FINAL YEAR PROJECT 2 (2021/2022)

MUSHROOM HOUSE MONITORING SYSTEM AND ENVIROMENT CONTROL SYSTEM USING IOT

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INTRODUCTION

SUMMARY OF THE PROJECT

INTRODUCTION OF THE PROJECT

GREY OYSTER MUSHROOM

- Commonly known as Oyster fungus which most edible mushrooms.
- Has cap shapes like a shell with 5 – 20 cm of diameter with colour of the mushroom can be white, yellow, pink, cream, brownish and dark grey.
- 90.8% total cultivated mushroom in Malaysia according to Ministry of Agriculture Malaysia.
- Temperature, humidity, carbon dioxide is a crucial parameters.

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PROBLEM STATEMENT, OBJECTIVE & SCOPE

MAIN PURPOSE OF THE PROJECT & LIMITATION OF THE PROJECT

PROBLEM STATEMENT

PROBLEM STATEMENT

- Grower does not alert with the changes of the environment parameters such as carbon dioxide, temperature, and humidity in the mushroom house.
- The growth of the mushroom is not efficient as environment changes can only be measure through sensory system
- Uncontrol environment parameters which affect the output of the grey oyster mushroom

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OBJECTIVES

1. Acquire several important parameters in the mushroom house

- Develop a system that measure the temperature, humidity and concentration of carbon dioxide in the mushroom house

2. Implementing IoT system in the monitoring & control system

- Develop a micro-controller-based that can monitor and control the system using Internet of Things (IoT)

3. Display data through web-based platform

- Develop a system that can display real-time data to a web-based system

PROJECT SCOPE

Limitation of the project

- Monitoring system will concetrate on grey oyster mushroom only in farmhouse located in Insitute of Sustainable Agrotechnology (INSAT), Perlis.
- The system will monitor a single storage closed environment in the mushroom farm.
- System will acqure data from sensor and push to the cloud for monitoring purpose.

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LITERATURE REVIEW

BACKGROUND RESEARCH ABOUT THE PROJECT

GREY OYSTER MUSHROOM

WHAT IS GREY OYSTER MUSHROOM

- It is a wood decomposer which usually grow on the dead organic matter [1].
- The shapes consists of a cap which shapes like a shell. (Diameter : 5 – 20cm).
- It is sensitive with the several environment parameters such as Carbon dioxide level, temperature and surrounding humidity.
- Advantage of mushroom is it can preventing the formation of the growth of tumors[2].

METHOD OF CULTIVATION

SUMMARY OF CULTIVATION METHOD

Method	Cylindrical Baglog Method	Wooden Tray Cultivation
Size of containers	Uses plastic bags with size of 15cm x 30cm	Uses any type of shape of wood tray with size of 100cm x 50cm
Time for spawn run	Around 30 -35 days	Around 30 days
Required temperature	- During spawn run, temperature need to retained at 25℃ - During fructification, temperature need to maintain at 17 - 20℃	- The temperature can be retained at 25℃ for both situation either spawn run or fructification
Production yield	Higher	Lower

EXTRINSIC FACTOR AFFECTING THE GROWTH

FACTOR THAT NOT CAUSED BY NATURAL PHENOMENA

Extrinsic factor	Optimum value	Reference
Temperature value	• During growth of mycelia: 25℃ • During fruit development: 25℃ – 35℃	❑ Choi, K. W. (2004) [3]
Humidity	• During spawn running: 60% – 80% • During growth of mycelia: 80% – 85% • During fruit development: 80% - 95%	❑ Bellettini, M. B., Fiorda, F. A., Maieves, H. A., *et. al.*(2019) [4]
Carbon dioxide concentration	• During spawn-run: 20,000ppm • During fruit development: 600ppm • During cropping: Below 600ppm	❑ Oei, P. (1996) [5]

RESEARCH GAPS

RESEARCH GAPS ON PREVIOUS RESEARCH

- Does not have any manual control system to override the automatic control.
- System developed does not consider the area that does not have any internet coverage.

LITERATURE REVIEW SUMMARY

Area	Findings/Discussion
Grey Oyster Mushroom	• Characteristic of the grey oyster mushroom • Life Cycle of the oyster mushroom • The phase of the growth of oyster mushroom
Method of cultivation	• Discuss regarding conventional method of cultivation which is wood tray method and cylindrical baglog method of cultivation
Factor affecting the growth of mushroom	• There are to main factors which are intrinsic and extrinsic factor that will affecting the growth of oyster mushroom • Several important parameters are determined that can affecting the growth of the mushroom.
Disease affecting mushroom yield	• The common disease has affected the production of mushroom can be determined. • The symptom of the disease is determined and the causes also being discuss in the literature review.
Sensor	• Temperature and humidity, carbon dioxide sensor is a common sensor that is use to monitor the mushroom house. • Due to the compatibility to microcontroller, it is commonly being use among researcher
Data transmission	• The uses of several type of module to communicate. • Nodemcu ESP32 have a build in WI-FI module which enable the system to connect with the Internet • The implementation of Wireless sensor network (WSN) • LORA and GSM can also be used for the area that have low internet connectivity.
Neural Network Techniques	• The advantages and disadvantages for several types of neural network techniques. • The implementation of fuzzy logic system for the control mechanism. • Method to setup fuzzy logic system. • Method to calibrate and validating the fuzzy logic system

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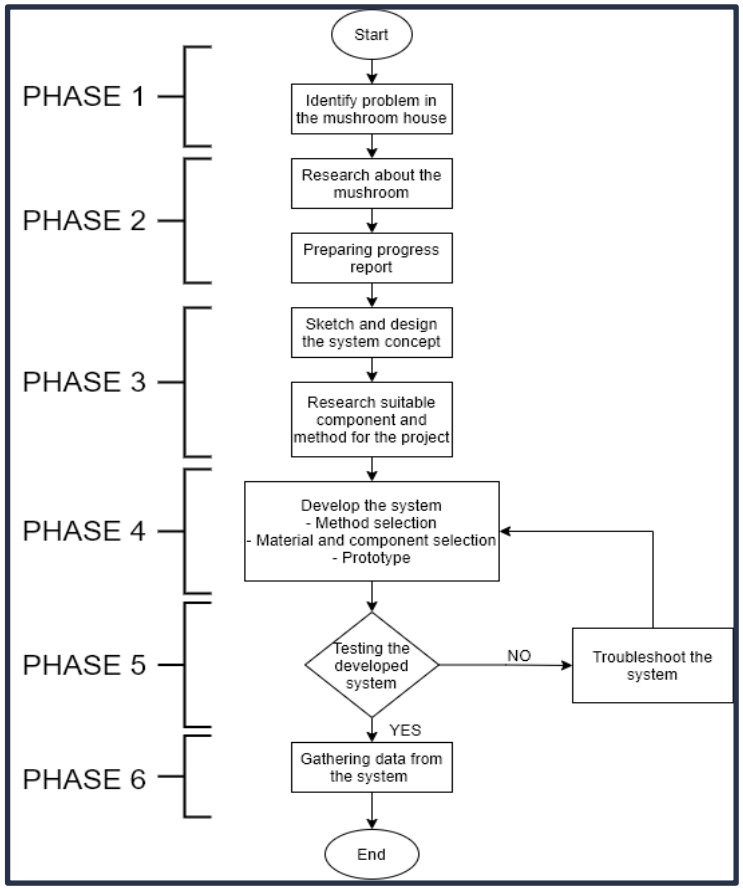
METHODOLOGY

FLOW OF THE PROJECT & SYSTEM OVERVIEW

Working Flow Of The Project



PHASE 1 – PHASE 2

- Problem need to identify and research about the mushroom cultivation before preparing progress report.

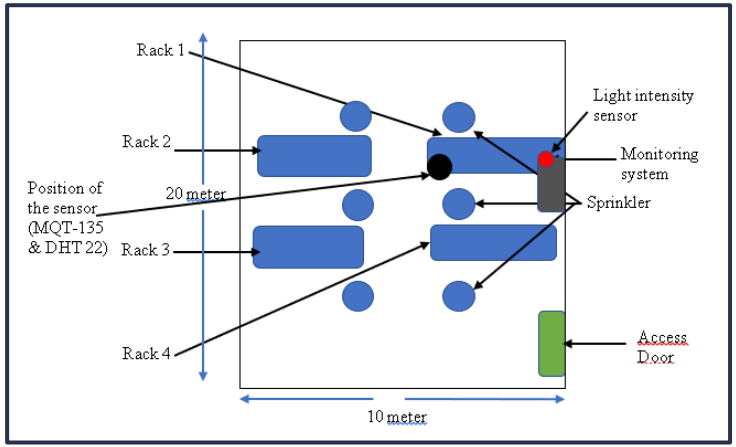
PHASE 3 – PHASE 4

- The concept of the system is sketch and design and research several suitable component. Finally development of the system

PHASE 5 – PHASE 6

- Testing and troubleshooting phase for the system and gather data from the system

Mushroom House Design



Design of the Mushroom House

- The size of the mushroom house is 20meter x 10meter.
- Height of the mushroom house is 4 meter height.
- Total racks inside the mushroom house is 4 racks

COMPONENT SELECTION

Power Supply

- To supply DC input for the NODEMCU and other electronic component
- Provide stable 5V to the whole system

NODEMCU esp32

- Allow the system to connect with the Internet
- Low power consumption with high processing power

DHT-22 sensor

- Sensor for Temperature and Humidity
- Better accuracy with optimum range of measurement

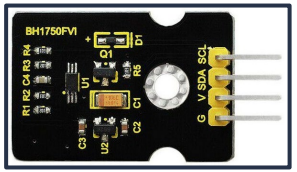
COMPONENT SELECTION

MQ-135

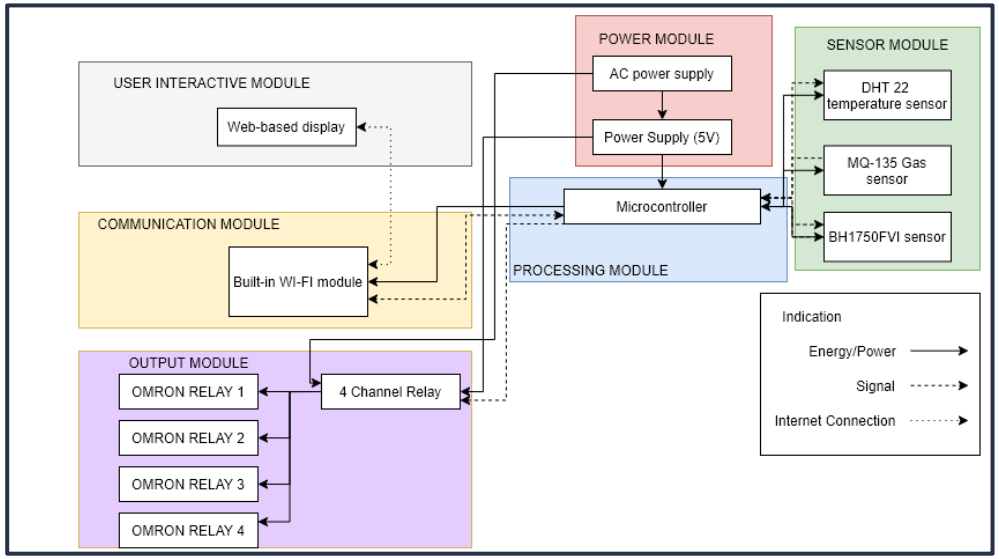
- Air quality sensor to detect the concentration of carbon dioxide
- Able to detect carbon dioxide gasses from 350ppm – 5000ppm

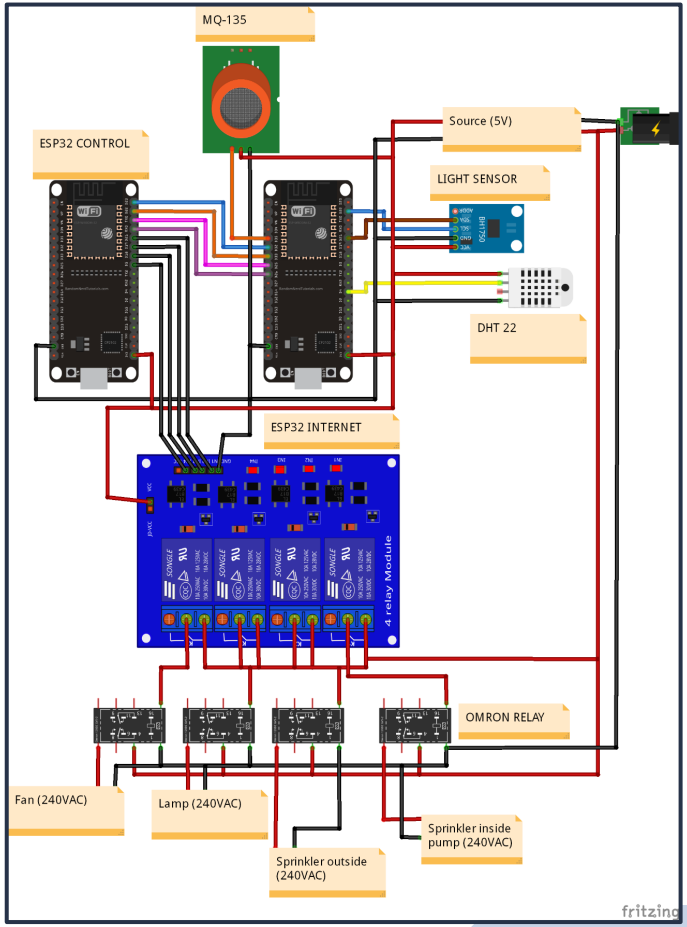
BH1750FVI

- Light Intensity sensor to detect the light intensity inside the mushroom house.
- Able to detect the light intensity from the range of 1 – 65535 lux.



System Architecture



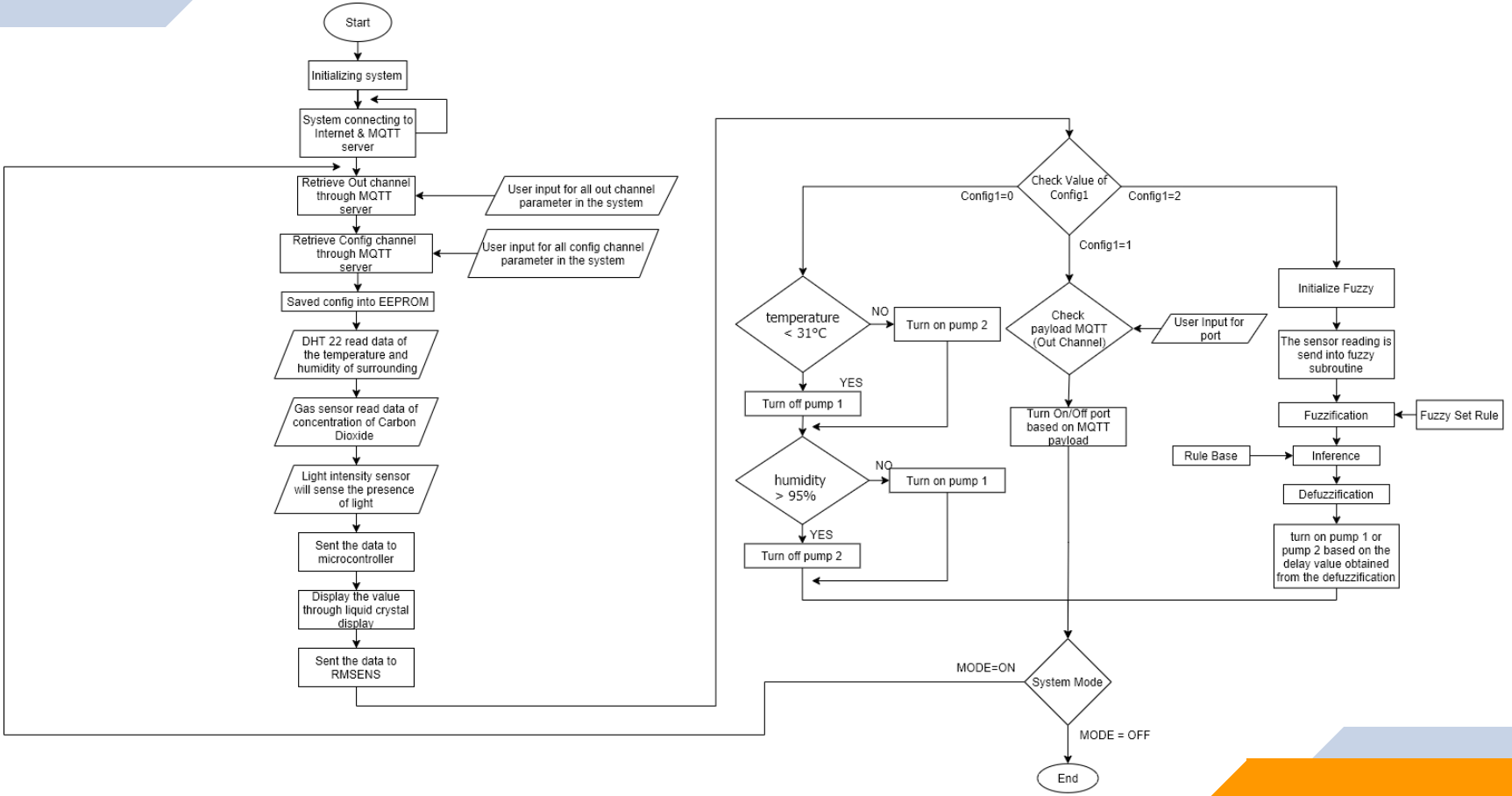


Block Diagram

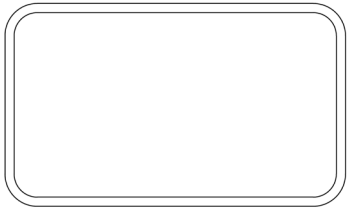
Consists of 5 component which is:-

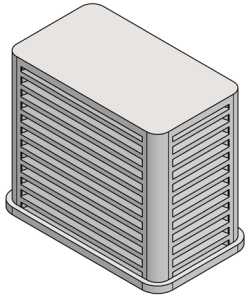
1. User interactive module
2. Communication module
3. Processing module
4. Sensor module
5. Power module
6. Output module

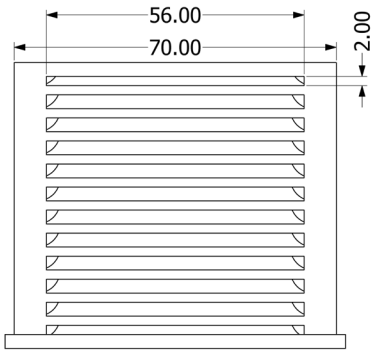
Working Flow Of The System

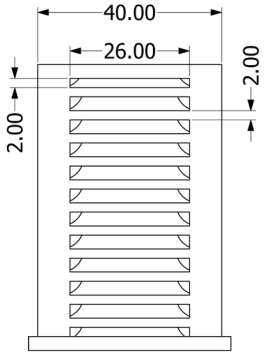


DEVELOPMENT OF THE SENSOR CASE









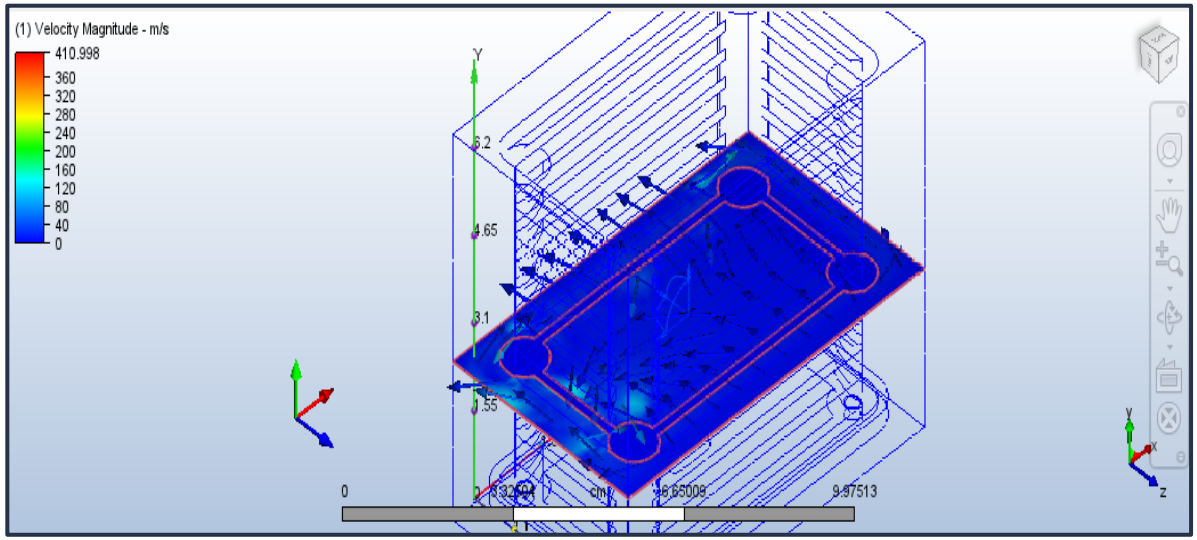
Development of the Sensor Case

Design Consideration:-

- Prevent water directly entered the sensor case if the mist sprinkler turned on.
- Allow the sensor to take the reading of the carbon dioxide, temperature and the humidity inside the mushroom house.

Simulation Result (Computational Fluid Dynamics)

Computational Fluid Dynamics Simulation Result (Plane X)

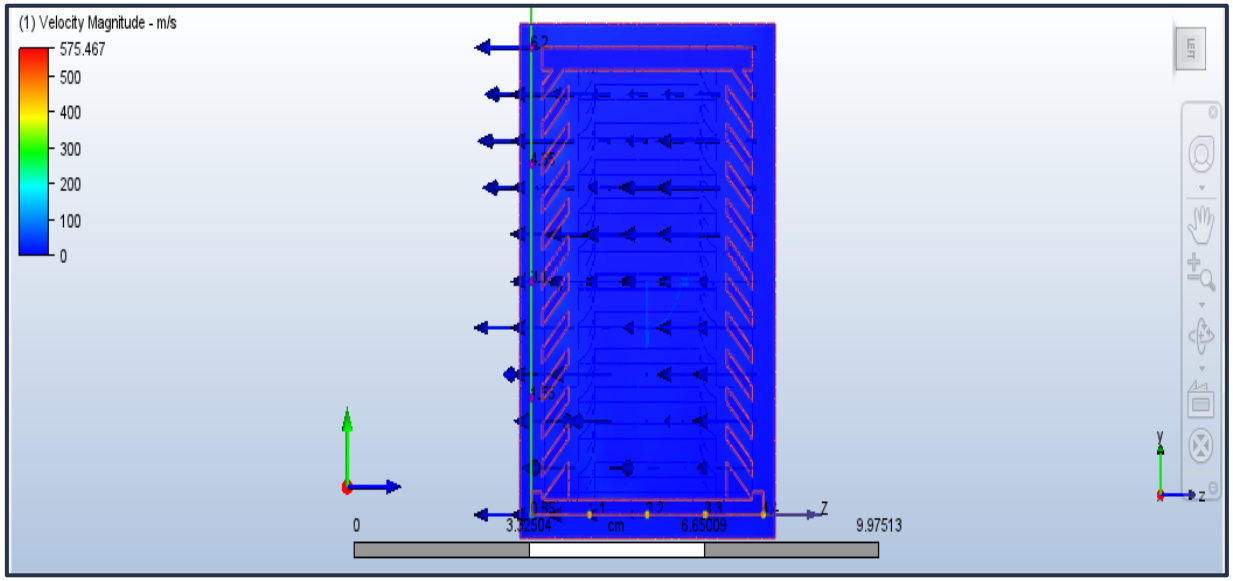


Simulation Result:

- The movement of the air is represented through the arrow of the vector
- It shows if the air flow through the side of the sensor case, it will either move through the sensor or turn to the left of the casing.
- Therefore, the sensor are capable to sense the environment parameter

Simulation Result (Computational Fluid Dynamics)

Computational Fluid Dynamics Simulation Result (Plane Y)

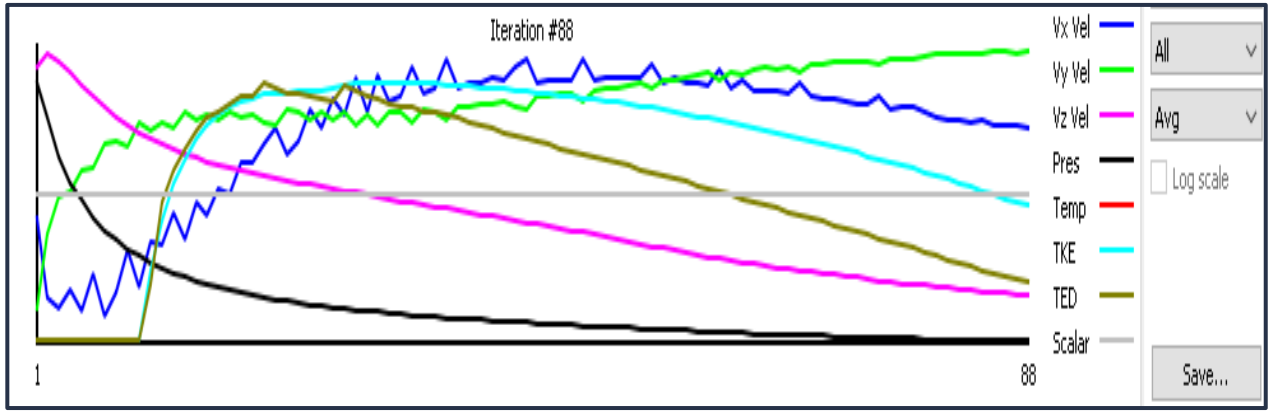


Simulation Result:

- Further analysis is done through Plane Y where it can be seen that the movement of the air is presented using the vector.
- The air is moving from the outside(right side) into the sensor case and move out(left side) of the sensor case.

Simulation Result (Computational Fluid Dynamics)

Computational Fluid Dynamics Simulation Result (Plot vector)



Simulation Result:

- The movement of the air inside the sensor case is computed and the result is presented as in the graph.
- It shows that the velocity of Vector x and y able to achieve the high speed will the Vector z decreases over time.
- This is because the bottom of the sensor case is secure which causes the air does not flow through Z –axis.

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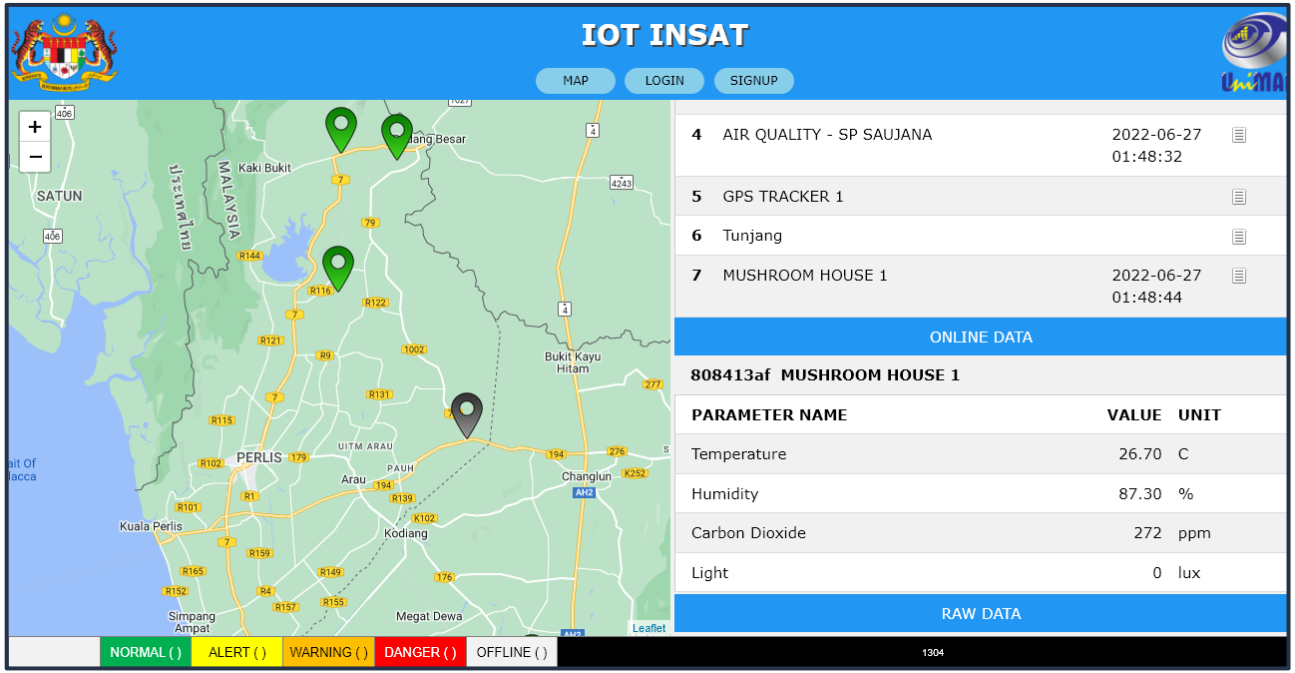
RESULT AND DISCUSSION

PROJECT OUTPUT

OBJECTIVE ONE

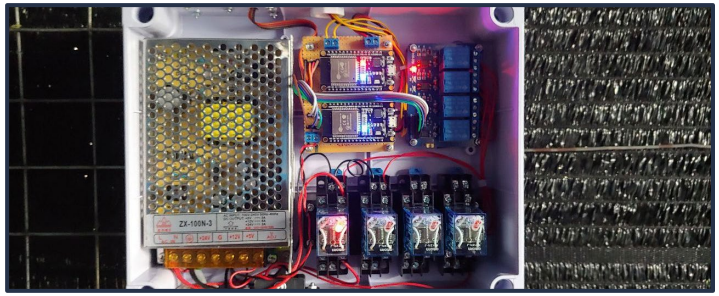
To acquire the temperature, humidity and concentration of carbon dioxide in the mushroom house

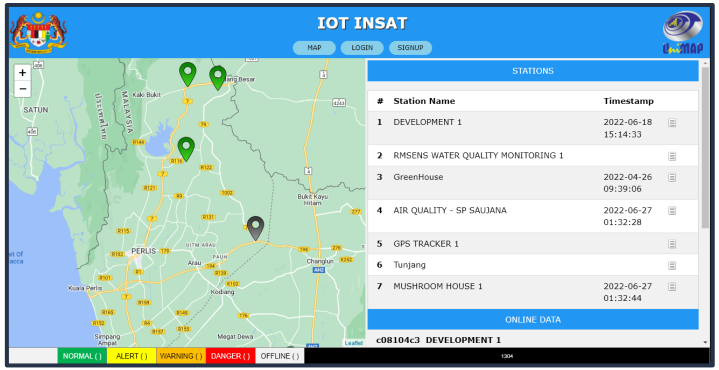


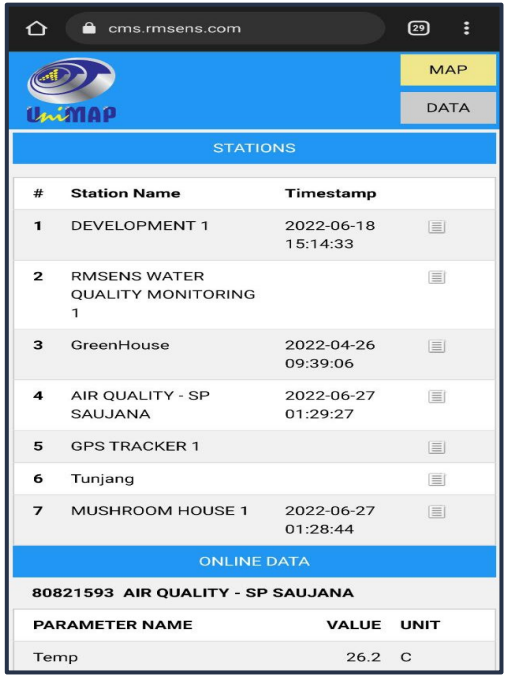
- The system able to acquire the reading of the temperature, humidity, concentration of carbon dioxide and light intensity inside the mushroom house.
- The system will post the data into the INSAT IOT system or through the serial terminal of the ESP32.

OBJECTIVE TWO

To develop a micro-controller-based that can monitor and control the system using (IoT)

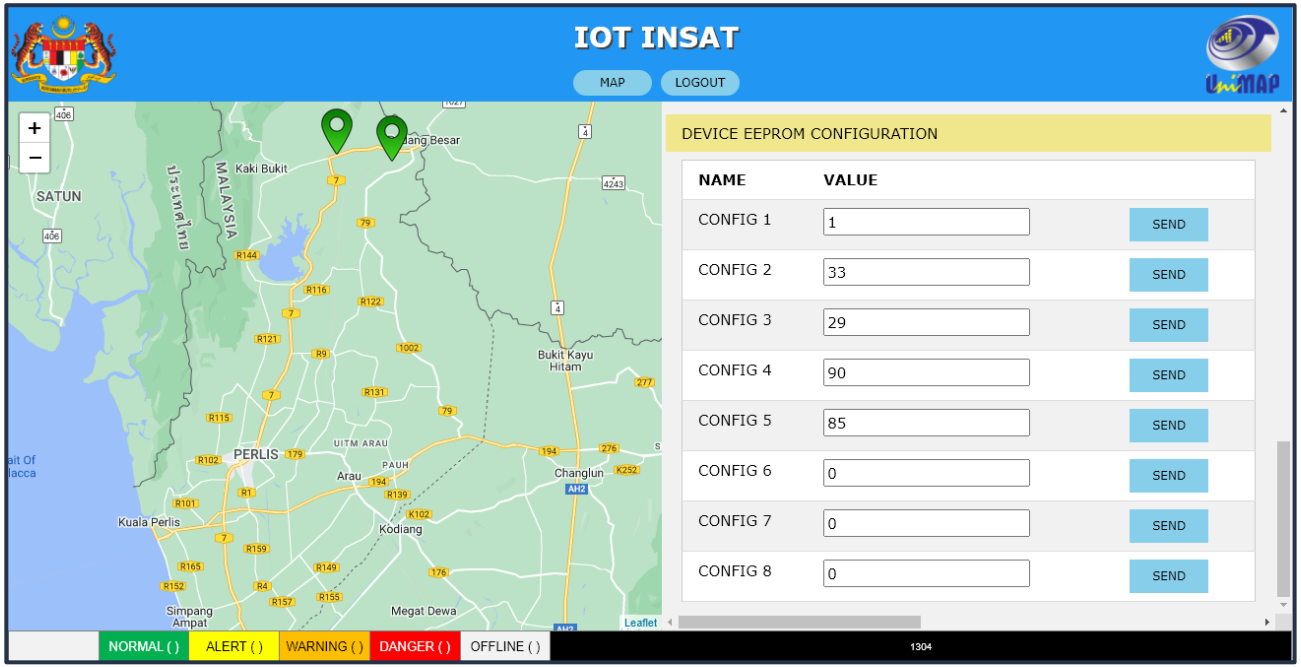






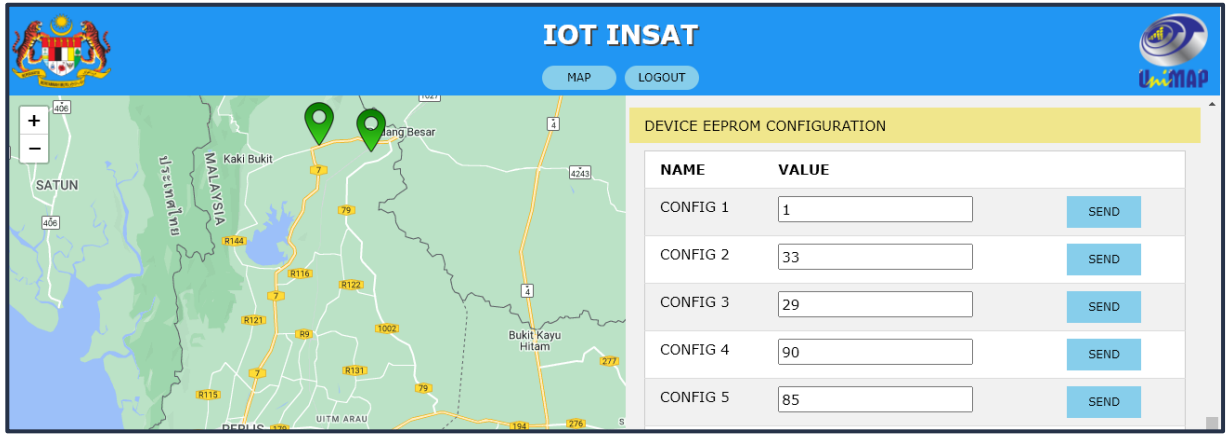
- The system is build using micro-controller based which is ESP32 microcontroller.
- The system can be monitored through the INSAT IOT system which the temperature, humidity, concentration of carbon dioxide and the light intensity is display inside the system.

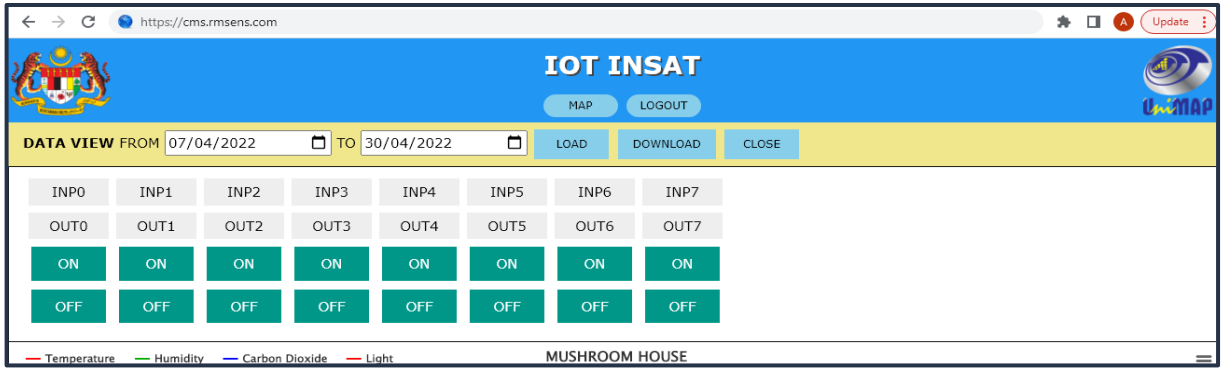
OBJECTIVE TWO



- The system has three type of mode which is
  - Manual control mode
  - Simple Logic Control
  - Fuzzy logic System
- Configuration of the mode is made at CONFIG 1.
- (0) – Simple Logic Control
- (1) – Manual Control
- (2) – Fuzzy Logic Control

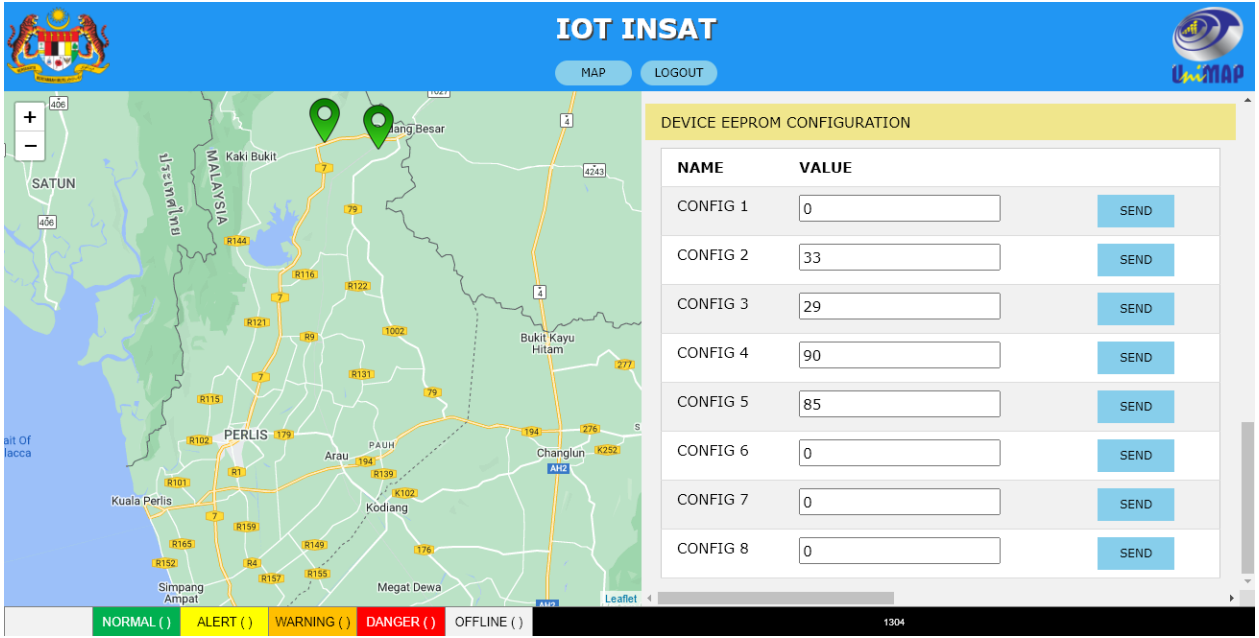
OBJECTIVE TWO





- Manual Control Mode
- The system mode need to set 1 at its config 1 to allow manual control mode.
- Allow farmer to activate the pump for both sprinkler manually through the INSAT IOT system.

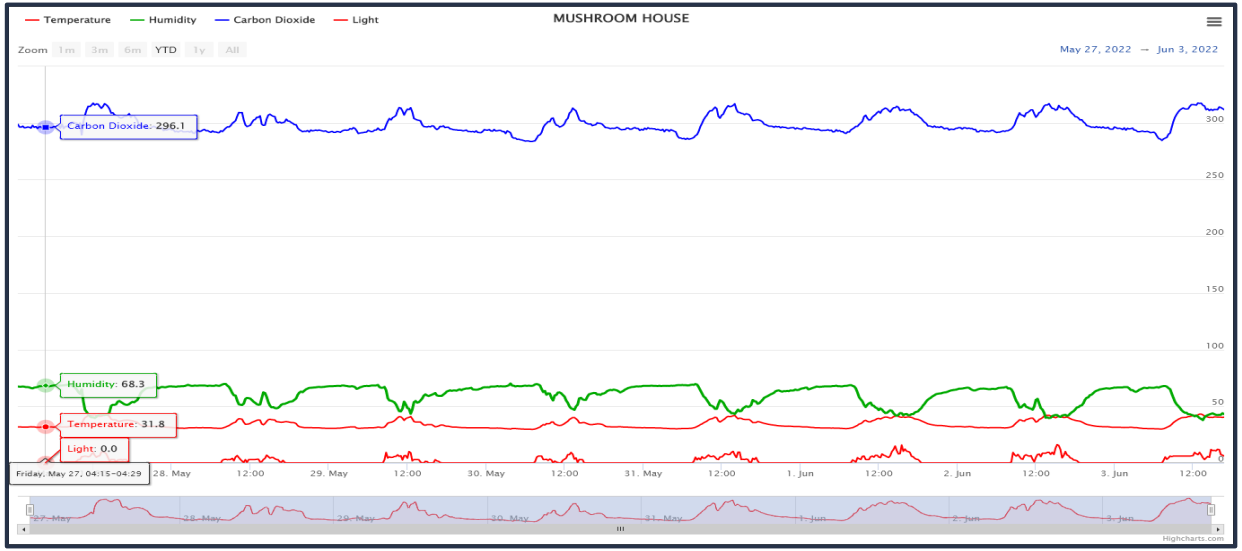
OBJECTIVE TWO



- Simple Logic Control Mode
- The mode of the system need to set to 0 to allow the system changed the mode to simple logic control mode.
- This mode will turned on the pump for sprinkler outside if the temperature is higher than value in config 2 and turn off if it is below the value of config 3.
- It will turned on the pump for sprinkler inside if the humidity is below the value in config 5 and turn off if the value is higher than config 4.

OBJECTIVE TWO

Data collection is performed on 27 May 2022 to 3 Jun 2022



No.	Parameter	Average Value	Highest Value	Lowest Value
1	Temperature(℃)	34.35	43.20	29.10
2	Humidity (%)	58.83	71.60	36.80
3	Carbon Dioxide (ppm)	299.75	340.00	254.00
4	Light Intensity (lux)	2.32	20.00	0

- Fuzzy Logic Control System
- For this control system, the data is analyzed in order to generate fuzzy logic control system.
- Therefore, the data collection is performed on 27 May 2022 – 3 Jun 2022.

OBJECTIVE TWO

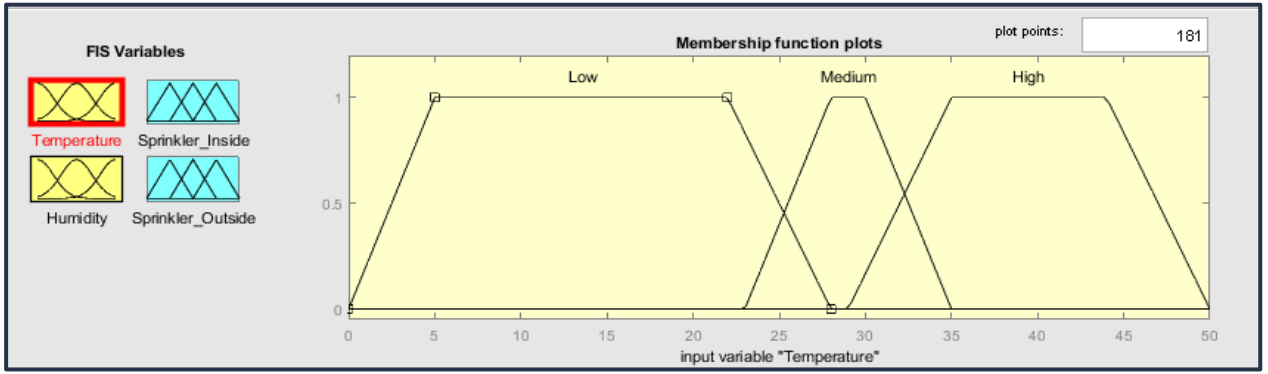
Data analysis from the data collection (27 May 2022 to 3 Jun 2022)

Range Value		Day						
		1	2	3	4	5	6	7
Temperature (℃)	Morning	30.4 - 39.1	30.4 - 39.1	30.4 - 39.1	30.4 - 39.2	30.4 - 39.1	30.4 - 39.1	30.4 - 39.3
	Evening	33.5 - 38.5	33.2 - 38.5	32.9 – 40.5	32.6 – 43.2	32.4 - 38.5	32.2 – 42.0	32 - 38.5
	Night	30.5 - 35.1	30.5 - 35.2	32.9 - 34.9	30.5 - 34.8	30.5 - 34.1	30.5 - 33.6	30.5 - 33.2
Humidity (%)	Morning	47.5 - 70	47.5 - 71	47.5 – 71.6	47.5 – 71.3	47.5 – 70.5	47.5 – 70.6	47.5 – 70.9
	Evening	46.7 - 63.1	46.7 - 63.2	38.9 - 63.3	36.8 - 63.4	46.7 - 63.5	37.8 - 63.6	46.7 - 63.7
	Night	58.4 - 68.6	58.4 - 68.7	58.4 - 68.8	58.4 - 68.9	58.4 - 68.10	58.4 - 68.11	58.4 - 68.12
Light Intensity (lux)	Morning	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10
	Evening	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10	0 - 10
	Night	0	0	0	0	0	0	0
Carbon Dioxide (ppm)	Morning	284 - 314	284 - 314	284 - 314	284 - 314	284 - 314	284 - 314	284 - 314
	Evening	291 - 312	291 - 312	291 - 312	291 - 312	291 - 312	291 - 312	291 - 312
	Night	283 - 304	283 - 304	283 - 304	283 - 299	283 - 299	283 - 298	283 - 298

- Data collection from 27 May 2022 – 3 Jun 2022 is further analyze by daily.
- There are three type of period which is Morning, Evening and Night.
- Morning : 6.30 am to 11.59 am
- Evening : 12.00 pm to 7.30 pm
- Night : 7.31 pm to 6.29 am

OBJECTIVE TWO

Temperature (℃)	Day						
	1	2	3	4	5	6	7
Morning	30.4 LOW – 39.1 HIGH	30.4 LOW - 39.1 HIGH	30.4 LOW - 39.1 HIGH	30.4 LOW - 39.1 HIGH	30.4 LOW - 39.1 HIGH	30.4 LOW - 39.1 HIGH	30.4 LOW - 39.1 HIGH
Evening	33.5 MEDIUM - 38.5 HIGH	33.2 MEDIUM - 38.5 HIGH	32.9 MEDIUM - 40.5 HIGH	32.6 MEDIUM - 43.2 HIGH	32.4 MEDIUM - 38.5 HIGH	32.2 MEDIUM - 42.0 HIGH	32 MEDIUM - 38.5 HIGH
Night	30.5 MEDIUM - 35.1 HIGH	30.5 MEDIUM - 35.2 HIGH	32.9 MEDIUM - 34.9 MEDIUM	30.5 MEDIUM - 34.8 MEDIUM	30.5 MEDIUM - 34.1 MEDIUM	30.5 MEDIUM - 33.6 MEDIUM	30.5 MEDIUM - 33.2 MEDIUM



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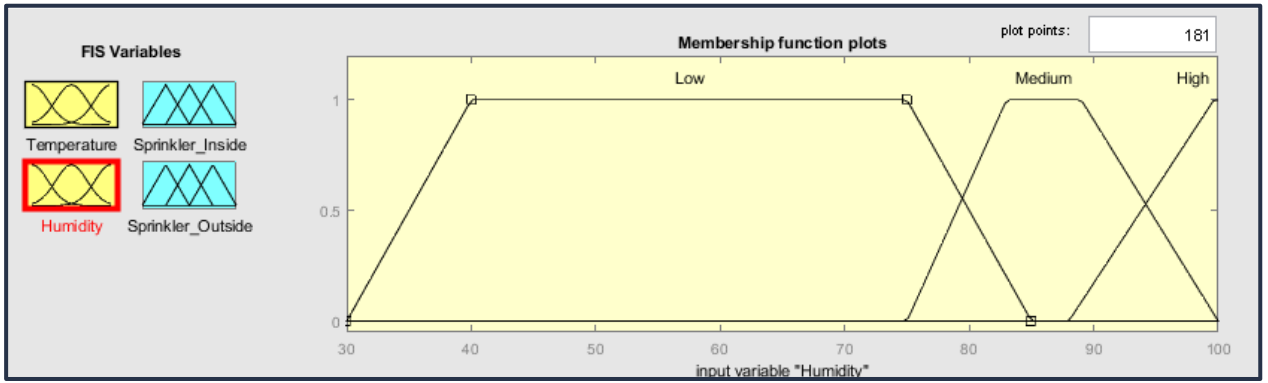
OBJECTIVE TWO

Humidity (%)	Day						
	1	2	3	4	5	6	7
Morning	47.5 LOW - 70 LOW	47.5 LOW - 71 LOW	47.5 LOW - 71.6 LOW	47.5 LOW - 71.3 LOW	47.5 LOW - 70.5 LOW	47.5 LOW - 70.6 LOW	47.5 LOW - 70.9 LOW
Evening	46.7 LOW - 63.1 LOW	46.7 LOW - 63.2 LOW	38.9 LOW - 63.3 LOW	36.8 LOW - 63.4 LOW	46.7 LOW - 63.5 LOW	37.8 LOW - 63.6 LOW	46.7 LOW - 63.7 LOW
Night	58.4 LOW - 68.6 LOW	58.4 LOW - 68.7 LOW	58.4 LOW - 68.8 LOW	58.4 LOW - 68.9 LOW	58.4 LOW - 68.10 LOW	58.4 LOW - 68.11 LOW	58.4 LOW - 68.12 LOW



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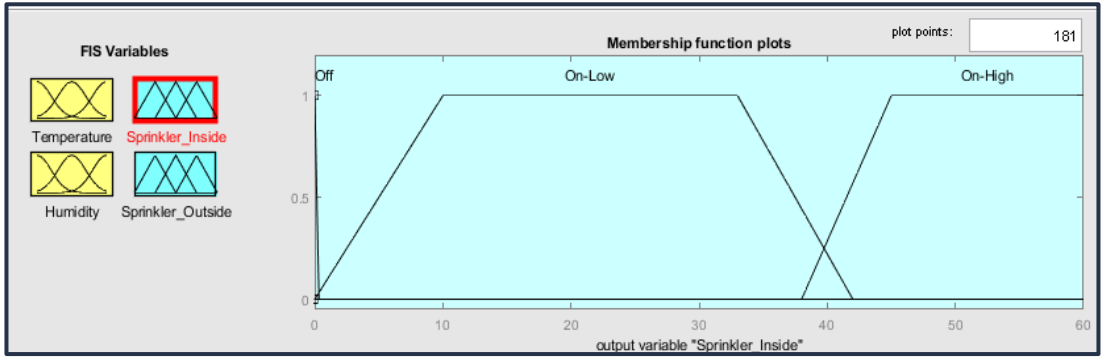
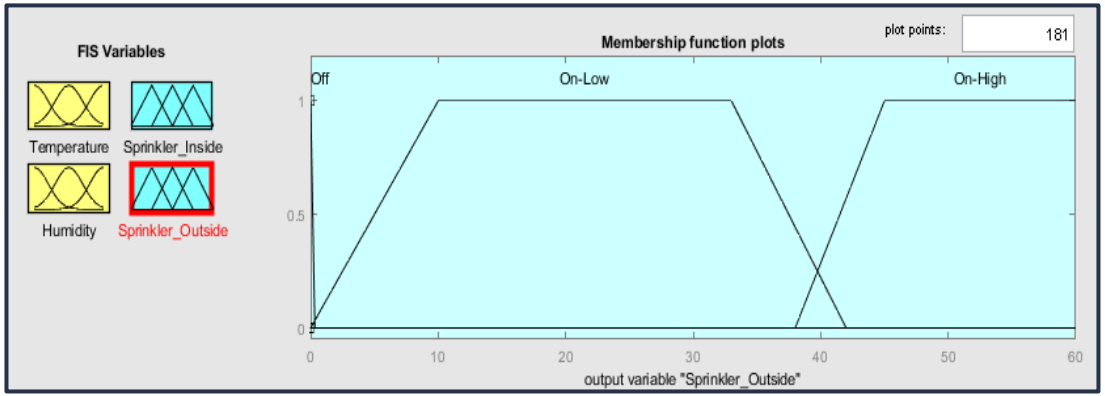
OBJECTIVE TWO

Output	Time (second)	
	On-low	On-high
Sprinkler Inside	0 - 40	40 - 60
Sprinkler Outside	0 - 40	40 - 60





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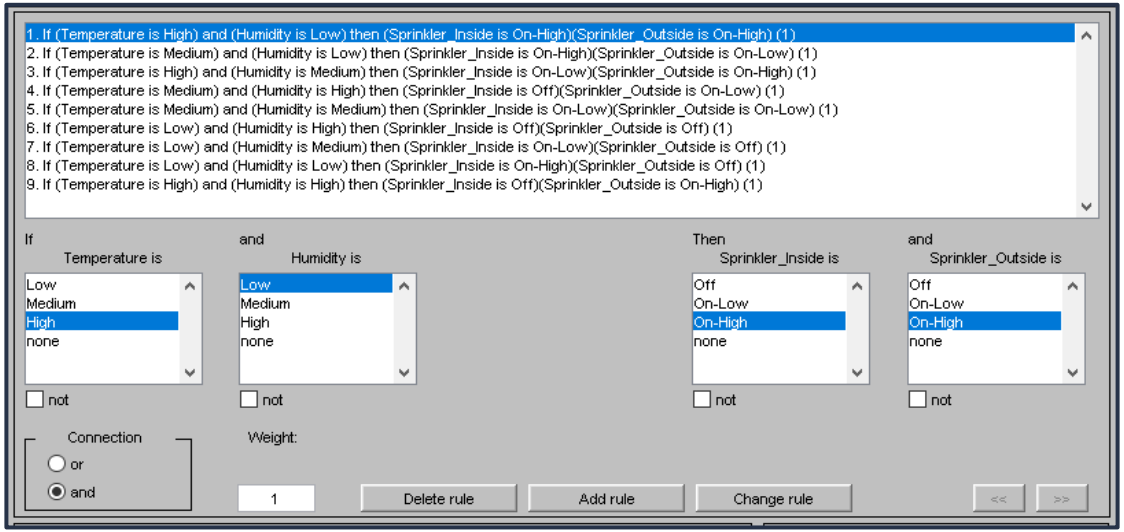
- Night : 7.31 pm to 6.29 am

OBJECTIVE TWO

Input (Temperature & Humidity) Output (Sprinkler Outside)		Temperature (℃)		
		low	medium	high
Humidity	low	Off	On-low	On-high
	medium	Off	On-low	On-high
	high	Off	On-low	On-high

Input (Temperature & Humidity) Output (Sprinkler Inside)		Temperature (℃)		
		low	medium	high
Humidity	low	On-high	On-high	On-high
	medium	On-low	On-low	On-low
	high	Off	Off	Off



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- Evening : 12.00 pm to 7.30 pm
- Night : 7.31 pm to 6.29 am

OBJECTIVE TWO

Result from Simulation for MATLAB and ESP32

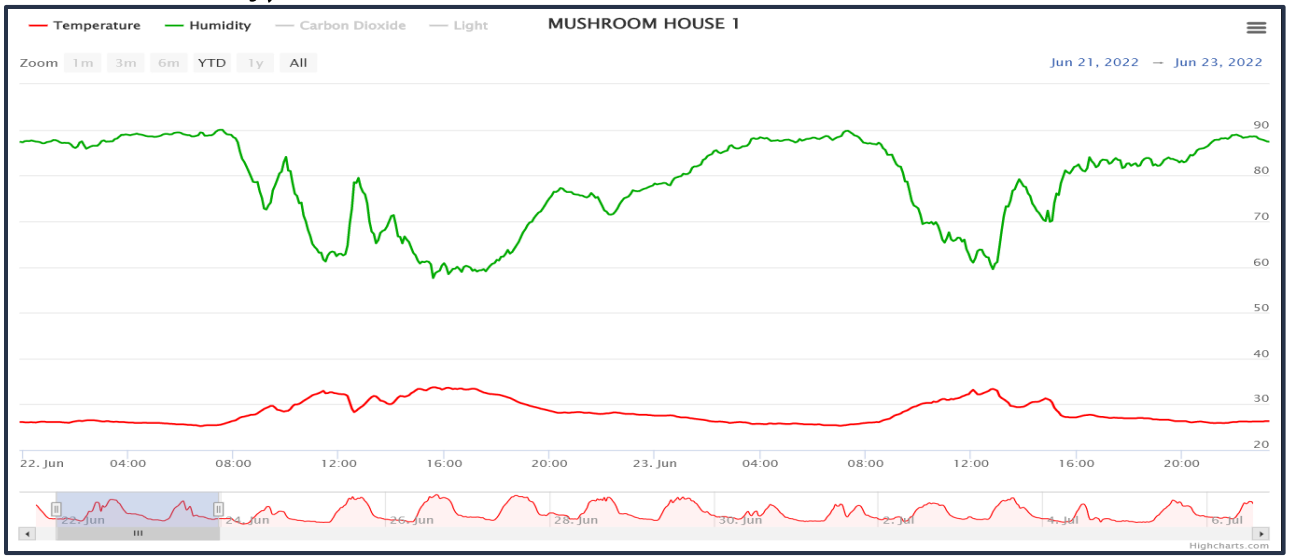
Period	Parameter (Average value)	
	Temperature (℃)	Humidity (%)
Morning (6.30am – 11.59am)	33.9	61.92
Evening (12.00 am – 7.29 pm)	36.39	53.21
Night (7.30 pm – 11.59 am)	31.10	66.44
Midnight (12.00am – 6.49 am)	28.8	87.80

Period	MATLAB toolbox		ESP32 microcontroller		Difference (%)	
	Sprinkler Inside (s)	Sprinkler Outside (s)	Sprinkler Inside (s)	Sprinkler Outside (s)	Sprinkler Inside	Sprinkler Outside
Morning	50.5	50.5	40.2	51.12	22.71	1.22
Evening	50.8	50.8	40.02	51.12	23.73	0.63
Night	50.2	22.1	50.54	17.66	0.67	22.33
Midnight	19.7	21.2	17.12	17.12	14.01	21.29

- Data collection from 27 May 2022 – 3 Jun 2022 is further analyze by daily.
- There are three type of period which is Morning, Evening and Night.
- Morning : 6.30 am to 11.59 am
- Evening : 12.00 pm to 7.30 pm
- Night : 7.31 pm to 6.29 am

OBJECTIVE TWO

System Output After Implementation of Fuzzy System (Temperature and Humidity)

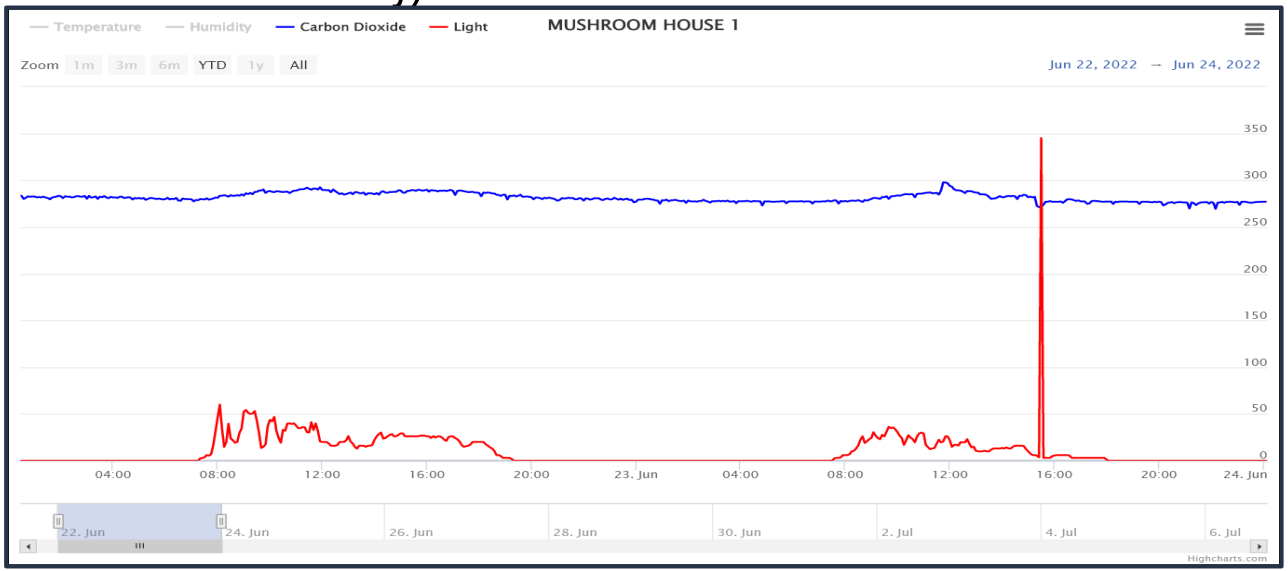


Statistical Variable	Temperature (℃)	Humidity(%)
Average	28.14	78.67
Max	33.70	90.10
Min	25.20	60.50

- Data collection from 27 May 2022 – 3 Jun 2022 is further analyze by daily.
- There are three type of period which is Morning, Evening and Night.
- Morning : 6.30 am to 11.59 am
- Evening : 12.00 pm to 7.30 pm
- Night : 7.31 pm to 6.29 am

OBJECTIVE TWO

System Output After Implementation of Fuzzy System (Carbon Dioxide and Humidity)



Statistical Variable	Carbon Dioxide (ppm)	Light Intensity (lux)
Average	281.45	9.73
Max	299.00	1713.00
Min	259.00	0

- Data collection from 27 May 2022 – 3 Jun 2022 is further analyze by daily.
- There are three type of period which is Morning, Evening and Night.
- Morning : 6.30 am to 11.59 am
- Evening : 12.00 pm to 7.30 pm
- Night : 7.31 pm to 6.29 am

OBJECTIVE TWO

Comparison between Simple Logic Control System and Fuzzy System

Environment Parameter	Temperature (℃)		Humidity (%)		Carbon Dioxide (ppm)		Light Intensity (lux)	
Statistical Variable	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**	**Initial**	**Final**
Average	34.29	28.14	62.19	78.67	299.75	281.44	1.44	9.73
Maximum	42.70	33.70	98.60	90.10	340.00	299.00	140.00	1713.00
Minimum	30.00	25.20	38.50	60.50	254.00	259.00	0	0

- The system only control temperature and the humidity
- Average reading of temperature drop by 19.70%
- Average reading of humidity increase by 23.40%

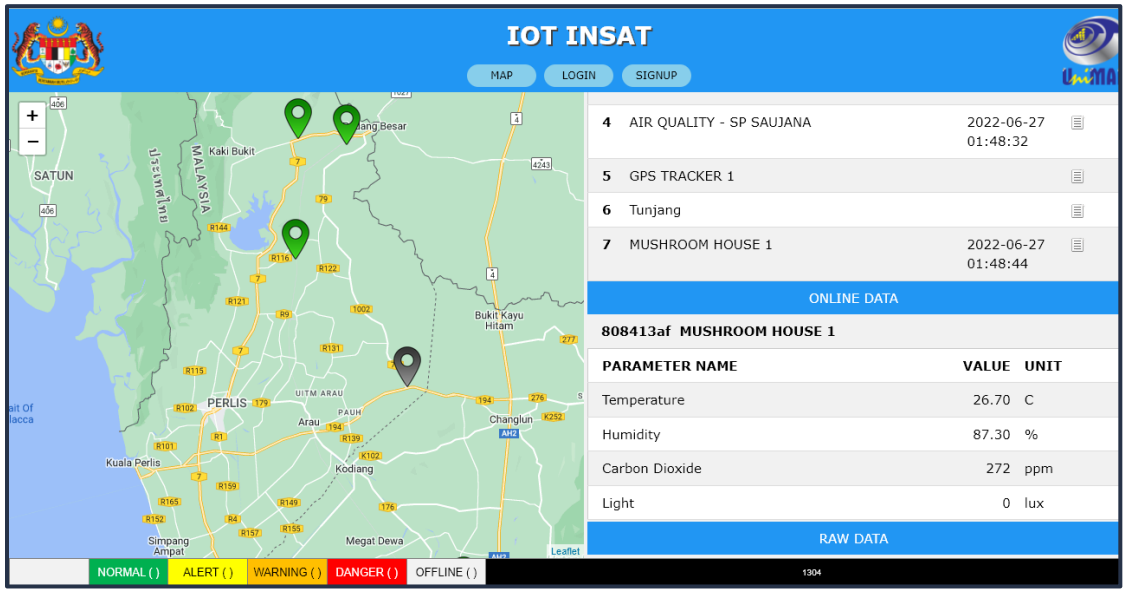
OBJECTIVE TWO

First Batch of Mushroom Production

- The system only control temperature and the humidity
- Average reading of temperature drop by 19.70%
- Average reading of humidity increase by 23.40%

OBJECTIVE THREE

To develop a system that can display real-time data from a web-based system.



- The system able to display the real-time data from the web based system.
- The system will shows the temperature, humidity, carbon dioxide concentration and the light intensity with the timestamp when the data is updated in the system.

6

CONCLUSION AND FUTURE WORKS

CONCLUSION OF THE PROJECT AND FUTURE WORKS

CONCLUSION AND FUTURE WORKS

- The mushroom house monitoring system and Environment Control System using IoT is developed to help the farmer handle and manage their mushroom house effectively.
- The first objective has achieve as the system able to acquire the reading of temperature, humidity, concentration of the carbon dioxide and the light intensity.
- Second objective also achieve as the farmer able to control the system through IoT system using different type of modes.
- Third objective achieve as the system to display the real time data through web-based system which is the INSAT IOT system.
- The system is tested and currently being used by Institute of Sustainable Agriculture (INSAT) UniMAP for their mushroom house production as first batch of mushroom has been produced by using this system.
- For the future works, the neural network can be implement by using data collected from this system.
- Off-grid power system or Solar power system can be implement to the system.

7

PROJECT DEMOSTRATION VIDEO

DEMOSTRATION OF THE SYSTEM

PROJECT DEMOSTRATION VIDEO

REFERENCES

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THANK YOU!

Any questions?

SUMMARY OF LITERATURE REVIEW

OVERALL SUMMARY OF LITERATURE REVIEW

Area	Findings/Discussion	References
Grey Oyster Mushroom	• Characteristic of the grey oyster mushroom • Life Cycle of the oyster mushroom • The phase of the growth of oyster mushroom	[11], [12], [13], [14], [18], [19]
Method of cultivation	• Discuss regarding conventional method of cultivation which is wood tray method and cylindrical baglog method of cultivation	[17], [21], [23], [24], [25], [29]

SUMMARY OF LITERATURE REVIEW

OVERALL SUMMARY OF LITERATURE REVIEW

Area	Findings/Discussion	References
Factor affecting the growth of mushroom	• There are two main factors which are intrinsic and extrinsic factor that will affecting the growth of oyster mushroom • Several important parameters are determined that can affecting the growth of the mushroom.	[17], [31], [32], [33], [35], [36], [39], [41], [42], [44], [45]
Disease affecting mushroom yield	• The common disease has affected the production of mushroom can be determined. • The symptom of the disease is determined and the causes also being discuss in the literature review.	[46],[47],[48],[49]

SUMMARY OF LITERATURE REVIEW

OVERALL SUMMARY OF LITERATURE REVIEW

Area	Findings/Discussion	References
Sensor	• Temperature and humidity, carbon dioxide sensor is a common sensor that is used to monitor the mushroom house. • Microcontroller compatibility is being discussed	[56],[57],[58],[59],[60], [61],[62],[63]
Data transmission	• The uses of several type of module to communicate. • NODEMCU esp32 have a build in WI-FI module which enable the system to connect with the Internet • The implementation of Wireless sensor network (WSN) • LORA and GSM can also be used for the area that have low internet connectivity.	[64],[65],[66],