Outreach Activity:
Coding with Arduino
## James Dyson Foundation Undergraduate Bursary 2018/19

1 Introduction

The activity involved the programming of an Arduino microcontroller, where the participants completed a set of tasks which increased in difficulty. Tasks were based on interfacing a microcontroller with an ultrasonic distance sensor, as well as a set of light-emitting diodes (LEDs).

(a) Arduino Microcontroller

(b) Ultrasonic Sensor
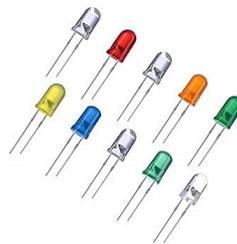
(c) Light-Emitting Diodes

Figure 1: Hardware

First, via a brief presentation, the participants were introduced to the concept of a microcontroller and that it can be used to interface with various types of sensors, as well as control devices such as motors and LEDs. Then, pairs of participants were formed and assigned a desktop computer and given a set of required hardware.

The remaining activity was detailed in a handout, giving preliminary information and information on programming tasks that needed to be completed.

2   Relevance

Programming is an essential part of an engineer's skill set - regardless of their chosen discipline. Learning to program teaches logical thinking and enables the individual to create and implement a vast number of different projects.

Furthermore, microcontrollers can be found in nearly every electronic device and form the basis for many digital tasks such as: signal processing, control, and automation. Thus, an early introduction to these programmable systems is essential for any aspiring engineer or scientist.

Lastly, all individuals involved in creating and developing this project heavily utilised microcontrollers in their final year projects. For instance, the core control unit of the self-balancing bicycle was an Arduino. A brief overview of the project is given in a further document.

3   Tasks

Tasks were presented as a nearly-complete program, with a key element (or line of code) missing. Boilerplate code, such as interfacing with sensors, was already given to the participants. Then, the participants were asked to *fill in the blanks* and solve the required problem using their own lines of code.

The tasks were as follows:

1. **Getting a distance measurement from the ultrasonic sensor**: Use transit time and speed of wave to calculate distance.

2. **Lighting up an LED**: Illuminate a red LED when the distance measured is below 20cm.

3. **Changing the brightness of the LED**: Instead of a simple on-off behaviour, the brightness should change gradually depending on the distance measured.

4. **Controlling a second LED**: Change the brightness of a second, green LED. The LED should get brighter as the distance increases (opposite to the red LED).

4   Outcome

The outreach activity went very well and the participants seemingly enjoyed getting familiar with programming and the Arduino. Even with only a few lines of code to fill in, participants made full use of the one hour time window given to them. Many participants had completed either task 3 or even task 4 at the end of the time period. Thus, the level of difficulty seemed appropriate.

Handout

The handout accompanying this outreach activity can be found as a separate document.

The handout details the process of compiling and running code for the Arduino platform, as well as essential information on ultrasound and LEDs. Most importantly, the tasks to be completed are described in great detail and provide a structured guide for the participant.

Collaboration

This outreach activity was originally developed by David Patterson of CUED (Chief Electronics Workshop Technician, EIETL). It was further developed by the following individuals:

- Philip Salmony: Design of outreach activity handout.

- Matt Coates: Modification of task source code.

- Folajimi Babasola: Design of slides for outreach activity presentation.