EMBEDDED LINUX PROJECT PLAN
Spring 2017

AquaPi: A Self-Watering Plant System

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PROJECT DESCRIPTION:

Self-watering plant system. For this project we use a moisture sensor, a water pump, and a temperature/humidity sensor. We activate the mechanism once the moisture sensor shows that the moisture in the soil is low. This causes the pump to activate and water starts flowing to the plant. The temperature and humidity sensors are used to keep track of the temperature and humidity around the plant. All of these are monitored from a web application that shows the current moisture level and both the temperature and humidity.

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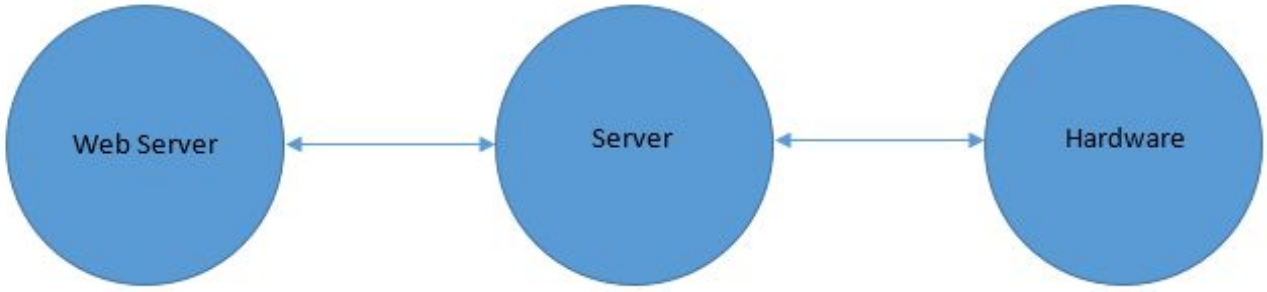
1. Project Goals:

It is predicted that by 2020, IoT based devices will reach a staggering 50 billion objects. This averages to roughly six and a half devices per person. While IoT usually catches the interests of those in technology fields, it is clearly an influence on everyone's daily lives. Most users may not even recognize they are using a device that could be classified as an IoT device.

The best part about IoT devices is that it will benefit everyone type of person in society. For our project, specifically, water pump is something that can help anyone control the water given to a plant at a given time. This delivers an easier and safer user experience that can include turning water pump on and off, seeing if the server is running, and with our project, soil moisture level. Controlling devices such as water pump and temperature sensor can have an impact on a reduction in energy costs, water costs and comfort for your plant. It can also be very useful to the elderly and disabled, these individuals that have access to the internet to operate devices around their house can minimize the effort and movement that is usually required to complete these tasks.

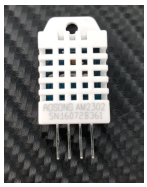
2. Project Implementation Details:



3. Project Breakdown:

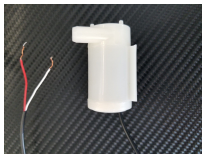
There were multiple hardware components to this project that makes it work properly. The hardware components are explained in details below:

- **Temp/hum sensor:**



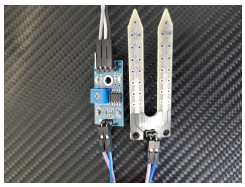
The DHT22 is a basic digital temperature and humidity sensor. It uses a capacitive humidity sensor and a thermistor to measure the surrounding air, and spits out a digital signal on the data pin. In our case, the sensor is used to measure both the temperature and humidity around the plant. The data collected from this sensor is saved into a database.

- **Submersible water pump:**



This Mini Water Pump is submersible and takes a voltage between 6 and 12 Volts. It has a motor inside it which pumps water in through the hole at the bottom and pumps it out the spout on the side (plastic tubing can be attached to the spout to reroute the liquid). A common task such as watering plants is easy with this water pump into the soil when the moisture levels are low.

- **Moisture sensor:**



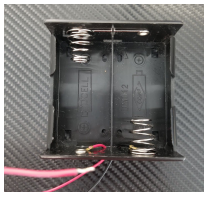
YL-69 moisture sensor. The soil moisture sensor or the hygrometer is usually used to detect the humidity of the soil. It was a perfect sensor to build an automatic watering system or to monitor the soil moisture of your plants. The sensor is set up by two pieces: the electronic board (at the left), and the probe with two pads, that detects the water content (at the

right). The sensor electronic board had components such as potentiometer, power LED, and a digital output LED.

- **Wooden Box:**

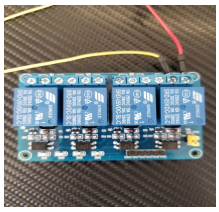
The wooden box was created from scratch to house the the hardware components, such as the relay switch, battery holder, Raspberry Pi, and most importantly the wires for the project. To create the box, we had to measure each component and see how much room they took. The width of the box was 6½ inches, the height was 3½ inches and the length was 5 inches. The two 6½ by 3½ inch pieces were connected together with screws to create a rectangle. Then we added the bottom to the rectangle with lid on the top with a hinge to open the box.

- **Battery Holder:**



D batteries are used to power the water pump. This wire connector battery holder holds two "D" batteries and has color-coded wire leads. The two colored wires are hot and neutral, hot being red and white being neutral.

- **Relay Switch:**



A 5 volt four channel relay switch was used was used as a power interrupter for the mini water pump. A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The main component to the relay is an

electromagnet, which is a coil of wire that becomes a temporary magnet when electricity flows through.

4. Challenges:

There were series of challenges we faced during the project. The first challenge was to get used to the project environment. Python is the programming language most commonly used with Raspberry Pi, but none of us were familiar with it so we had to learned it as we went. At this part, we started our research on the different commands to the Python programming. When we started our research, we found out that Python programing could be used to program different devices like C programing that i am using in Embedded systems Texes board. We also learned that Python had very specific structure to coding like indentation and variable types do not need to be declared.

Moisture sensor was the second most challenging part of the project because we it is not a commonly used sensor with Raspberry Pi. the trouble we had with sensor at first was that we did not know how to code in python and it was hard to code for the project. The second trouble we had with the moisture sensor was that the built-in potentiometer meter was hard to celebrate at the right location. The third and the final challenge for the the moisture sensor was that when we submerged it in soil it was not fully dipped, which created the reading problems for moisture sensor code.

Pump

Adding relay switch

Not enough power for the pump

Just like with python we were all unfamiliar with web servers as well. So we took a flask tutorial to create a server and webpages used in our project. MORE TO ADD after server is done.

Using the DHT22 sensor was an easy part of the project due to the ample amount of code available online already for it. Both adafruit and pigpio have libraries for it. There was also detailed explanation on how to hook it up using wires, resistor, and breadboard.

5. Project Stakeholder's and Communication Plan

Table 1. Team Member Roles and Responsibilities.

Team Member	Role	Responsibility
Otto	Water Pump	Water pump code, helped with the integration of the pump code into the moisture sensor code.
Dhanvinder	Moisture Sensor	Moisture sensor code, helped with the integration of the pump code into the moisture sensor code.
Mario	Temp/Hum	Temp/hum code, created a database to store the readings of the sensor, helped with the integration of the pump code into the moisture sensor code.
All Together	Web Server	Work on web app, The Box.

Each member has separate responsibilities which are outlined in table 1. However, each member was not limited to development in their area stated in the table. For this project to

deliver a working product, each component relies on the others working. Each team members had ensured that one piece does not excel past the others in terms of development. Resources were allocated on a weekly basis when progression is measured at class meetings. The stakeholders in the project or members not a part of the development team that have invested interest in the outcome of the project are our advising team, Professors Easwaran.

LESSONS LEARNED:

There were many lessons learned with project for as planning the project goes. Project plans such as this paper have been developed and timelines have been established. Resource allocation and weekly meetups with just the group members and with the professor were essential to the success of this project. As a group, we learned how to manage stress and divide up the work among three of us. We also learned to communicate our problems to each other through a phone and email. For the server, we learned how to use terminal based language, which was Linux.