From the ground to the cloud: recording and publishing scores from a car racing game using a Raspberry Pi

The UK Highways agency makes use of thousands of sensors built into roads and motorways to monitor and predict the flow of traffic. This can be modelled through a simplified game with toy cars.

The objective of this project is to instil the idea that sensors can be built from simple circuits and that the combination of smaller building blocks can be used to build a powerful system that appears to be more than the sum of its parts.

The game can be built incrementally: constructing simple "homemade" sensors aims to teach the students about electrical circuits; reading the sensor data on the Pi introduces students to simple programming using Scratch; and being asked to calculate the vehicle speed based on sensor data introduces students to simple physics.

Learning objectives

In this project students will learn:

- What sensors do and how they can be made from simple components
- How to construct simple circuits using resistors, transistors and light sensors
- How to make observations and record findings
- How to use the raspberry pi to read data from sensors
- Using scratch, how to write a simple computer program to read user inputs
- How physics can be applied to calculate the speed of moving objects

Required materials

The following electronic components are required for each sensor. A typical lesson will require two light gates and two contact sensors and one raspberry pi per group of students. Most science / electronics departments should stock the electronic components and tools.

Sensor	QTY	Component
Light gate	1	Breadboard
	1	2N2222 transistor
	1	OFT3301 IR phototransistor
	1	IR LED
	1	LED
	3	1k resistor
	1	100k potentiometer
Contact sensor	1	1k resistor
		Tin foil
Group	1	Raspberry pi
	1	Power supply
	1	HDMI Cable
	1	Monitor, Mouse, Keyboard
	2	Toy car, track
	1	Power supply

Project Outline

Part 1: Sensors and Introduction to electronics - constructing the sensors

The first lesson introduces students to electronic components including the phototransistor which forms part of the light gate sensor. Students are encouraged to think about where similar sensors are embedded and what these sensors can be used for.

As part of their investigations with the sensors, students are encouraged to take measurements and record observations which will later be used to verify that the sensors will work as expected when connected to the pi.

Part 2: Programming and Reading the sensors on the Raspberry Pi using Scratch

This part of the project introduces students to programming using SCRATCH. Using the Pibrella interface card, students will write trivial programs that contain all the building blocks which will be used for reading the sensors in the final part of the project.

Part 3: Putting everything together – writing a simple game

The first simplest implementation of the game can is given as a step-by-step activity. After students are able to read the information from sensors using the Pibrella board, speeds and times can be calculated using the SCRATCH programming language on the Raspberry pi. At this point it may be useful to save the work and give students free reign to make their own game mechanic and experiment with writing their own software or to summarise and think of how they can use their sensors in the real world.

Limitations

Calculating the speed using the raspberry pi lacks precision. Rather than measuring in meters per second, a more precise speed can be attained using centimetres per second.

Alternative Activity

Rather than measuring time of objects in transit, students can make a game throwing a ball into a cup and counting a score.