Genius Garden

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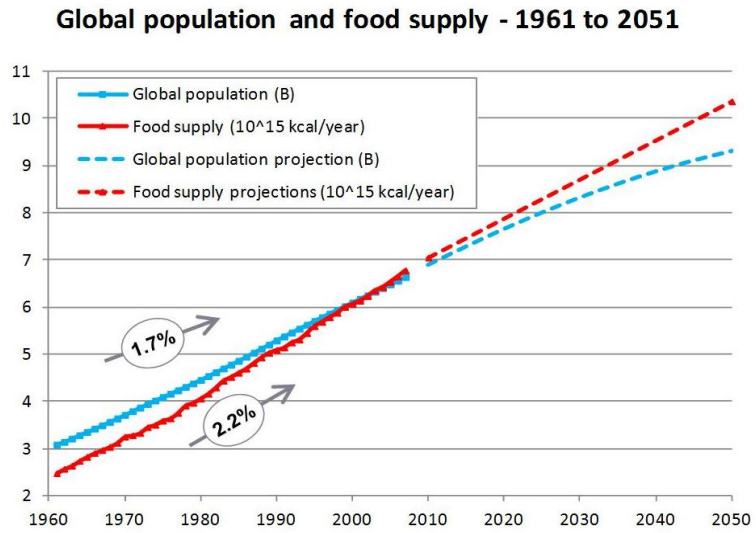
iLAB1 project showcase

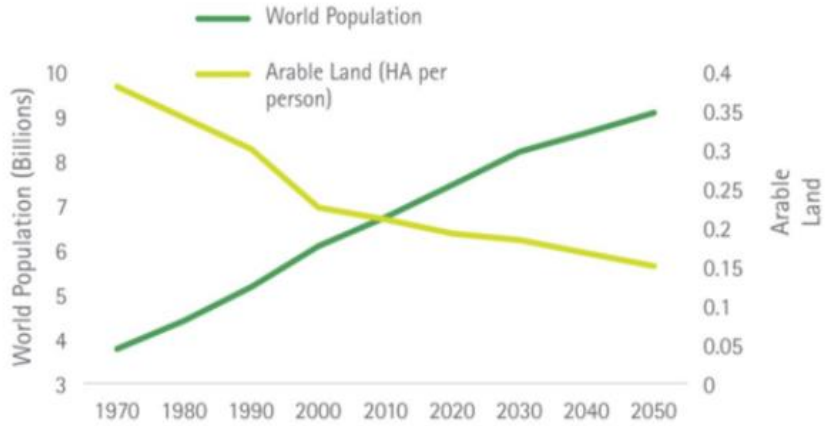
Master in Data Science and Innovation

University of Technology Sydney

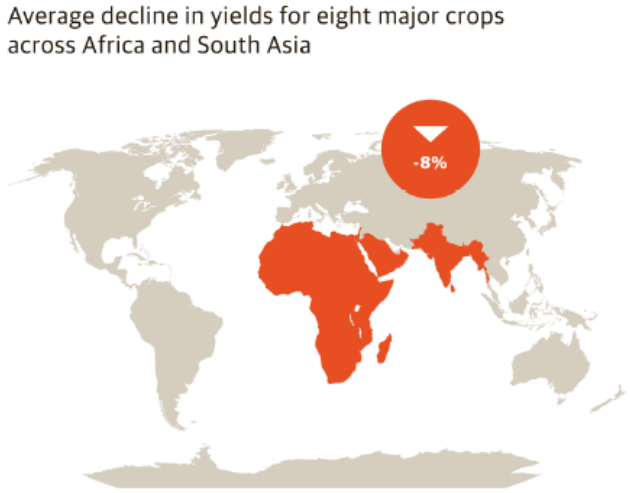
Food demand forecast:



Sorce:http://www.tasteofsustainability.com/wp-content/uploads/2012/02/2050-global-population-and-food-supply1.jpg



Source: FAO, United Nations, WHO



Source: https://cgspace.cgiar.org/handle/10568/35215/Climate change, food security and small-scale producers

What is Genius Garden ?

- A community based precision-agriculture backyard farm prototype.
- Hydroponic method of gardening.
  - Uses less power and conserved water.
  - Outdoor garden, very challenging growing climate (sometimes, 4 seasons in one day).
- Solar powered with small backup battery.
- IOT implementation.
- Utilised cloud computing resources for data storage.
- AI controlled plant growing with insect detection.

Components

100 W Solar Panel with Charge controller

Plastic Box as water tank

PVC Pipes

8 MP NoIR Camera

8 MP RGB Camera

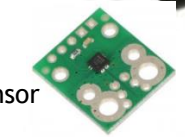
26 AH battery

Atlas PH probe

Atlas EC probe

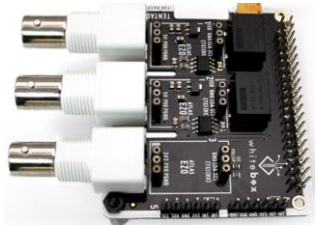
12Vdc Peristaltic Pump

5W 12Vdc Immersible Pump



ACS711 Current sensor

DC Relay



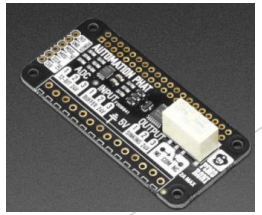
Tentacle T3

DS18B20 Digital Temperature sensor

Raspberry Pi 3

Raspberry Pi Zero W

Automation pHAT

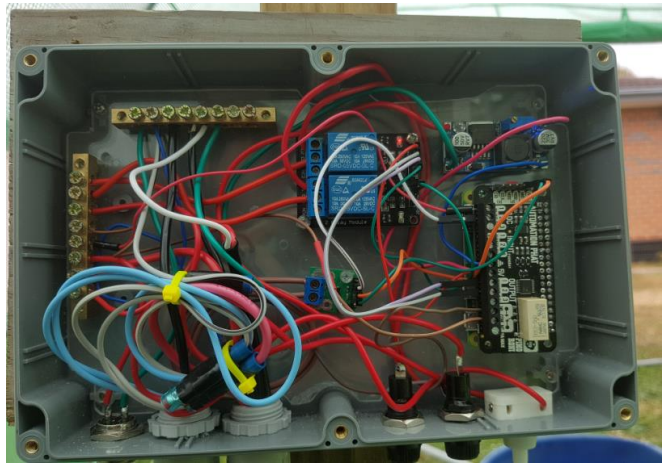


DHT11 Humidity and Temperature sensor

Electronics Devices Assembly:

Motor Control Box

- Used in weather forecast webscrape, 4 water circulator mini pumps, and solar panel voltage and current sensors.

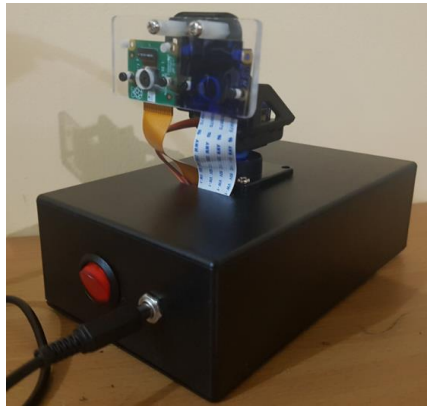


Nutrient Mixer Box

- Measures pH, EC and water temperature.
- Controls nutrients, tap water and acid buffer mixing.

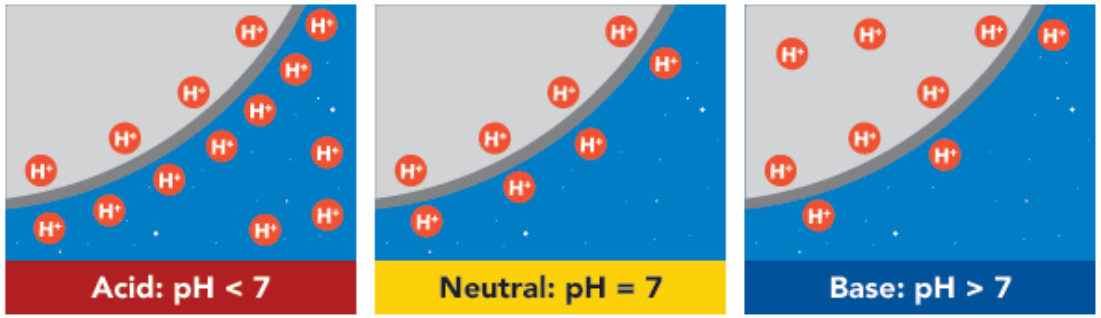
Plant Health Camera Box

- Captures NoIR, colour and NDVI photos of the plants.



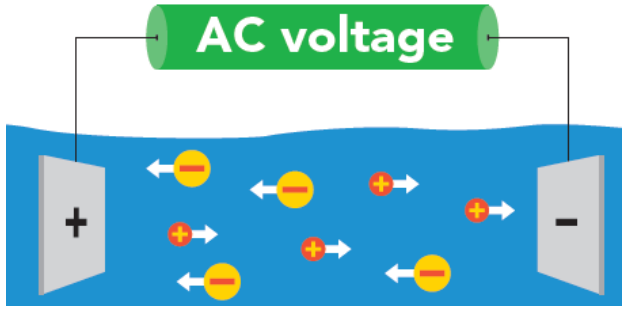
What is PH?

- Potential of Hydrogen
- Is a numeric scale from 1 to 14 used to indicate the Acidity or Alkalinity of water.
- Water and nutrients solution needs to be in proper pH range for efficient absorption of nutrients by the plant.
- pH of the nutrient solution is measure by Atlas pH prove.



What is EC

- Electrical Conductivity
- Indicates the amount of nutrients, salt or impurities in water.
- High conductivity occurs when the water contains more free electrolytes.



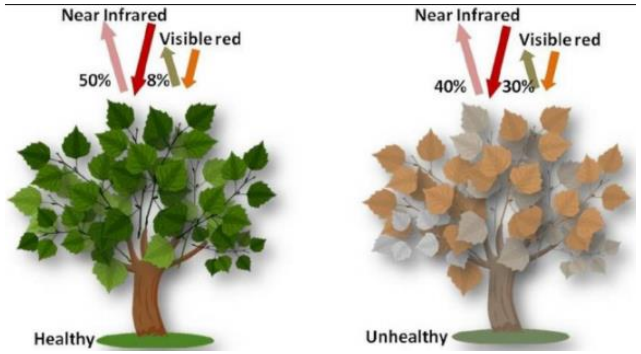
- At high temperature, plants absorbs more water to cool down resulting to more nutrients absorption leading leaf burn-out.
- EC is measured by Atlas EC probe.

Over-fertilized, the leaf will curl and
The tips goes brown like a burn

Nutrient deficient

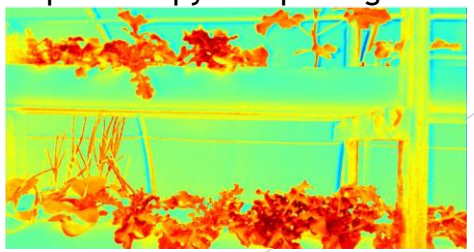
What is NDVI

- Normalised Difference Vegetation Index
- Uses the visible and near-infrared bands of the light spectrum as a way to indicate plant health.

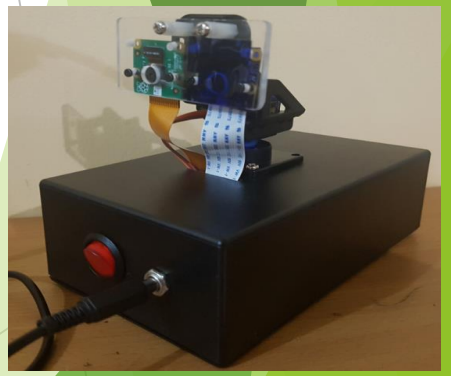


- **NDVI= (NIR-RED) / (NIR+RED)**
- Images below are taken by the dual lens Raspberry Pi Camera and post processed using OpenCV python package.
- Deep red means healthy plant.

NDVI image processed using OpenCV 3 python package

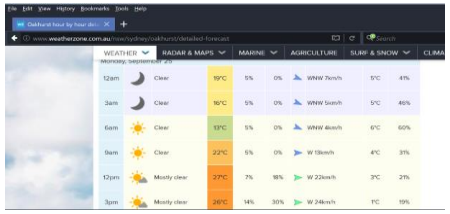


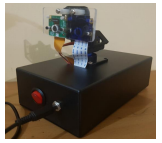
Raspberry Pi Dual Camera

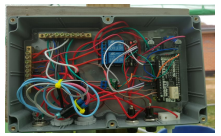


End to End IOT Architecture

- Web scraped weather forecast, images are sent to AWS IOT Cloud using web API.
- Sensors data are sent to AWS IOT Cloud using MQTT protocol







boto3 python package

AWS CLI

Paho-mqtt
python package

AWS IoT

Secure communication via TLS with AWS IoT

Data sent AWS IoT Device Gateway

Trigger a rule in AWS IoT

S3

DynamoDB

AWS Lambda

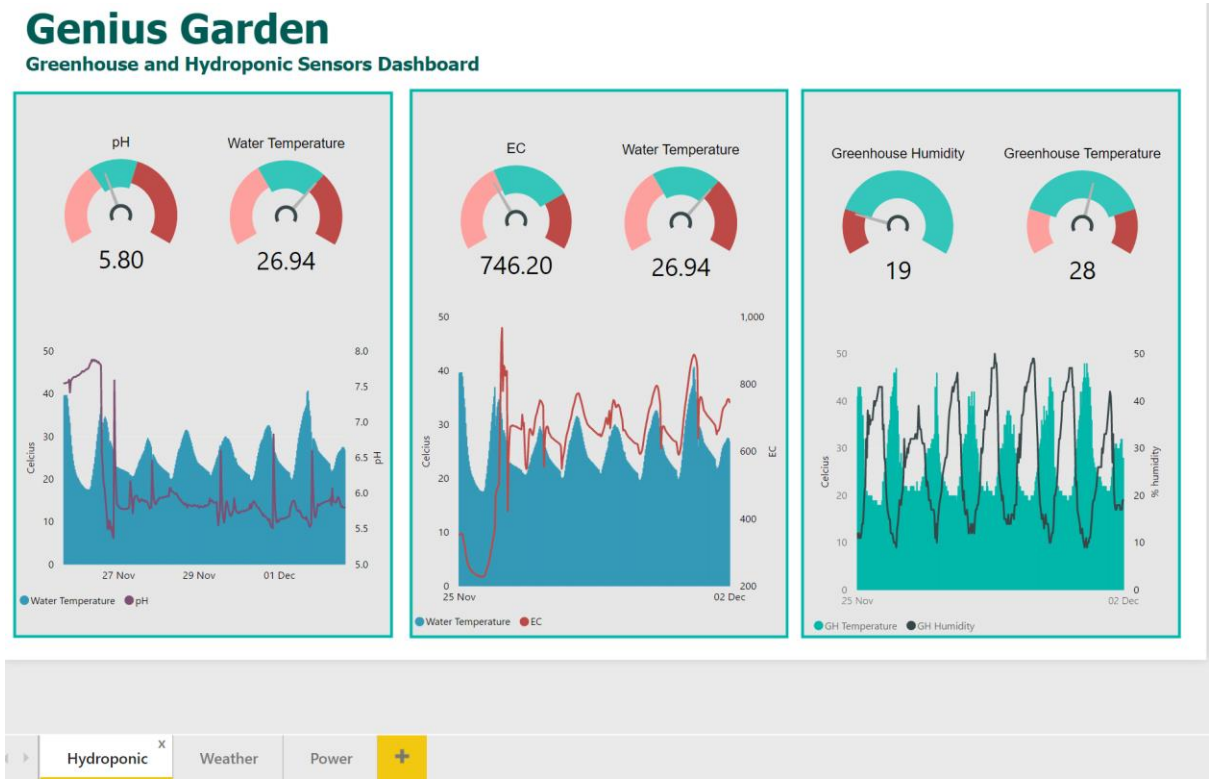
API Gateway

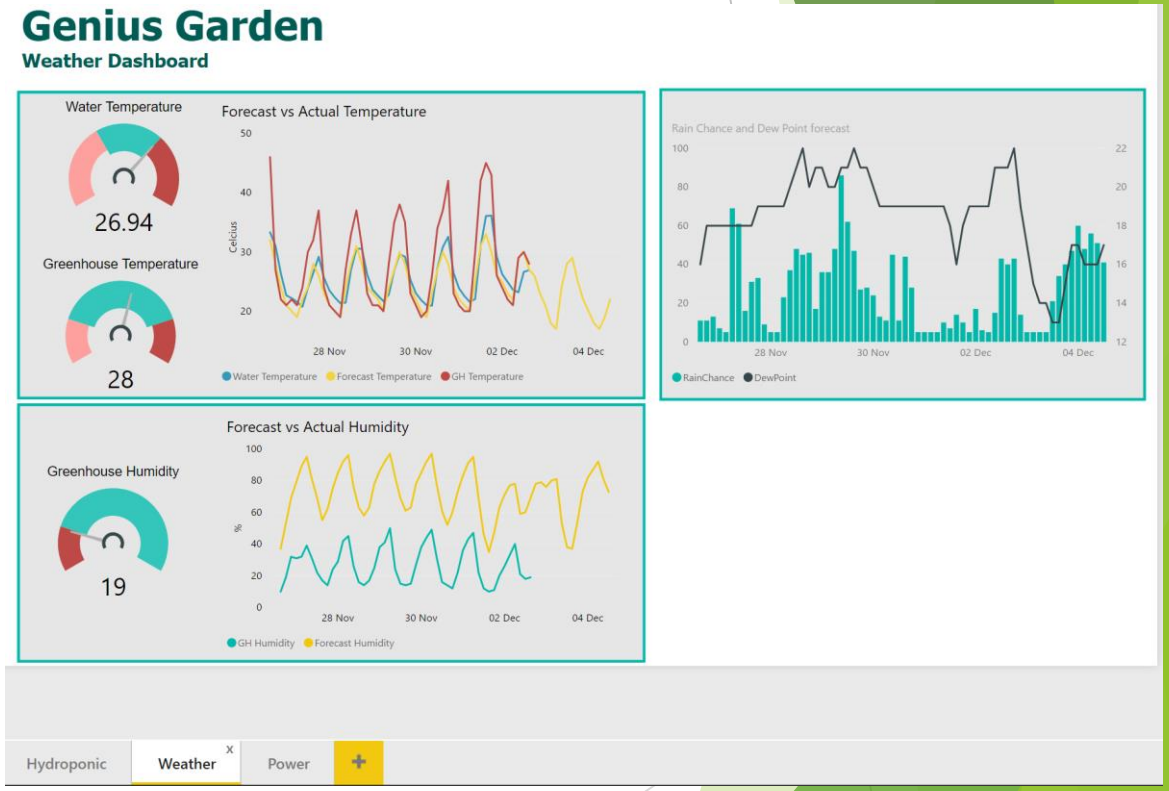
Power BI

Data to/from Mobile and web applications

Dashboards

Data visualization of collected data using Power BI





Plant photos

Various Vegetables

Berries

Grapes

Next Step (iLab2)

- Development of custom user interface (mobile and desktop app) using Python Kivy package to replace Power BI.
- Develop Deep Reinforcement Learning model for plant nutrient, acid buffer, water and air mixer to control level of EC, pH and Oxygen with respect to change in temperature and plant growth stage.
- Insect Detection Feature integration using transfer learning Convolutional Neural Network (CNN).