Project's website: http://StudentEng2016.github.io/

FarmBot

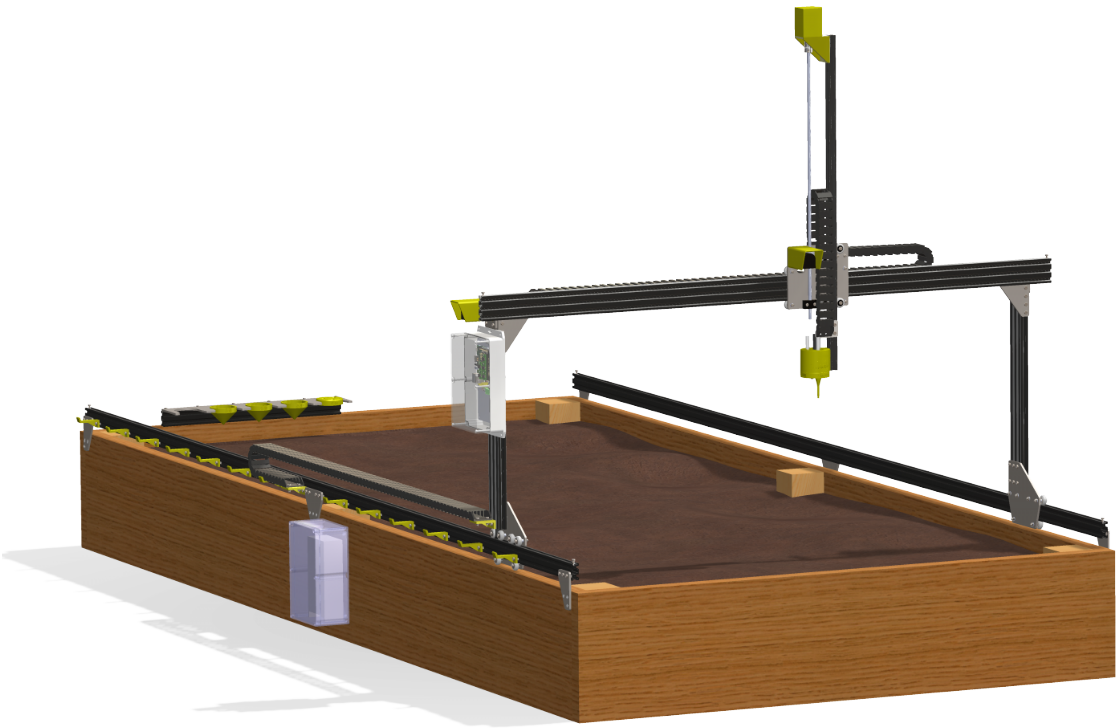

Figure 1:

Image source: (Day, 2016)

From: Alisha Singh Chauhan, Adanegbe Amadasun

Discipline: Computer Engineering Technology

Date Submitted: March 03,2017

Declaration of Joint Authorship

We, Alisha Singh Chauhan and Adanegbe Amadasun, students of the Applied Technology department hereby declare that the following technical report submitted for CENG 355 Computer Systems Project is expressed in our own words.
The research which has been used from various sources, such as words, numerical data, figures, tables etc. has been either paraphrased or cited separately. The original sources of cited work may be located using APA style in References page at the back.

Approved Proposal

Prepared by Adanegbe Amadasun, Alisha Singh Chauhan Computer Engineering Technology Students

Executive Summary

As students in the Computer Engineering Technology program, we will be integrating the knowledge and skills we have learned from our program into this Internet of Things themed capstone project. This proposal requests the approval to build the hardware portion that will connect to a database as well as to a mobile device application. The Internet connected hardware will include a custom PCB with sensors and actuators for an automated farming device. The mobile device functionality will include photo sensors, temperature sensors and moisture sensors, which will be further detailed in the mobile application proposal. We will be collaborating with the following company/department. In the winter semester, we planned to form a group together as we both are building similar hardware this term and working on its mobile application. The hardware was completed in CENG 317 Hardware Production Techniques independently and the application was completed in CENG 319 Software Project. These will be integrated in CENG 355 Computer Systems Project.

Background

FarmBot is going to address some the problems the agricultural industry faces, such as loss of money, inefficiency of some equipment and exploitation of resources. FarmBot is going to be more economical and ecofriendly unlike other agricultural equipment being used. It incorporates precision farming, which happens to be a concept based on observing, measuring and responding to inter- and intra-field variability in crops. The device is going to be constructed in the FarmBot company. It is going to be made of an Arduino Mega 2560, Raspberry Pi 3, disassembled hardware packages and other software sources. The FarmBot Genesis runs on custom built tracks and other supporting infrastructure which needs to be self assembled. The robot itself relies on a GUI platform which users can access through the FarmBot's web app. The physical robotic system is set in alignment with the crops that are plotted out in the virtual version on the web app. This is how FarmBot can be efficient and reliably distribute water, fertilizer and other elements to keep the plants healthy and striving with minimun wastage. The device is going to be cheaper than conventional tools and cost-effective.

We have searched for prior art via Humber's IEEE subscription selecting "My Subscribed Content" (Billingsley, Oetomo, & Reid, 2009) and have found and read (Bergerman et al., 2015) which provides insight into similar efforts.

In the Computer Engineering Technology program, we have learned about the following topics from the respective relevant courses:

- Java Docs from CENG 212 Programming Techniques In Java,
- Construction of circuits from CENG 215 Digital And Interfacing Systems,
- Rapid application development and Gantt charts from CENG 216 Intro to Software Engineering,
- Micro computing from CENG 252 Embedded Systems,
- SQL from CENG 254 Database With Java,
- Web access of databases from CENG 256 Internet Scripting; and,
- Wireless protocols such as 802.11 from TECH152 Telecom Networks.

This knowledge and skill set will enable me to build the subsystems and integrate them together as my capstone project.

Methodology

This proposal is assigned in the first week of class and is due at the beginning of class in the second week of the fall semester. My coursework will focus on the first two of the 3 phases of this project:
Phase 1 Hardware build.
Phase 2 System integration.
Phase 3 Demonstration to future employers.

Phase 1 Hardware build

The hardware build will be completed in the fall term. It will fit within the CENG Project maximum dimensions of 12 13/16" x 6" x 2 7/8" (32.5cm x 15.25cm x 7.25cm) which represents the space below the tray in the parts kit. The highest AC voltage that will be used is 16Vrms from a wall adaptor from which +/- 15V or as high as 45 VDC can be obtained. Maximum power consumption will be 20 Watts.

Phase 2 System integration

The system integration will be completed in the fall term.

Phase 3 Demonstration to future employers

This project will showcase the knowledge and skills that we have learned to potential employers.

The tables below provide rough effort and non-labour estimates respectively for each phase. A Gantt chart will be added by week 3 to provide more project schedule details and a more complete budget will be added by week 4. It is important to start tasks as soon as possible to be able to meet deadlines.

Labour Estimates	**Hrs**	**Notes**
Phase 1		
Writing proposal.	9	Tech identification quiz.
Creating project schedule. Initial project team meeting.	9	Proposal due.
Creating budget. Status Meeting.	9	Project Schedule due.
Acquiring components and writing progress report.	9	Budget due.
Mechanical assembly and writing progress report. Status Meeting.	9	Progress Report due (components acquired milestone).
PCB fabrication.	9	Progress Report due (Mechanical Assembly milestone).
Interface wiring, Placard design, Status Meeting.	9	PCB Due (power up milestone).
Preparing for demonstration.	9	Placard due.
Writing progress report and demonstrating project.	9	Progress Report due (Demonstrations at Open House Saturday, November 7, 2015 from 10 a.m. - 2 p.m.).
Editing build video.	9	Peer grading of demonstrations due.
Incorporation of feedback from demonstration and writing progress report. Status Meeting.	9	30 second build video due.
Practice presentations	9	Progress Report due.
1st round of Presentations, Collaborators present.	9	Presentation PowerPoint file due.
2nd round of Presentations	9	Build instructions up due.
Project videos, Status Meeting.	9	30 second script due.
Phase 1 Total	**135**	
Phase 2		
Meet with collaborators	9	Status Meeting
Initial integration.	9	Progress Report
Meet with collaborators	9	Status Meeting
Testing.	9	Progress Report
Meet with collaborators	9	Status Meeting
Meet with collaborators	9	Status Meeting

Incorporation of feedback.	9	Progress Report
Meet with collaborators	9	Status Meeting
Testing.	9	Progress Report
Meet with collaborators	9	Status Meeting
Prepare for demonstration.	9	Progress Report
Complete presentation.	9	Demonstration at Open House Saturday, April 9, 2016 10 a.m. to 2 p.m.
Complete final report. 1st round of Presentations.	9	Presentation PowerPoint file due.
Write video script. 2nd round of Presentations, delivery of project.	9	Final written report including final budget and record of expenditures, covering both this semester and the previous semester.
Project videos.	9	Video script due
Phase 2 Total	**135**	
Phase 3		
Interviews	TBD	
Phase 3 Total	**TBD**	
Material Estimates	**Cost**	**Notes**
Phase 1		
A microcomputer composed of a quad-core Windows 10 IoT core compatible Broadcom BCM2836 SoC with a 900MHz Application ARM Cortex-A7 32 bit RISC v7-A processor core stacked under 1GB of 450MHz SDRAM, 10/100 Mbit/s Ethernet, GPIO, UART, I²C bus, SPI bus, 8 GB of Secure Digital storage, a power supply, and a USB Wi-Fi adaptor.	>$80.00	An example of a retailer: [3].
Peripherals with cables		
Sensors		
Actuators		
Hardware, etc.		
Phase 1 Total	**>$200.00**	
Phase 2		
Materials to improve functionality, fit, and finish of project.		
Phase 2 Total	**TBD**	
Phase 3		
Off campus colocation	<$100.00	An example: [4].
Shipping	*TBD*	
Tax	*TBD*	
Duty	*TBD*	
Phase 3 Total	**TBD**	

Concluding Remarks

This proposal presents a plan for providing an IoT solution for FarmBot This is an opportunity to integrate the knowledge and skills developed in our program to create a collaborative IoT capstone project demonstrating my ability to learn how to support projects. We request the approval of this project.

Abstract

The Farmbot is basically CNC farming technique which has proved to be the great way for the production of small scale food. It has turned out to be a reliable and approachable source to accomplish the idea of integrating an artificial approach to take care of the cultivation. This project deals with the following hardware components, such as PCF8591 sensors, nozzels which an inject the substances controlled by axes with the software governed by Arduino/RAMPs stack and internet of Raspberry Pi. This project is designed to be completed under the time span of 3-4 months to put together everything. It gives user the opportunity to customize their own farm using the web app.

Table of Contents

List of Illustrations

1. Introduction

An open source automated farming device which operates like a 3D printer. But instead of extruding plastic, its tools are seed injectors, watering nozzles, sensors etc.

2. Project Description

2.1 Purpose

FarmBot is going to address some the problems the agricultural industry faces like lost of money, how ineffective some of their equipment are and how they waste resources.

2.2 Hardware Specification

Figure 2:

Image source: (Krassenstein, 2014)

Image source: (Inc, 2017)

(Describe farmbot parts)

FarmBot will be able to perform the following task:

- Monitor the temperature around the plant,
- Provide light to the plant.

The hardware component for FarmBot that We have are:

- Raspberry pi 3 – It is used to receive data from FarmBot and send it to the Arduino

Image source: (Pimoroni, 2017)

- Arduino mega 2560 – It is used to control the bi-polar stepper motor

Image source: (Robotics & Electronics, 2017)

- Sensor Hat (light and temperature) – It is used to receive data about light and temperature from surrounding.
- Bi-polar Stepper motor – It controls the movement of the FarmBot

Image source: (Controls, 2017)

2.3 Software Specification

2.3.1 Database work breakdown

Currently, We only have a local database for our FarmBot project. The database stores the plant number, date, and name locally. Once the app is deleted the users will lose access to all their data.


FarmBot
Seeder
Water
The Universal Tool Mount
Featuring 12 electrical connections, three liquid/gas lines, and magnetic coupling.
Seed Injection
Powered by a vacuum pump, the seeder sows with millimeter accuracy.
Watering
Precision water your plants with the gentle shower of this nozzle.
Soil Sensor
Weeder
The Soil Sensor
Measure moisture content to optimize for all soil types and environments.
Camera
FarmBot always keeps its eye on your garden to detect weeds and monitor plant health.
Weed Suppression
This tool physically disrupts and destroys the fragile root systems of infant weeds.

Figure 3:

Figure 4:

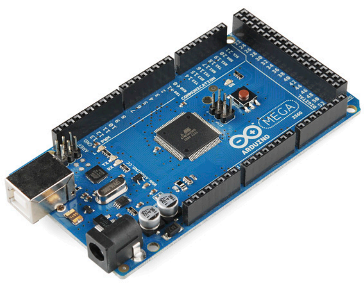

Figure 5:

Figure 6:

We plan on getting a server to so all users data can be stored in the cloud and can be accessed by them at any time.

(Developed by Adanegbe Amadasun)

2.3.2 Application work breakdown

FarmBot is going to be more economical and ecofriendly unlike other agricultural equipment being used. It incorporates precision farming, which happens to be a concept based on observing, measuring and responding to inter and intra-field variability in crops. The device is going to be constructed be the FarmBot company, it is going to be made of an Arduino Mega 2650, Raspberry Pi 3, Sensor hat (which can read temperature, light, and soil condition), and Bi-polar stepper motor.

We plan on using the an arduino mege2560 to control the bi-polar stepper motor to make it move on its X-axis.

(Developed by Alisha Singh Chauhan)

2.3.3 Web and work breakdown

An app was created to use for the FarmBot, this app would be used to control the FarmBot to plant seed at desire position in the bed. Also, the user can choose the option of giving the FarmBot light for a duration of time, watering the plant etc.

After installing the app on your mobile phone, users will be prompt to create an account by choosing user name and password. This will then give them access to their FarmBot and its data stored in the cloud.

The user can then pick the seed of the crop they want to plant, and the care option they want to apply to the seed (i.e. The light duration, or how frequently they want to water the plant) and submit the options they picked

The user would be given the access to control the FarmBot and apply the option picked from the previous screen.

We plan on connecting FarmBot's app with raspberry pi, so that users can be able to send data to it.

We would both work on this.

(Developed by Adanegbe Amadasun and Alisha Singh Chauhan)

2.5 Build Instruction

2.5.1 Introduction

The Farmbot is designed in a such a way that it will work and execute the commands given by the user through software. The working is clearly explained with the design model given below.

2.5.2 Bill of Materials

- Raspberry Pi 3 Complete Starter Kit - 32 GB Edition - $74.35 (Corporation, 2017)

- Arduino Mega - $49.95 (Inc., 2017d)
- 5v Switching Power Supply - $15 (**???**)
- Ramps 1.4 for 3D Printer – $35.95 (Inc., 2017g)
- Stepper Motor Driver - $14.25 (Inc., 2017e)
- Bipolar Stepper Motor - $29.50 (Inc., 2017c)
- Time Pulley - $9.00 (Inc., 2017b)
- Rotary - $4.95 (Inc., 2017f)
- Timing Belt - $19 (Inc., 2017a)
- Total = $284.70 + HST

2.5.3 Time Commitment

The design model needs at least 5-6 hours to put everything all together. It includes the laser cutting of the outer cage and then soldiering all the components into the case appropriately.

Task	Estimated Time
Printing PCBs	30 mins
Soldering PCBs	2 hrs
Testing Sensors and motor	2 hrs
Designing and Laser-cutting Box	40 mins
Assemblying parts	1 hr
Uploading FarmBot firmware (Raspberry pi 3)	30 mins
Uploading FarmBot firmware (Arduino)	25 mins

2.5.4 Mechanical Assembly

Image source: (Aronson, 2017)

• The outer case was made by laser cutter and have a transparent shielding to have a clear view of the components placed inside.

• The Arduino is placed underneath the Ramp Shield with approximately the gap of half an inch.

• Adjacent to that the stepper motor is being placed with its one end outwards to have a connection with the belt

• Setup the Raspberry Pi with the farmbot firmware on it so that it generates a gateway for the connection in between web application and the mobile device.

• Get the firmware for the Arduino as well.

• Assemble the firmware for the Ramp shield.

• Add the stepper motor and generate the connection of Arduino and pi.

• Enable the stepper motor and ramp shield by giving an adequate power supply.

2.5.5 PCB and Soldering

2.5.6 Power Up and Testing

The project can be tested by giving the commands from the mobile application and the belt moves according to the distance mentioned by the user. The Raspberry Pi becomes a hotspot and enables the Wi-Fi connection for the mobile device so that it can connect

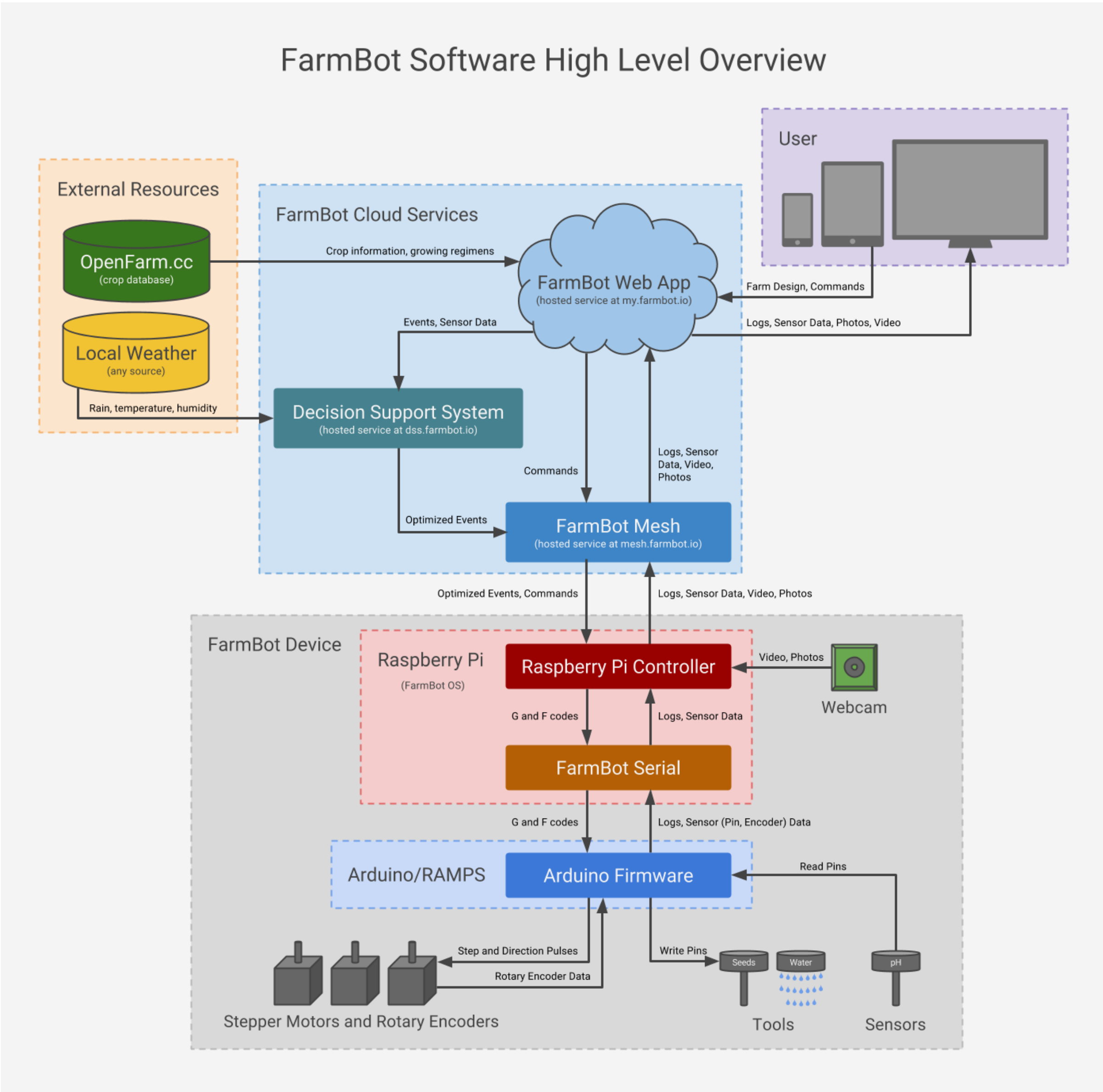
FarmBot Software High Level Overview
External Resources
OpenFarm.cc
(crop database)
Local Weather
(any source)
FarmBot Cloud Services
Crop information, growing regimens
FarmBot Web App
(hosted service at my.farmbot.io)
User
Farm Design, Commands
Logs, Sensor Data, Photos, Video
Events, Sensor Data
Rain, temperature, humidity
Decision Support System
(hosted service at dss.farmbot.io)
Commands
Logs, Sensor Data, Video, Photos
Optimized Events
FarmBot Mesh
(hosted service at mesh.farmbot.io)
Optimized Events, Commands
Logs, Sensor Data, Video, Photos
FarmBot Device
Raspberry Pi
(FarmBot OS)
Raspberry Pi Controller
Video, Photos
Webcam
G and F codes
Logs, Sensor Data
FarmBot Serial
G and F codes
Logs, Sensor (Pin, Encoder) Data
Arduino/RAMPS
Arduino Firmware
Read Pins
Step and Direction Pulses
Rotary Encoder Data
Write Pins
Seeds
Water
pH
Stepper Motors and Rotary Encoders
Tools
Sensors

Figure 7:

3. Progress Report

3.1 Report 1 (Week 5)

From: Adanegbe Amadasun Cc: Alisha Singh Chauhan

Dear Sir,

This is our email regarding progress report and the milestone we have covered so far on our project. We are still behind schedule because I did not make a case from last semester for our project. Last semester, I could not keep up with the schedule I created for myself because of my course load and some of the parts I was working with were new to me. But this semester, I have a better understanding of my project and how to do it. We are trying to come up with ideals on how on the stepper motor move different parts of the FarmBot. After we are done with that, we would start working on the code need to move the stepper motor. We have an android app working which we would use to connect to our FarmBot. We have built a case for our FarmBot and we are currently trying to create a pulley system.
Last week Friday, we had success in uploading teacup firmware into our Arduino for the pulley system. Our budget has changed because I have planning on purchasing new parts. I am first going to check the Alisha's parts to m Alisha project to know which of the we can use.

Sincerely, Adanegbe Amadasun

3.2 Report 2 (Week 6)

From: Adanegbe Amadasun Cc: Alisha Singh Chauhan Dear Sir,

This is our email regarding progress report and the milestone we have covered so far on our project. We now have a better understanding on how to go about our project. We worked with Vlad last week Friday to accomplish various task for our project such as: • Tuning our stepper driver to allow 0.6 amps of current • Lasercut a hole through our case for the pulling system • We also learnt how to crimp wires, we crimp our stepper motor wire to make it easier to connect it to ramp shield. We have built a case for our FarmBot and are still working on creating our pulley system. Also, we had success in uploading teacup firmware into our Arduino for the pulley system, and we are currently trying to figure out the distance to use for stepper more to move.

Work breakdown: we have distributed the workload among us in the following way. Database Work Breakdown: Adanegbe will be working on the database part of the project. Currently, we only have a local database for our FarmBot project. The database stores the plant number, date, and name locally. Once the app is deleted the users will lose access to all their data. (Developed by Adanegbe Amadasun)

We plan on getting a server to so all users data can be stored in the cloud and can be accessed by them at any time

Application and work breakdown: Alisha will be proceeding with this. FarmBot is going to be more economical and ecofriendly unlike other agricultural equipment being used. It incorporates precision farming, which happens to be a concept based on observing, measuring and responding to inter and intra-field variability in crops. The device is going to be constructed be the FarmBot company, it is going to be made of an Arduino Mega 2650, Raspberry Pi 3, Sensor hat (which can read temperature, light, and soil condition), and Bi-polar stepper motor.

Hardware breakdown: We are working on the hardware together.

Sincerely, Adanegbe Amadasun

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