EEE 416 – Microprocessor and Embedded Systems Laboratory

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# Final Project Demonstration

# IoT Based Smart Agriculture System


Submitted by – Group A.05

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# Outline

1. Abstract
2. Introduction
3. Design
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5. Analysis and Evaluation
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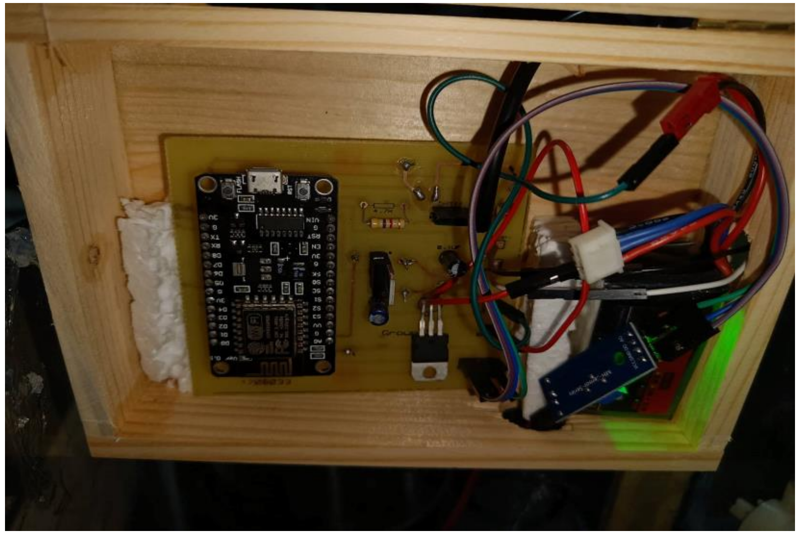
# 1. Abstract

The main objective of this project was to design a smart agriculture system using Internet of Things(IoT). Real time data monitoring with surveillance system has been implemented in this project. This project aims at real life implementation at large scale.
Measuring different data and weather parameters, data have been sent to cloud server and necessary steps have been automated for ease.

In short -

- DHT11,Sonar sensors, rain sensor etc. & surveillance system with machine learning have been implemented.
- Automatic water pump system and buzzer system have been implemented.

# 2. Introduction

Although Bangladesh's economy depends mostly on agriculture, farmers are still not quite comfortable with digital system and automation. This project will help the farmers with proper information and steps.

Because of lack of information, farmers face difficulties to harvest their crops. This project will help farmers decrease their loss. The implementation of this project will ensure maximum harvest and help farmers to get acquainted with IoT.


# 3.1 Design: Methods

◦ Total implementation has five segments

1. Data Monitoring
2. Application of Monitoring (Irrigation System)
3. Real-time Weather Monitoring
4. Security System
5. Leaf Image Analysis using Machine Learning and Automation

# 3.1.1 Data Monitoring

- Following data related to farming are monitored and uploaded to web server.

1. Humidity (DHT11 sensor)
2. Soil Moisture
3. Temperature (DHT11 sensor)
4. Soil Temperature (DS18B20 sensor probe)

- NodeMCU ESP8266 was used to collect data from sensors and send the data to Adafruit IO for visualization. (Free version of Adafruit IO was used for this purpose)

# 3.1.2 Application of Monitoring (Irrigation System)

- One application of monitoring, the irrigation system, is done using the following apparatuses.

1. Water pump (motor)
2. Soil Moisture (HL69/YL69 sensor probe)

- Irrigation system was operated on threshold percentage of soil moisture sensor result.
- NodeMCU ESP8266 was used for data collection.

# 3.1.3 Real-time Weather Monitoring

- Real-time weather monitoring is done using the following apparatuses.

1. Absolute Pressure (BMP180 sensor)
2. Rain (Rain sensor)

- Data for absolute pressure, sea-level pressure and altitude of a particular area are collected from BMP180 Barometric Sensor. The altitude of the current location was given as input.
- A rain sensor is used to detect rainfall. Even if there is less than moderate rainfall, the sensor will detect it.
- Data were updated on Blynk server.

# 3.1.4 Security System

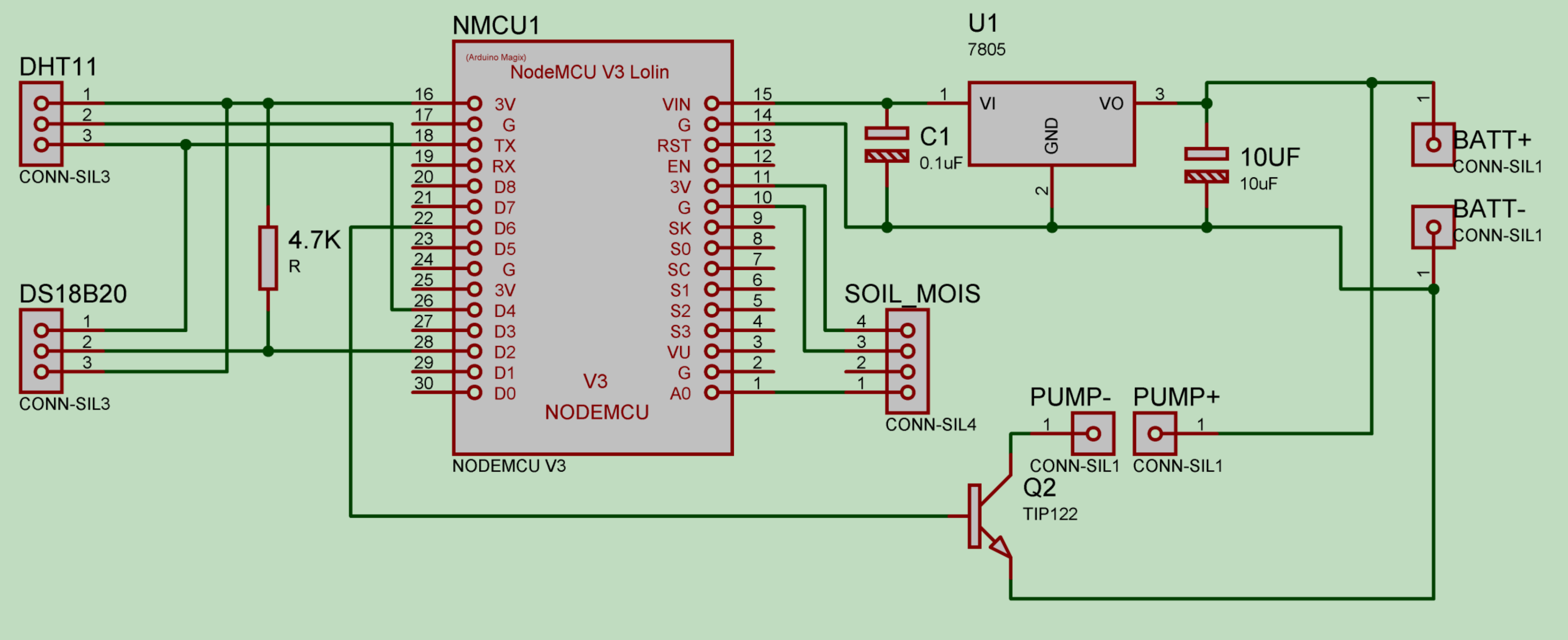
- MQ135 gas sensor was used to monitor toxic gas in the system.
- ESP32 was used to get live stream feed of the total system.
- Captured video can provide a baseline for surveillance and security system.
- Another possible application is image processing of captured video frame.
- Machine learning or artificial intelligence model can be implemented to provide prediction to the input capture.

# 3.1.5 Leaf Image Analysis using Machine Learning and Automation

- Leaf Image from Plant Village dataset and Cassava Leaf dataset were used.
- Features were extracted from VGG16 architecture.
- Extracted features were trained on Random Forest (77% accuracy) and Xgboost Classifier (93% accuracy).
- Xgboost classifier was used to predict on captured video frame of ESP32 cam
- Data was updated on Adafruit IO

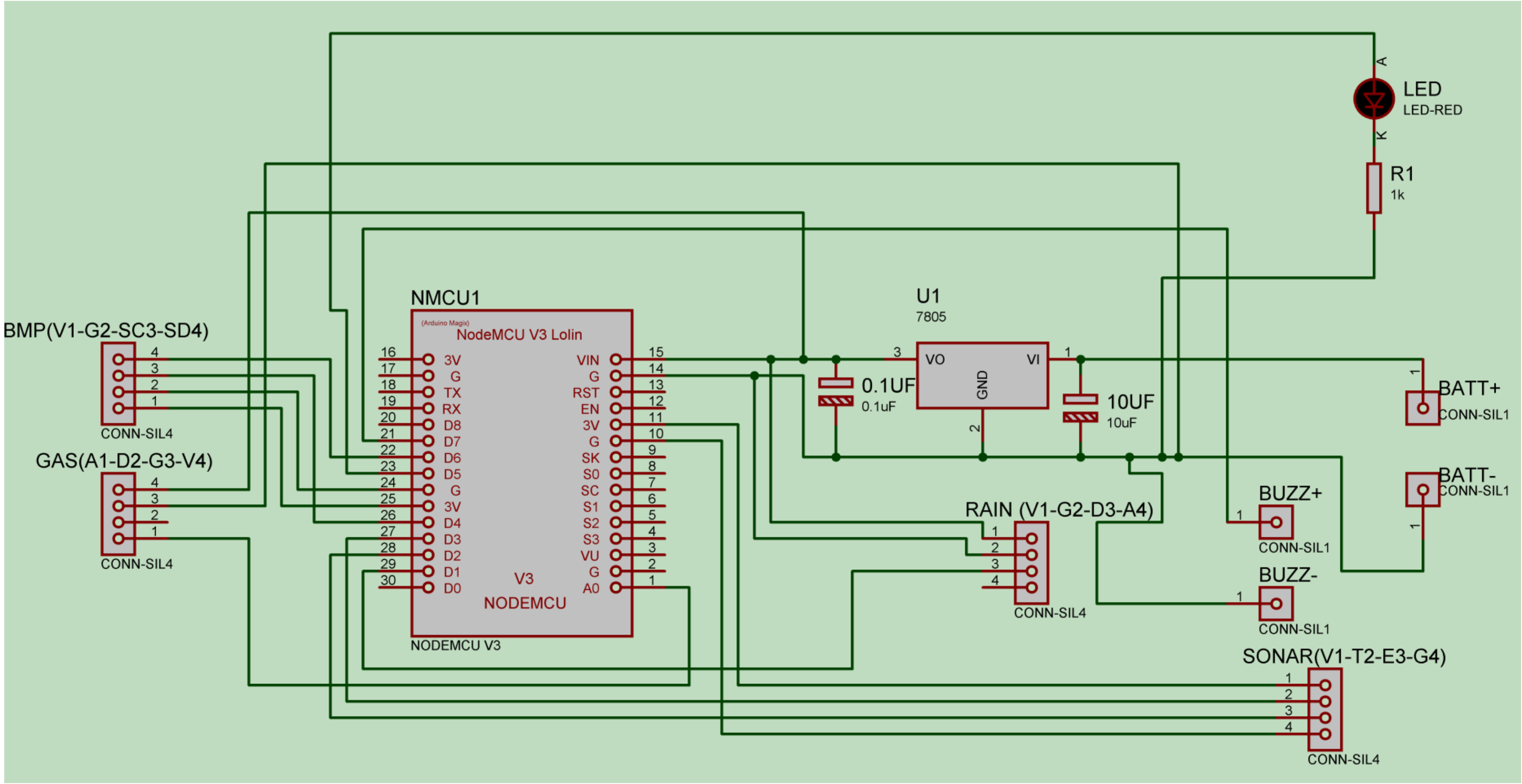
# 3.2 Design: Circuit Diagram(1)

The is the circuit diagram of the board 1 consisting of Soil Moisture Sensor (Soil Moisture), DHT 11 (Temperature and Humidity), DS18B20 (Soil Temperature sensor). It also drives water pump.



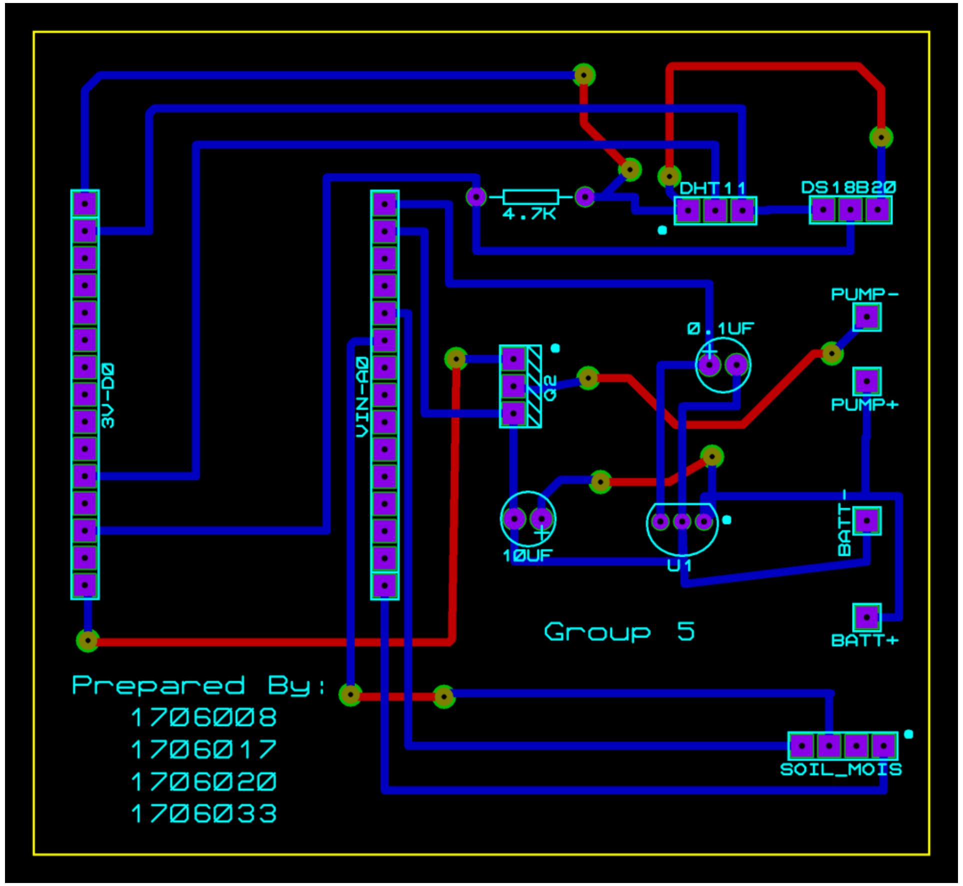
# 3.2 Design: Circuit Diagram(2)

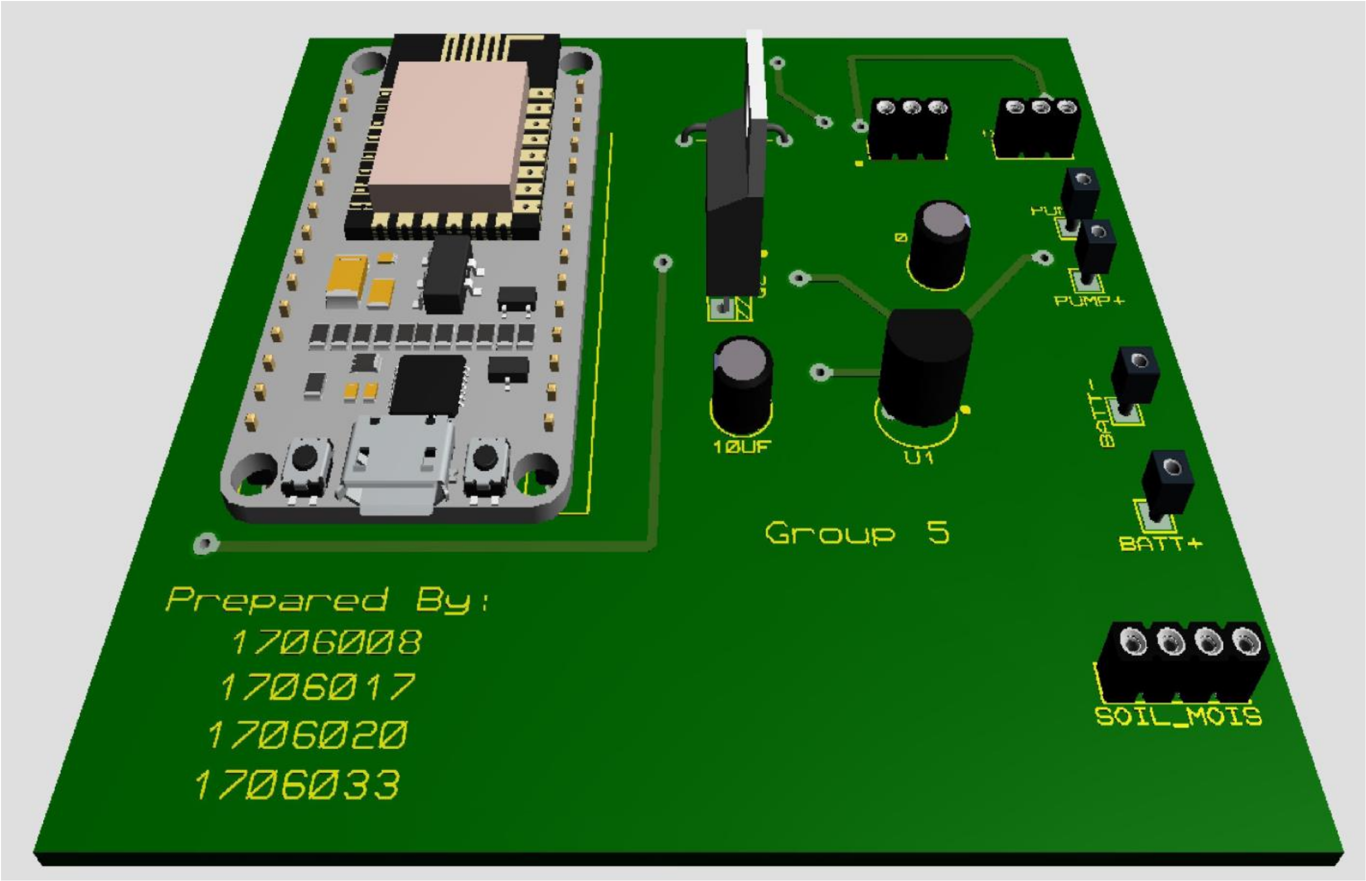
The is the circuit diagram of the board 2 consisting of BMP 180 (Pressure and Altitude Sensor), HC-SR04 SONAR (as Water Level Detector in this project), MQ-138 (Gas Sensor) and Rain Alarm sensor.



# 3.4 Design: PCB Layout and 3D rendering(1)

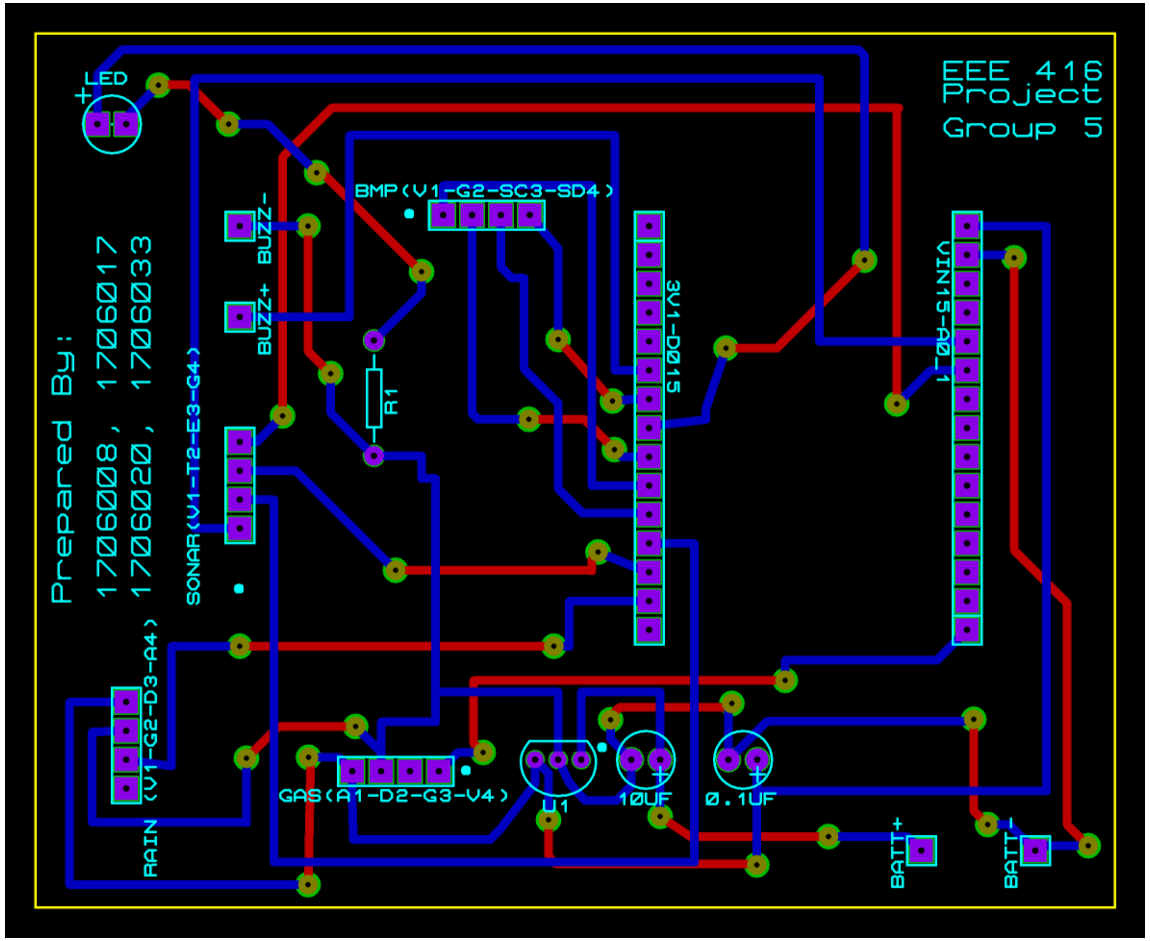
PCB layout and 3D rendering of Board 1

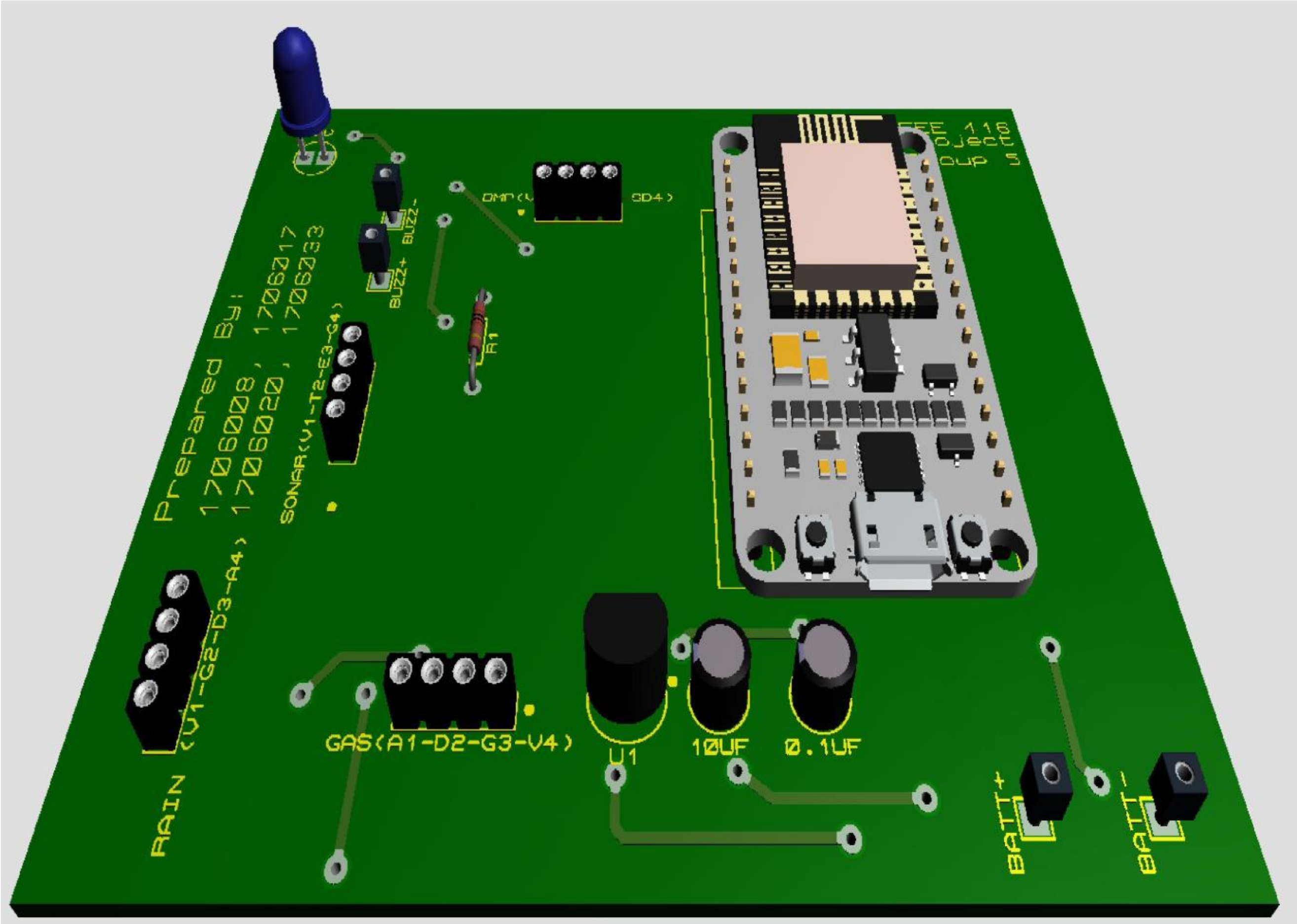


# 3.4 Design: PCB Layout and 3d rendering(2)

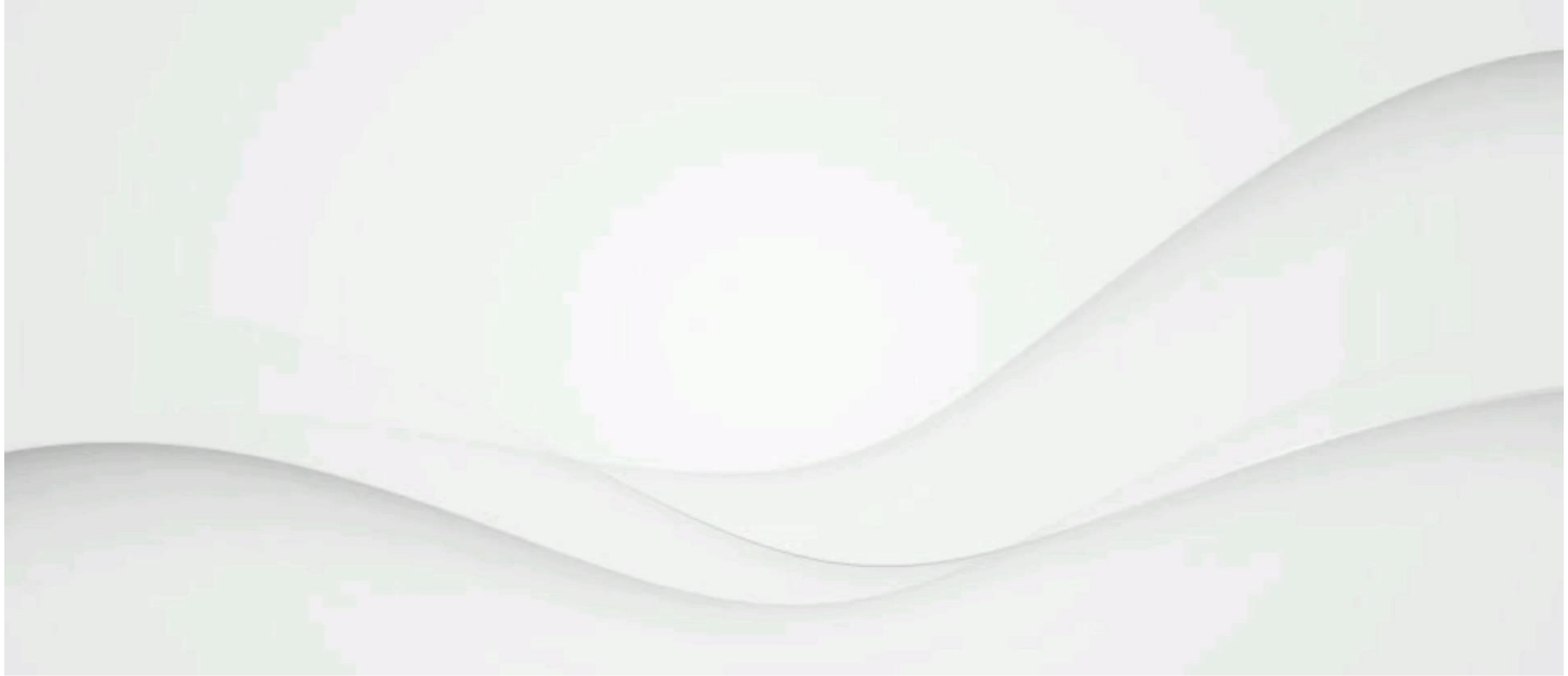
PCB layout and 3D rendering of Board 2



# 4 Implementation: Demonstration(1)

Now, we will see the video demonstration of different sensors working in our project:



Link: Project_Video_Demonstration.mp4

# 4 Implementation : Demonstration (2)

- Xgboost classifier on top of VGG16 architecture was used to predict the ESP32 cam input. Model was successful for single and multiple healthy leaves image and single leaf image with disease.
- Correct Prediction for single and multiple healthy leaves:

[4]
healthy

[4]
healthy

# 4 Implementation : Demonstration (3)

- Prediction on single and multiple leaves with disease:

[0]
Early blight

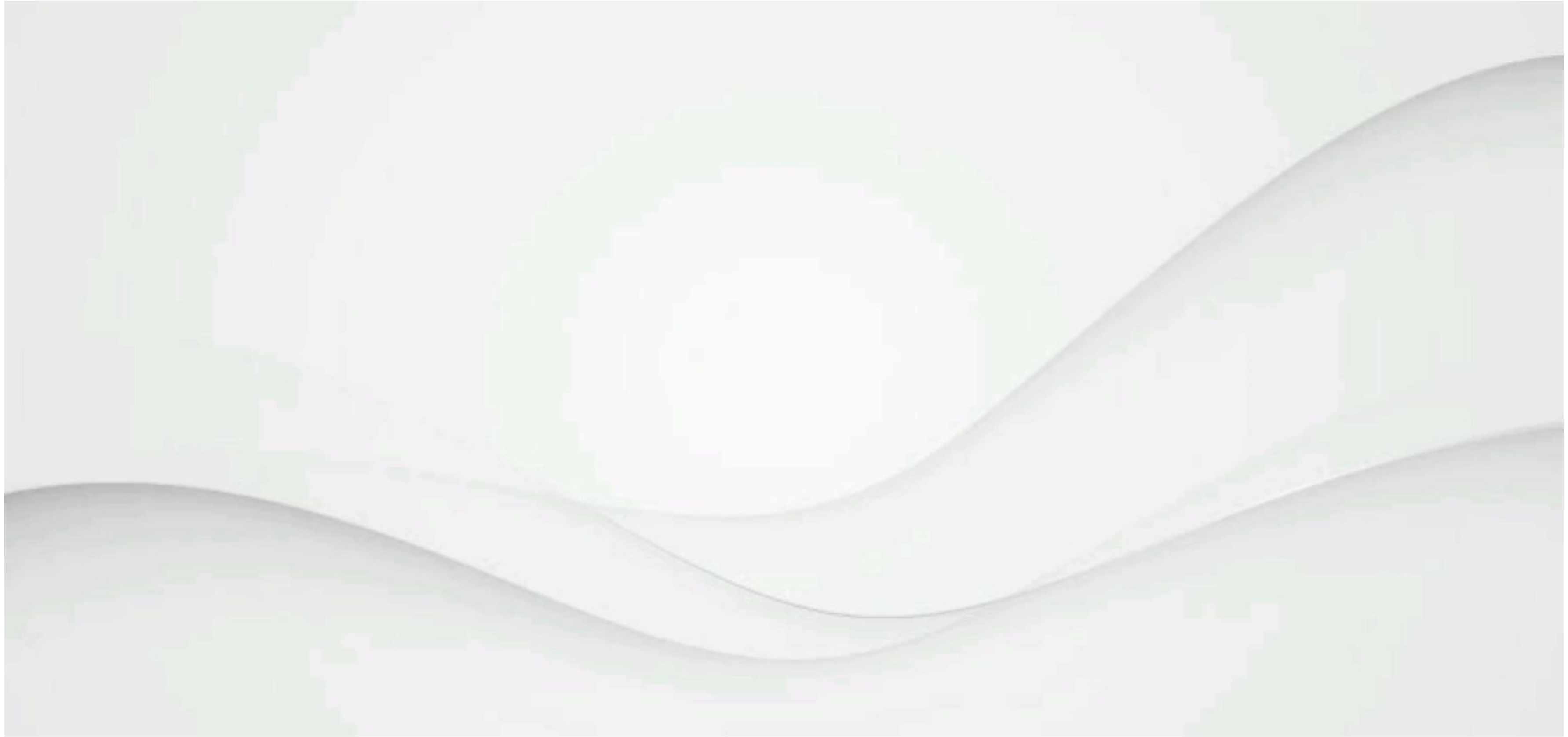
Correct Prediction

[1]
Late blight

Wrong Prediction

# 4 Implementation : Demonstration (4)

- Now we will see the video demonstration of Leaf disease detection part:



Link: ML_DL_Camera_Detection.mp4

# 4.1 Implementation: Photo Gallery

# 4.2 Implementation: External Links

- GitHub link:

  https://github.com/munim-sah75/IoT-Based-Smart-Agriculture-System.git

- YouTube Link:

  https://youtu.be/v6FSAP1Xo8k

# 5. Analysis and Evaluation

- 5.1 Novelty
- 5.2 Project Management and Cost Analysis
- 5.3 Practical Considerations of the Design
- 5.4 Assessment of the Impact of the Project
- 5.5 Evaluation of the Sustainability

# 5.1 Novelty

- Different IoT sensors have been implemented together to form a smart agricultural system unit
- All sensors' outputs are sent to the cloud servers using IoT
- Pumps and surveillance cameras can be implemented using the sensors
- A machine learning model has been used to detect healthy and sick plants using surveillance cameras. The camera sends images to the server whence the model determines the health of the plant.

# 5.2 Project Management and Cost Analysis

| Name of equipment | No. of units bought | Unit Price | Total Price |
|---|---|---|---|
| DHT11 Sensor | 2 | 136 | 272 |
| BMP180 Sensor | 1 | 170 | 170 |
| HCSR04 Sensor | 1 | 96 | 96 |
| Rain Sensor | 1 | 130 | 130 |
| Esp8266 board | 2 | 470 | 940 |
| Esp32 camera module | 1 | 850 | 850 |
| PCB | 2 | 354.5 | 709 |
| Plants | 3 | 83 | 250 |
| Aquarium + Whole Setup | 1 | 1200 | 1200 |

# 5.3 Practical Considerations of the Design

- **Considerations to Public Health and Safety:** The equipment used in the experiment are safe enough. One power source is used to power up some sensors, but the impact is minimal.
- **Considerations to Environment:** This project itself monitors changes in environment, so there is no possibility of any harm towards the environment.
- **Considerations to Cultural and Societal Needs:** This project has the potential to bring considerable changes in Bangladesh's agriculture system. Digitization of agriculture can improve farmer's lives a lot. The agricultural society can witness a cultural shift.

# 5.4 Assessment of the Impact of the Project

- **Assessment of Societal Issues:** If farmers are readily acceptive of such a project and ease their farming, there is a strong possibility of an overall social development. Society will be more developed.
- **Assessment of Health and Safety Issues:** Some safety (and thereafter health-related) issues may become apparent if safety measures are not taken while using and preserving the instruments involved.
- **Assessment of Legal Issues:** No illegal works were done while conducting the project, so there should be no legal issues.
- **Assessment of Cultural Issues:** This project implementation may collide with the traditional farming system followed by some farmers. However, if thought from a long-term perspective, this project implementation will be a lot helpful to the farmers.

# 5.5 Evaluation of the Sustainability

- **Evaluation of Sustainability:** The project implementation is quite sustainable, only the power source should be replaced/recharged after some time. Solar cells could be used to charge the batteries.
- **Evaluation of Impact of Design in Societal Context:** Although many farmers are yet to get acquainted with modern technology, this implementation is quite user-friendly for the farmers. It can also make people more interested than usual about technology in general.
- **Evaluation of Impact of Design in Environmental Context:** Lithium-ion batteries may be thrown after usage which may cause environmental hazard. That's why, renewable energy sources should be considered for a hazard-free implementation.

# 6. Reflection on Individual and Teamwork

6.1 Individual Contribution of Each Member

6.2 Mode of Teamwork

6.3 Diversity Statement of Team

6.4 Logbook of Project Implementation

# 6.1 Individual Contribution of Each Member

Although the project was a team effort, individual effort on certain works has made the combined efforts easier. Here is a detailed description of individual contributions of each member in this project:

- Sheikh Munim Hussain(1706008): Gas Sensor, Rain Sensor, PCB.
- Md. Jahidul Hoq Emon(1706017): Surveillance System, Adafruit IO.
- Shafin Shadman(1706020): Irrigation, SONAR Sensor.
- Azazul Islam(1706033): BMP180 Sensor, Machine Learning Model Training.

## 6.2 Mode of Teamwork and Diversity

**Diversity:** Our team consists of people from different districts of the country. Munim is from Satkhira, Emon is from Brahmanbaria, Shafin is from Kushtia and Azazul is from Dhaka. Also, two of our members are hall residents (Munim and Emon), whereas the other two are attached. Munim is gravitated towards cricket and new smartphones, Emon is more inclined to video games, Shafin has interests in vehicles and Razon is an international affairs enthusiast.

**Teamwork:** After class time, the team worked together to implement this project. Hall room and Central Library have been used to work together. Buying different equipment, ordering them and so on have been done together. Here is a picture of the whole team working snapped by a friend-

# 6.3 Logbook of Project

| Date | Milestone Achieved | Individual Role | Team Role | Comments |
|---|---|---|---|---|
| 09-07-2022 | SONAR sensor worked | Emon & Munim coded the sonar code and implemented the logic. | Shafin & Azazul bought the sensor and generated the logic behind the codes. | Our sensor could work successfully to measure a certain distance. |
| 13-07-2022 | DHT11 Sensor worked | Munim coded the DHT11 sensor to calculate humidity and temperature. | Shafin,Emon & Azazul collected muds to use in the process. | Accurate calculation of temperature and humidity has been done. |
| 20-07-2022 | BMP180 Sensor Worked | Azazul coded the BMP180 and calculated pressure. | Real time data was monitored to match with calculation by Emon & Munim. | Practical data matched with experimental data . |
| 27-07-2022 | Adafruit IO setup. | Emon & Shafin created a dashboard using Adafruit IO. | Proper code was done to send data to server using Adafruit by the team. | Real time data monitoring was achieved. |
| 03-08-2022 | Rain Sensor worked | Munim setup the rain sensor and it pressed buzzer if it could detect rain. | Rest of the team members worked to get data to the server. | Real time monitoring of weather reached another milestone. |
| 08-08-2022 | Esp32 camera module | Emon & Azazul worked to setup esp32 camera. | Other members worked to get the data to server. | Live streaming made possible to a local host using the camera module. |
| 15-08-2022 | Machine Learning model training and detection. | Azazul trained an ML model and predicted the leaves' condition. | Other members collected photos for the database and did preprocessing. | Model successfully trained with very nice accuracy.Detection was done using esp32 camera photos. |
| 22-08-2022 | Water Pump for irrigation. | Shafin & Munim setup the water pump for irrigation purpose . | Value of threshold moisture and other criteria were calculated by Azazul & Emon. | It pumped water according to moisture of the soil. Also the pump could be manually controlled by Adafruit. |
| 28-08-2022 | Plants bought and aquarium setup. | Emon & Shafin collected plants from nursery for demonstration purpose | Munim & Azazul setup the plants in the aquarium and integrated the sensors inside. | An overall setup of the project has been done. |
| 30-08-2022 | Project video presentation and demonstration. | All worked equally here. | The whole team worked together to merge all the efforts and make the project come to life. | Everything merged together and it worked! |

# 7. References


- Plantvillage Dataset: https://www.kaggle.com/datasets/emmarex/plantdisease
- Cassava Leaf Image Dataset: https://www.kaggle.com/competitions/cassava-leaf-disease-classification/data
- VGG16 Architecture Prediction: https://www.kaggle.com/code/meetnagadia/tomato-leaf-disease-prediction-using-vgg16-and-cnn
- Esp32 camera: ESP32-CAM, Camera Module Based on ESP32, OV2640 Camera Included (waveshare.com)


Thank
you!