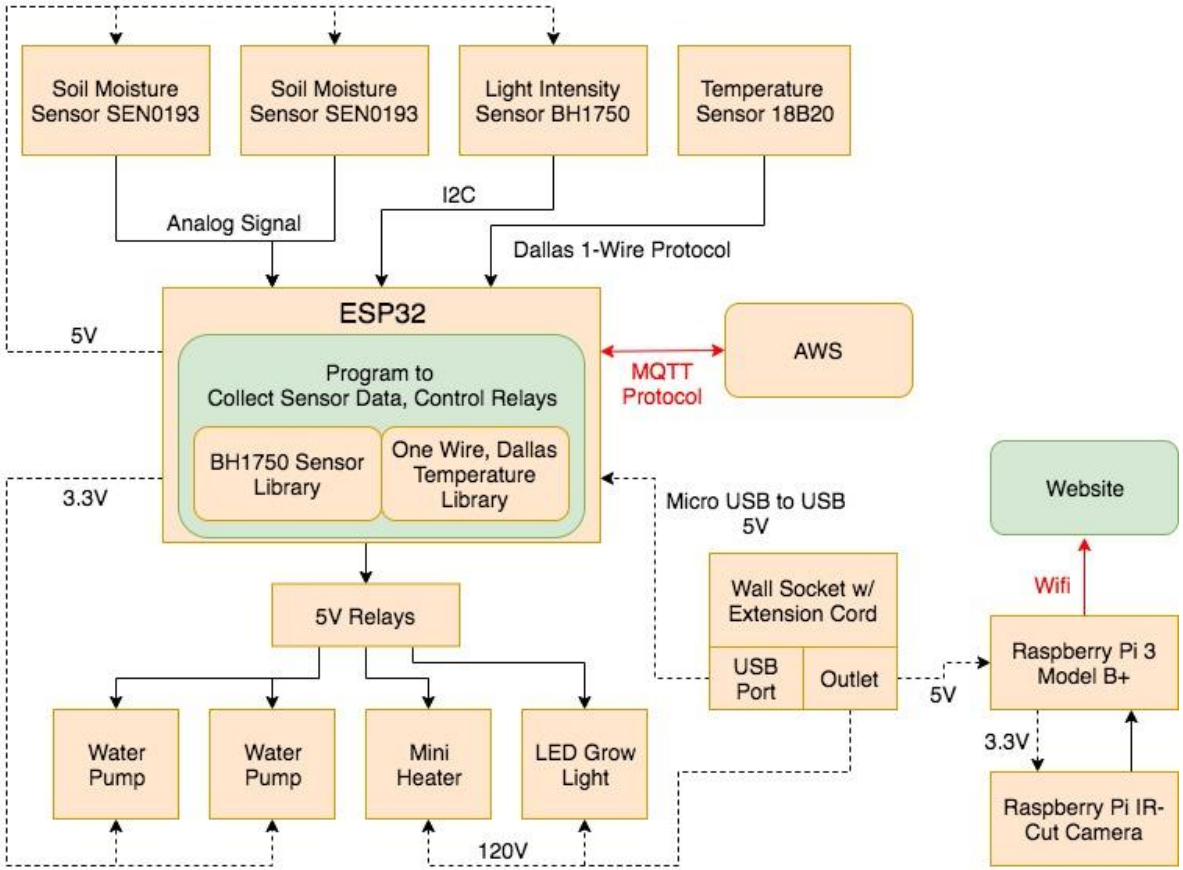
# Team E3 | Graduating Gardeners

Hiroko Abe, Sarah Jang, Kanon Kihara

# Application Area

- Create a gardening environment at home
- Automate conditions
  - Lighting, heating, soil moisture
  - Specific to plant species
  - Option for manual control
- Detects growth status and defects
- Monitor plants live

# System Specification / Block Diagram (Hardware)



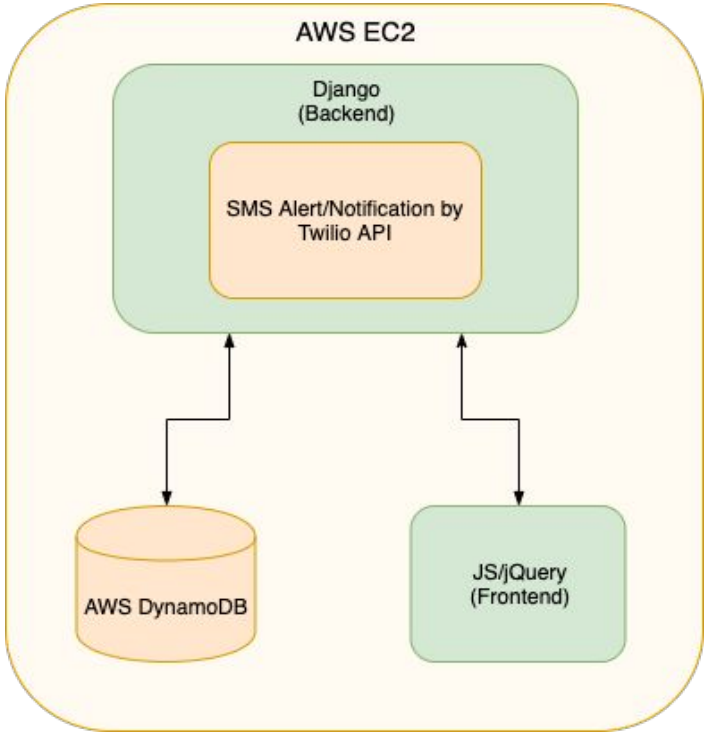

KEY

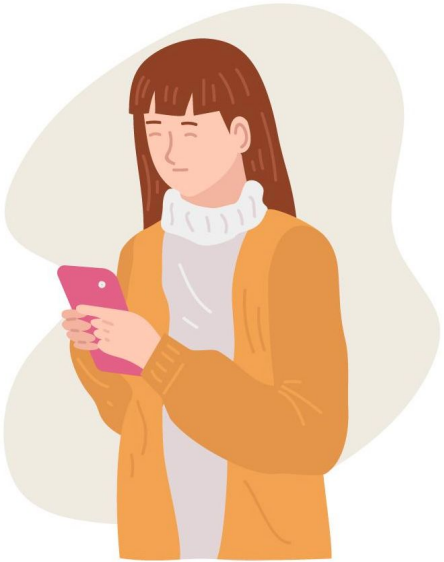
Hardware | Software | Off the Shelf | Newly Designed

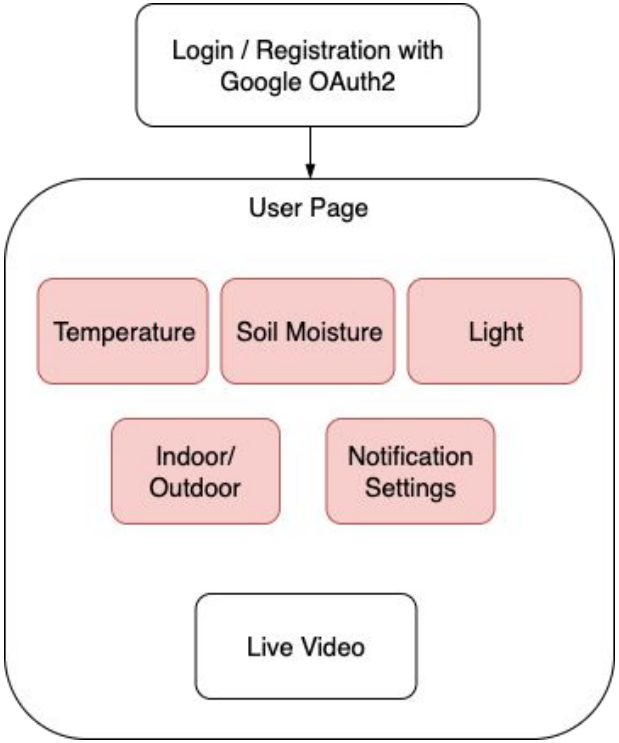
# Solution Approach (Hardware)

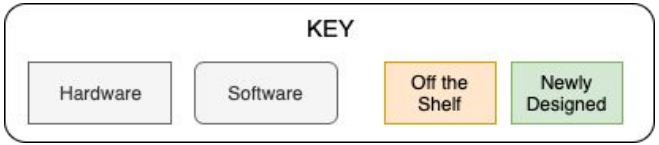
| System Components | Purpose | Why |
|---|---|---|
| Temperature sensor (18B20)<br>Mini heater, 5V relay | Heating | 18B20 library, waterproof<br>Simple on/off control w/ relay |
| Soil moisture sensor (SEN0193)<br>Water pump, 5V relay | Watering | Capacitive sensor<br>Simple on/off control w/ relay<br>Low flow rate |
| Light intensity sensor (BH1750)<br>LED plant grow light, 5V relay | Lighting | Dallas 1-wire protocol library<br>Simple on/off control w/ relay<br>Better than fluorescent |
| ESP32 | Data Transmission | MQTT protocol to send sensor data/receive commands to/from AWS IoT |

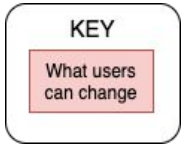
# System Specification / Block Diagram (Web App.)





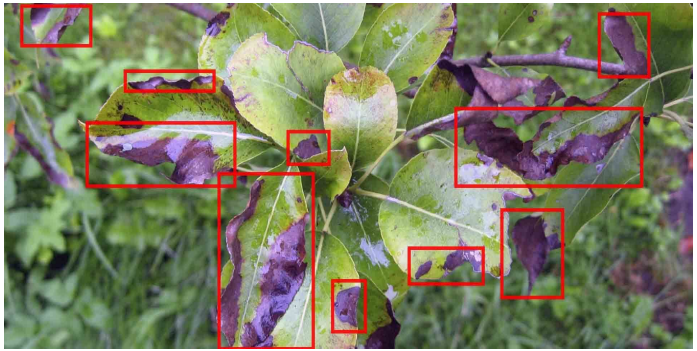



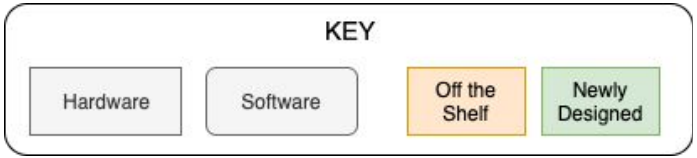



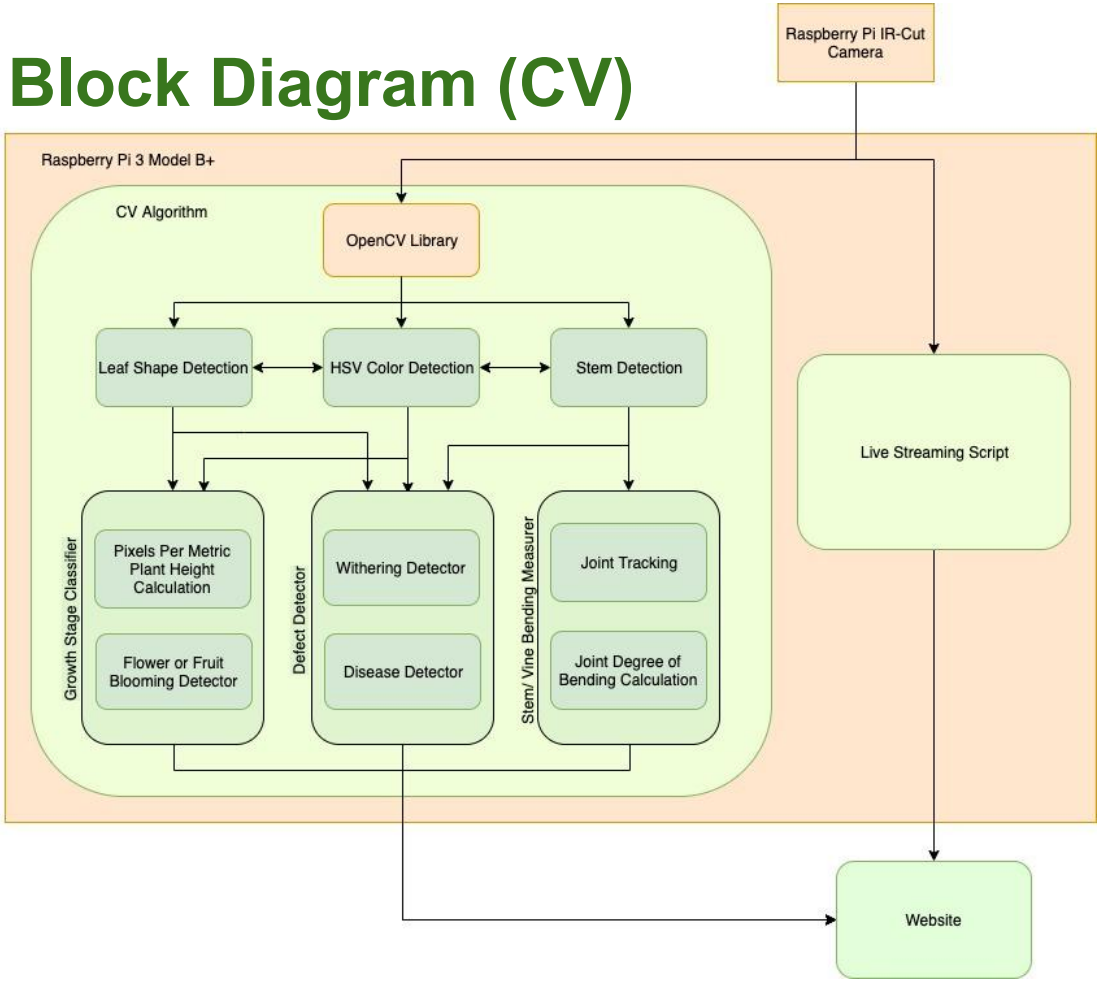
# Solution Approach (Web App)

| Component | Purpose | Why |
|---|---|---|
| AWS EC2 | Cloud solution | Compatible with AWS IoT and DynamoDB |
| AWS DynamoDB | Database | Compatible with ESP32, using AWS IoT Core |
| Django | Backend Development for Web Application | High-level Python webframe |
| Twilio | Alert / Notify users by sending SMS messages | Compatible with Python |

# System Specification / Block Diagram (CV)





# Solution Approach (CV)

| Component | Purpose | Why |
|---|---|---|
| Raspberry Pi 3 Model B+ | Connect camera and embed CV application code for real-time analysis in greenhouse | Powerful for 24/7 live streaming<br>Supports camera version<br>Sends data/ stream via wifi |
| Raspberry Pi IR-Cut Camera | Provide input for computer vision analysis and monitoring | Day and night vision for constant monitoring<br>1080p for high quality imaging |
| OpenCV | Computer Vision Analysis | Includes HSV color detection, edge detection, shape/ size detection functions<br>Works well with Python |

# Testing, Verification and Metrics (Hardware)

| Functionality | Testing Strategy | Metrics |
|---|---|---|
| Heating | Place in <45°F and set the target temperature to 60°F | Reach 60°F within 1 hour (∓5°F) and maintain temperature |
| Watering | Test sensor with dry/saturated soil | Waters dry soil within 1 hour,<br>does not water saturated soil |
| Lighting | Place in dark/sunlight | Lights turns on in dark,<br>stays off in sunlight |
| Data Transmission | Modify greenhouse conditions physically/through web app.<br>Record time to send/receive | Web app. notified < 1 minute<br>Hardware notified < 1 minute |

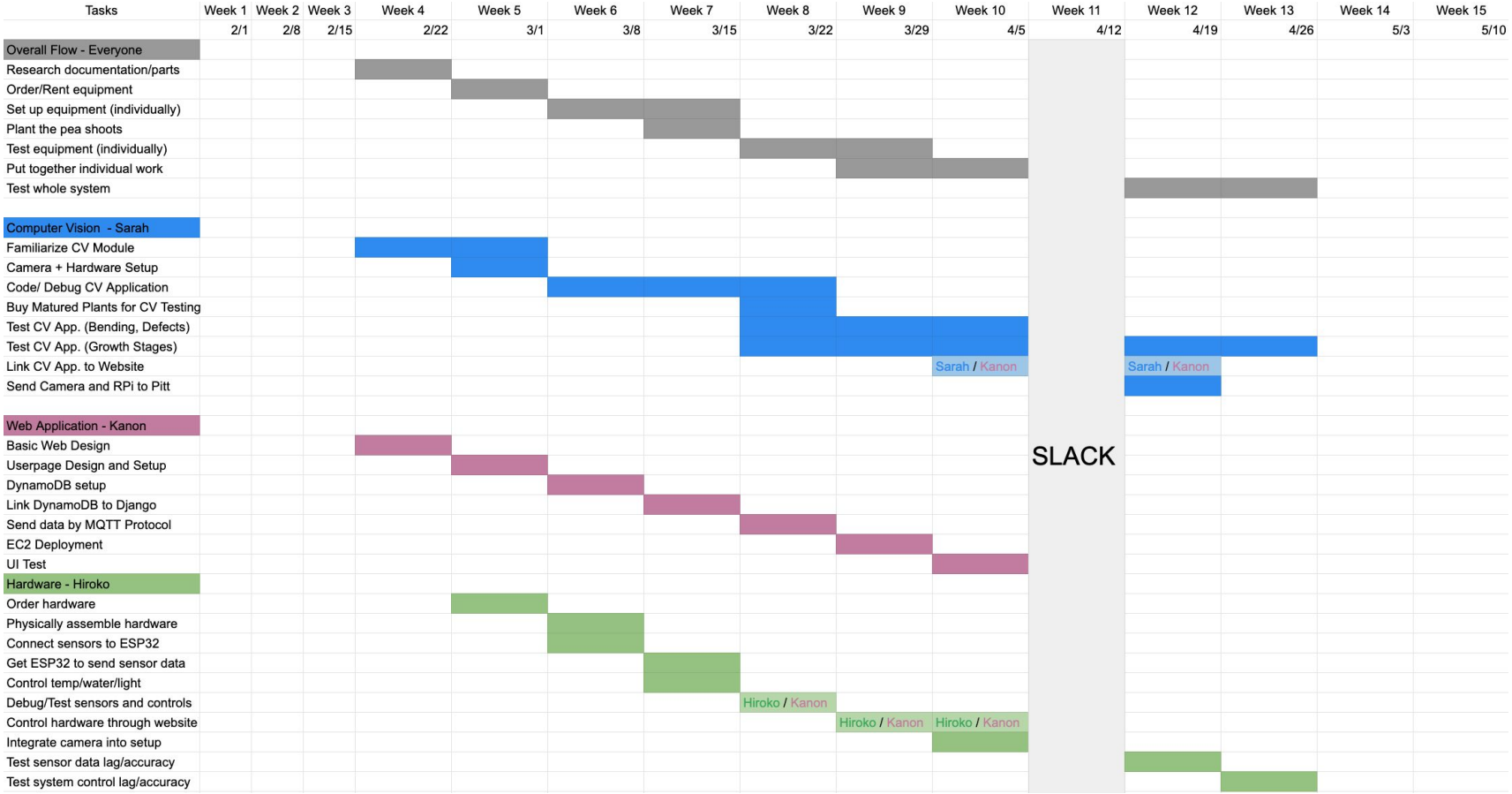
# Testing, Verification and Metrics (Software)

| Functionality | Testing Strategy | Metrics |
|---|---|---|
| Defect Detection | Wither by coloring leaves/neglect<br>Simulate diseases w/ discoloring | False positive <10%, False negatives <5%<br>20 tests each for withering/disease |
| Vine Bending | Bend vines<br>Buy tall/ mature pea shoots | Vines bending >45° from stem<br>>= 90% Accuracy with 20 tests |
| Growth Stage Detection | Capture growth of pea shoots | Classifying growth stages >= 90% accuracy<br>Germination (End of Week 1), Flowering (Week 2 - 3), Harvest (Week 3 - 4) |
| Video Streaming | Software tools that measure video and network latency | Latency <= 10 seconds,<br>Ideally <= 5 seconds |
| Web UI | Get random users to navigate through the web app. | Testers flawlessly and intuitively navigate through website. 8/10 people should find the navigation easy. |

# Risk Factors

- Getting wrong data from database
  - Try to regain data before outputting the value on the website
  - If the value changes drastically (i.e. 68˚F to 86˚F), notify the user
- Night vision does not perform well as expected
  - Turn on the white LED light at night to capture the video / perform CV
- Outdoor greenery blends in with plant on camera
  - Put colored background behind plant for image contrast
- Issues with hardware (sensor breaks/falls out, water runs out of tank, etc.)
  - Notify user to check greenhouse via SMS/email

# Schedule


Tasks
Week 1 2/1
Week 2 2/8
Week 3 2/15
Week 4 2/22
Week 5 3/1
Week 6 3/8
Week 7 3/15
Week 8 3/22
Week 9 3/29
Week 10 4/5
Week 11 4/12
Week 12 4/19
Week 13 4/26
Week 14 5/3
Week 15 5/10
Overall Flow - Everyone
Research documentation/parts
Order/Rent equipment
Set up equipment (individually)
Plant the pea shoots
Test equipment (individually)
Put together individual work
Test whole system
Computer Vision - Sarah
Familiarize CV Module
Camera + Hardware Setup
Code/ Debug CV Application
Buy Matured Plants for CV Testing
Test CV App. (Bending, Defects)
Test CV App. (Growth Stages)
Link CV App. to Website
Sarah / Kanon
Sarah / Kanon
Send Camera and RPi to Pitt
Web Application - Kanon
Basic Web Design
Userpage Design and Setup
DynamoDB setup
Link DynamoDB to Django
Send data by MQTT Protocol
EC2 Deployment
UI Test
SLACK
Hardware - Hiroko
Order hardware
Physically assemble hardware
Connect sensors to ESP32
Get ESP32 to send sensor data
Control temp/water/light
Debug/Test sensors and controls
Hiroko / Kanon
Control hardware through website
Hiroko / Kanon
Hiroko / Kanon
Integrate camera into setup
Test sensor data lag/accuracy
Test system control lag/accuracy