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Automated Hydroponic System Using Image Recognition

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2020

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Hydroponic System Definition

Hydroponics is a method of growing plants in a soilless medium, using a nutrient rich-solution.



Advantages of a Hydroponic System

Location
Independent



Reduction of
Manual Labour



All Year Round
Harvest



Efficient Use
of Water



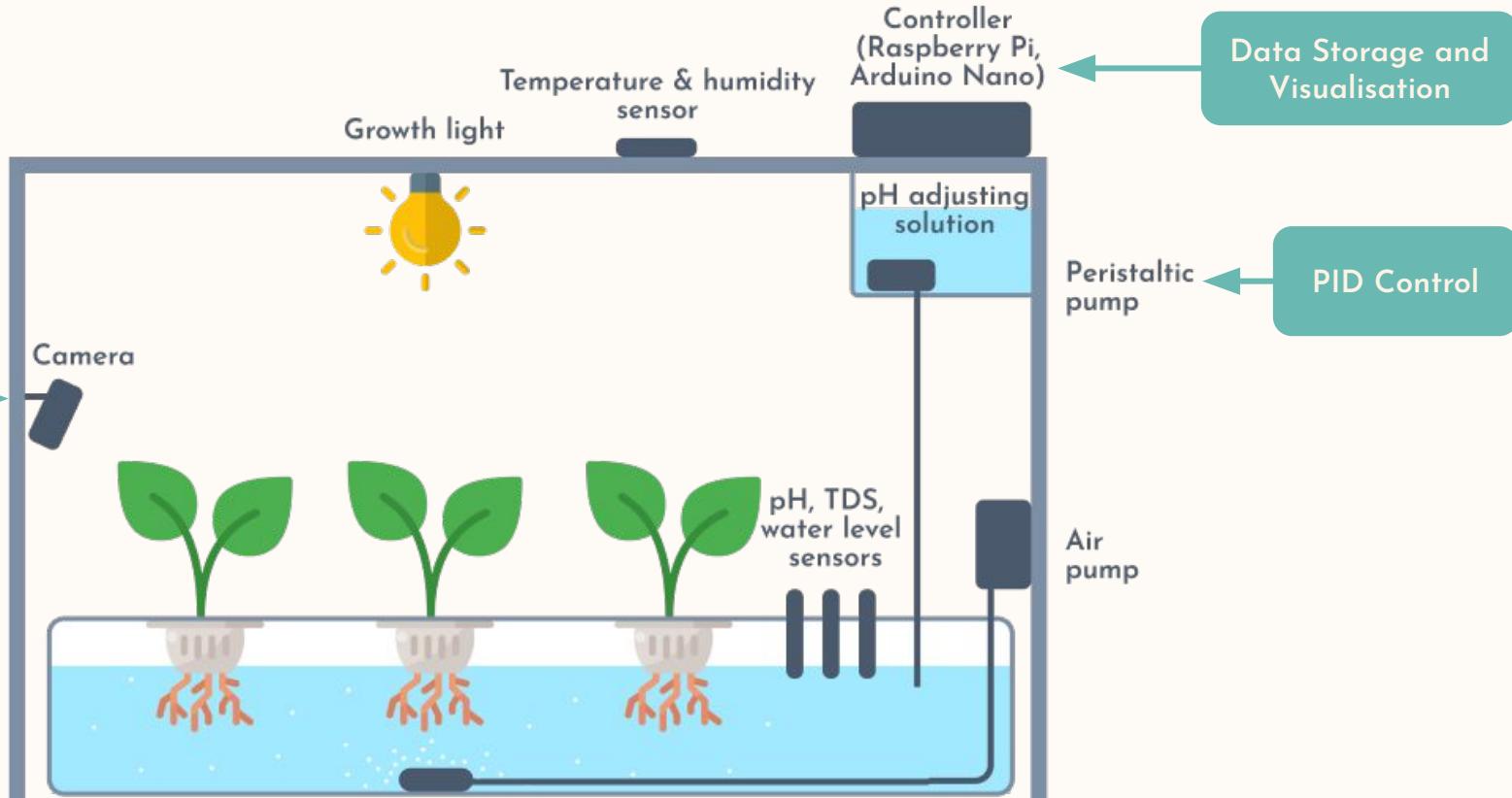
Increased
Yield



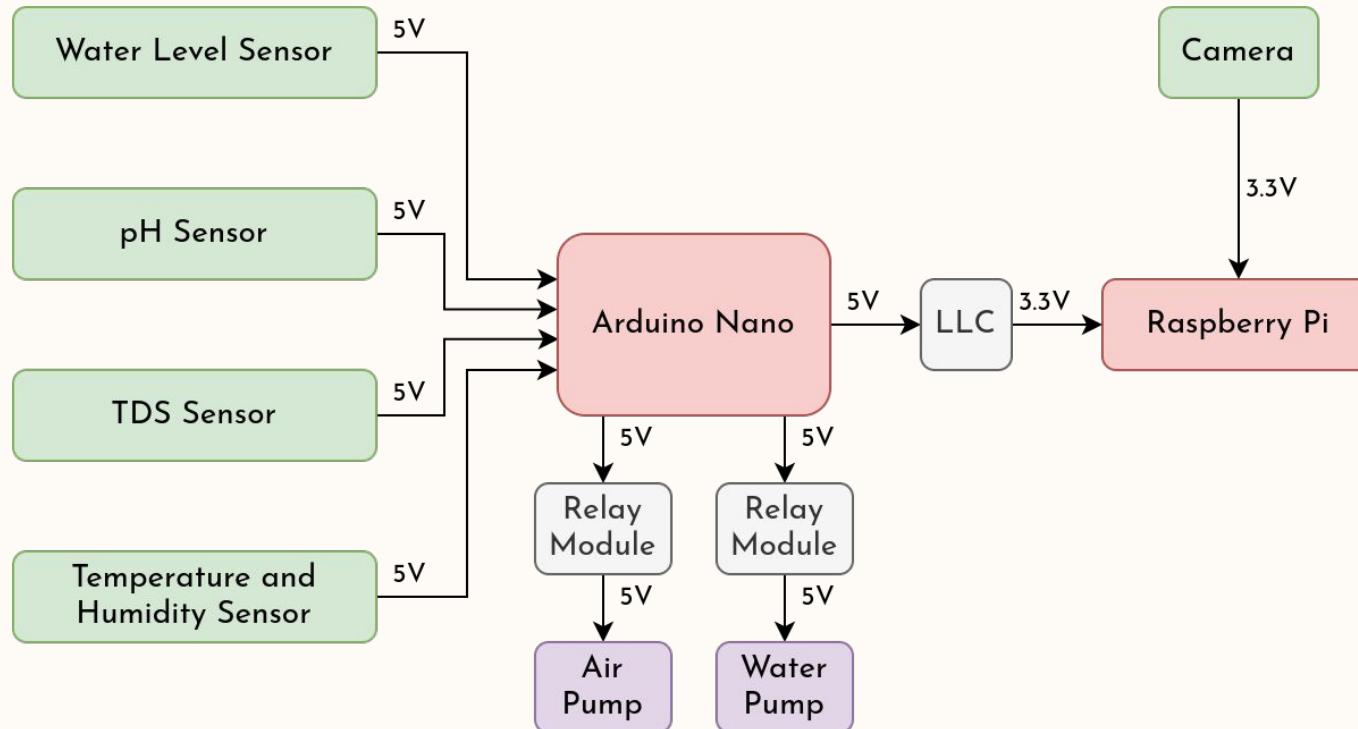
Efficient Use
of Space



Hydroponic System Structure



Block Diagram of the System



Components Specifications



Peristaltic Pump
3V-5V | 100 mA



Air Pump
3V-6V | 350 mA



Arduino Nano
5V | 19 mA



Raspberry Pi 3 B+
5V | 980 mA



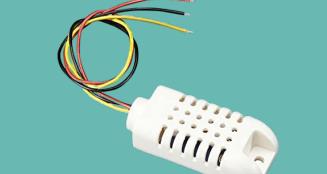
Power Supply
5V | 3A



pH Sensor
5V



TDS Sensor
5V | 6 mA



DHT22 Sensor
5V | 2.5 mA

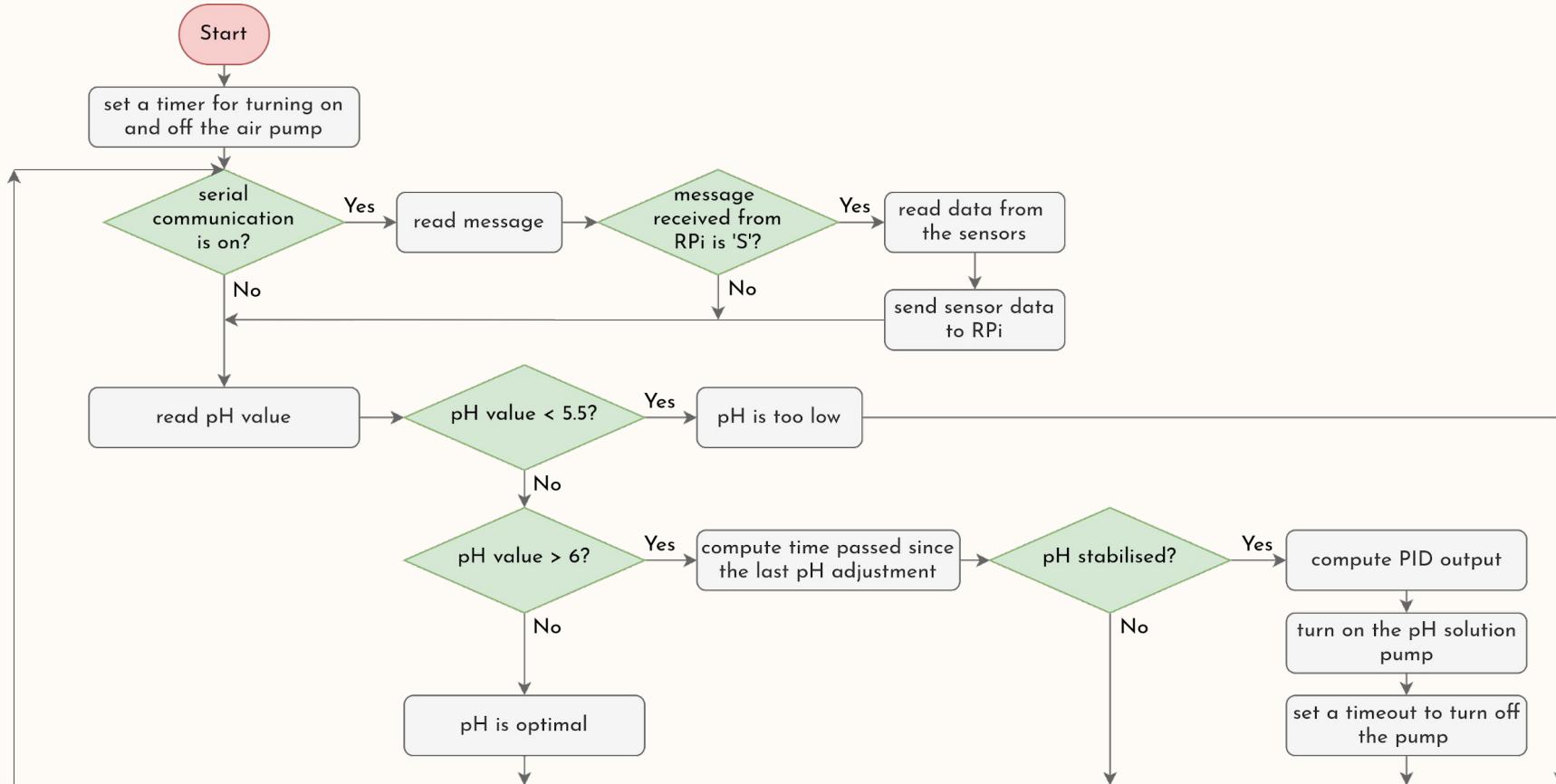


Water Level Sensor
5V

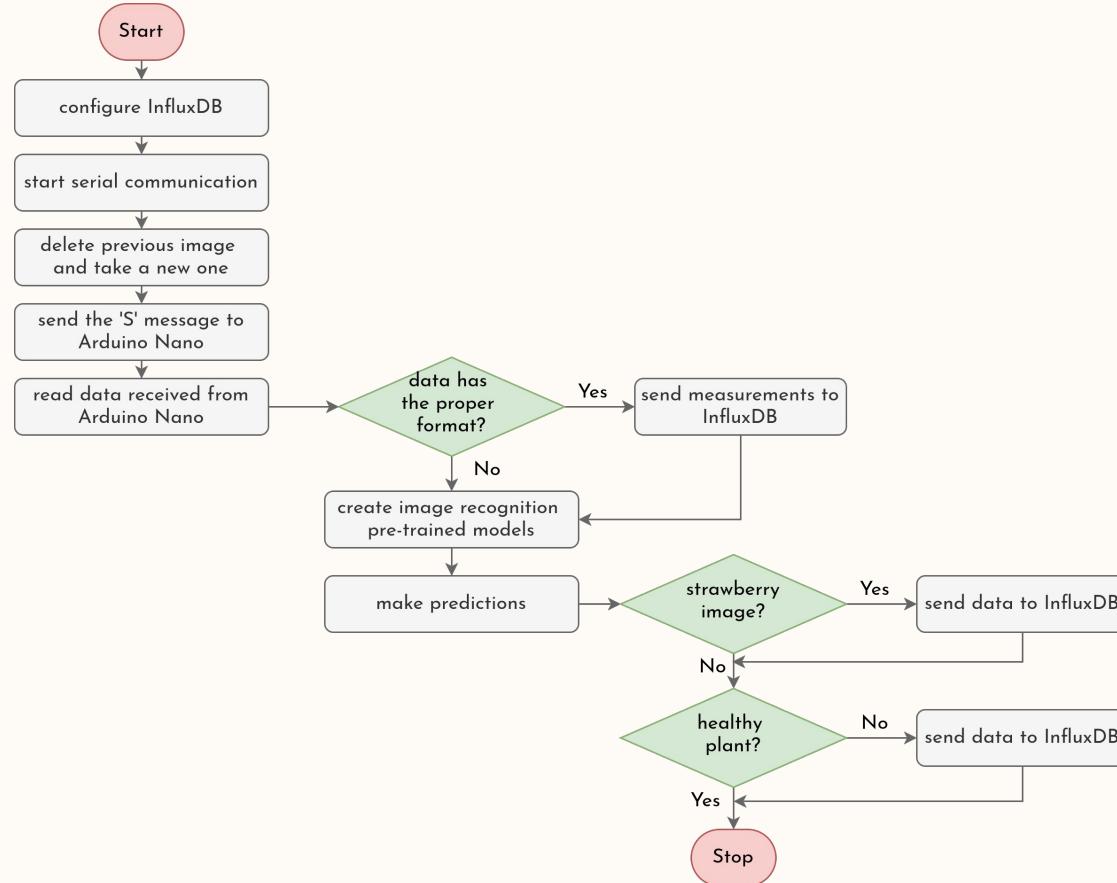


Camera v1.3
5V | 250 mA

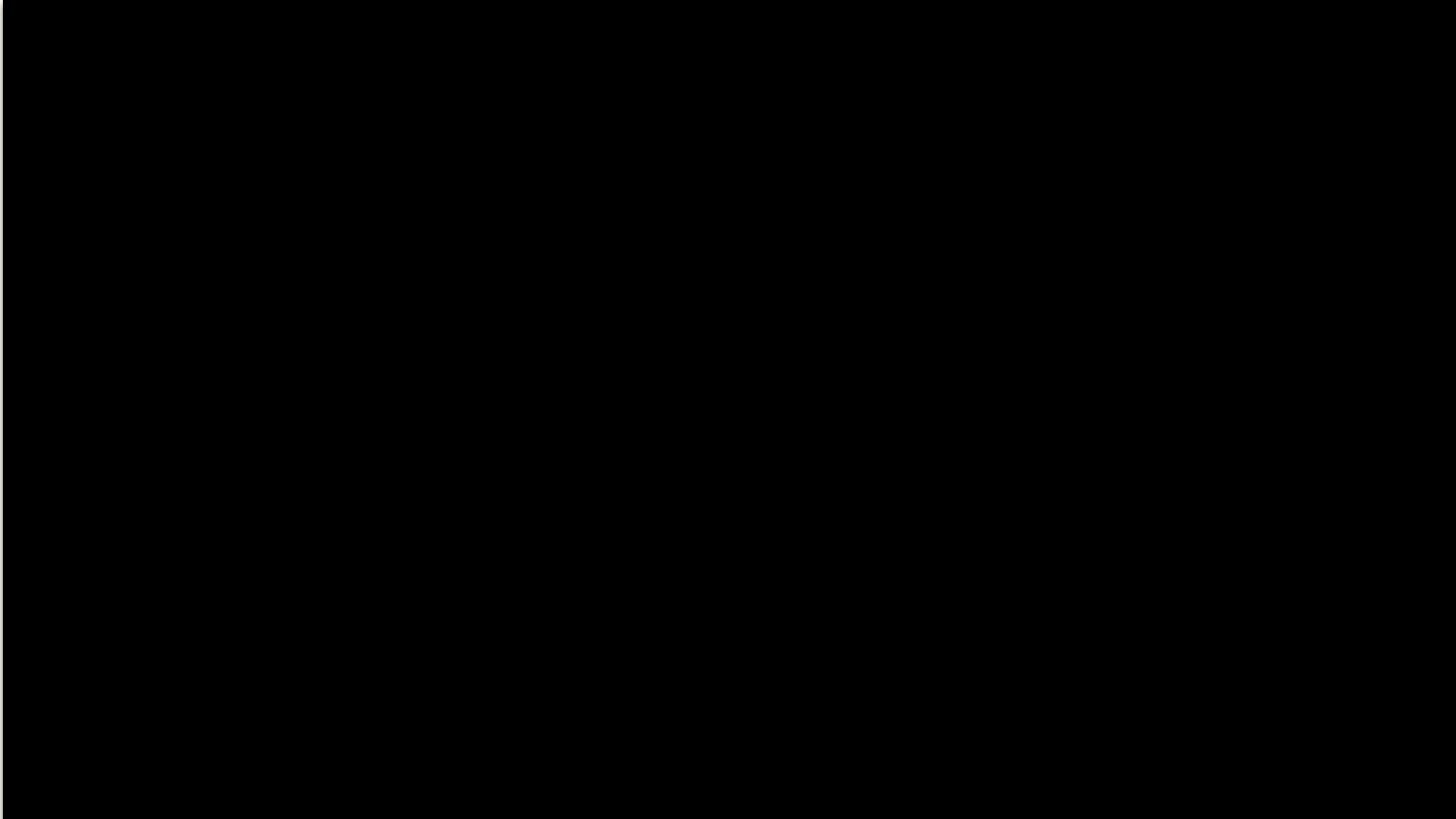
Arduino Nano - C/C++ Code Flowchart



Raspberry Pi - Python Code Flowchart



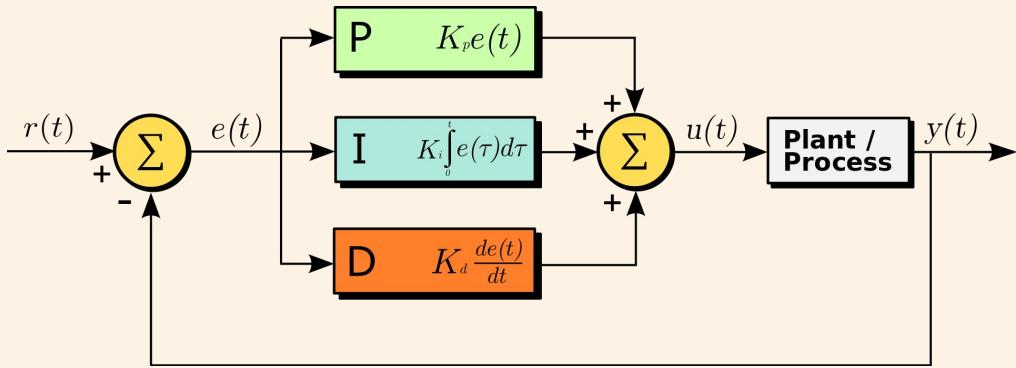
Air Pump Demonstration



Data Monitoring Demonstration



PID Theoretical Aspects



Source: teachmemicro.com

- P **Proportional Term**
corrects the instantaneous error
- I **Integral Term**
eliminates steady state error
- D **Derivative Term**
predicts the error

$$u(t) = K_p e(t) + K_i \int_0^t e(\tau) d\tau + K_d \frac{de}{dt}$$

Proportional Term

$$error = setPoint - input$$

Integral Term

$$elapsedTime = currentTime - previousTime$$

$$cumulativeError = cumulativeError + error \cdot elapsedTime$$

Derivative Term

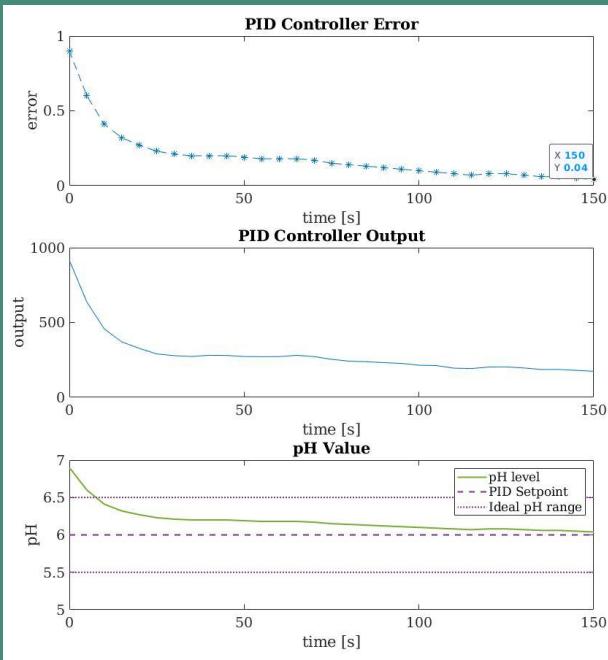
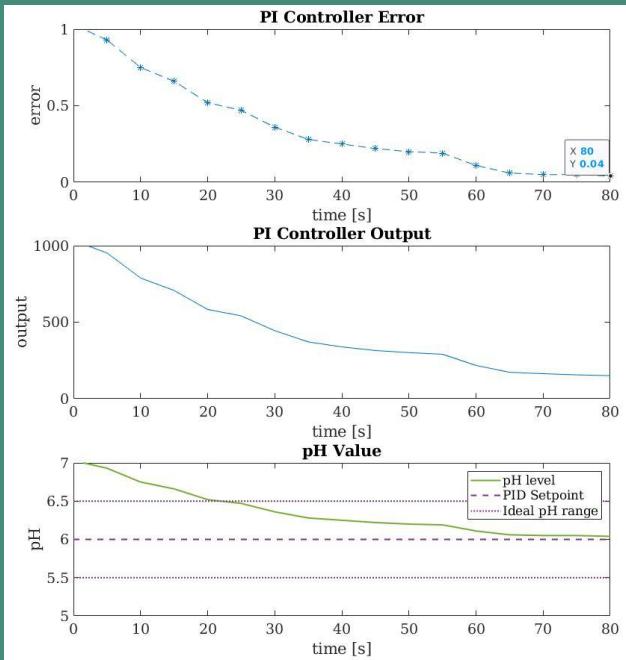
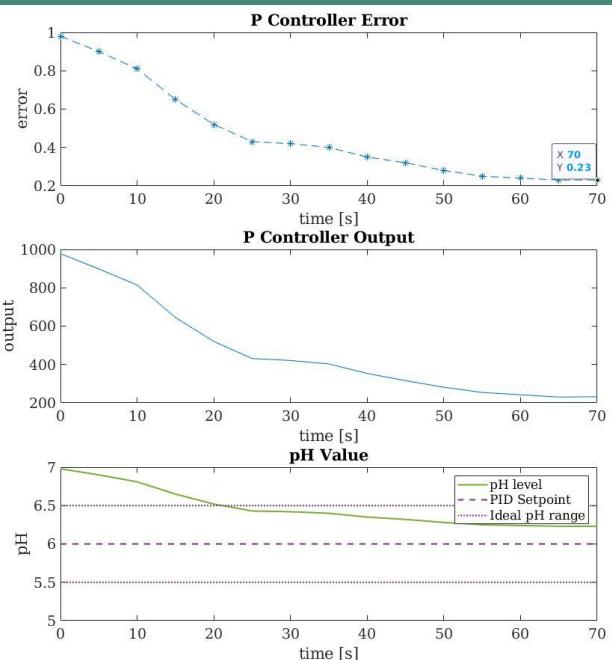
$$rateError = \frac{error - lastError}{currentTime - previousTime}$$

PID Output

$$out = K_p \cdot error + K_i \cdot cumulativeError + K_d \cdot rateError$$

Experimental Results

$$K_p = -1000, K_i = -2, K_d = -100$$

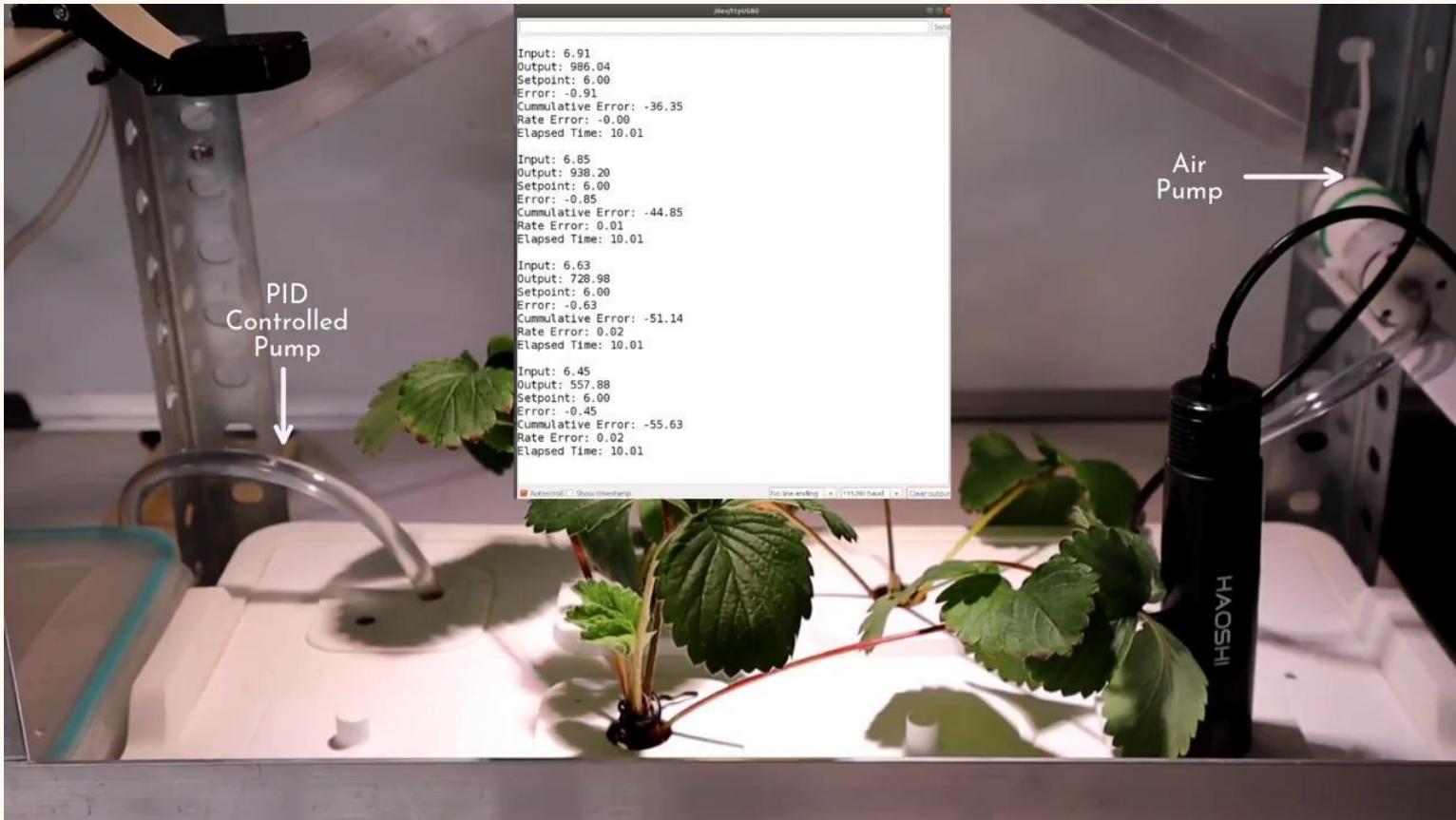


P Controller

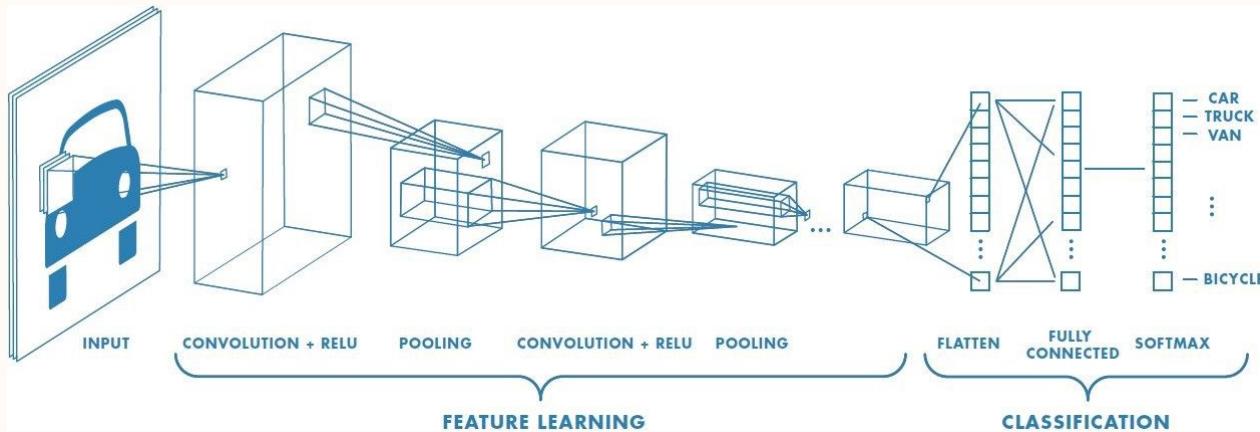
PI Controller

PID Controller

PID Demonstration



Layers of a Convolutional Neural Network



Source: towardsdatascience.com

Convolution Layers

- feature extraction
 - uses filters
 - output feature maps

Non-linear Layers

- activate the neuron output
 - map the input into output

Pooling Layers

- reduce the resolution of features
 - abstract the image

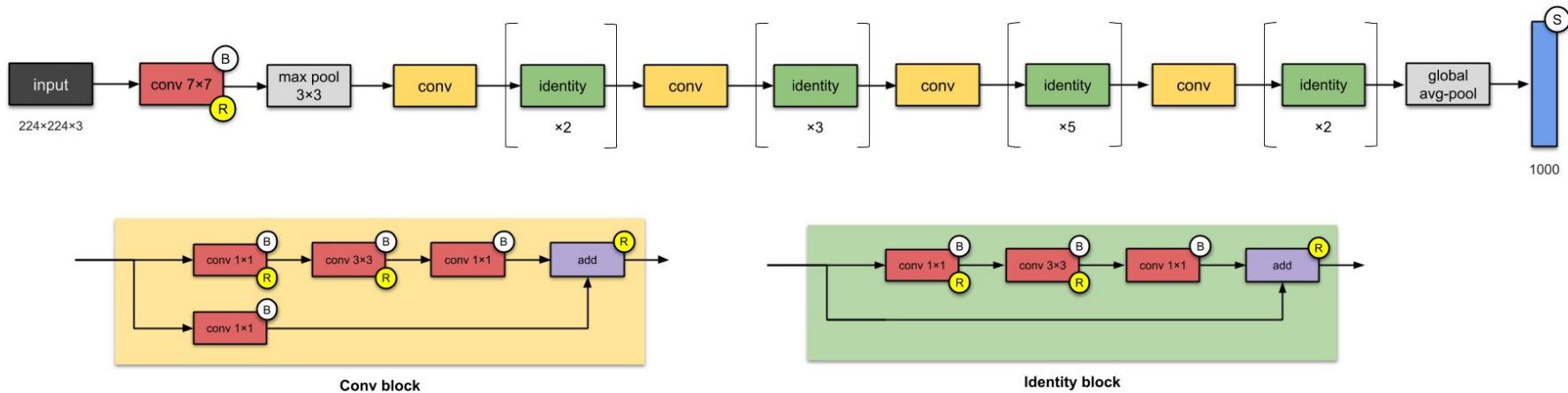
Flattening Layer

- converts
tensor
matrices to
vectors

Dense Layers

- fully connected
 - make predictions

Detection of a Strawberry Fruit Using a Pre-trained Model



Source: towardsdatascience.com

ResNet50 Model Architecture

Plant Health Detection Using Transfer Learning

Training Dataset

1056 images



Source: PlantVillage Dataset

Transfer Learning

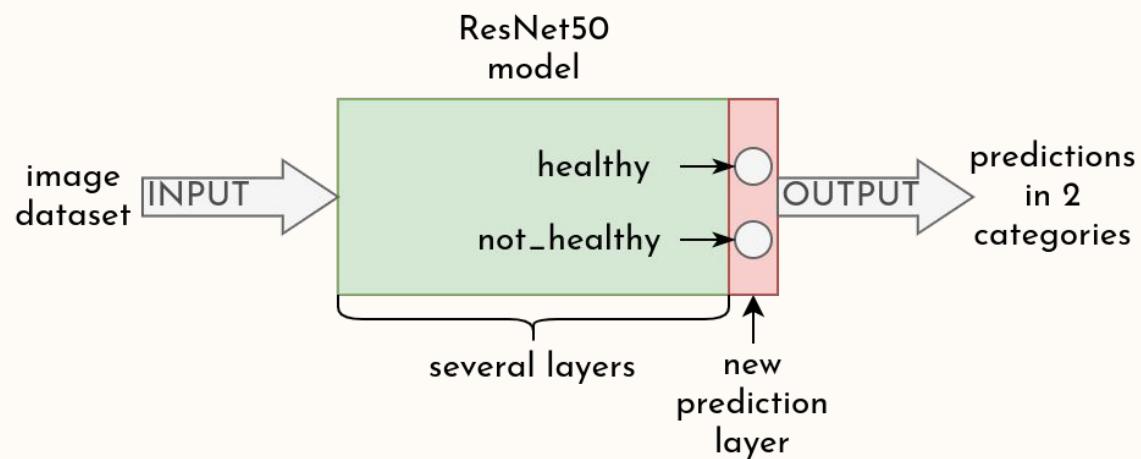
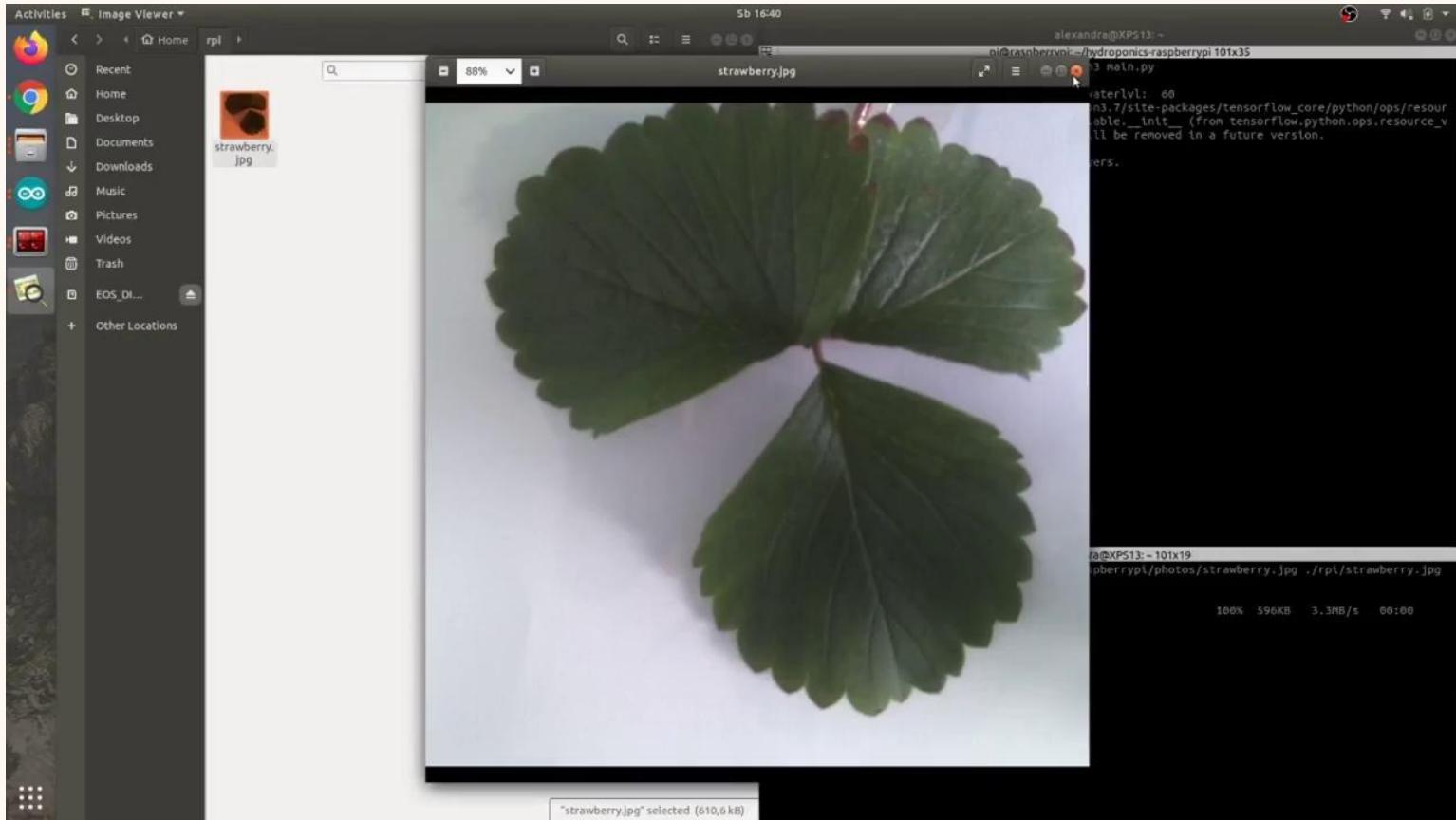


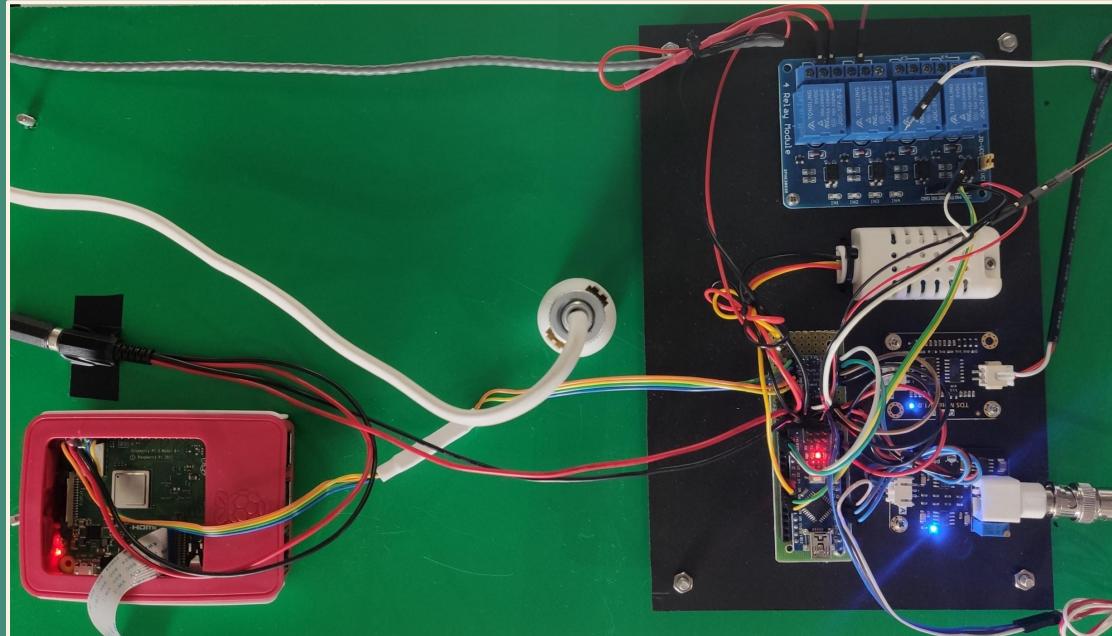
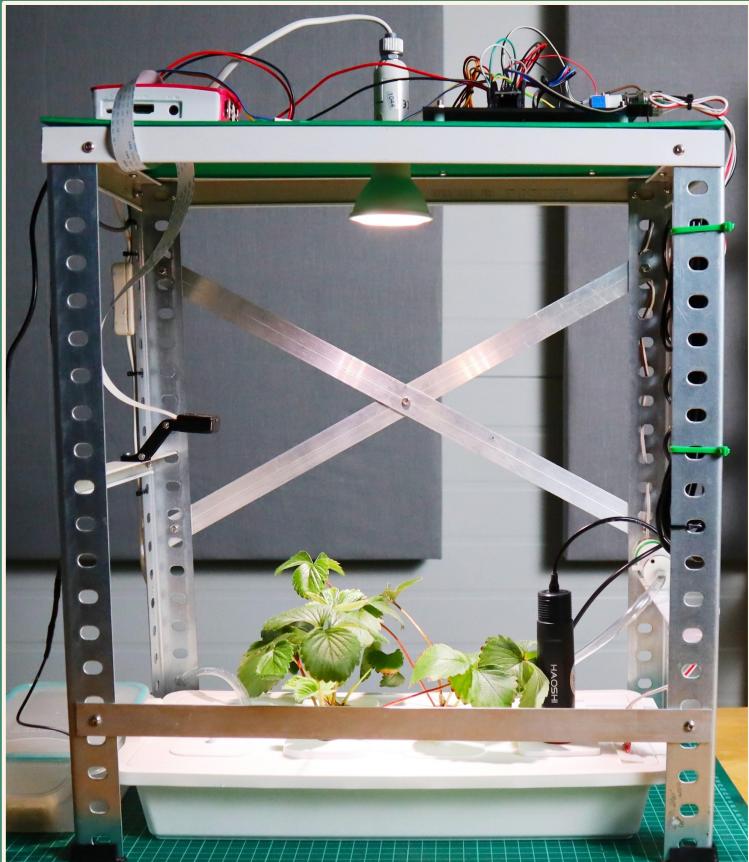
Image Recognition Demonstration



Personal Contributions

1. I implemented the hardware part of the system (electrical connections of the sensors, actuators and controllers).
2. I developed an algorithm for collecting sensors data and storing it in a time-series database.
3. I implemented the visual interface.
4. I developed a PID algorithm for automatic control of the pH level.
5. I implemented a pre-trained neural network model for strawberry recognition.
6. I trained and implemented a neural network model for plant health detection through transfer learning.

Final Project

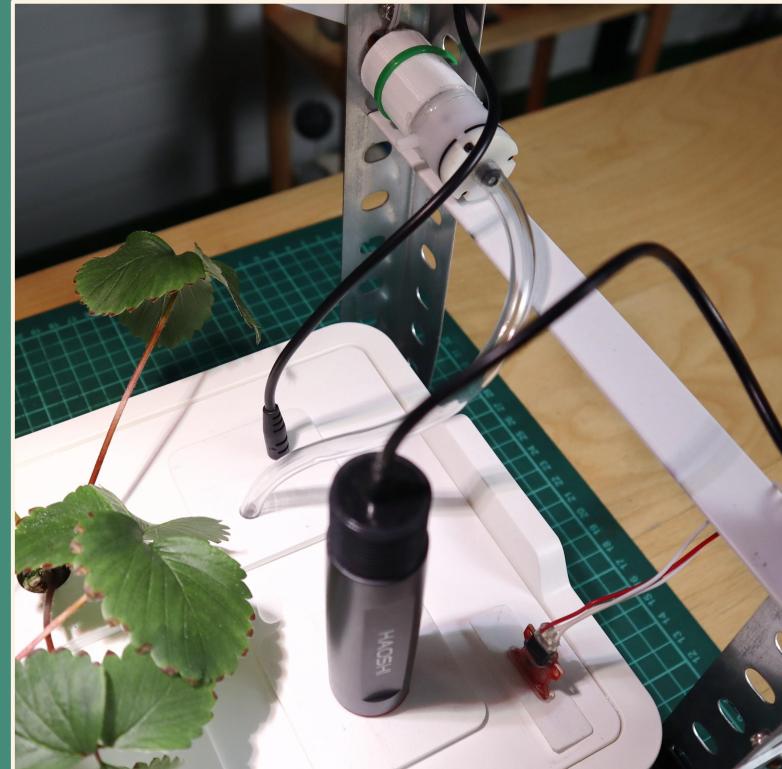


Assembled project (left) and electrical connections (up)

Final Project



TDS sensor and air pump mount



pH and water level sensors

Final Project



Camera Mount



**Thank you for your attention!
Any questions?**



Source: Eddie Mendoza on Artstation

Data Monitoring Demonstration

