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IoT Based Smart Farming for Plant Disease Detection

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Abstract: This study before developing the system to identify plant diseases is to study the types of plants and diseases that will occur to plants. Plant disease detection is an aspect that needs to be emphasized especially by farmers in planting in the garden. The process of identifying plant diseases takes a long time if the garden area is too large. With the advent of new technologies such as the Internet of Things (IoT) using Arduino cameras and integrate with a system called Smart Farming. IoT Based Smart Farming for Plant Disease Detection needs to achieve objectives such as analyze the plant disease detection based on an object-oriented approach, developing a system that includes the classification of plant disease by using machine learning technique and evaluating the system. Agile methodology is a software development that focused on phases such as Planning, Designing, Developing, Testing, Release and Feedback. Process of plant disease detection will be modelling through classification with deep learning technique. The project was implemented using Visual Studio Code as the code editor and Jupyter Notebook to create the model classification, MySQL as the database and Python as the programming language which includes Flask as the Python web framework. This system will facilitate users in controlling plants through the system to be developed as well as cameras as IoT hardware. Therefore, this system can improve the effectiveness and efficiency of evaluation more accurately.

Keywords: Internet of Things, Plant Disease Detection, Agile, Smart Farming

1. Introduction

Several countries have focused the agricultural industry as a new technology to society especially farmers. Malaysia is a country in Southeast Asia that relies heavily on agriculture to alleviate poverty and maintain peace. The World Bank estimates that 78 percent of the world's poor live in rural regions and rely on agriculture for a living [1]. Furthermore, the industry is under increasing pressure to fulfil the rising population's consumer demand. The efficiency, productivity, and optimization of agricultural

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practises are critical for these two reasons. In Malaysia, IoT-based smart agriculture aims to enhance the agricultural industry while also reducing poverty.

Technology that has been acquired in terms of aspects of planting, watering, harvesting up to crop health. The presence of Smart Farming when developing Internet of Thing (IoT) connected devices applications or websites in agriculture. The development of IoT can also improve in terms of aspects of agricultural practices to grow more advanced. In agriculture, like in other industries, the Internet of Things promises hitherto unattainable efficiency, resource and expense savings, automation, and data-driven operations. However, in agriculture, these advantages aren't enhancements; they're remedies for a whole industry grappling with a slew of severe issues. Farmers can monitor their product and conditions in real time thanks to IoT-enabled agriculture. With excelled efficiency, they have quick insights, can foresee problems before they occur, and make well-informed judgements on how to prevent them. IoT solutions in agriculture also provide automation, such as demand-based irrigation, fertilisation, and robot harvesting. 77% of the Malaysia’s population will live in cities by the time we reach 32.37 million people [2]. Short food supply chains are possible with IoT-based greenhouses and hydroponic systems, and they should be able to feed the masses. Food can be grown in supermarkets, on the walls and rooftops of buildings, in shipping containers, and, of course, in the comfort of everyone's home, thanks to smart closed-cycle agricultural systems. In agriculture, IoT refers to the improved agility of operations. Farmers can immediately respond to any significant change in weather, humidity, air quality, or the health of each crop or soil in the field thanks to real-time monitoring and forecast systems. New capabilities aid agriculture experts in saving crops in the face of harsh weather fluctuations.

Farmers and agricultural specialists must be able to detect illnesses in plants at all times. The suggested system's main goal is to use IoT to identify plant illnesses. The illness starts on the plant leaves in the majority of cases. As a result, we have considered detection of plant disease on leaves in the proposed study. Images are a valuable source of data and information in the agricultural sciences. In recent years, photography has been the only tool utilised to replicate and publish such data [3]. However, mathematically processing or quantifying photographic data is challenging. Because of improvements in computers and microelectronics linked with conventional photography, digital image analysis and image processing technologies assist to bypass these issues. These technologies help in the enhancement of pictures from the microscopic to the telescopic visual range, as well as the analysis of such images. Several image-processing applications for agricultural operations have been created. In order to enter the photos, these apps employ camera-based hardware devices or colour scanners. With ever-changing computing systems, computer-based image processing is experiencing fast innovation. The specialised imaging systems on the market, which need the user to press a few keys to obtain results, are not particularly adaptable and, more significantly, come at a premium price.

Fruits and vegetables are two essential commodities that are utilised in our daily diets and to replenish nutrients in the human body. Any illness that is naturally occurring and has the potential to harm fruits and vegetables, as well as diminish production, quality, and quantity of goods. As a result, correct categorization and diagnosis of leaf disease may be critical in preventing agricultural erosion. Viruses, fungal, and bacterial infections are all carried by various fruits and vegetable leaves. When an illness affects a plant's leaf, the texture, colour, shape, and size of the leaf reveal the infection's symptoms. Because most of the symptoms are tiny, illness diagnosis is impossible owing to human vision's limitations.

However, utilising scientific knowledge and experience, it is important to build a highly efficient approach for detecting illness signs. Initially, datasets are used to collect the acquired crops leaf pictures of fruits and vegetables. A normal digital camera or a high-resolution mobile phone camera may be used to capture the photos. The gathered leaves of fruits and vegetables are then subjected to image processing. For identifying plant illnesses, several image processing techniques such as capture, pre-processing, restoration, segmentation, augmentation, feature extraction, and classification are used [4]. The pre-processing approach converts raw input leaf image datasets into suitable process datasets format in order to improve leaf image quality and remove unwanted sections from the pictures. To properly diagnose leaf illness, image augmentation is used to change and facilitate the leaf picture representation. As a result, the training and testing leaf image datasets are supplemented to reduce the risk of overfitting and to improve the model's simplicity [5]. The augmentation approach is used to enlarge the original leaf image collection using flipping, cropping, and rotating techniques, as well as convert the leaf pictures to RGB using colour transformation. The enhanced leaf pictures, on the other hand, are generated to keep the image quality and size in the healthy and unhealthy leaf databases balanced. Additionally, the classification method may be used to detect diseases in colour images. Convolutional neural network (CNN) models are used as a classification technique in this article. Many present agricultural systems can detect some plant leaf diseases but do not give a strategy for preventing them. As a result, utilising a graphical user interface, to offer a system that can identify illnesses and also suggest a preventative action.

2. Related Work

2.1 Overview of Paddy and Chilli in Malaysia

In this section to introduce the definition, type of disease, symptoms and control of paddy and chilli in Malaysia. Paddy or rice paddy is flat, small that can locate in southern and eastern of Asia. Wet-rice farming is the most common agricultural practise in the Far East, where it takes up a tiny percentage of total area yet feeds the bulk of the rural people. Malaysia continues to implement tough and progressive measures throughout the Eleventh Malaysian Plan (2016–2020) and National Agro-Food Policy (2011–2020) steps to encourage the growth of the paddy and rice sectors [6]. Rice is a major crop in the globe, with over half of the world's population relying on it for survival. Rice is a staple cuisine for many people across the world, including Malaysians. Chilli is a called to ‘Capsicum annuum and capsicum frutecens’. Capsicum or “Kapsimo” is derived from the Greek word meaning “to bite”. However, many decades ago, they adapted to Malaysian Tropical Climate. In Malaysia, Chilli (Capsicum annum L.) plant is a high-value vegetable is grown in soilless culture pots [7]. Lack of care of rice and chilli crops can cause the disease to spread to the whole plant over a long period of time. Therefore, control for both crops should be taken care of to prevent disease.

2.2 Comparison with Existing Systems

As the explanation for each existing system that related and compared to the features of the proposed system. This includes the features contained in Plant Disease Detection by using IoT. The comparison results are shown in Table 1.

Table 1 System’s Comparison

System / Features	Plant Leaf Diseases Identification using Convolutional Neural Network with Treatment Handling System	Brown Spot Disease Severity Level Detection using Binary-RGB Image Masking	Paddy Disease Detection System Using Image Processing	IoT Based Smart Farming for Plant Disease Detection
System Platform	System Platform	System Platform	System Platform	System Platform
Web-Based	Web-Based	Web-Based	Web-Based	Web-Based
Web-Based	Web-Based	Web-Based	Web-Based	Web-Based

Web-Based	Web-Based	Web-Based	Web-Based	Web-Based
Web-Based	Web-Based	Web-Based	Web-Based	Web-Based
Login / Registration	Login / Registration	Login / Registration	Login / Registration	Login / Registration
No	No	No	No	No
No	No	No	No	No
No	No	No	No	No
Yes	Yes	Yes	Yes	Yes

3. Methodology/Framework

The choose of methodology for project development was using agile model. This model necessitates ongoing meeting with stakeholders as well as continual development at each level. This lifecycle model started with several ways to expedite development in order to bring a new software to market more quickly. Figure 1 below show the agile model as a project development methodology.

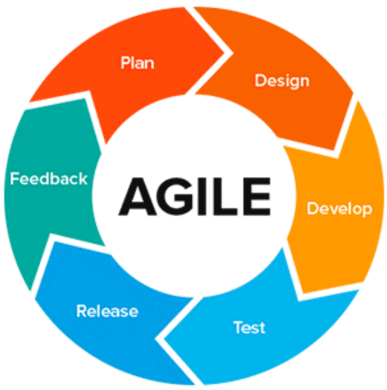

Figure 1 Agile Methodology Model

Source: https://www.wearemarketing.com/blog/what-is-the-agile-methodology-and-what-benefits-does-it-have-for-your-company.html

3.1 Planning Phase

This project integrating IoT hardware and the system. IoT hardware should determine to capture the plant disease and the system be able to monitor through the dashboard about plant disease detection. The crop of plant disease should through the process called image processing technique to enhanced image or extract some useful information from it.

3.2 Designing Phase

Tools used to start a design phase such as draw.io online software that easily to draw likes flow chart, ERD, DFD, use case and others that related to the diagrams. This tools are a free source and give some an advantages because there are many good collaboration features and friendly interface to make more understand especially for a beginner.

3.3 Developing Phase

The developing of web system by using Visual Studio Code as a code editor. It is a free software that can implement as many as programming language want to use. MySQL as a relational database, free-to-use and provides complete support for all application development requirements. For a training and testing model by using a Jupyter Notebook that need run through Anaconda environment. The IoT hardware by using Arduino will be integrate with the web system by using a Wi-Fi signal, so the system enables to show the camera through the Arduino camera.

3.4 Testing Phase

Testing occurs as new features are introduced, rather than waiting for development to be completed before testing can begin. Questions and answers are important in a testing phase for all the stakeholders to work closely together. When the stakeholders are satisfied to the system, it should ready to next phase.

3.5 Release Phase

Release phase will be begun to deploy and end-users are the ones who use it. It's critical to keep an eye on these early phases for faults or flaws that were overlooked during testing. Between the production and support teams, there should be a handover with appropriate training. The developers should keep the system running smoothly and show users how to use it. This phase will be finalizing the documentation of guided to use the system especially end users and production staff.

3.6 Feedback Phase

The lastly is feedback phase after releasing the system to end users. In this phase, this web system will be evaluated to determine some feedback from users to be improve. In this phase also the developers get to know how far the web system will affect the objectives. The feedback will be conduct through a few of questionnaire that related to the web system such as user-friendly, satisfaction, errors and efficiency. From the feedback given, it will be adding or improving the functionality into the web system for more features.

4. Results and Discussion

4.1 System architecture

The structural design of systems is known as system architecture, and it is a type of software that provides basic functions and automation. Figure 2 show the system architecture of IoT Based Smart Farming for Plant Disease Detection.

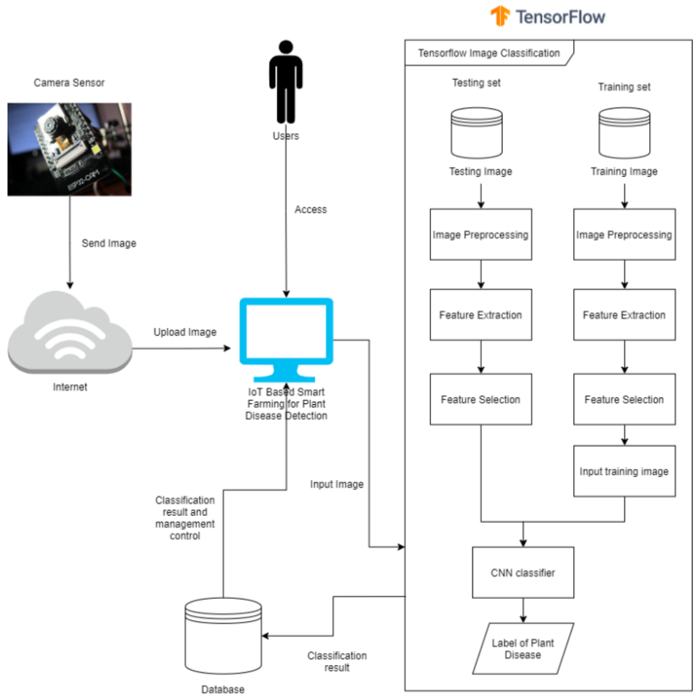

Figure 2 System architecture of IoT Based Smart Farming for Plant Disease Detection

4.2 Main Flowchart

In a system design shows overall of flowchart of the IoT Based Smart Farming for Plant Disease Detection. Flowchart is a way of displaying how data flows in the system. Figure 3 show the illustration of flowchart with including all modules and operations.

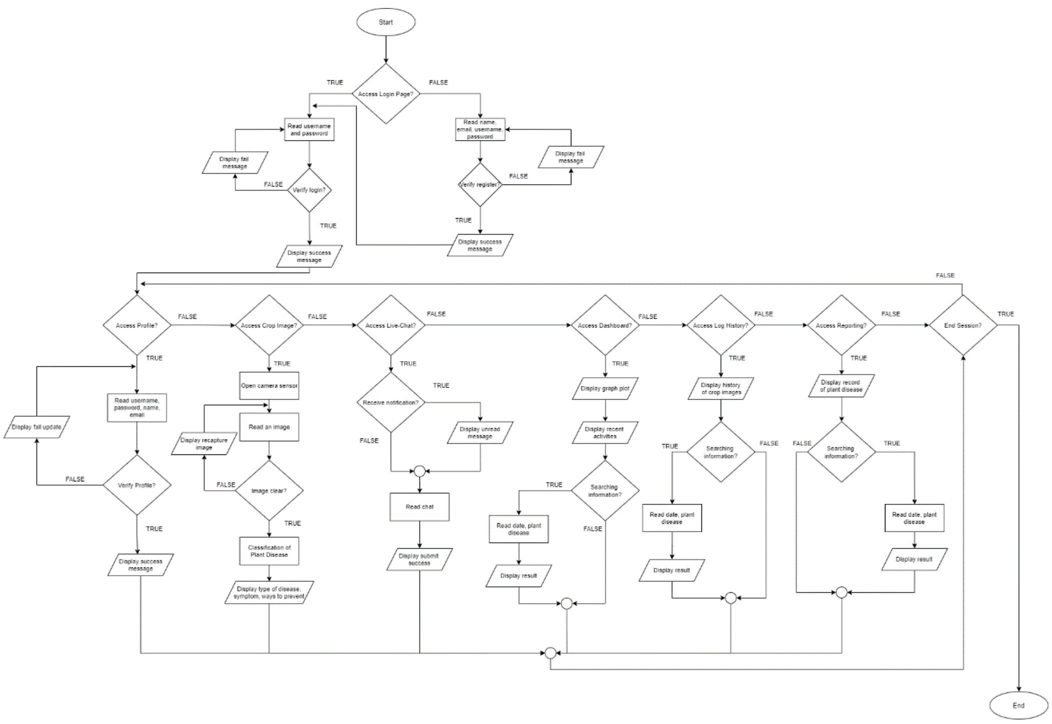

Figure 3 User Flowchart for IoT Based Smart Farming for Plant Disease Detection

4.3 Main Menu

Figure 4 below show home interface after the user success login into the system. In this page, the system will show the name of user at the top right. If the user did not login yet, the crop disease menu will not appear.

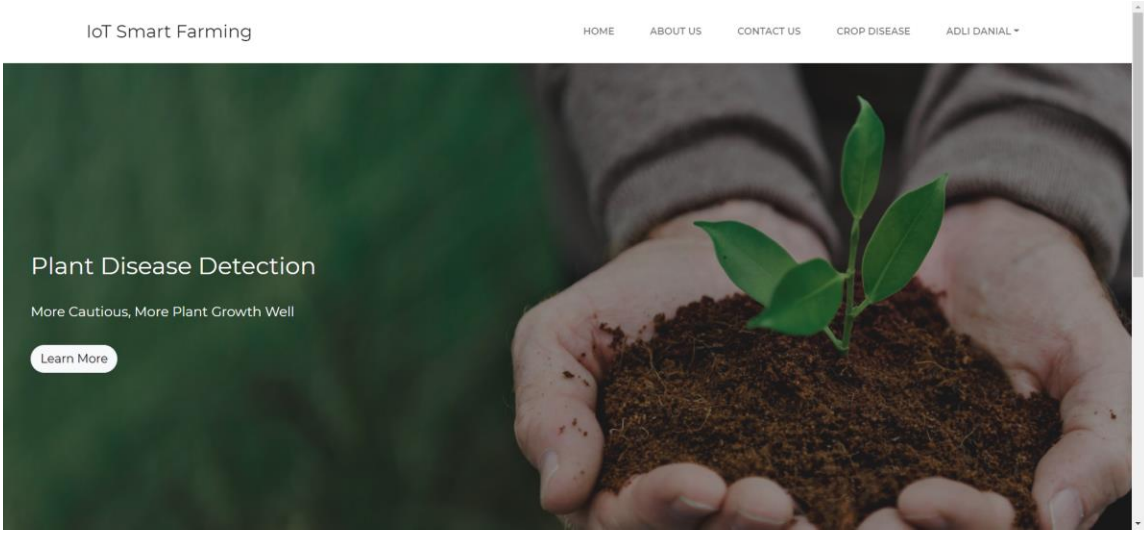

Figure 4 Home Interface

Acknowledgment

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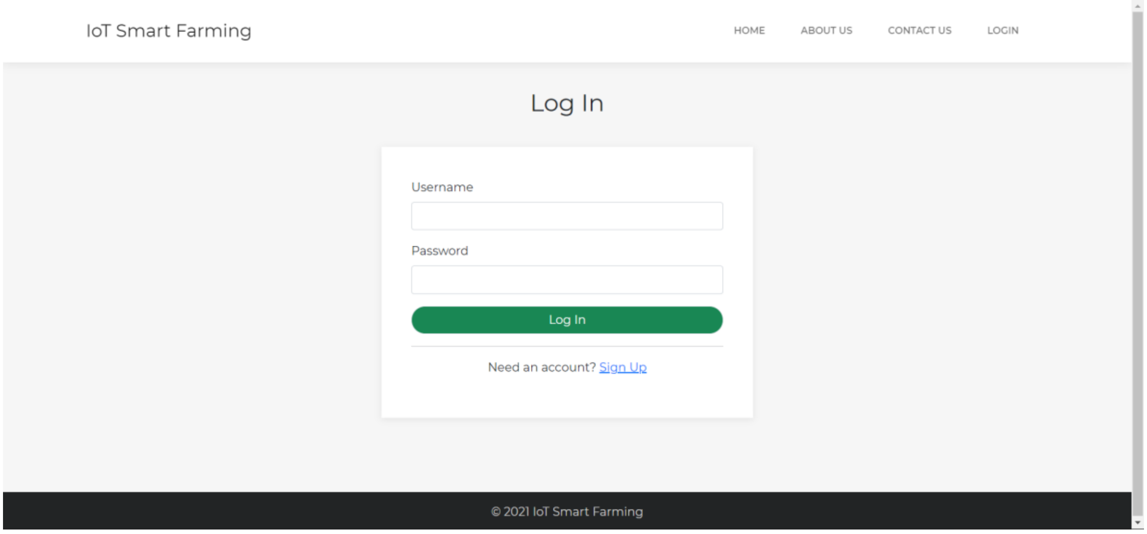
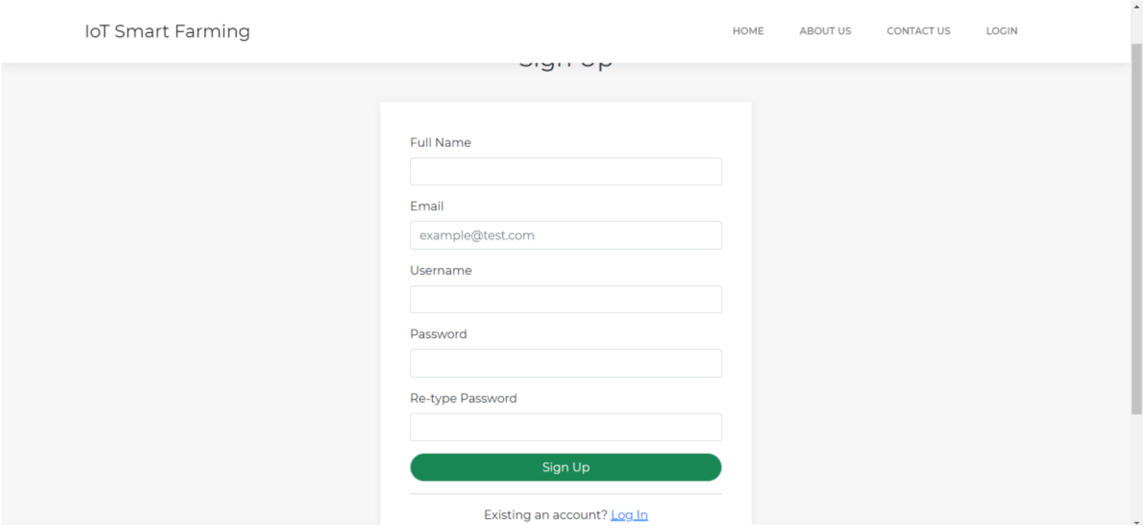
Appendix A



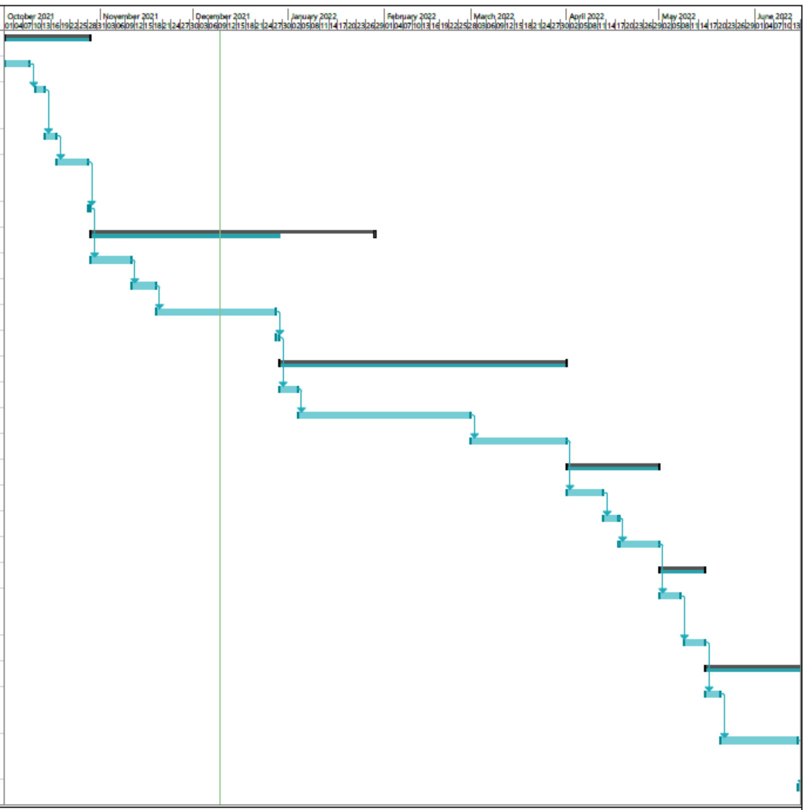
Log In Interface



Register Interface

Appendix B

ID	Task Name	Duration	Start	Finish
1	**1.0 Planning Phase**	**20 days**	**Fri 01/10/21**	**Thu 28/10/21**
2	1.1 Establishing the Project Initiation	6 days	Fri 01/10/21	Fri 08/10/21
3	1.2 Determine problem statement, objective, scope	3 days	Mon 11/10/21	Wed 13/10/21
4	1.3 Create a proposal document	3 days	Thu 14/10/21	Sun 17/10/21
5	1.4 Submit a proposal document for review	8 days	Mon 18/10/21	Wed 27/10/21
6	1.5 Presentation proposal	1 day	Thu 28/10/21	Thu 28/10/21
7	**2.0 Design Phase**	**66 days**	**Fri 29/10/21**	**Fri 28/01/22**
8	2.1 Wireframe Design	9 days	Fri 29/10/21	Wed 10/11/21
9	2.3 Designing Structure Database	6 days	Thu 11/11/21	Thu 18/11/21
10	2.3 Designing User Interface	27 days	Fri 19/11/21	Mon 27/12/21
11	2.4 Presentation PSM 1	1 day	Tue 28/12/21	Tue 28/12/21
12	**3.0 Developing Phase**	**67 days**	**Wed 29/12/21**	**Thu 31/03/22**
13	3.1 Creating Database	4 days	Wed 29/12/21	Mon 03/01/22
14	3.2 Creating User Interface System	40 days	Tue 04/01/22	Mon 28/02/22
15	3.3 Compilation of Modules	23 days	Tue 01/03/22	Thu 31/03/22
16	**4.0 Testing Phase**	**22 days**	**Fri 01/04/22**	**Sat 30/04/22**
17	4.1 Perform System Testing	8 days	Fri 01/04/22	Tue 12/04/22
18	4.2 Recognizing System Error	4 days	Wed 13/04/22	Sun 17/04/22
19	4.3 Improving System Error	11 days	Mon 18/04/22	Sat 30/04/22
20	**5.0 Release Phase**	**12 days**	**Sun 01/05/22**	**Sun 15/05/22**
21	5.1 Documentation Training Procedures	7 days	Sun 01/05/22	Sat 07/05/22
22	5.2 Training Real Time User	6 days	Mon 09/05/22	Sun 15/05/22
23	**6.0 Feedback Phase**	**23 days?**	**Mon 16/05/22**	**Wed 15/06/22**
24	6.1 Collection of Feedback from User	5 days	Mon 16/05/22	Fri 20/05/22
25	6.2 Transforming Request into Changes	18 days	Sat 21/05/22	Tue 14/06/22
26	6.3 Presentation PSM 2	1 day	Wed 15/06/22	Wed 15/06/22



Project: IoT Based Smart Farming for Plant Disease Detection

Task | Split | Milestone | Summary | Project Summary | Inactive Task | Inactive Milestone | Inactive Summary | Manual Task | Duration-only | Manual Summary Rollup | Manual Summary | Start-only | Finish-only | External Tasks | External Milestone | Deadline | Progress | Manual Progress

Page 1

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