pocket ‘ponics

Elli Howard
Alex Cusell
Rohan Patel
Catherine Abbruzzese
Graham Hill
Matthew Bonsignore

Group 35

Project Goals

Broader Impacts

- 30-60% of the world is employed in agriculture
- Agriculture outputs increased 20% in the last decade
- Despite this, 11% of US households are food-insecure
- This is in part due to the growing food deserts in cities

Our Solution

- Easy-to-use app and greenhouse combination that allows non-technical users to grow hydroponic food
- App walks users through setting up, monitoring, and harvesting
- Greenhouse monitors pH, EC, water levels, pumps and lights.
- Backend collects data from greenhouse, does necessary computations, and surfaces data for frontend

Project Requirements

Sensor Grid Requirements

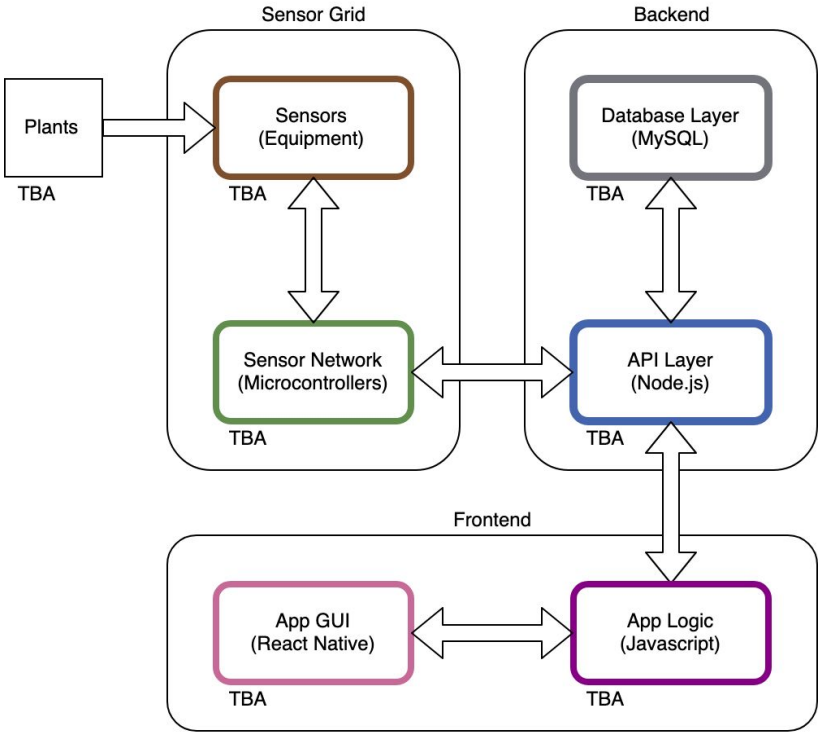
- Collect data from sensor array and make adjustments live
  - Water Levels, pH, Electrical Conductivity
  - Activate water and nutrient pumps, and LEDs
  - Receive adjustments from the backend system
- Stable DC power system
  - Rectify 120V AC to 12V DC
  - Backup system stretch goal
- Stand alone SOC (System on Chip)
  - Connects Sensor Grid to backend system
  - Sends signal for adjustments to MCU and Sensors
- MCU (Microcontroller unit) and PCB (Printed Circuit Board)
  - AVR-RISC based microcontroller which can collect sensor readings
  - A custom PCB houses connections to MCU to Sensor Grid

Backend Requirements

- Receive sensor readings from sensor grid
  - Water level, pH, electrical conductivity
  - General greenhouse data
- Receive specific information from the app
  - Greenhouse/tier changes
- Retrieve/store data in MySQL database
  - Sensor readings
  - Greenhouse and tier information
- Send data to app
  - Sensor readings
  - Greenhouse and tier information
- Authentication

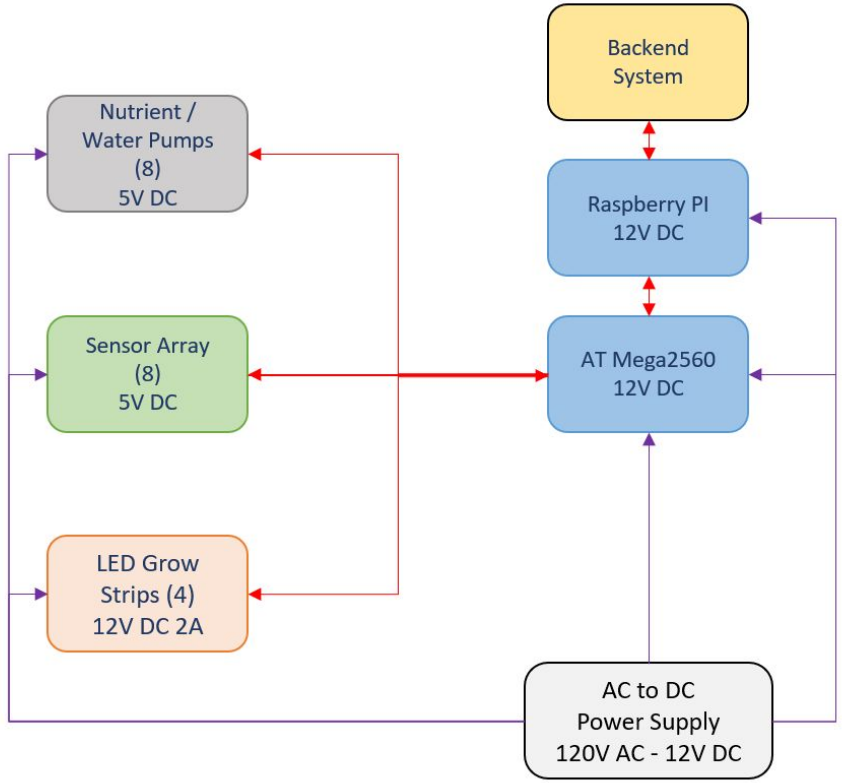
Frontend Requirements

- Retrieve information from back end
  - Greenhouse and tier data
  - User Login and authentication
- Display greenhouse in easy-to-understand ways
  - Greenhouse display
  - Tier Display
- Provide notifications for user action
  - Refill tanks
  - Running on battery power
  - Harvest food
- Easy setup of new greenhouses
- Step-by-step instructions for actions


Sensor Grid
Backend
Plants
TBA
Sensors
(Equipment)
TBA
Database Layer
(MySQL)
TBA
Sensor Network
(Microcontrollers)
TBA
API Layer
(Node.js)
TBA
Frontend
App GUI
(React Native)
TBA
App Logic
(Javascript)
TBA
Key
Matthew
Graham
Cat
Rohan
Elli
Alex
TBA
To Be Aquired

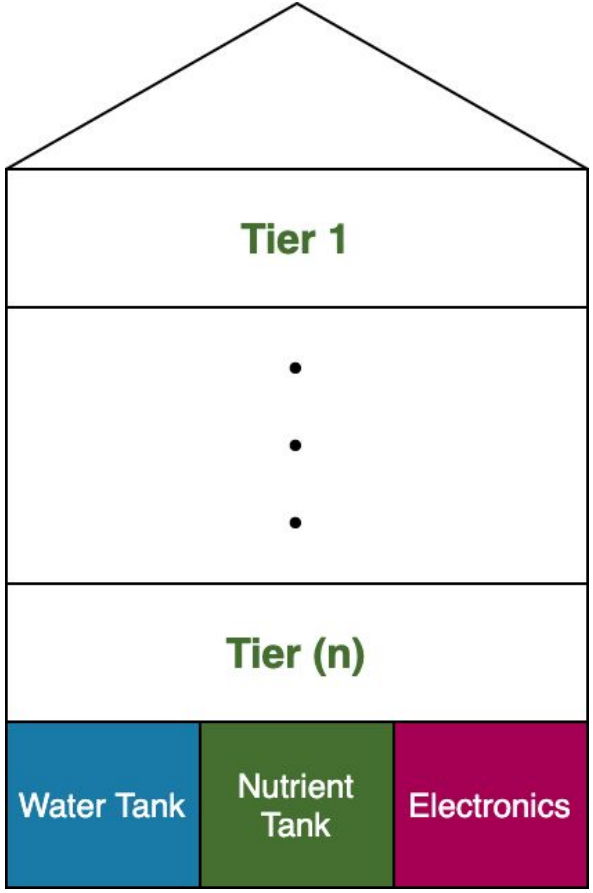
Greenhouse

Greenhouse Overview



Greenhouse Overview

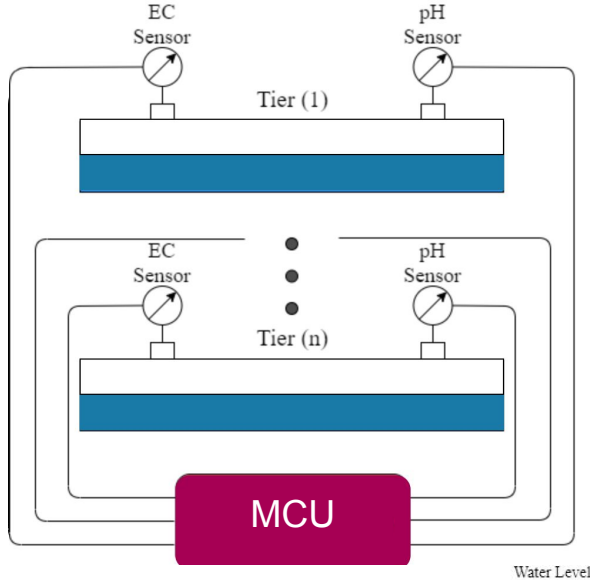
- Greenhouse contains the Sensor Grid and Power Grid
  - Electronics
    - Sensor Grid
      - Input Array
      - Output Array
    - Power Grid
  - Water Tank
  - Nutrient Tank
- Layout subject to change



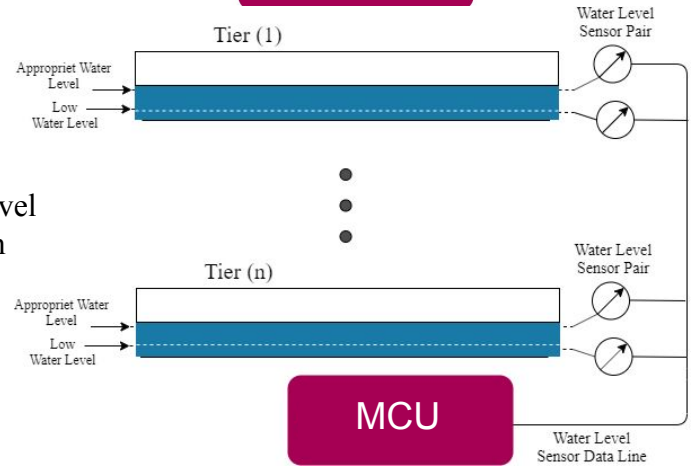
Input Array

- SOC requests data from MCU hourly
- Uses the EC, pH and Water Level sensors
- SOC sends data to API and returns what the expected values should be

pH and EC Sensor System



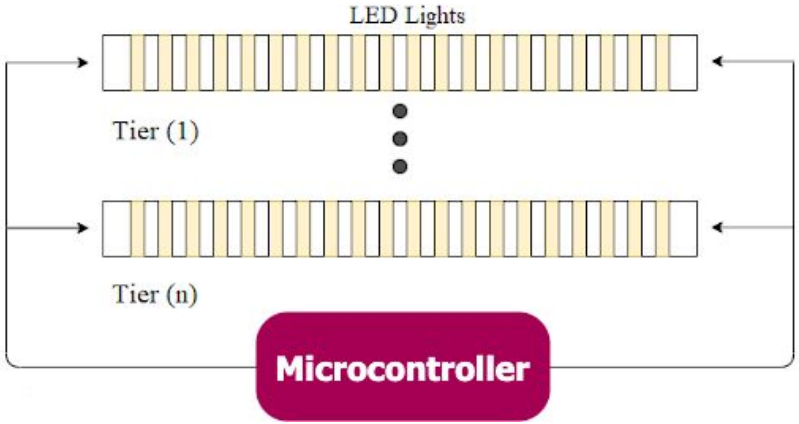
Water Level System



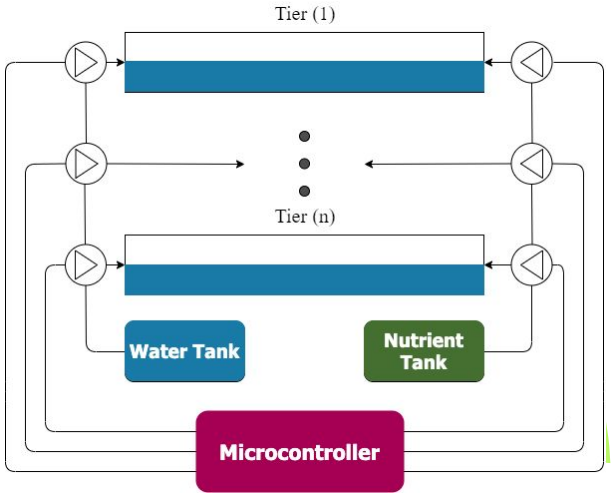
Output Array

- Receives data from SOC
- Activates or deactivates the LED's, Water pumps, or Nutrient Pumps

LED System



Pump System

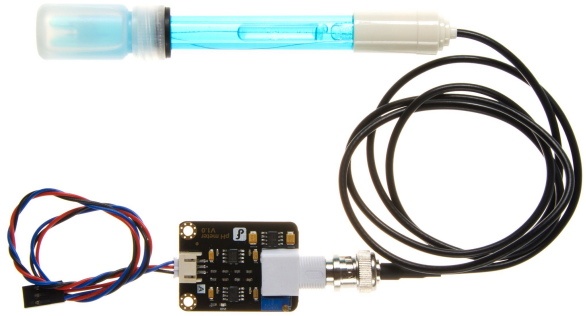


TDS Sensor

Model	Gravity: Analog TDS Sensor
Input Voltage	3.3V ~ 5.5V
Output Voltage	0V ~ 2.3V
Working Current	3mA ~ 6mA
Measurement Range	0ppm ~ 1000ppm
Price	$11.80

pH Sensor

Model	Gravity: Analog pH Sensor
Input Voltage	3.3V ~ 5.5V
Output Voltage	0V ~ 3.0V
Measurement Range	0pH - 14pH
Measurement Accuracy	±0.1 @ 25℃
Price	$29.50



Water Level Sensor

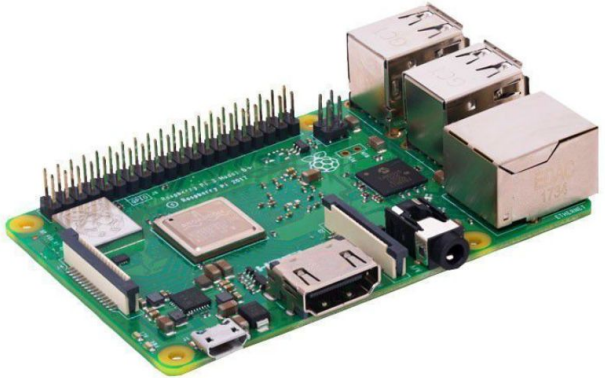
Model Number	DP5200
Breakdown Voltage	220V
Max Current Switching	0.5A
Temperature Rating	-10℃~85℃
Price	$1.83

Microcontroller

Chip	Microchip AT Mega2560
Flash	256KB
RAM	8KB
Clock Speed	16 MHz
GPIO	86
Analog Pins	16
Communication	UART/SPI/USB
Price	$28.50 per Dev Board $11.85 per Chip

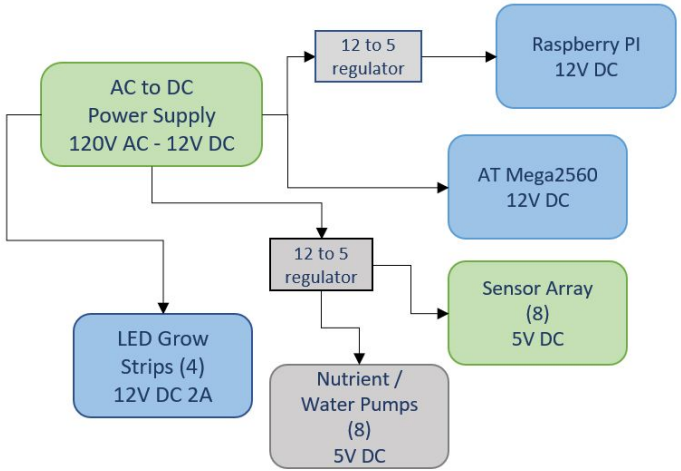
Raspberry Pi

System	Raspberry Pi 3 B+
Clock Speed	1.4GHz
RAM	1GB LPDDR2 SDRAM
Wireless	2.4GHz/5GHz IEEE 802.11 Bluetooth 4.2
Supported OS	Raspbian, Ubuntu Core, Manjaro ARM, many more
Communication	UART/SPI/USB
Price	$35.00 per unit



Power System

- 120V AC Power Input
  - Split into three 12V DC outputs
- Three 12V branches
  - MCU and SOC
  - LEDs
  - Sensors and Pumps
- Must not exceed 240 Watts for all components



Power Supply

	LEDMO Switching Converter Power Supply
Input	AC 100V/240V 50/60 Hz
Output	DC 12V (±10%) 20A (240W)
Working Temperature	20° to 60° Celcius
Size	7.83 in X 4.33 in X 1.88 in
Price	$21.99 price per unit

Successes

Communication to API

MCU to SOC Communication

Sensor component communication

Difficulties

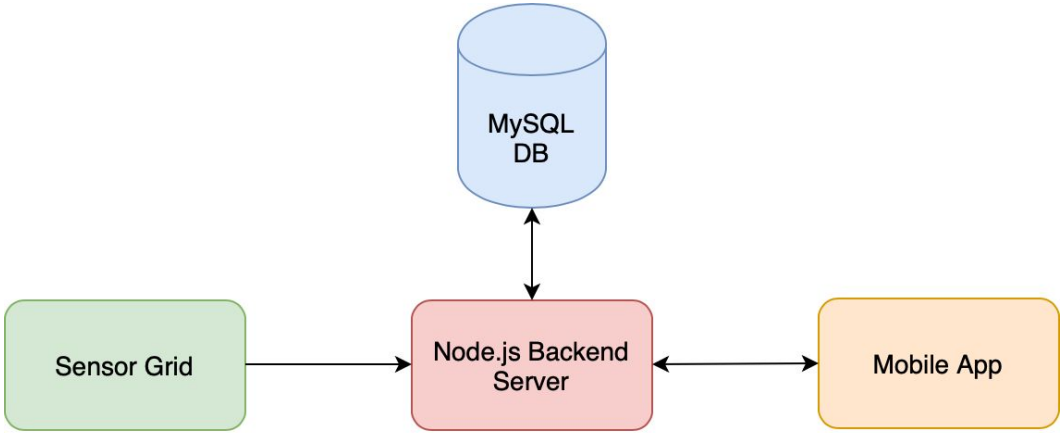
Power Management

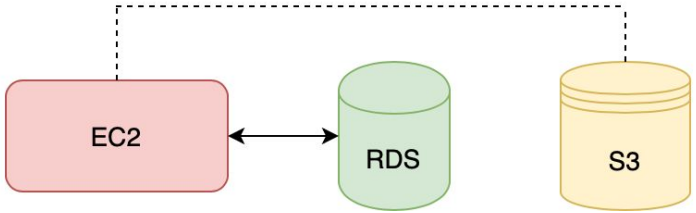
Heat Distribution for LEDs

Spatial Distribution for Components

Backend

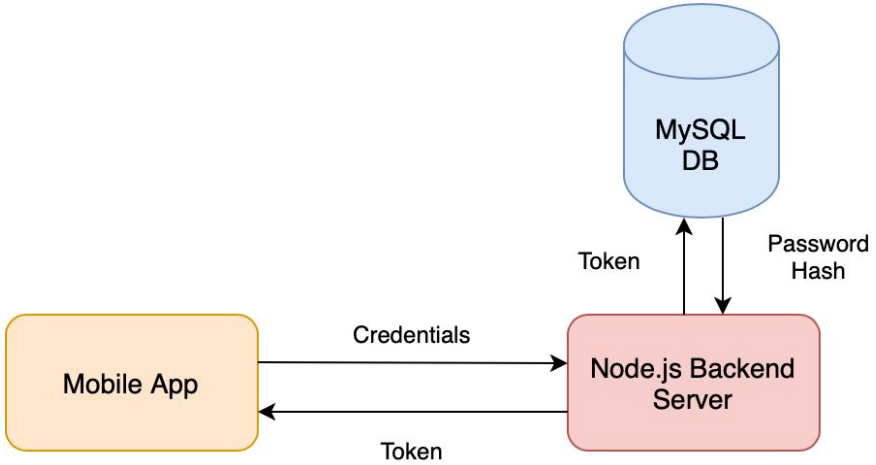
Overall Design





Node.js Server

- Authentication & Authorization
  - Active Sessions
  - user_id columns
- Interaction with MySQL Database
  - mysql package
  - Connection Pool
  - Queries
  - Transactions
- API Endpoint Groups
  - /auth
  - /mobileapp
  - /sensorgrid
  - /adminportal



Node.js Server

- Notification Delivery to Mobile App
  - Transplant Seedlings
  - Ready to Harvest
  - Greenhouse Status
    - Power Source
    - Water Tank Level
    - Nutrient Tank Level

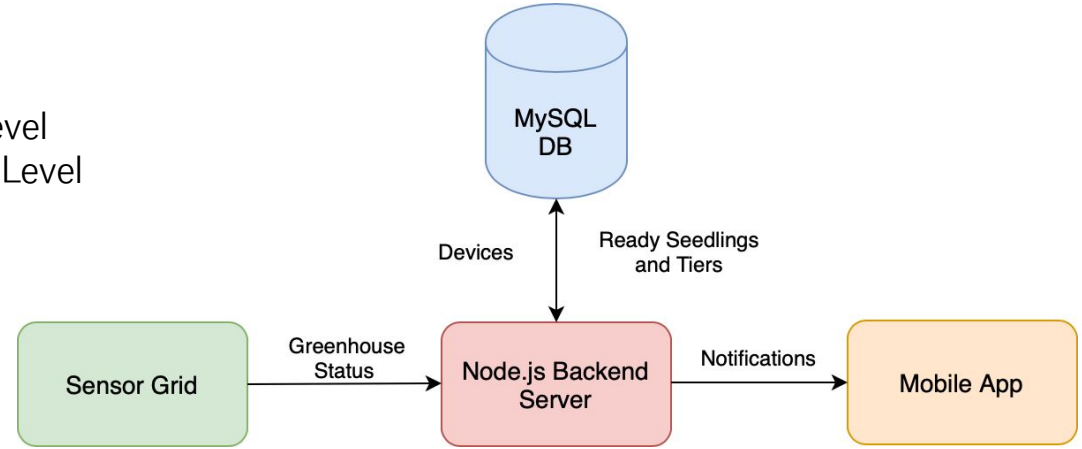
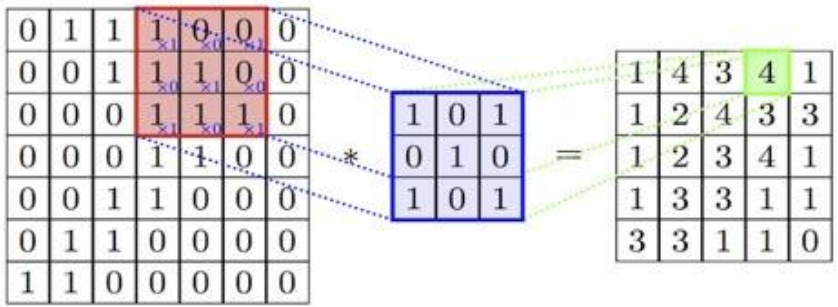
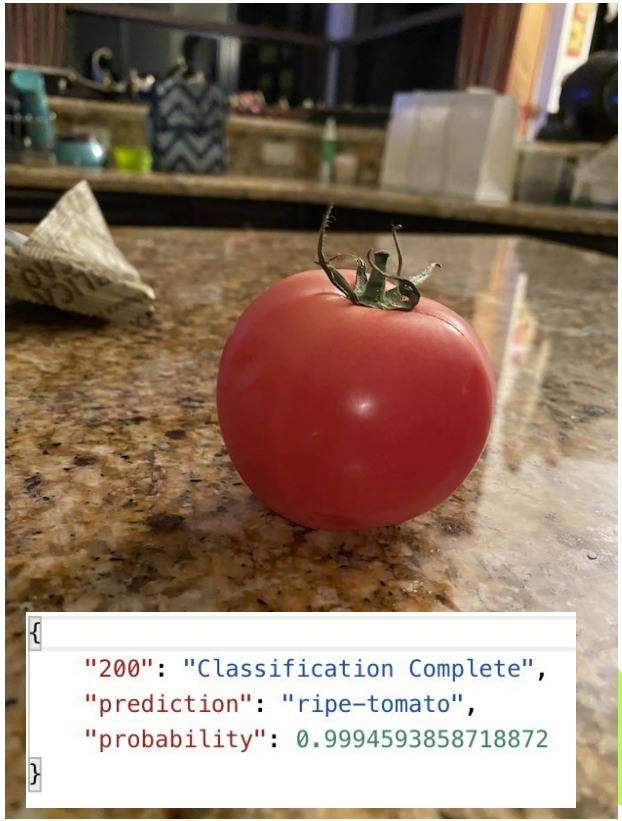


Image Classification

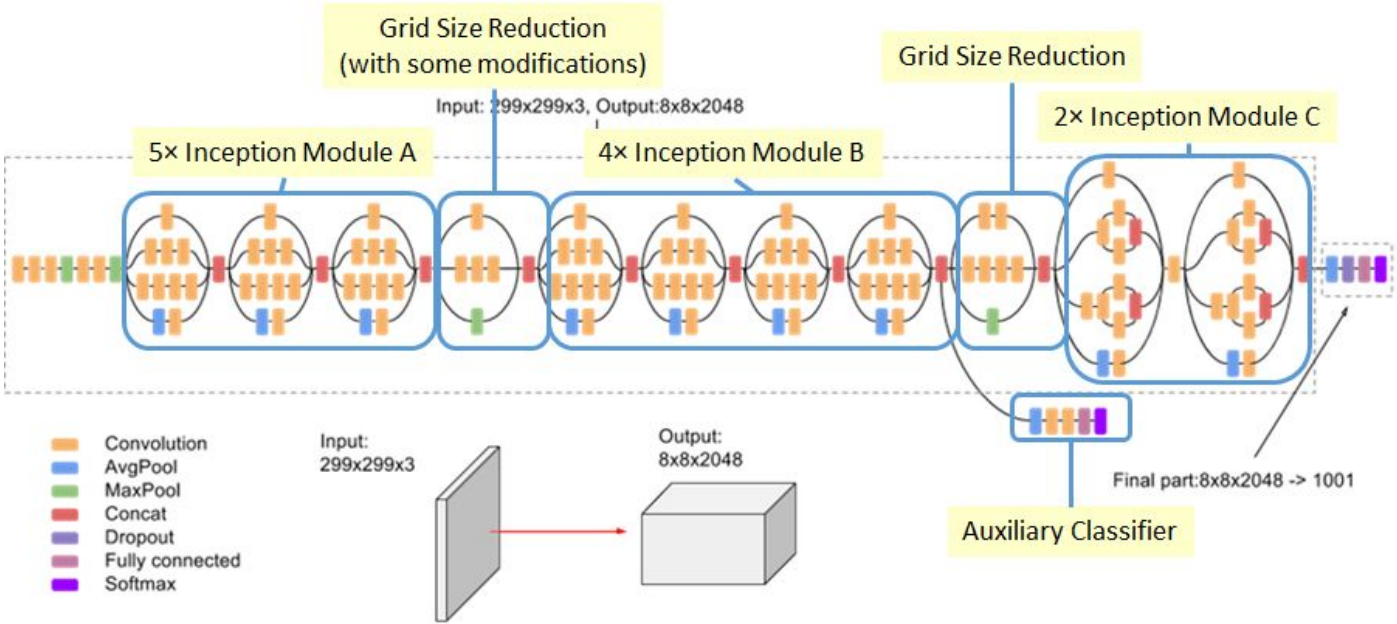
- Pretrained, Modified InceptionV3 Convolutional Neural Network
- Overall Accuracy
  - 9 classes
- Overfitting
  - Dropout
  - Early Stopping
  - Checkpoint



Convolution Operation

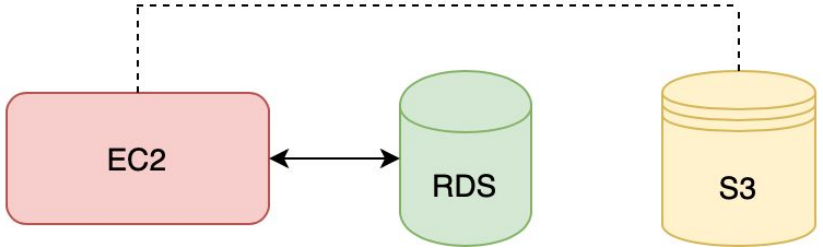


Inception V3

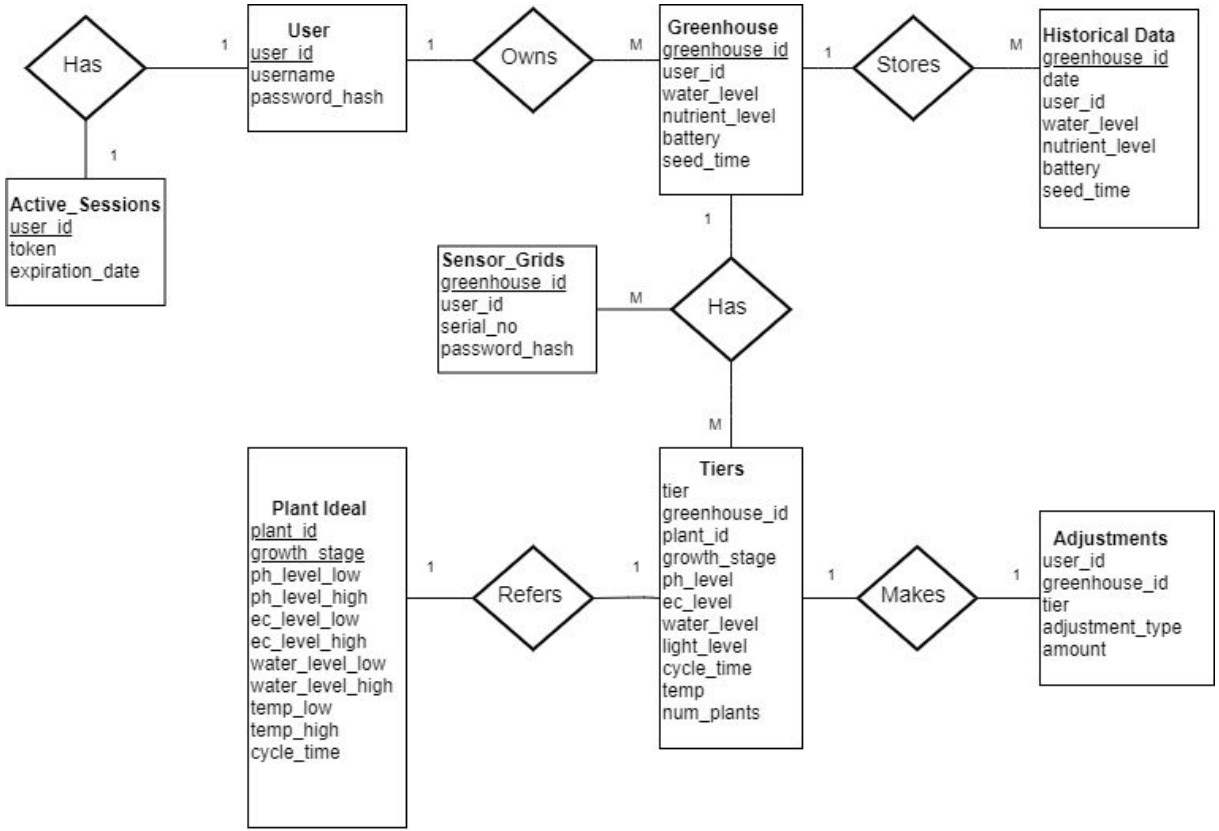


AWS Components

- EC2 Instance
  - t3.medium
  - 4GB RAM
  - CV Requirements
- RDS Instance
  - MySQL Database
- S3 Bucket
  - Assets
  - Mobile App
- Why AWS?
  - Industry Standard
  - AWS Educate Program



mySQL Database



Testing

- Unit tests
  - API
  - Jest framework
  - Coverage included in Jest

- Integration testing
  - Use Postman to send requests to the endpoints
  - Verify information in the database

Successes

API Endpoints

MySQL Database

Deployment

Image Classification

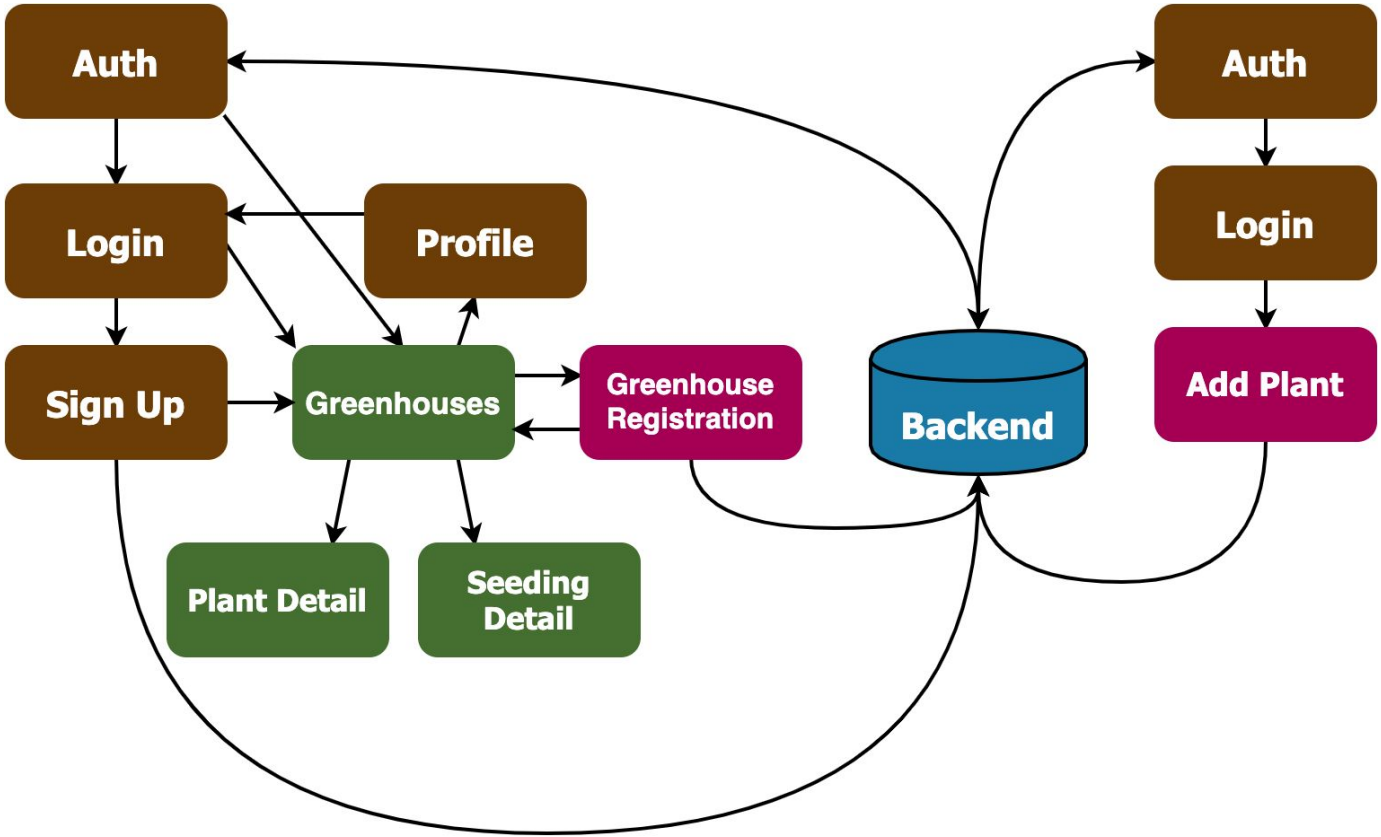
Difficulties

Anomaly Detection

Building Dataset

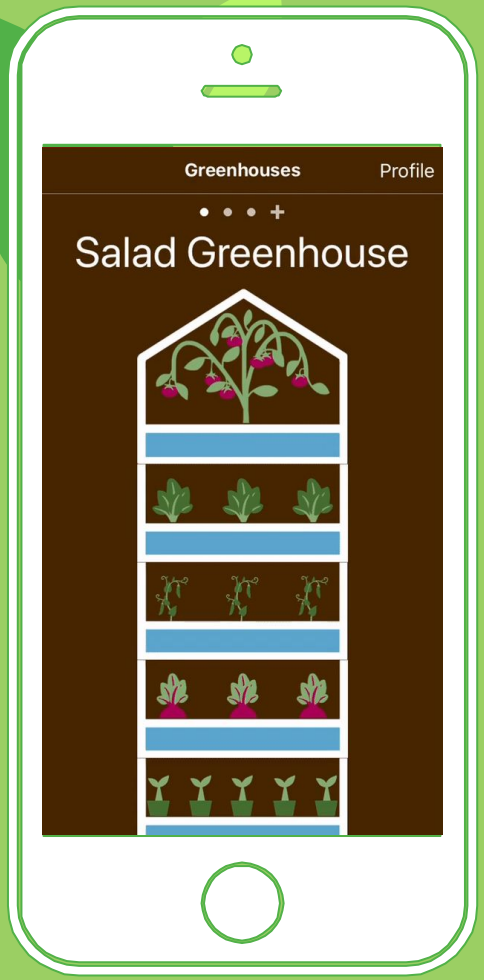
Frontend

Frontend Design



App Technologies

- React Native
  - Modular composition allows for reuse of components
  - Compatibility across iOS and Android
- Expo Client
  - Quickly build compact app files for distribution
  - Manage permissions and interfacing with native systems like the camera
  - Assist with push notification coordination between Apple and Google

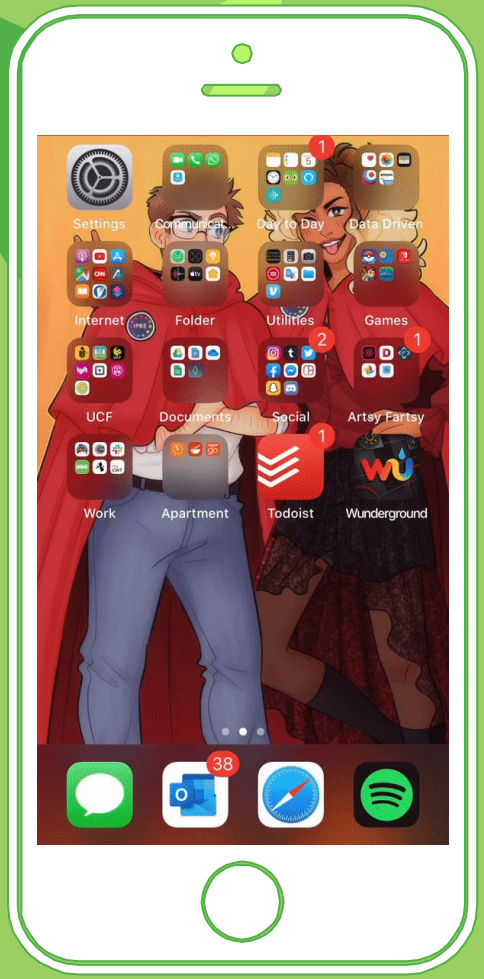


Greenhouse Monitoring

- Displays current data from greenhouse sensors
- Shows the user estimated harvest dates
- Collects and displays historical sensor readings for the greenhouse
- Greenhouse data maintained by a global state monitor

Greenhouse Registration

- App connects with the greenhouse over LAN
- Wifi connection info is sent to the greenhouse
- User decides which plants are grown on each tier & fills up reservoirs
- App uses REST API to register the greenhouse to the database



User Interactions

- Refill water
- Refill nutrients
- Plant Seedlings
- Transplant Seedlings
- Harvest Plants

All are accompanied by detailed instructions and Push notifications

Website

- pocketponics.com
- Information for the general public
- Admin portal
  - Authenticates admin users
  - Adds new plants that users can grow

Successes

- Full WCAG compliance
- Compatibility between Android and iOS
- Real-time push notifications for UX
- Graphical display of historical data
- Camera input for ML categorization of plants

Difficulties

- Real-time data display with async database updates
- Extensibility of plant model
- Access to UCF Server

Administrative

Budget

Description	Vendor	Price per Unit	Amount	Estimated Price
Arduino	arduino.cc	$40.00	1	$40.00
pH Sensor Kit	amazon.com	$19.65	4	$78.60
Pump system	amazon.com	$11.98	2	$23.96
Water Tank	amazon.com	$19.33	2	$38.66
EC/TDS Sensor		$12.90	4	$51.60
Lights	amazon.com	$13.99	1	$13.99
Liquid Electrical Tape	amazon.com	$6.98	1	$6.98
PCB Fabrication		$50.00	1	$50.00
Buck Convertor	amazon.com	$10.95	2	$10.95
Relay	amazon.com	$5.50		$55.00
Construction Materials		$100	1	$100.00
Miscellaneous Electronics		$50.00	1	$50.00
AWS Student Account	amazon.com	$0.00	1	$0.00
Hydroponic Plant Nutrient	amazon.com	$25.00	1	$25.00
Total Amount				**$544.74**

Completion Status

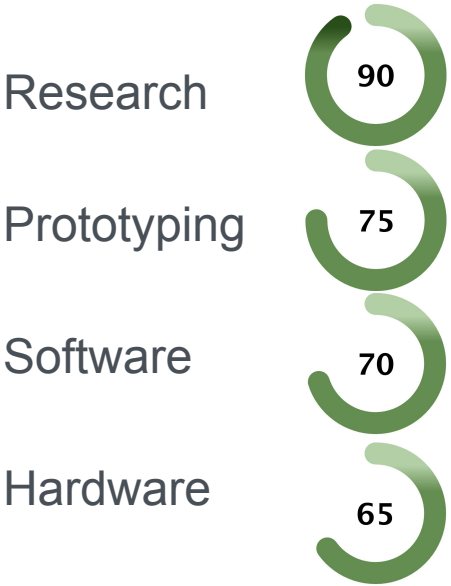
Greenhouse

Backend

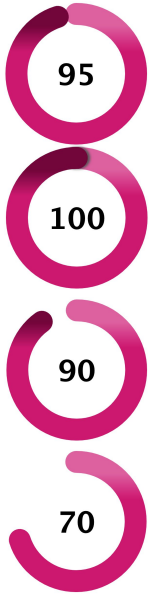
Frontend

Completion Breakdown

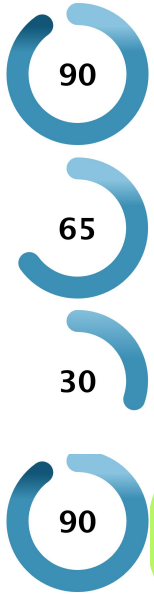
Greenhouse



Backend



Frontend



Remaining Tasks

Greenhouse

Finish Power System

Finish PCB testing for integration

Complete Tier Assembly

Backend

Finish unit and integration tests

Integrate with greenhouse

Frontend

Unit and Integration Testing

Finalize Admin Portal

App publication to iOS and Android

Thanks!

For further information,
visit pocketponics.com

or email
ehoward@knights.ucf.edu