pocket ‘ponics

Semi-Automated Microscale Greenhouse Leveraging Hydroponic Technology

Senior Design Interdisciplinary Project

Department of Electrical Engineering and Department of Computer Science
University of Central Florida

Initial Project Documentation

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Sponsors and Stakeholders

The beauty of pocket ‘ponics is that anyone can use it. Whether you live in the Amazon Rainforest or the Sahara Desert, your growing options are not limited by the climate in which you live. It doesn’t matter whether you’re an expert agriculturist or you struggle to keep a cactus alive, pocket ‘ponics is for you. pocket ‘ponics makes it easy for anyone, anywhere to grow whatever their heart desires, regardless of geographic location or skill. pocket ‘ponics seeks to empower consumers to grow their own produce, free of GMOs and harsh chemicals.

In third world countries such as South Africa and Yemen, finding enough food to stay alive is a struggle in and of itself. pocket ‘ponics would provide a user-friendly, cost-efficient solution to a life-threatening issue around the globe. We focus a lot on making our product simple so that it can be easily used by children, elderly and everyone in between. pocket ‘ponics does not have any sponsorships or contributors at this time. The funding of the prototype will be equally divided amongst group members.

Project Narrative

The World Factbook estimates that 30-60% of the Earth's population is employed in agriculture around the world[1]. Records show that many of those people spend more than 12 hours per day working on food production, from farmers that rise and set with the sun, to meat factory worker that take increasingly long shifts. In various agricultural industries, food production has increased by 20% or more in the last decade.

And yet, despite this massive investment into agriculture, the Food and Agriculture Organization of the UN (FAO) estimates that 800 million people (1 out of 9) suffer from regular food shortages and that over 2 billion people (1 out of 4) have micronutrient deficiencies.[2] Indeed, eradicating hunger was the first of the eight Millennium Development Goals[3] that the United Nations hoped to meet by 2015, and is the second of the seventeen current Sustainable Development Goals[4], which the UN aims to achieve by 2030.

One of the reasons for this dichotomy is the increasing migration of people to cities. As people become more distant from the source of their food, increased energy is needed to transport the food, causing the price to skyrocket. Furthermore, cities often contain food desserts, which are areas where food is scarce due to the absence of grocery stores or food prices that are outside of the resident's budget.

To solve this issue, many people have proposed that people living in urban areas should grow their own food. Rooftop gardens, balcony vegetables, and community plots have all become more popular in the past decade, but all of them have several drawbacks. They require significant space, time, and knowledge devoted to their cultivation and harvesting, and many people cannot afford any of those necessary factors.

This project works to alleviate all of the drawbacks of traditional urban farming. To reduce the space needed for cultivation, pocket 'ponics will use a tiered hydroponics system. An individual micro-greenhouse will contain five tiers, each with a different plant growing in a hydroponic medium. This will allow a variety of plants with distinct nutrients needs to be grown in a space about the size of a traditional bookshelf. It also removes the need for soil and sunlight, allowing the cultivation of food to be moved to more convenient locations with ease.

[1] "Labor Force – By Occupation". *The World Factbook*. Central Intelligence Agency. Archived in the Wayback Machine from the original on 22 May 2014. Retrieved 13 Sept 2019.
[2]"FAO and Post 2015." *FAO*, Food and Agriculture Organization of the United Nations, 2015, www.fao.org/resources/infographics/infographics-details/en/c/266124/. Retrieved 13 Sept 2019.
[3]"United Nations Millennium Development Goals." *United Nations*, United Nations, www.un.org/millenniumgoals/. Retrieved 13 Sept 2019
[4]"United Nations Sustainable Development." *United Nations*, United Nations, 2015, www.un.org/sustainabledevelopment/. Retrieved 13 Sept 2019

Similarly, pocket ‘ponics will need much less time invested in it than the large amounts of time that are typically required for traditional agriculture. By leveraging an advanced sensor grid to monitor water level, pH, and electrical conductance, pocket ‘ponics will remove the burden of monitoring from the users. Furthermore, electronically-controlled lighting, as well as water and nutrient pumps will ensure that the day-to-day operation of a pocket ‘ponics systems is primarily autonomous. Users will only need to do the initial seeding, move plants to their correct trays, and the final harvest of any food.

The largest benefit that pocket ‘ponics will provide over traditional agriculture is the lack of specialized knowledge that will be needed to operate it. The autonomously maintained hydroponics will require no knowledge of hydroponic systems; users will simply plug in the micro-greenhouse, register it to the app, set up the plants, fill the water and nutrient tanks, and harvest the eventual output. Similarly, the users would not need any knowledge of growing seasons or nutrient levels required for each plant; a user-friendly mobile application will prompt the users whenever they need to take action, and a sophisticated backend will provide information on each plant. This information can be used to facilitate the operation of the micro-greenhouse and can be displayed to the user.

Beyond simply compensating for the flaws of traditional architecture, pocket ‘ponics will make the growing process more transparent to users. At any time, users will be able to use the mobile application to view the current status of the plant in the micro-greenhouse, and users will be able to adjust the settings outside of the default ranges to better fit their environment. Similarly, the hydroponics and sensor grid will be set up for ease of use, so that moving seedlings and maintaining plants is a simple process for those with no knowledge, but highly customizable for those with the knowhow.

Overall, the goal is to enable people with no knowledge of hydroponics or agriculture to easily grow food within the small space of an apartment or a home. By bringing agriculture back into cities and food deserts, pocket ‘ponics could help people eat healthier, by bringing balanced nutrients and vegetables fresh into their homes. It could also help to alleviate hunger and food insecurity, without the requirement of massive restructuring efforts.

Project Requirements

Sensor Grid Requirements

- Monitor and measure specific metrics of greenhouse data
  - Water levels, pH, conductivity, and plant nutrients
    - Single sensor readings when water levels are low
    - Single sensor to monitor water pH levels
    - Sensor to monitor other greenhouse data
- Sensors and electrical connections waterproofed
  - Cover solder points and exposed wires with waterproofing covering
- Fabbed PCB or Arduino
  - Connects sensors to software backend
  - Supplies and regulates power and signal to sensor network
  - Ethernet network connection for app connection
- Power System
  - Reliable power source
  - Rectified to give constant DC voltage to all components
  - Easily maintainable
  - 120V 60Hz Wall outlet connection stepped down
  - 4 AA batteries for backup power

Backend Requirements

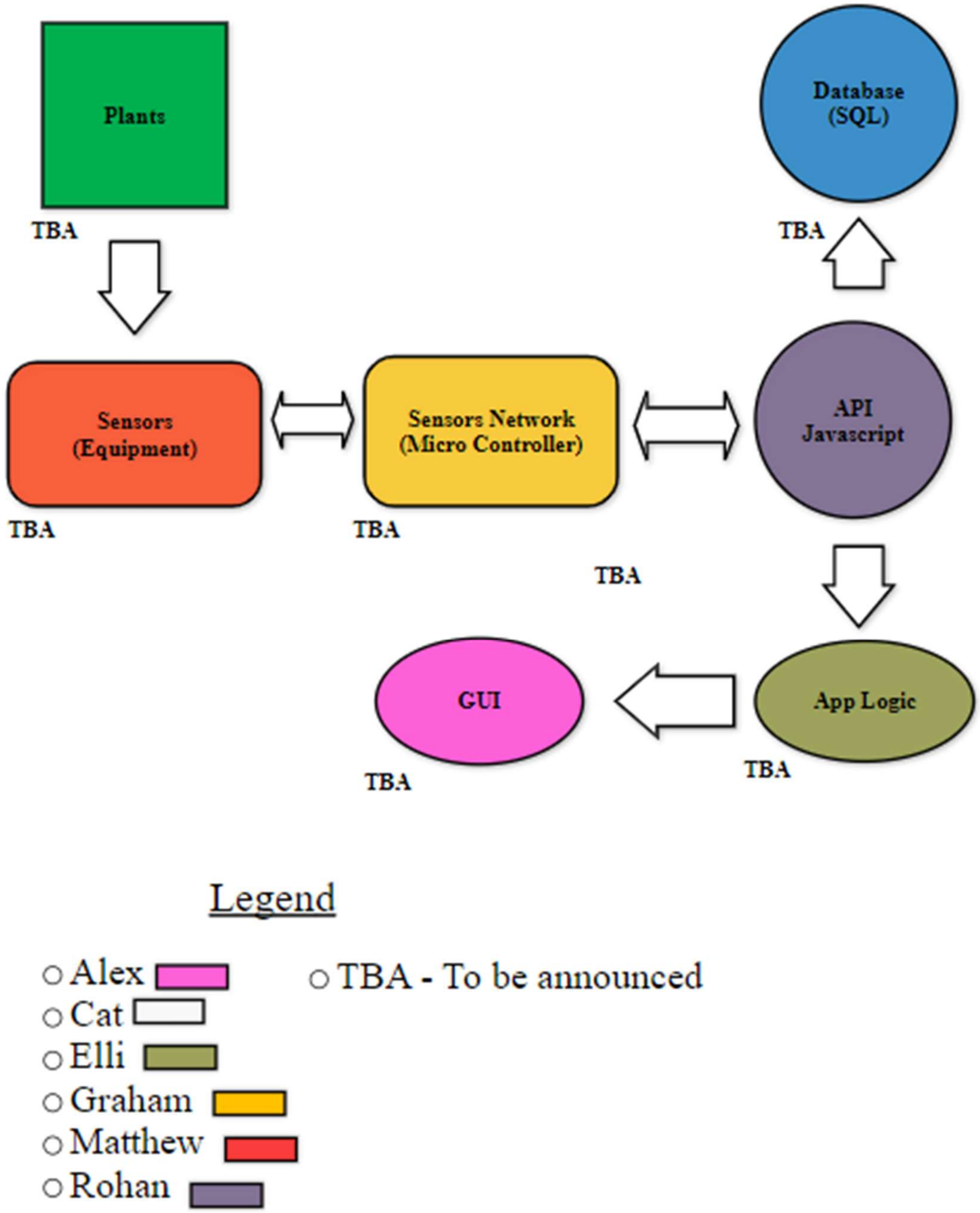
- Retrieve specific information on each greenhouse from database
  - Water level, pH and conductivity
    - Single sensor reading for specified level
    - All sensor readings for specified level
    - All sensor readings for greenhouse
  - Cycle time
- Retrieve specific information on each greenhouse from sensor grid
  - Water level, pH and conductivity
    - Single sensor reading for specified level
    - All sensor readings for specified level
    - All sensor readings for greenhouse
  - Light level
- Store specific information on each greenhouse in database
  - Water level, pH and conductivity
    - Single sensor reading for specified level
    - All sensor readings for specified level
    - All sensor readings for greenhouse
  - Cycle time
- Send specific information on each greenhouse to app
  - Water level, pH and conductivity
    - Single sensor reading for specific level
    - All sensor readings for specific level
    - All sensor readings for greenhouse

    - Light level, cycle time
- Monitor greenhouse sensor readings and determine if user-adjustment needed
    - Refilling water or nutrients
    - Planting seedlings or moving to different tier
    - Harvesting plants
- Send commands to greenhouse
    - Adjust light levels for specific level
    - Adjust light levels for greenhouse

Frontend Requirements

- Set up a new user's account
- Log in to the user's account
- Walkthrough to setup a new micro-greenhouse
- List all greenhouses associated with the account
    - Delete and modify greenhouses
- Notifications
    - Refill water
    - Refill nutrients
    - Plant seedlings
    - Move seedlings to the proper tier
    - Harvest plants
- Display specific information on each greenhouse
    - Water level, pH, and conductivity for each tier
    - Growing time for each tier
    - Estimated harvest time for each tier
    - Historical data for greenhouse
- Adjust greenhouse rhythms
    - Modify light levels and cycle times

Block Diagram



Budget Proposal

The prices found are based on online research. Prices listed might change as new or different components are selected for use, and will be updated with each revision of the design documentation. There is currently no sponsor for project, so all spending and funding will come from the students.

Pocket 'Ponics Parts List					
Part Number	Description	Vendor	Price per Unit	Amount	Estimated Price
	Arduino	Arduino.cc	$40.00	1	$40.00
	pH Sensor Kit	amazon.com	$29.99	5	$149.95
	Pump system	amazon.com	$50.00	5	$250.00
	Water Tank	amazon.com	$100.00	1	$100.00
	Electrical Conductance Sensor			5	$0.00
	Lights	amazon.com	$22.99	5	$114.95
	Liquid Electrical Tape	amazon.com	$6.98	1	$6.98
	Step up Transformer		$10.10	1	$10.10
	Step Down Transformer		$10.10	1	$10.10
PCB	PCB Fabrication		$50.00	1	$50.00
	Construction Materials		$200	1	$200.00
	Miscellanious Electronics		$50.00	1	$50.00
	AWS account	amazon.com	$149.95	1	$149.95
	Hydroponic Plant Nutrient	amazon.com	$25.00	1	$25.00
	TOTAL Amount				$1,157.03

Initial Project Milestones

Senior Design 1

#	Task	Start	End	Status	Responsible
1	Project Selection & Role Assignment	08/25/19	09/10/19	Completed	All Members
	Senior Design Documents				
2	Initial Design Document	09/11/19	09/20/19	Completed	All Members
3	First Draft	09/22/19	10/31/19	Not Started	All Members
4	Final Document	11/01/19	12/01/19	Not Started	All Members
5	Group Meeting with Professors	09/25/19	09/25/19	Not Started	All Members
	Research and Design				
6	Sensor Grid Configuration & Layout	09/21/19	10/20/19	Not Started	Matthew, Graham
	Component Selection	09/21/19	10/05/19	Not Started	Graham
	Interaction with Backend	10/06/19	10/20/19	Not Started	Matthew
7	Backend API Endpoints and Database Schema	09/21/19	10/20/19	Not Started	Rohan, Catherine
	API Endpoints	09/21/19	10/05/19	Not Started	Rohan
	Database Design	10/06/19	10/20/19	Not Started	Catherine
8	Frontend App Design	09/21/19	10/20/19	Not Started	Elli, Alexandra
	User Interactions Diagram	09/21/19	10/05/19	Not Started	Elli
	GUI Final Design	10/06/19	10/20/19	Not Started	Alexandra
9	Final Block Design	10/20/19	10/25/19	Not Started	All Members

Senior Design 2

10	Build Initial Prototype	01/09/20	03/10/20	Not Started	All Members
11	Testing & Redesign	TBA	TBA	Not Started	All Members
12	Finalize Prototype	TBA	TBA	Not Started	All Members
13	Peer Presentation	TBA	TBA	Not Started	All Members
14	Final Report	TBA	TBA	Not Started	All Members
15	Final Presentation	TBA	TBA	Not Started	All Members