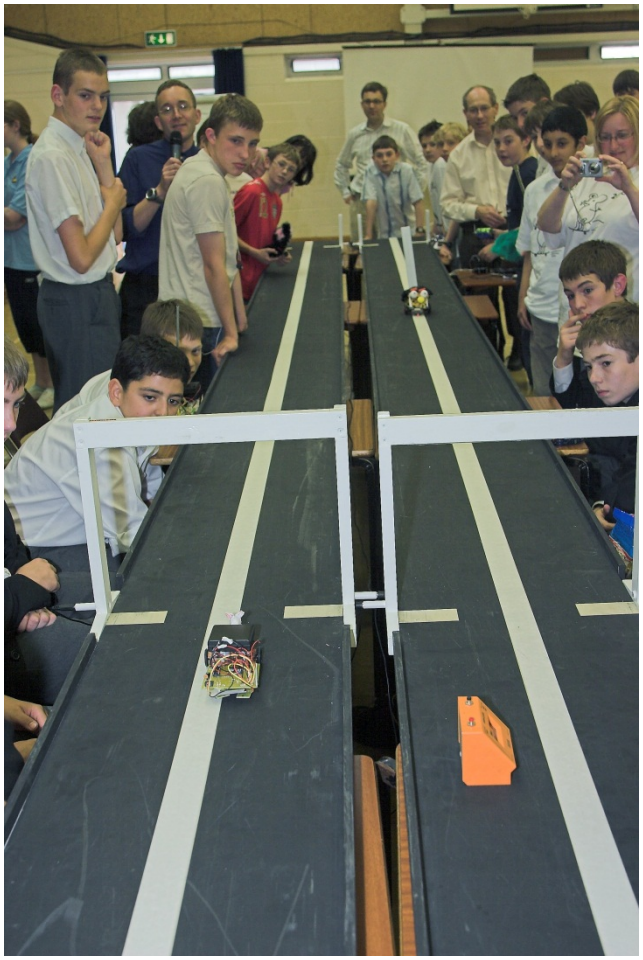
by

Bernard Grabowski and Duncan Louttit

Drag Race

This event features in both the UK Schools competition and the IET Robot Triathlon.

- **There is a traffic light or countdown start.**
- **The mouse must travel 6m following a white line.**
- **The mouse must stop before the end of the 7.2m track.**



Line Follower

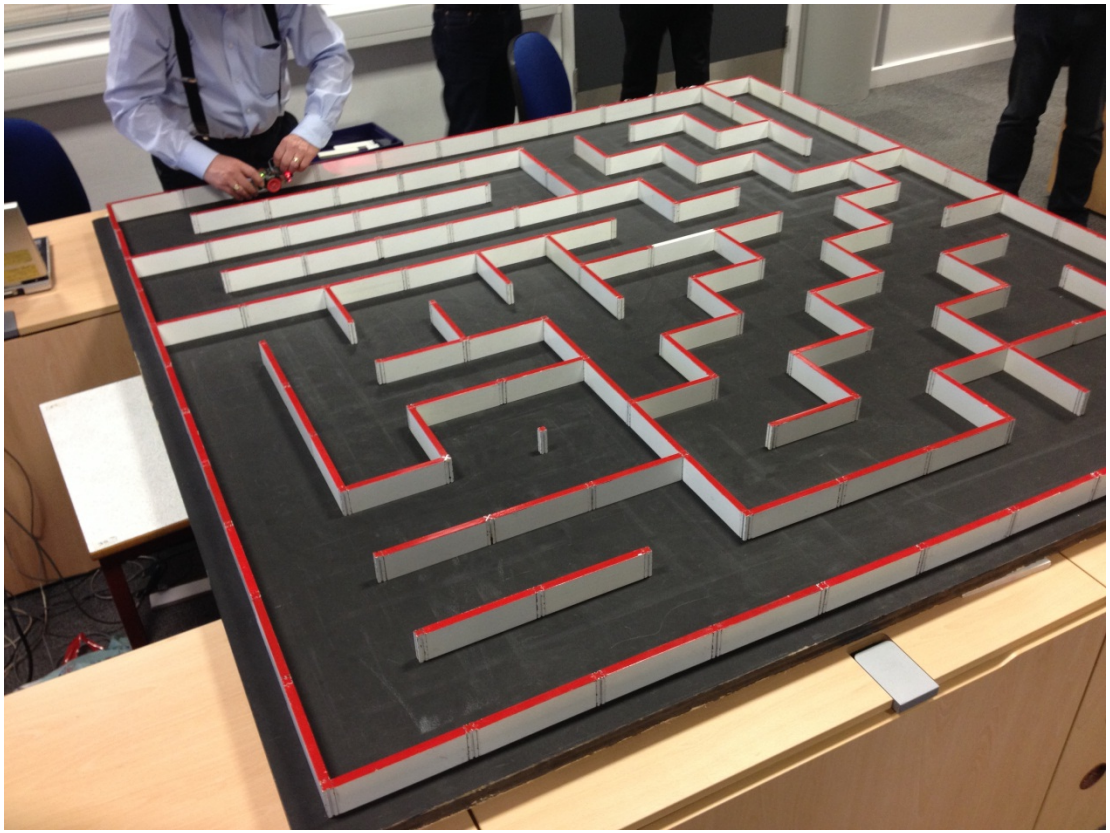
This event features in both the UK Schools competition and the IET Robot Triathlon.

- ❑ **The mouse must follow a white line.**
- ❑ **The mouse must travel in the direction of the arrow.**
- ❑ **The mouse must start and stop between marked lines.**

Non-Contact Wall Follower

This event features in the UK Schools competition.

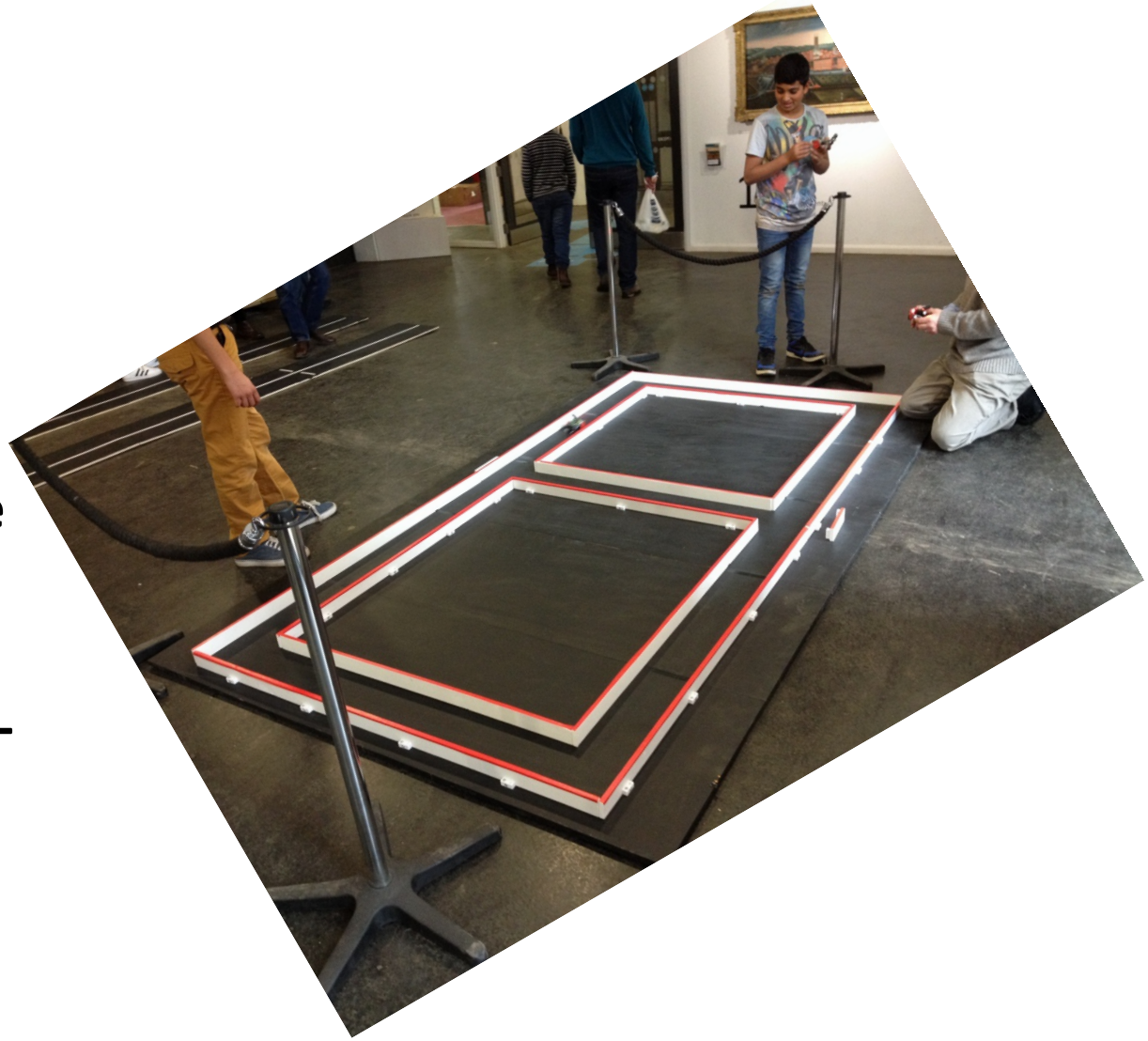
- ❑ **The mouse must follow the left hand wall.**
- ❑ **The mouse must travel to the maze centre autonomously without touching the walls.**



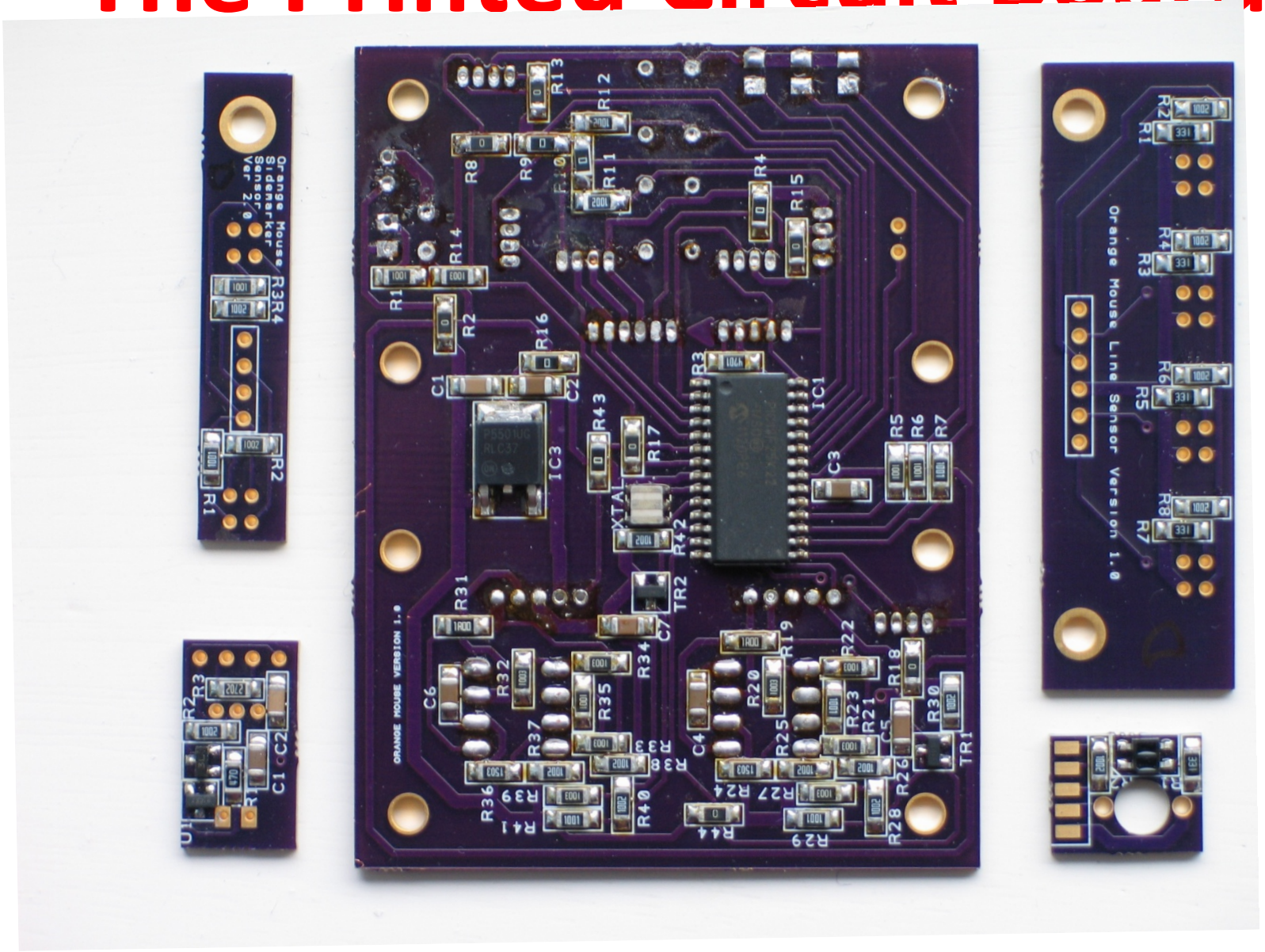
Time Trial

This event features in the IET Robot Triathlon.

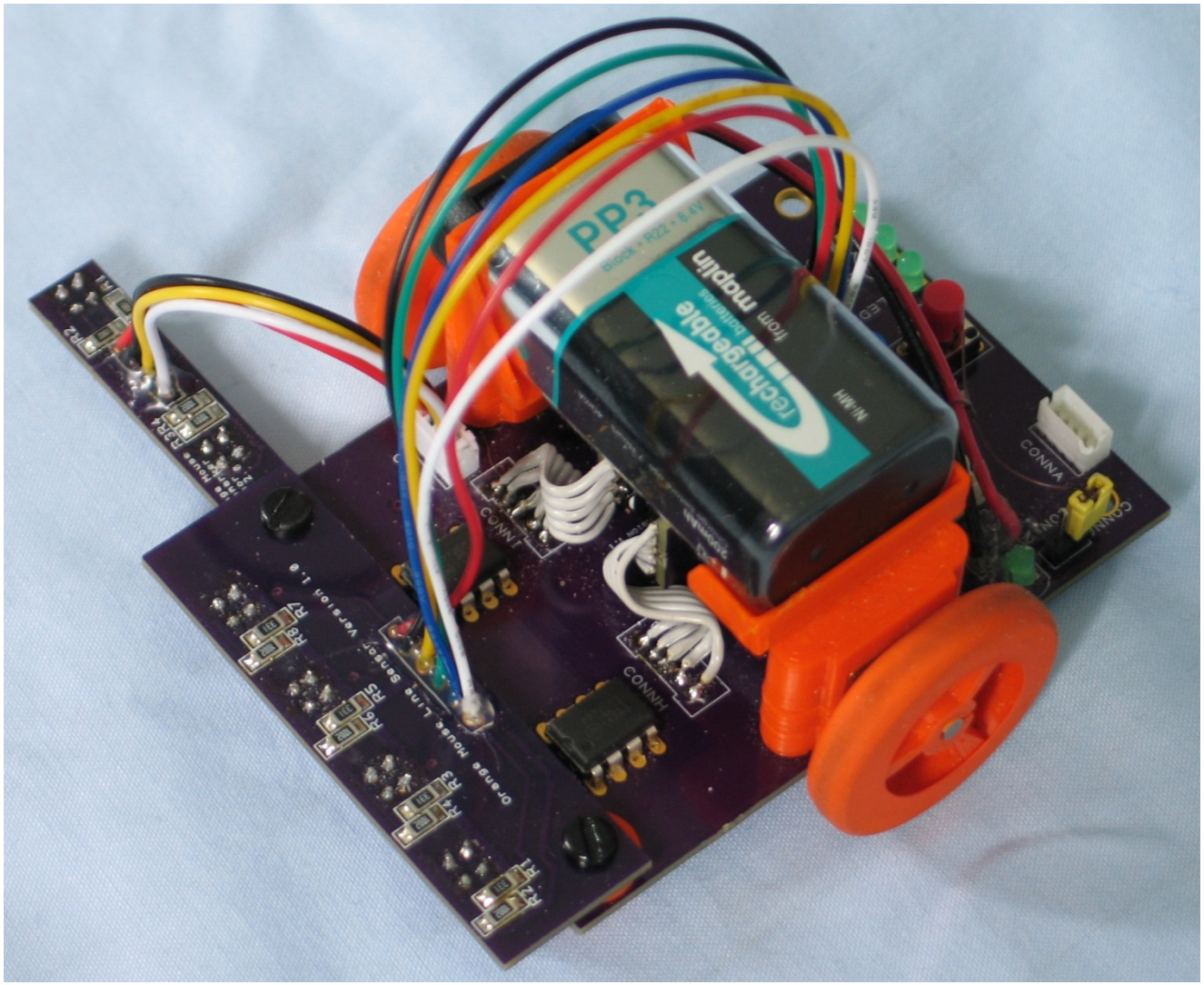
- ❑ **The mouse must follow the left hand wall for the standard course.**
- ❑ **The mouse must travel a figure-of-eight route for the advanced course.**



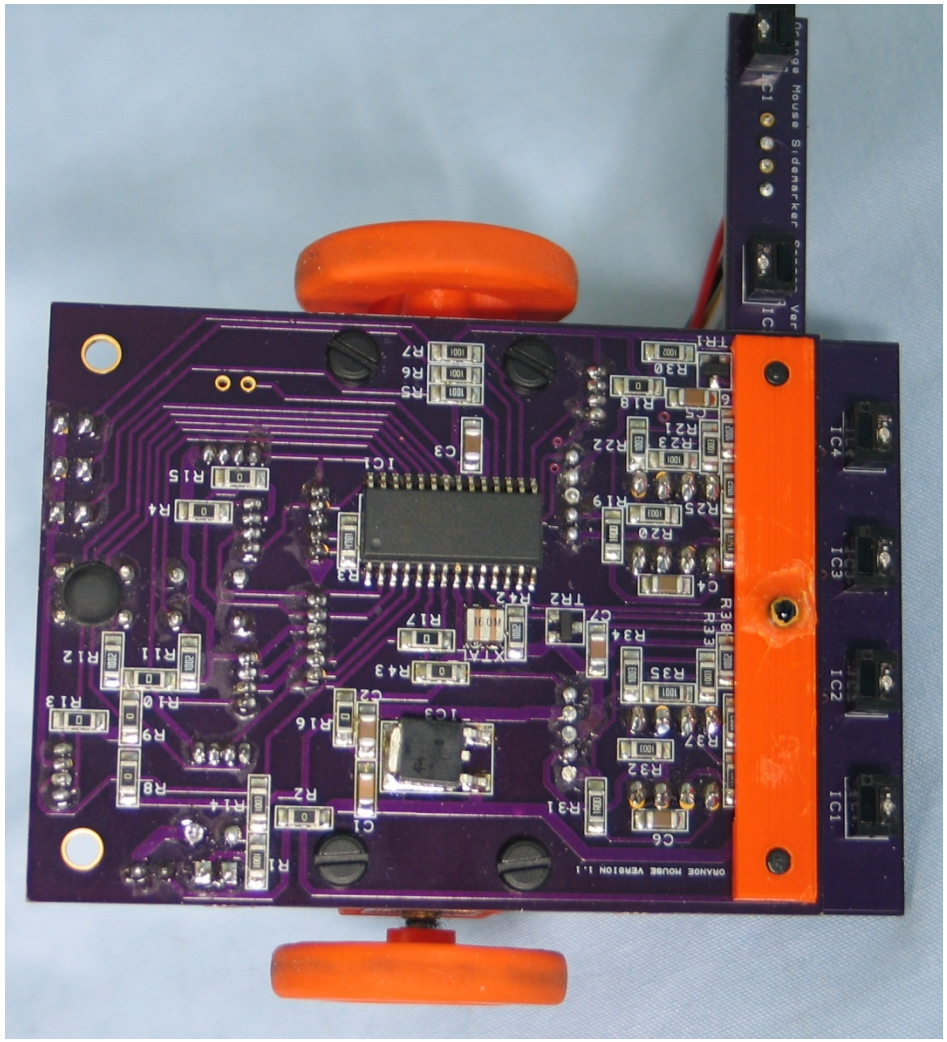
The Printed Circuit Boards



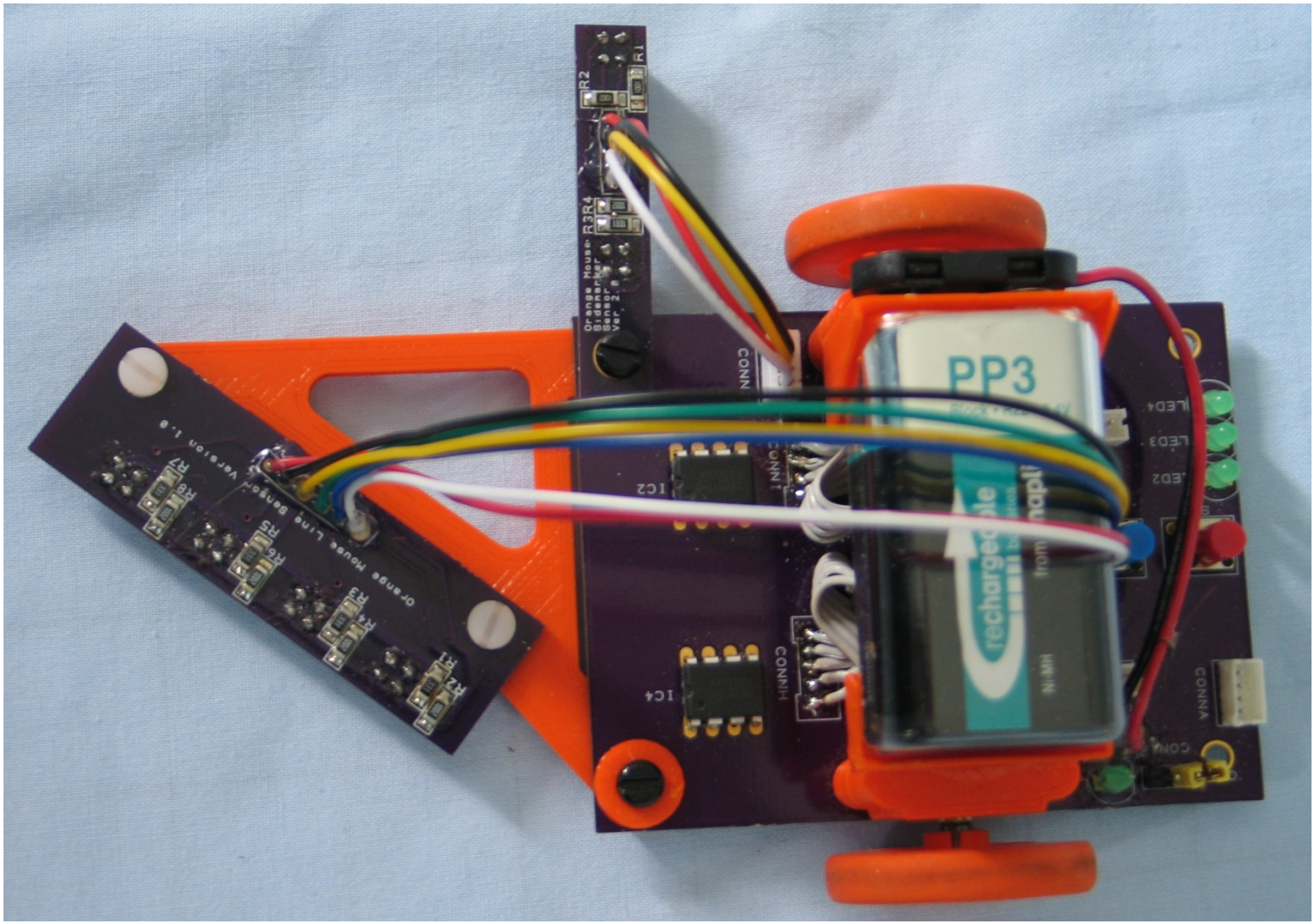
Line Follower Configuration



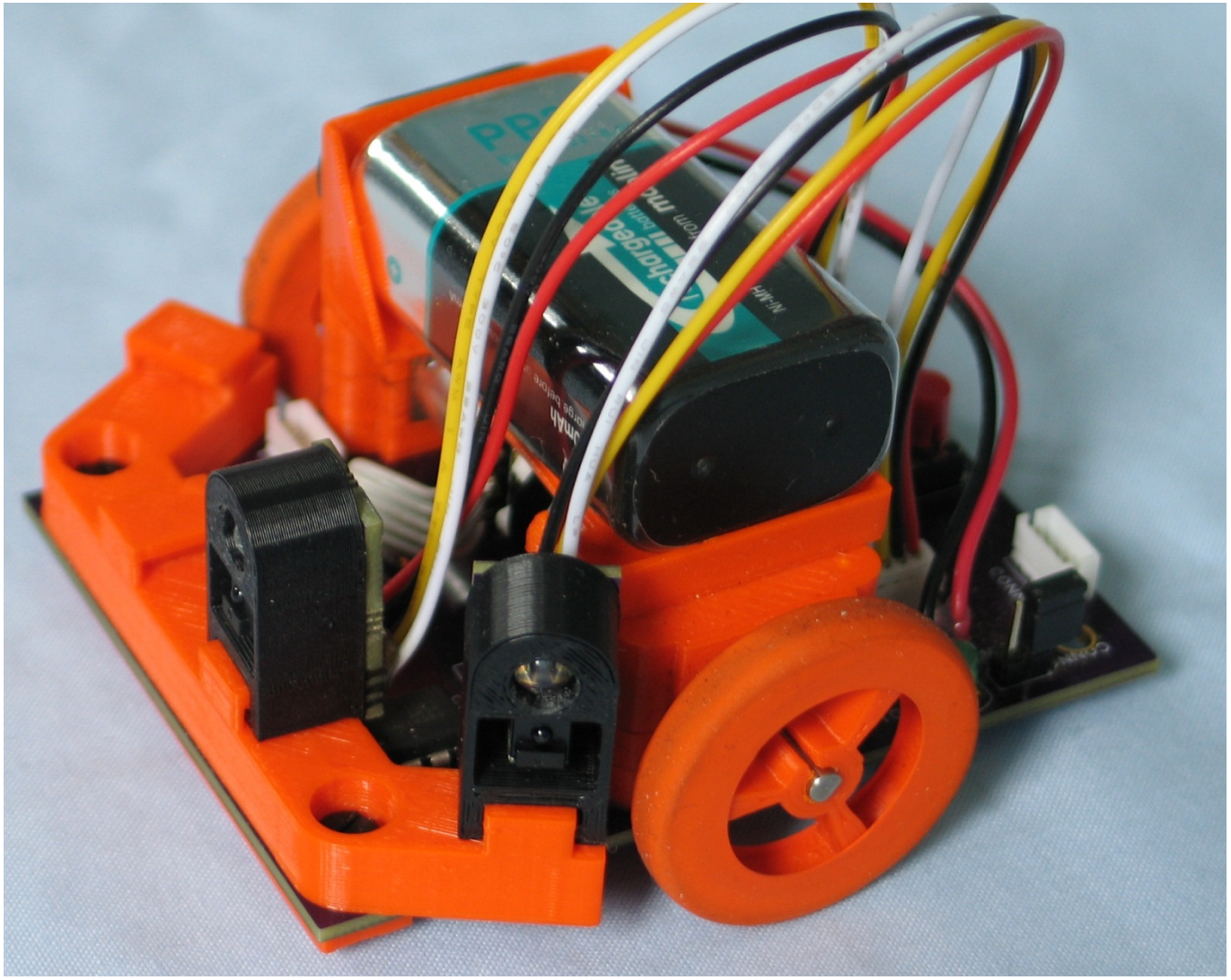
Line Follower Underside



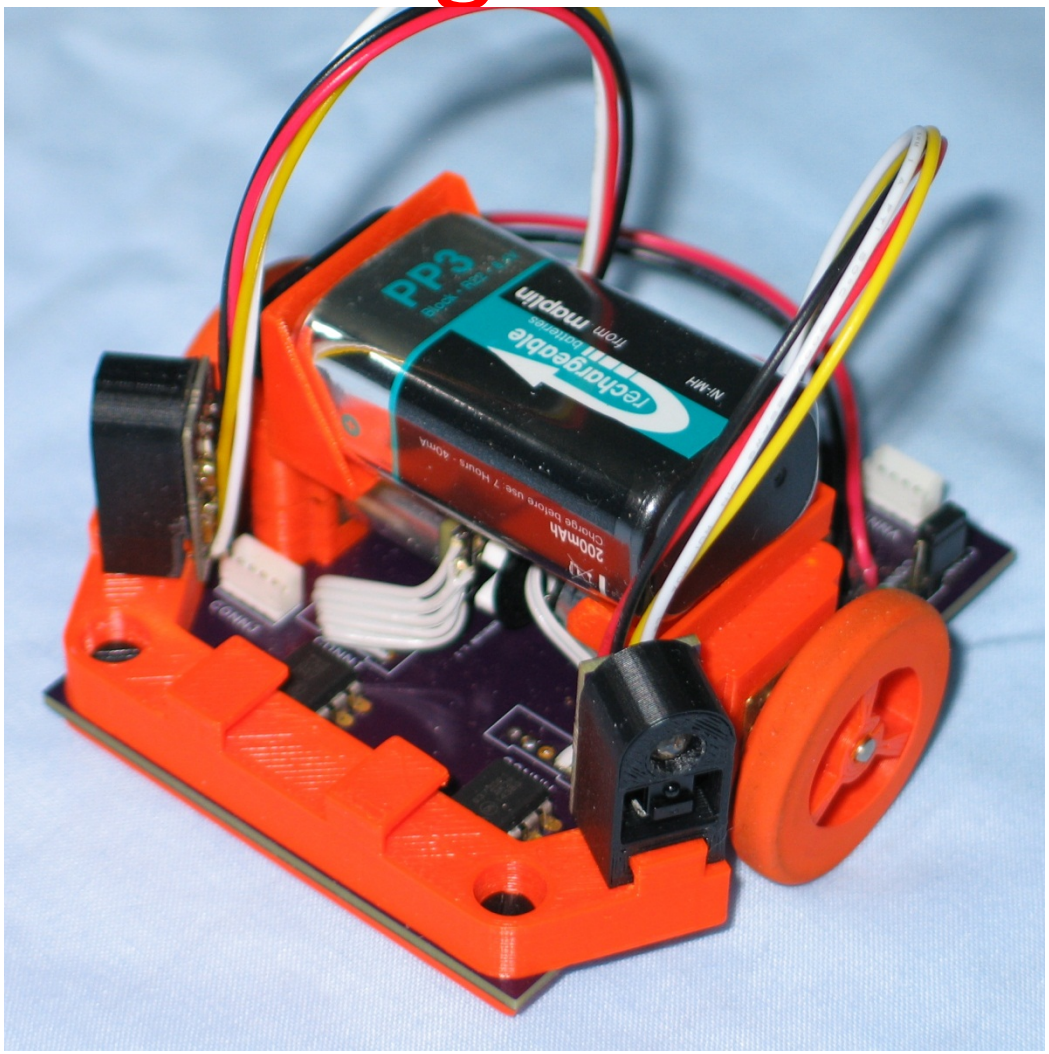
Drag Race Configuration



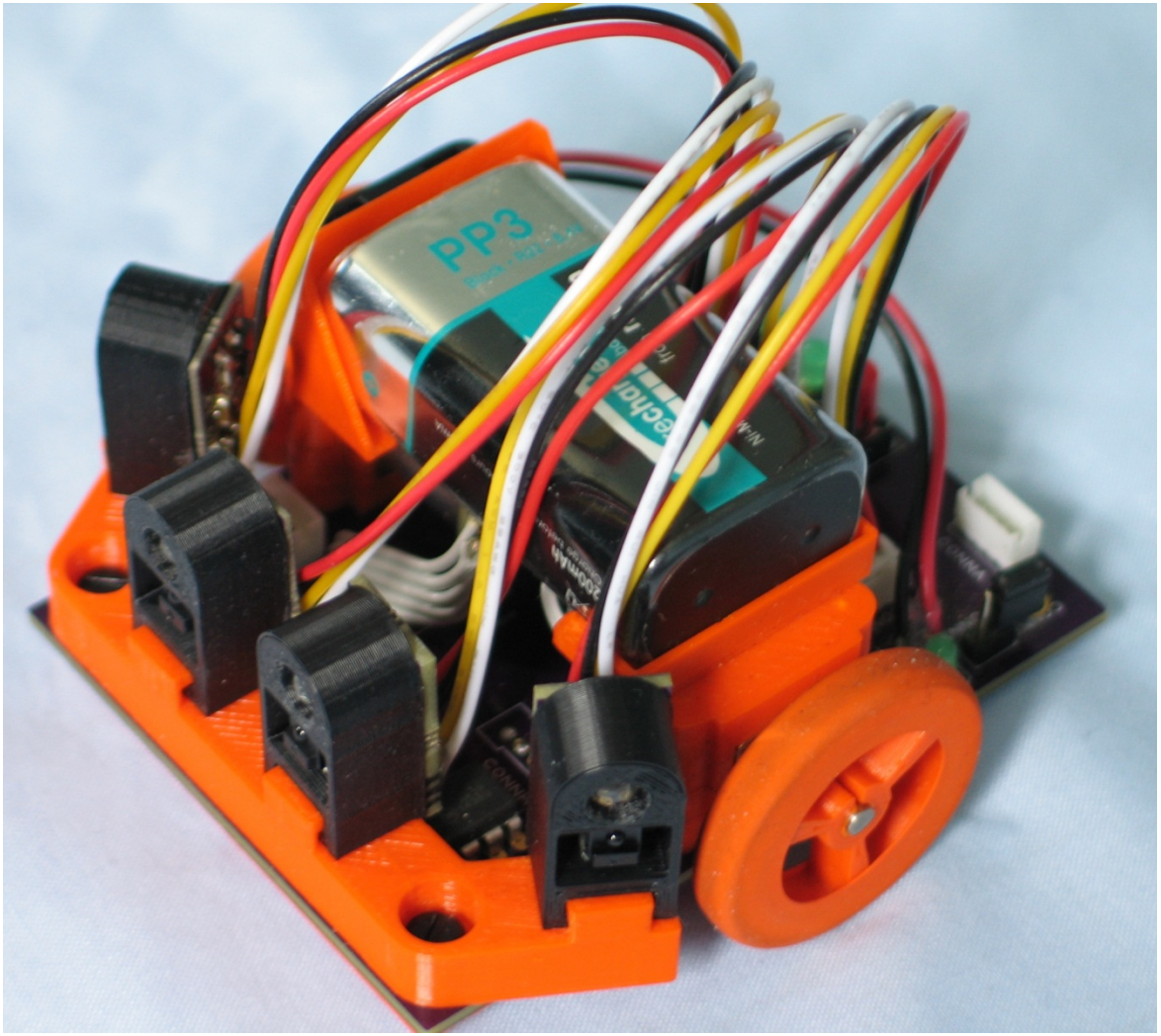
Wall Follower Configuration



Advanced Time Trial Configuration



Future Development?
Maze Solver Configuration



Sub-Systems

When designing the Orange Mouse decisions had to be taken in the selection of:

- ❑ Battery
- ❑ Motors
- ❑ Odometry
- ❑ Tyres
- ❑ Sensors
- ❑ Connectors
- ❑ Programming

Battery Selection

When choosing the Orange Mouse battery the age of the children making it was an important factor.

Alkaline 9V	LiPo 9V	NiMH 8.4V	LiPo 11.1V
46g	26g	31g	23g

Motor Selection

In order to comply with the IET Triathlon rules the motor had to be an N20 type Micro Metal Gearmotor. We found a cheap source on the Pimoroni website.

PIMORONI

Tech Treasure for Tinkerers

Search for a product

RASPBERRY PI | MICRO:BIT | ARDUINO & CO. | KITS | BREAK

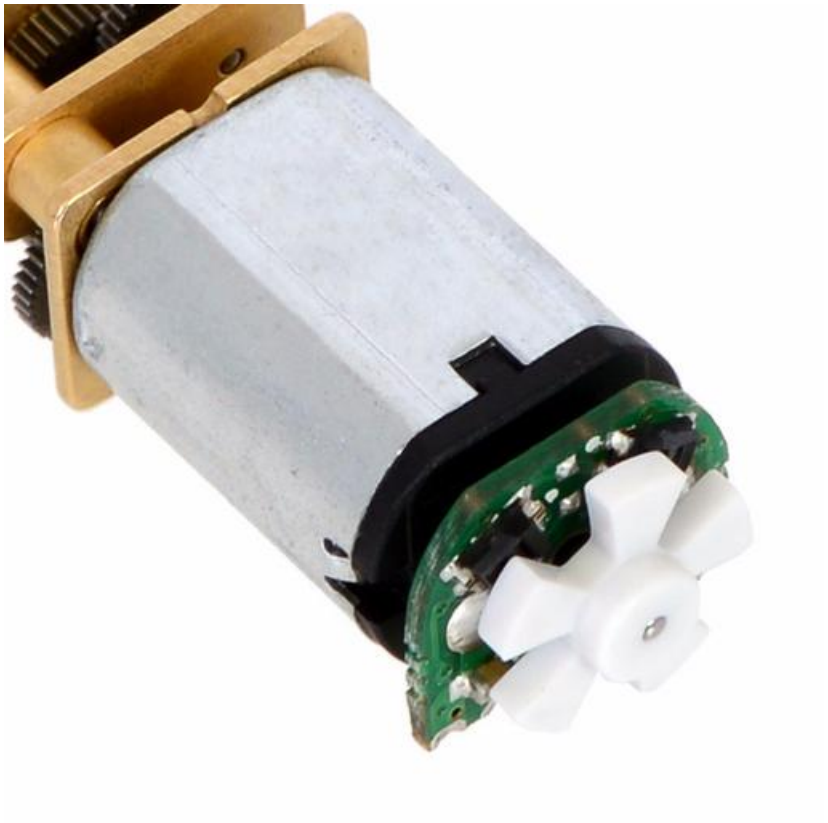
Micro Metal Gearmotor (Extended back shaft

11:1 – £5	ADD TO
20:1 – £5	ADD TO
50:1 – £5	ADD TO
298:1 – £5	ADD TO
1006:1 – £5	ADD TO

Odometry

We needed odometry on at least one wheel to measure the distance travelled in the drag race.

The extended back shaft on the gearmotor gave us a very neat solution.



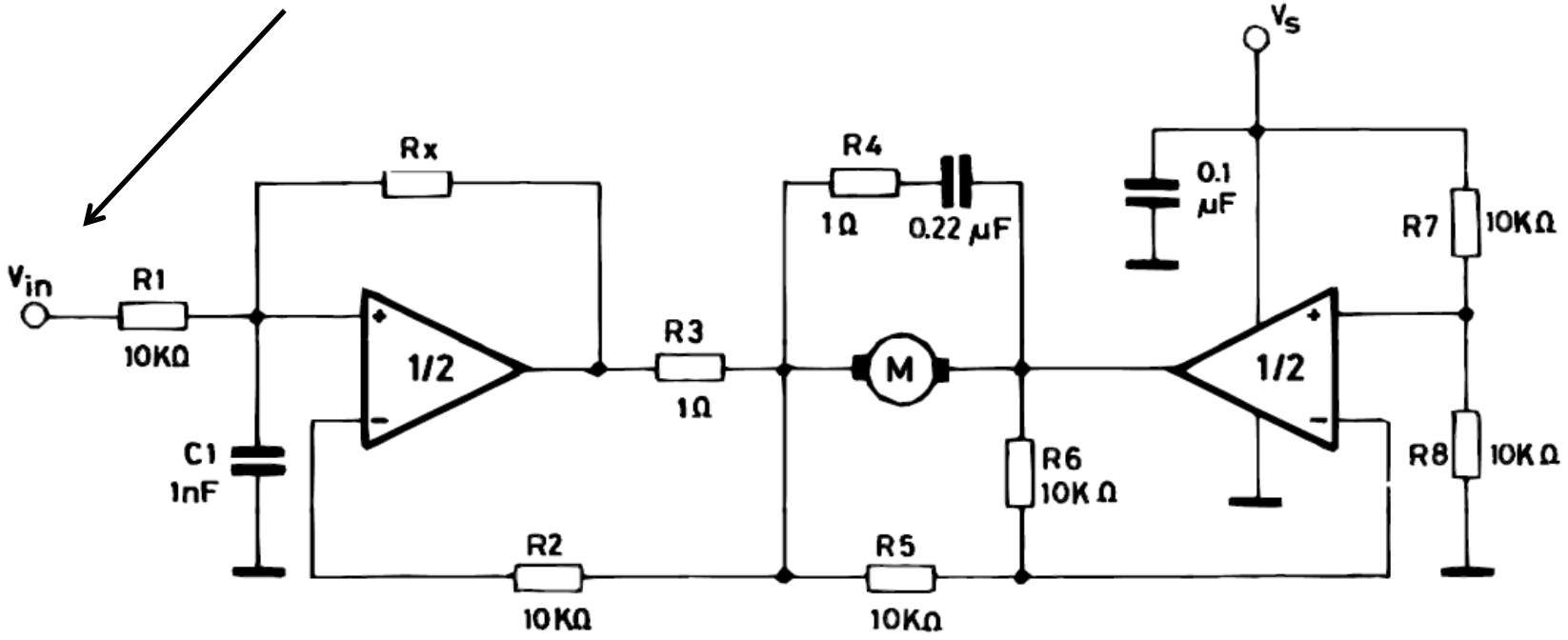
The commercial parts for the optical quadrature PCB were more expensive than the motor!

Duncan produced a simpler design which we used in Orange Mouse

Motor Control Circuit

Bidirectional speed control circuit from TCA0372 Power Operational Amplifier datasheet.

$V_{in} > V_s/2$ forward. $V_{in} < V_s/2$ reverse

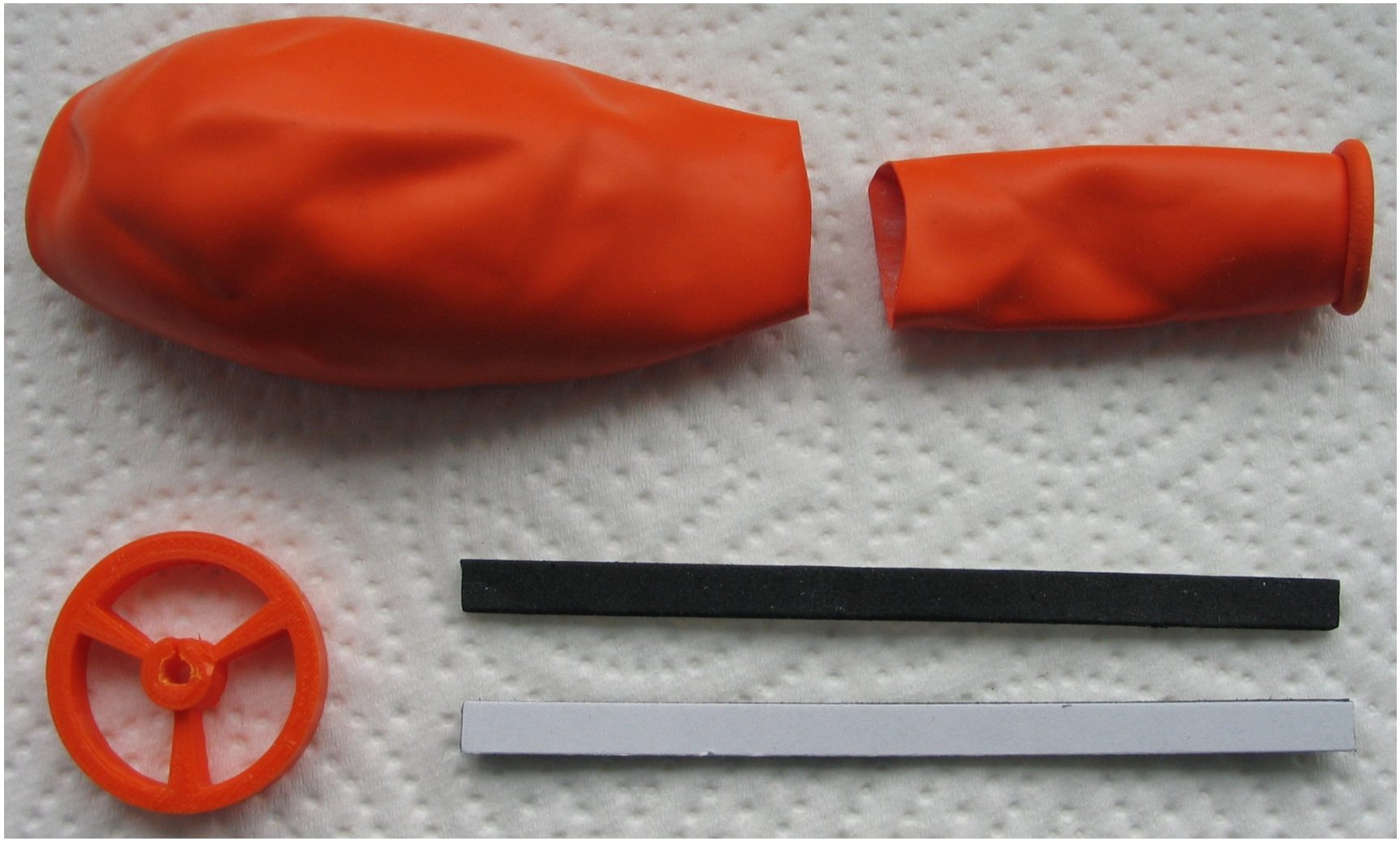


Wheels

The most important factors here were gear ratio, diameter and grip.

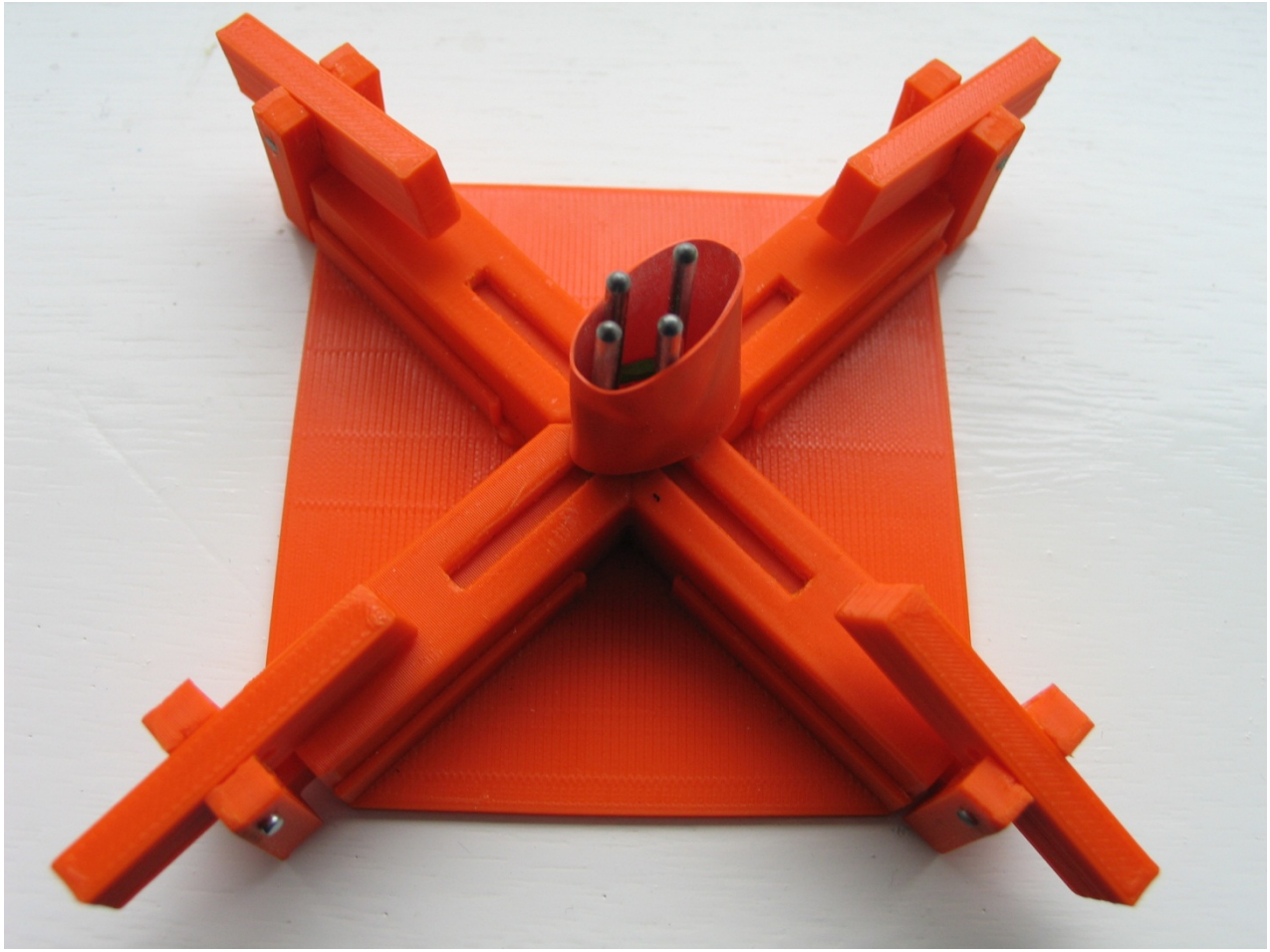
- Tests showed that a 20:1 gearbox and 32mm diameter wheels were well matched.
- We had successfully used balloon rubber tyres in previous designs.
- We found that a layer of foam rubber below the tyre improved the grip.

Wheel Making Kit

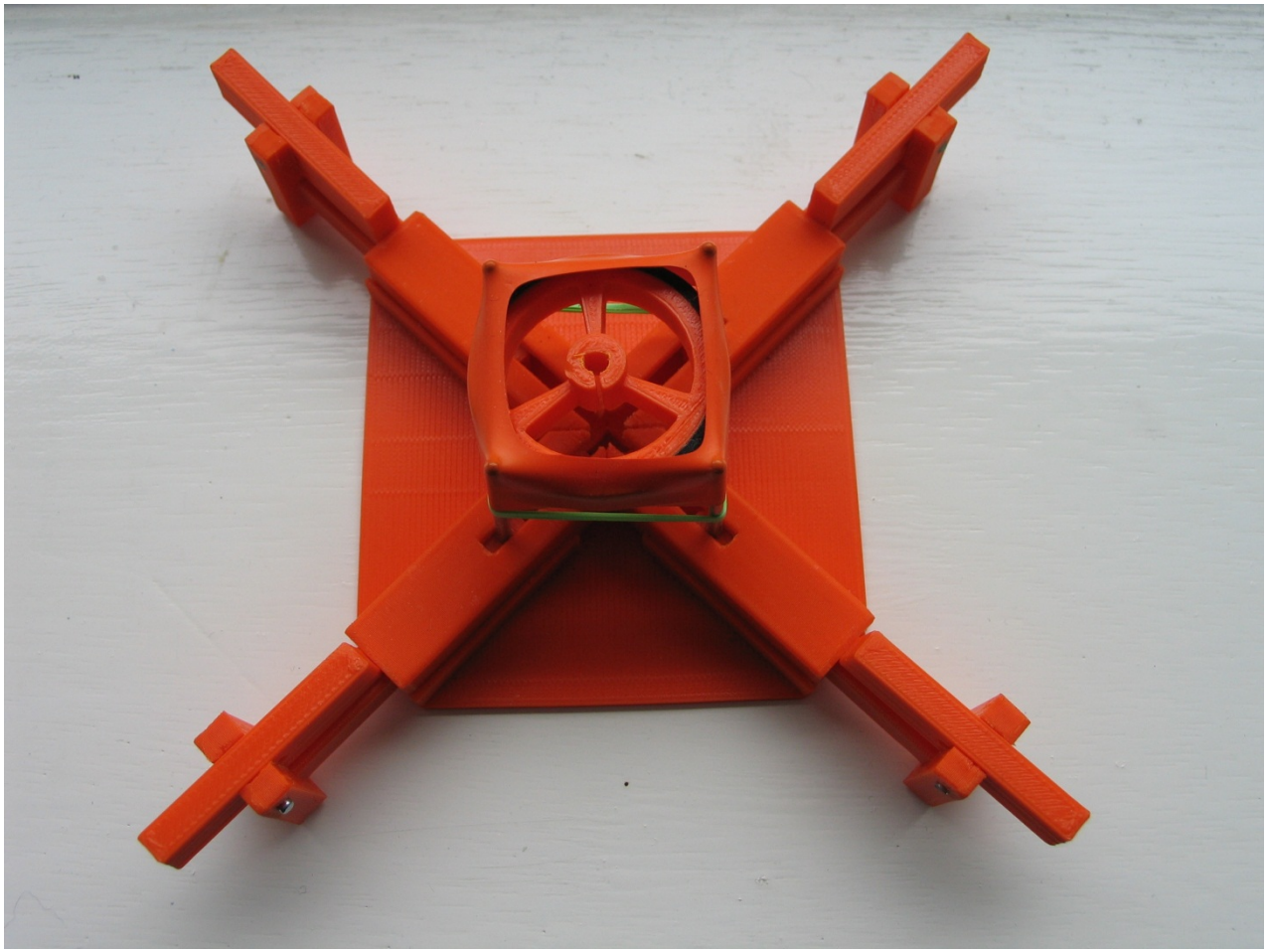


Applying the foam

Stretching the balloon tyre



Fitting the tyre



The finished wheel

Wall Follower Sensors

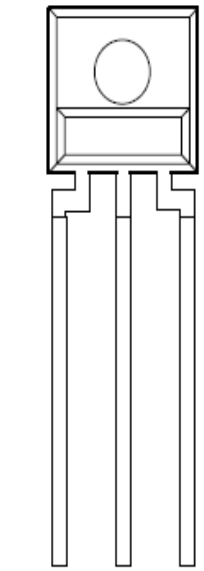
TAOS TEXAS ADVANCED OPTOELECTRONIC SOLUTIONS®

TSL260R, TSL261R, TSL262R
INFRARED LIGHT-TO-VOLTAGE OPTICAL SENSORS

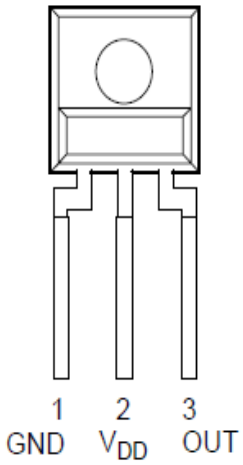
TAOS049C – NOVEMBER 2005

- Integral Visible Light Cutoff Filter
- Monolithic Silicon IC Containing Photodiode, Operational Amplifier, and Feedback Components
- Converts Light Intensity to a Voltage
- High Irradiance Responsivity, Typically 111 mV/(μW/cm^2) at λ_p = 940 nm (TSL260R)
- Compact 3-Lead Plastic Package
- Single Voltage Supply Operation
- Low Dark (Offset) Voltage....10mV Max
- Low Supply Current.....1.1 mA Typical
- Wide Supply-Voltage Range.... 2.7 V to 5.5 V
- Replacements for TSL260, TSL261, and TSL262
- RoHS Compliant (–LF Package Only)

PACKAGE S
SIDELOOKER
(FRONT VIEW)



PACKAGE SM
SURFACE MOUNT
SIDELOOKER
(FRONT VIEW)



Wall Follower Sensors

Round Infrared LED Lamp 5mm

multicomp

OFL-5102

Features:

- Standard 5mm Package
- High Radiant Intensity
- Low Forward Voltage

Maximum Ratings at Ta=25°C

Reverse Voltage (<100 A)	: 5V
D.C. Forward Current	: 50mA
Pulse Current (Pulse Width of 0.1ms, 1/10 Duty Cycle)	: 200mA
Operating Temperature Range	: -25°C to +85°C
Storage Temperature Range	: -40°C to +100°C
Soldering Temperature Dip Soldering	: 260°C for 5 secs
Soldering Temperature Hand Soldering	: 350°C for 3 secs

Electrical & Optical Characteristics at Ta=25°C

Chip			Lens Colour	Dominant Wavelength (nm) at 20mA	Radiant Intensity (mW) at 20mA		Forward Voltage (V) at 20mA		Viewing Angle $2\theta^{1/2}$ (deg)
Material	Emitted Colour	Brightness			Min.	Typ.	Typ.	Max.	
A1GaAs/GaAs	InfraRed	-	Water Clear	940	7	15	1.25	1.5	10

Line Follower Sensors

FAIRCHILD
SEMICONDUCTOR®

June 2013

QRD1113 / QRD1114
Reflective Object Sensor

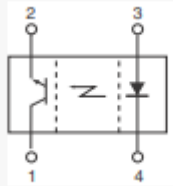
Features

- Phototransistor Output
- No-Contact Surface Sensing
- Unfocused for Sensing Diffused Surfaces
- Compact Package
- Daylight Filter on sensor

Description

The QRD1113 and QRD1114 reflective sensors consist of an infrared emitting diode and an NPN silicon phototransistor mounted side by side in a black plastic housing. The on-axis radiation of the emitter and the on-axis response of the detector are both perpendicular to the face of the QRD1113 and QRD1114. The phototransistor responds to radiation emitted from the diode only when a reflective object or surface is in the field of view of the detector.

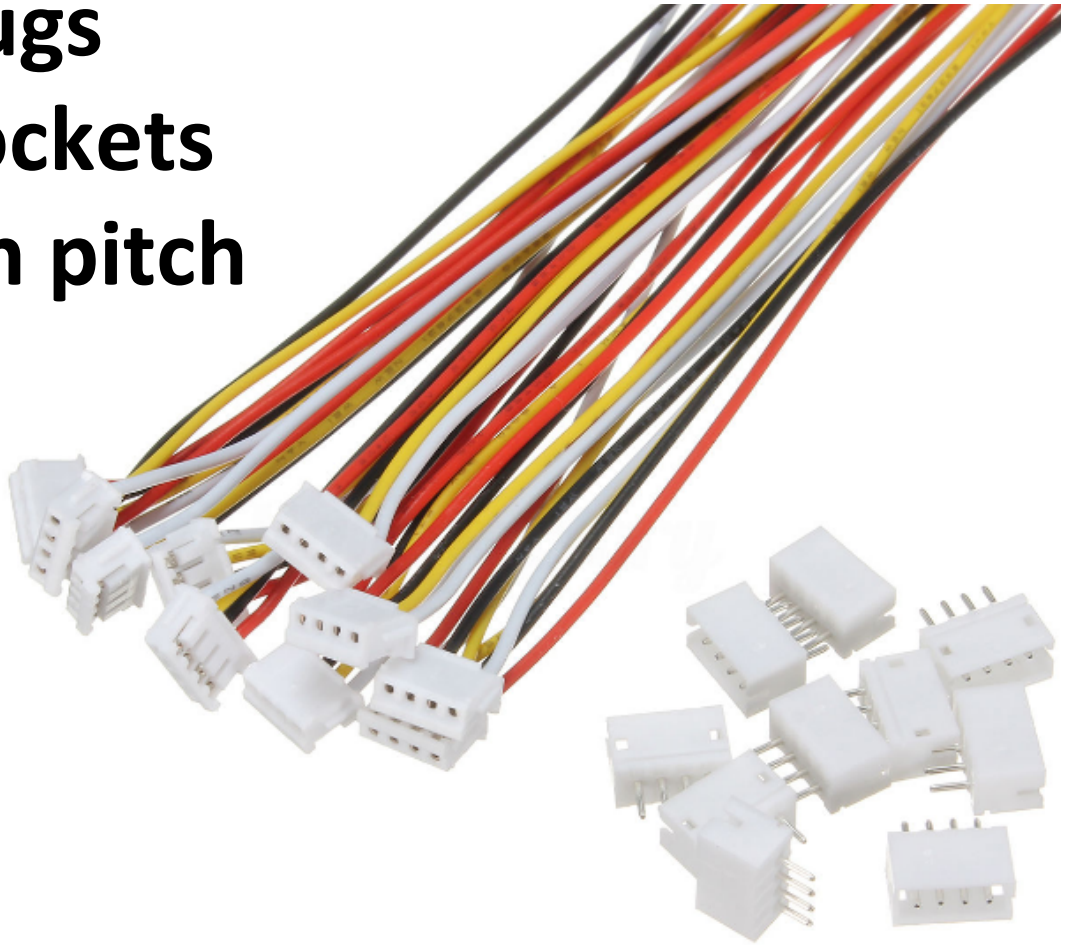
Schematic



PIN 1. Collector PIN 3. Anode
PIN 2. Emitter PIN 4. Cathode

Connectors

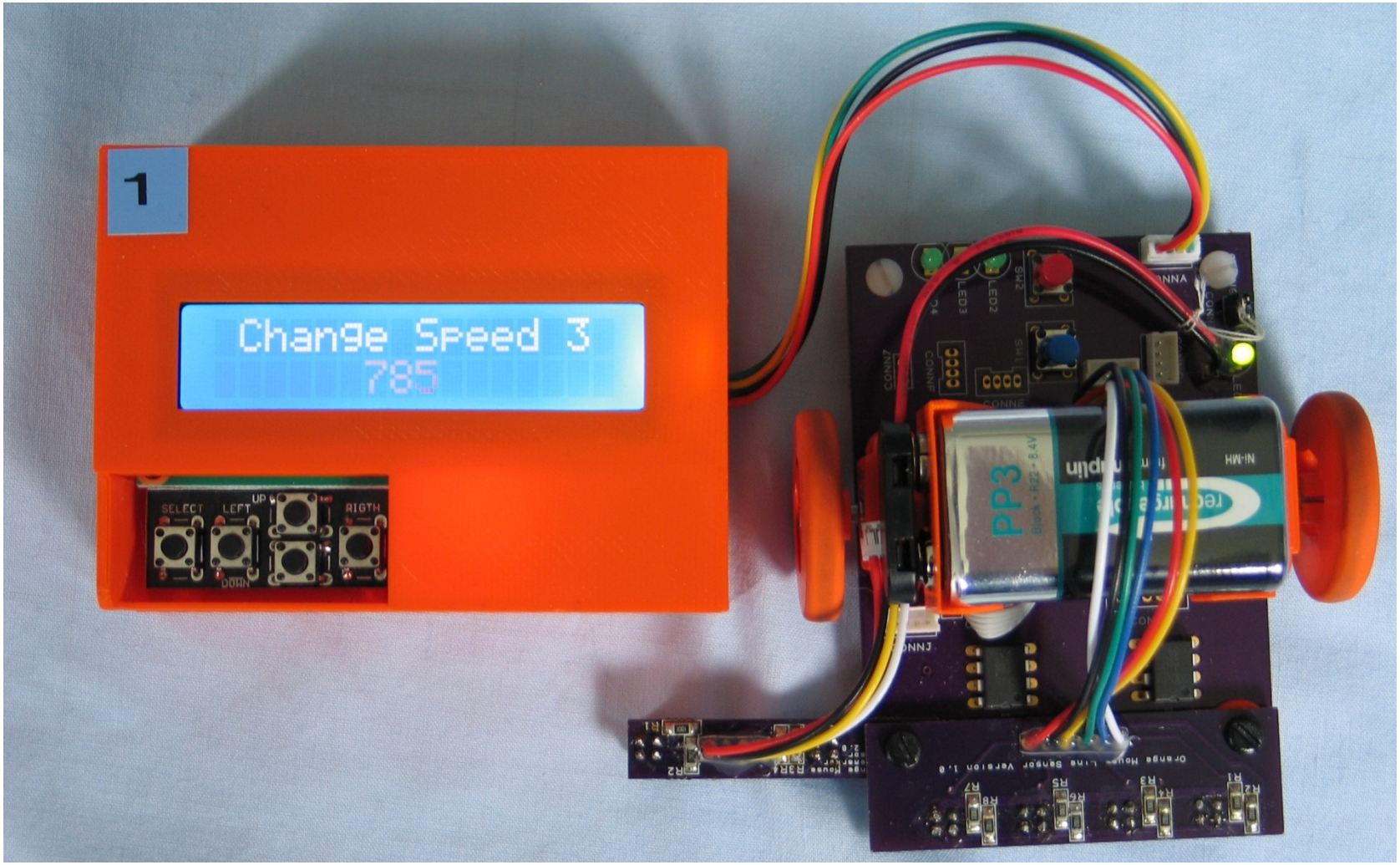
JST Plugs
and sockets
1.5mm pitch



Programming

- The Orange Mouse uses a PIC Microcontroller.
- It is programmed in Proton Basic.
- The program is compiled into assembler code and downloaded using PicKit 2 serial programmer.
- Users do not write the program but have access to the parameters needed to test and tune their mice using a custom programming box.

Testing and Tuning



Wall Following Technique

- Read the left sensor.
- Prioritise left (anticlockwise) turns.
- Read the forward sensor.
- If a wall is detected ahead turn clockwise.
- Otherwise follow the left hand wall.

Line Following Technique

The Line Position from four Analogue Sensor Readings is calculated using the Weighted Average Method:

$$\frac{0 \times \text{Sensor1} + 1000 \times \text{Sensor2} + 2000 \times \text{Sensor3} + 3000 \times \text{Sensor4}}{\text{Sensor1} + \text{Sensor2} + \text{Sensor3} + \text{Sensor4}}$$

Line Following Technique

The Line Position from four Analogue Sensor Readings is calculated using the Weighted Average Method:

$$\frac{0 \times Sensor1 + 1000 \times Sensor2 + 2000 \times Sensor3 + 3000 \times Sensor4}{Sensor1 + Sensor2 + Sensor3 + Sensor4}$$

It works but why?