Brewduino

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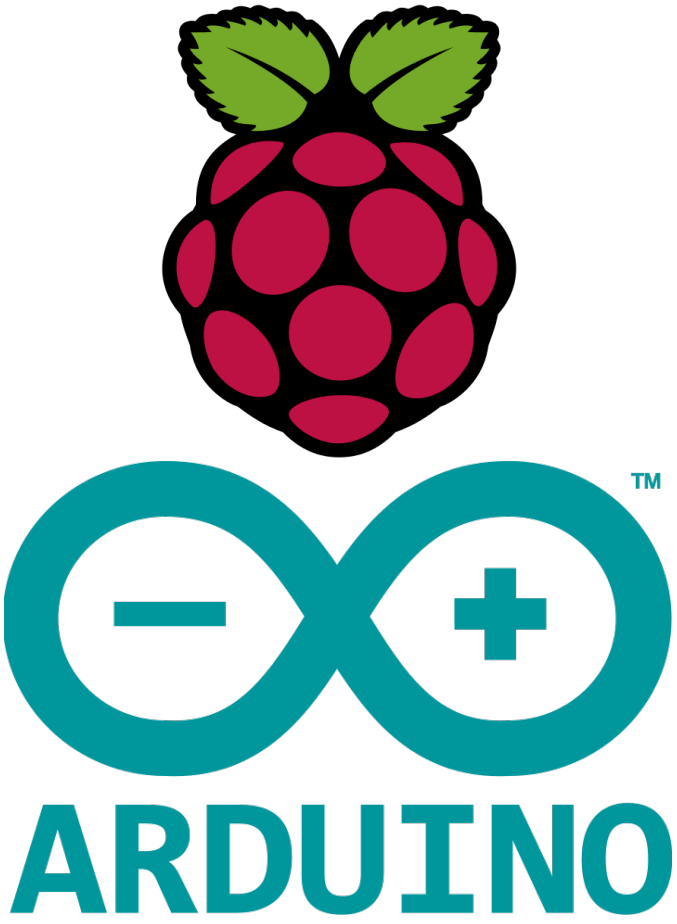

CS413 Embedded Systems

Group One

Phase One Report

University of Strathclyde, Glasgow

We confirm and declare this report and the assignment work is entirely the product of our own efforts and we have not used or presented the work of others herein.

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Contents

Introduction

The initial scope of the assignment is to design and implement an embedded systems 'gadget' with the use of an Arduino and/or a Raspberry Pi.

After a week of discussion, we have decided to implement the Hyper Text Coffee Pot Control Protocol (HTCPCP)[3], with a system that allows the user to send requests for coffee over internet for either immediate or future consumption. A server will be implemented to handle the requests to be sent to our Arduino controlled coffee pot, which will then create coffee on demand. In addition, we hope to include the functionality of adapting the Barduino, a project from a previous year, to supply milk or other ingredients to a user's drink as well.

Assessment of Capabilities

Arduino

The Arduino is an open source microcontroller primarily aimed at electronics prototyping. It can interact with various components such as LEDs, motors, etc. Software can be used to control these sensors, actuators and other electrical components, making it a popular product for use in such projects, especially in education.

As it is a microcontroller it is designed to interact with analogue inputs of the outside world, which the Raspberry Pi does not have the ability to do as it can only deal with digital I/O (via GPIO). This allows easy collection of data through various sensors.

The Arduino Uno is the microcontroller we have decided to use for this project, as it meets the requirements for our project, listed below:

- Has sufficient size of onboard flash to hold the main program.
- Can be easily extended through the use of shields for additional hardware interface requirements.
- Uses 5V supply, meaning it does not require any power transformers to be compatible with other components (i.e. Raspberry Pi).

The primary disadvantages of the Arduino when compared to the Raspberry Pi is its lack of network capabilities, and the Arduino's lack of processor power. The Pi allows us to run the necessary independent web server, and make it accessible to an external client. Due to this the Pi shall be used to do any computationally intensive tasks and use the Arduino to interact with the other hardware.

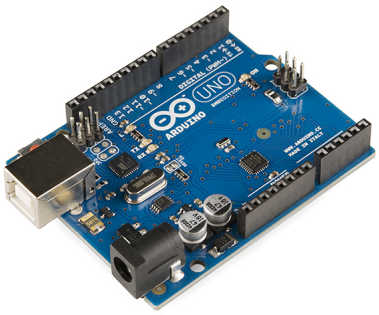


Figure 1: Arduino Uno.[2]

Specification

This is taken from the official specification sheet found here[1]:

Microcontroller	ATmega 318P
Operational Voltage	5V
Input Voltage	7-12V
Input Voltage (Limits)	6-20V
Digital I/O	14 (6 PWM)
Analogue Input	6
DC Current per I/O Pin	40mA
DC Current per 3V Pin	50mA
Flash Memory	32KB (0.5KB reserved for bootloader)
SRAM	2KB
EEPROM	1KB
Clockspeed	16 MHz
Price	$21.97

Raspberry Pi

The Raspberry Pi is a single-board computer with a small form factor (roughly the size of a credit card), which was created as an educational tool by the Raspberry Pi Foundation.

It commonly uses the Linux operating system, and has a Broadcom system on a chip, which includes an ARM1176JZFS, with floating point, running at 700 MHz, and a Videocore 4 GPU. It is also capable of 24 GFLOPS of general-purpose compute and features several texture filters and DMA infrastructure. The Pi's OS must be booted from a microSD card though an external storage device can be used afterwards.

The Pi is a more powerful device than the Arduino, since it is designed as a computer out of the box, and therefore has more capabilities rather than just being a microcontroller. This makes it ideal for acting as a middleman between the user and the Arduino.

The Pi will be used to run the Java Spring application allowing it receive requests from external clients. It can then handle their requests and interact with the arduinos to operate the Coffee machine and Brewduino. This means our most likely course of action will be accessing the Pi through its IP address in the user's browser.

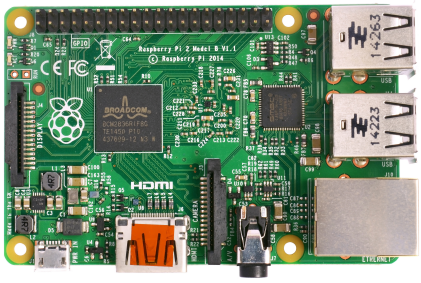


Figure 2: A Raspberry Pi Model B.[4]

Specification

For a full specification, it can be found on the Raspberry Pi's website [5].

System on Chip	Broadcom BCM2836
CPU	900 MHz quad-core ARM Cortex-A7
Memory	1 GB
Ethernet (Limits)	10/100 Mbits/s
USB 2.0	4 Ports
On Board Storage	MicroSD slot
Price	$16.00

Development Environment

The development environment that we shall use for the Arduino is the Arduino Integrated Development Environment (or Arduino Software (IDE)). For development on the Pi we will be using Raspbian with a Java Spring application acting as our web service for the system. For software development, the Git version control and GitHub's issue tracking will be used for convenience.

For the purposes of sharing documents such as the user manaual and technical guide, a Google Drive folder will be shared, allowing for the use of Google Docs allowing an easier way to simultaneously work on documents. Smartsheet will be used for the production of Gantt charts for the same reasons.

Additional Resources

Note: since we felt we had relatively few additional components, we felt at this stage a full spreadsheet would be superfluous and thus omitted.

Coffee Pot

Since the HTCPCP is all about sending requests for coffee, a coffee pot is naturally required for the whole thing to work. We have decided on the Andrew James 1100 Watt Digital Filter Coffee Maker.

Price: *$*27.99

Purchased from: Amazon UK

Barduino

As part of our project, we have found the potential of adapting the Barduino, a previous year's Embedded Systems project into our own, for the use of supplying the coffee with milk and other ingredients if desired. Since the project owners have not claimed it, it has been deemed available for appropriation.

Price: *$*0.00

Purchased from: N/A

Servo Motor Controller

Price: *$*20.50

Purchased from: Pimoroni

Figure 3: The Coffee Maker

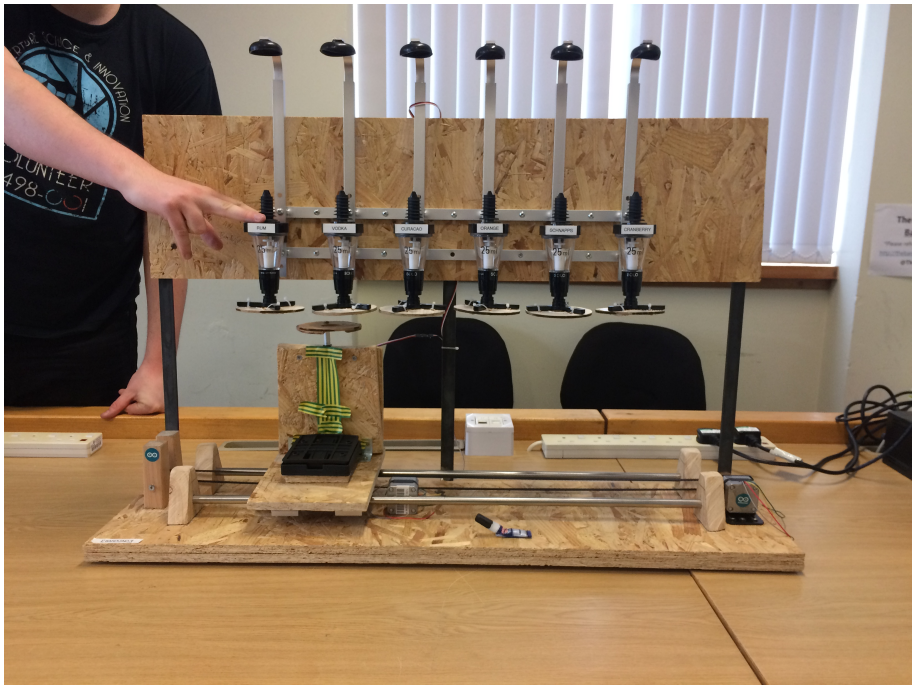
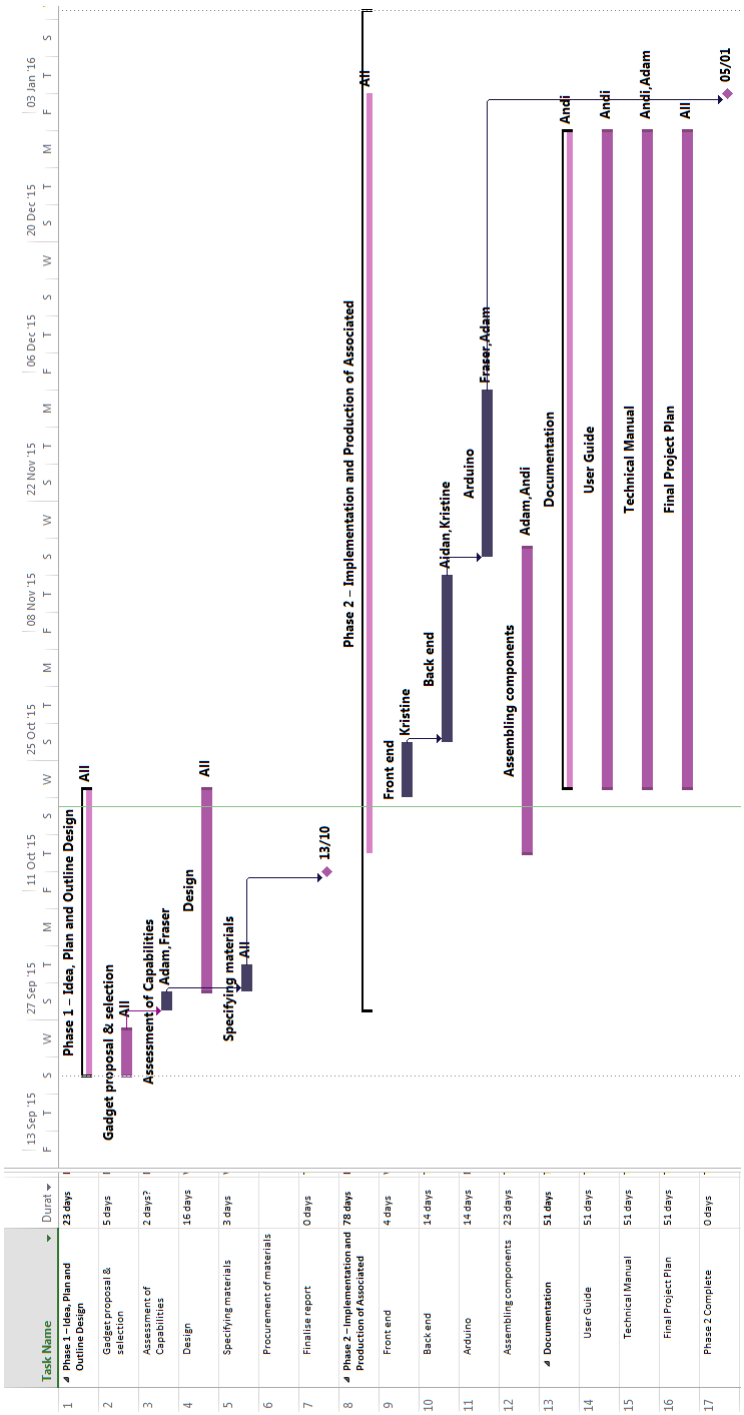


Figure 4: The Barduino

Planning

A high-res version is available at:



Design

Overall

The User goes onto the Brewduino webpage (available through Pi's IP address) and fills out a form specifying the type of coffeee that they want. The Spring application wll recieve these requests. Accepted requests will be passed to Arduino, which will execute code determined by the form's values.

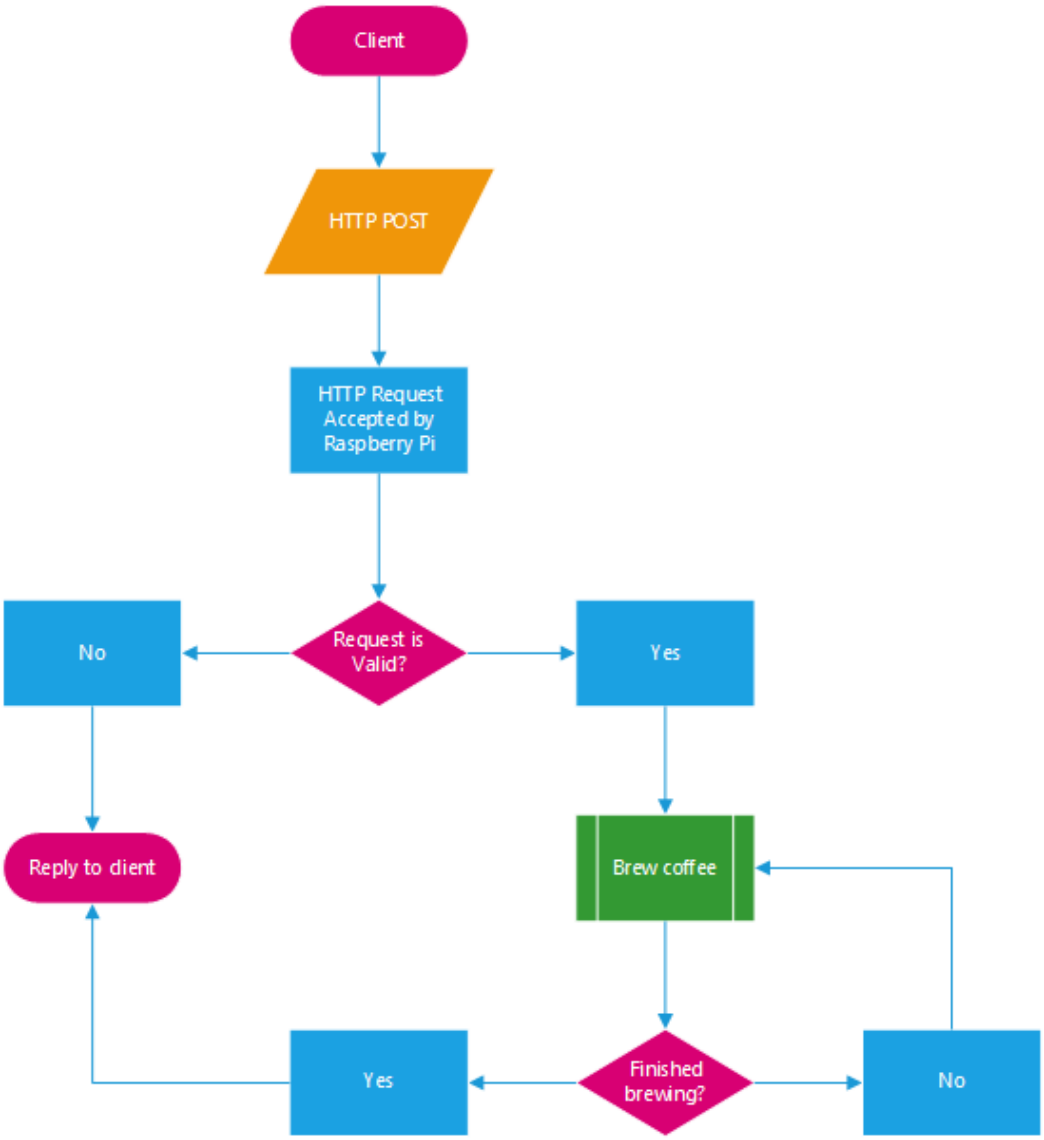


Figure 5: A flowchart defining how the overall system works

Hardware

Software

There are three primary components of the software side of this project. Those are:

- A website through which users can order coffee.
- A Java Spring application to handle the above requests and pass to Arduino.
- The Arduino software triggering the coffee brewing and serving.

The typical user will only be exposed to the website aspect of this stack, which will be able to provide all neccessary information through the website, such as when there is no coffee available.

Website

The website is relatively simple. In order to obtain coffee, all they need to do is complete the form that is provided to them. Given the current set up, the URL is likely to be of the form IP:8080/brewduino, where IP is the address of the Pi. The system will ideally provide the user information such as the amount of coffee available right now, and how many requests are currently in a queue to be filled.

Java Spring Service

The Raspberry Pi will be hosting a Java application utilising the Spring framework to allow for us to take the form submission and act upon it in Java. This has the advantages of allowing communication between the Java application and the user, as well as between the application and Arduino.

The Java application is made up of four core classes, this system is a spin-off of Spring's guide on Handling Form Submissions[8] (due to the structure of this, a class diagram was deemed unsuitable for provision):

- Application
  - Main method runs the system here, through the Spring framework, making it an extermely simple class.
- Brewduino

  - This class acts a data structure representing the form the user fills out on the website. Each field in the class represents a part of the website's form.

- BrewduinoController
  - This class handles the requests sent from the user to the Pi, and acts upon them. It will validate the user's input, and communicate with the Arduino to fulfill the request.

- Arduino
  - This class handles all communication with the Arduino, acting as a middleman between the Arduino and the BrewduinoController.
  - The Arduino class will make use of a suitable framework, such as JArduino[7] or ZXTX[6] to handle communication with Arduino.

Current Progress

When we started this assignment, the Brewduino was not our original concept. The initial idea was to create a Dalek (or Dalek like machine) whose camera could be viewed in a browser. However, we decided to go with the Brewduino project after it was suggested a couple of weeks later, since we felt it would be a more interesting project to tackle compared to the Dalek.

So far, we have acquired the coffee pot and commandeered the Barduino for our project. In addition, an early start has been made on the Spring application, since some development was done as part of the research into its feasibility and suitability for the Brewduino.

An attempt has been made on the disassembly of the coffee pot we are using to be connected to our Arduino, although that has not been completed (see the plan for the projected completion).

References

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[3] L. Masinter. Rfc 2324 - hyper text coffee pot control protocol (htcpcp/1.0). https://tools.ietf.org/html/rfc2324, 1998.

[4] Multicherry. Raspberry pi: Model b v1.1. https://en.wikipedia.org/wiki/File:Raspberry_Pi_2_Model_B_v1.1_top_new_%28bg_cut_out%29.jpg.

[5] Raspberry Pi. Raspberry pi model specifications - raspberry pi documentation. https://www.raspberrypi.org/documentation/hardware/raspberrypi/models/specs.md.

[6] Rxtx. Rxtx. http://rxtx.qbang.org/wiki/index.php/Main_Page.

[7] SINTEF-9012. Sintef-9012/jaruino. https://github.com/SINTEF-9012/JArduino.

[8] Spring. Getting started - handling form submissions. http://spring.io/guides/gs/handling-form-submission/.