UNIVERSITY OF BIRMINGHAM

Internet of Things: Extracting and Reading Data from Sensors

Purpose

With the rise of the Internet of Things, more objects are becoming embedded with sensors and gaining the ability to communicate though the web. Advances in wireless networking technology and the greater standardisation of communications protocols make it possible to collect data from these sensors in real time from almost everywhere.

The aim of this experiment is to build a prototype using a Raspberry Pi computer and an Arduino sensors board to get an understanding of the process of extracting and reading data from sensors with a view to incorporate this technology to processes in the university.

Products Overview

The choice of hardware used for this experiment includes an Arduino board and a Raspberry Pi computer. This choice was made based on the following criteria:

- Cost: the equipment is affordable and inexpensive
- Reliability: Arduino boards are widely used to support sensors and are robust platforms to collect information and to test the principles required by the experiment. Raspberry PI as a low cost simplified computer platform that can be used as the server/web end.
- Access: both Arduino boards and Raspberry Pie are open source, what means access to the API to facilitate the development

What is Raspberry Pi?

Raspberry Pi is a credit-card-size single board 32 bit computer. The original purpose of Raspberry Pi was to promote teaching basic computer science concepts in schools, however because of its low cost and multi functions, it has brought many inventive approaches to computing. Raspberry Pi comes with a New Out of Box System (NOOBS) system and an application store (The Pi Store) website for users to exchange apps.

What is Arduino board?

Arduino board is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It is a single-board 8 bit microcontroller, intended to make the application of interactive objects or environments more accessible. It can be purchased pre-assembled or as do-it-yourself kits. Arduino programs are written in C or C++. The Arduino integrated development environment (IDE) is a cross-platform application that comes with a software library called “Wiring” which provides many common functions for developers.

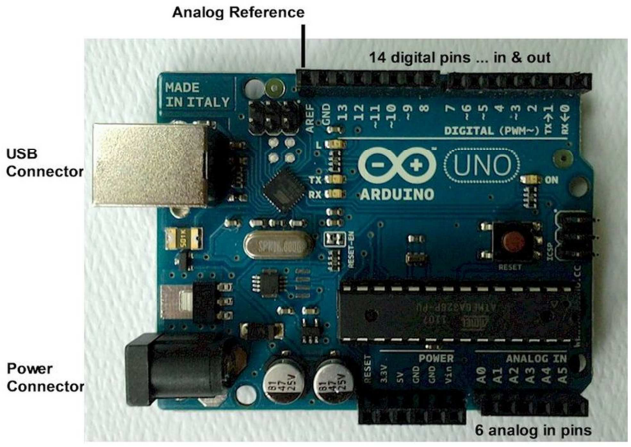

Fig 1 an official Arduino Uno with description of the I/O locations

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Sensors:

A sensor is a converter that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base. Nowadays, sensors are used in many applications including transport, machinery , medicine, manufacturing and robotics.

Experiment Description

The experiment began with setting up the Raspberry Pi and Arduino board, and then moved on to get familiar with the various functions of the products and explore reading data from sensors. The ideal is to explore the potential usage of the products through these fundamental experiments.

The experiment was carried in the following aspects:

1. Setup Raspberry Pi: Assemble the Raspberry Pi box, download the NOOBS installer and install it onto the SD card. Connecting to Raspberry Pi to keyboard, mouse and monitor, select the HDMI mode for the display. So the Raspberry Pi is up and running. Raspberry Pi app store provides users over 100 games, applications and tutorials to further customize Raspberry Pi.
2. Setup Arduino board: assemble the Arduino board, breadboard and the holder; download the Arduino environment, then connect the board to the computer and install the drivers, finally launch the Arduino applications.
3. Once the Arduino board was set up, a range of electronic components was tested with small and simple circuits. LED blinking and fading was first tested, and then a various lighting sequences control was tested with 8 LEDs.
4. Measuring temperature with Arduino board: TMP36 temperature sensor was used in this experiment; it outputs 10 millivolts per degree centigrade on the signal pin, then converting it from digital value to degrees, display the degree on the debug window in the Arduino IDE environment.
5. Further experiment planned includes using an Arduino to send email whenever movement is detected with a PIR sensor, this could be useful in the building and office security. And wireless gardening, using a soil moisture& temperature sensor connected to an Arduino and a Wi-Fi Chip to automatically send measurements from the garden to the cloud or the hosting computer.

Findings

- Raspberry Pi and Arduino board are viable products to prototype extracting and reading data from sensors.
- The Internet of Things is an area developing very fast. There are several themes that could benefit from further investigation:

    a) Tracking behaviour: When sensors are embedded in products to track users' behaviour, eg: wearable sports gear with sensors to encourage a healthy lifestyle, sensors that track shopper's profile data (stored in their membership cards) and help them make purchase decisions by providing additional information or offering discounts.
    b) Enhanced situation awareness: achieving real-time awareness of physical environments. For example, security personnel can use sensor networks that combine video, audio and vibration detectors to spot unauthorised access to a site.
    c) Sensor-driven decision analytics: assisting human decision making through deep analysis and data visualisation. Examples include continued monitoring of chronic diseases to help doctors determine the best treatments.

Recommendations

- There are possible scenarios in the university where sensors could be used to improve processes, for example, a sensor-driven gym equipment management tool could help the gym managers optimise the use of equipment, e.g.:

Currently, the Sports Centre hires a company –Gymetrix- to gather information on customer demand before buying new equipment. Every Gymetrix visit costs £ 4000 pounds. What Gymetrix does is to attach wireless sensors to every piece of equipment to measure when it is in use. It also conducts customer surveys about favourite equipment and customer experience.

A sensor-driven gym equipment management tool built in-house could provide a continuous feed of real time data on sports equipment usage to the Sports Centre managers. Managers could use this information to monitor the availability of gym equipment and make the most suitable, flexible arrangements to meet demand for certain types of equipment during peak times. For the public, customers could know how busy the gym is at a certain time.

- To pursue the prototyping/development of this technology any further it is advisable to liaise with teams of experts in the areas of Engineering and Robotics in the University.