Vision-Based Monitoring (VBM) for Plant Quality and Control System

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***Abstract* - This research paper designs and implements a prototype of VBM system by using a line follower robot car for indoor hydroponic plant monitoring. The proposed robot car was using line following IR sensors to follow the track line. The robot car controlled by Arduino Mega 2560. The robot is connected to Raspberry Pi for image processing purpose. The image processing can be archived by implementing the object surface area measurement method. The python module OpenCV, Numpy, matlabplt, glob, docx and OS were involved for image preprocessing and surface area calculation respectively. Hence, a document in pdf format will generate and send to the NAS system through WiFi. In fact, more actions can be taken as saved the result in PDF format as other workers able to view the entire results, taking some actions for example add on comments, signing and recording. Therefore, the document copy on board will be deleted to reduce occupied memory resources. The NAS system was builded by Raspberry Pi and a hard disk. It is connected to router via ethernet cable to gain stable internet connections. After that, the workers can link the NAS folder and have review on their desktop remotely.**

Keywords - Crops, Image processing, Plant growth, Vision based monitoring.

I. Introduction

The progress of greenhouse agriculture in Malaysia getting mature and diversity. Malaysia only 19 selected agriculture products recorded Self-Sufficiency Ratio (SSR) which less than 25 agriculture commodities recorded in 2019 [1]. The impact was due to implementation of Movement Control Order (MCO) to curb COVID-19 pandemic, the number of human labors are strictly restricted thus affected agriculture productions. Thus, this impact made workers hard to monitor the crops growth. Moreover, workers were work from home and they have to perform the daily tasks as before MCO. The project implementation able to let them monitor from a far distance. As the project implemented to help human workers to monitor the plant growth, the worker able to keep their rooms in ambient conditions by reducing the chance enter the rooms. So that the environment is easy to take care and keep clean.

This paper will develop the VBM system for plants growth. The aim of this research as implementing the machine vision into hydroponic system to monitor the status of the plants hence improve the production of hydroponic. There are several designs of machine VBM system introduced. There are some challenges in this project for example the integration of line follower robot car with image processing unit to capture the crops, storage handling problems and the limited processing power of the board. Those issues will be solved and bring the benefits such as new approach to reduce the burden of workers to take care the hydroponic rooms. Thus, the human workers are released from normal tasks and able to improve the detailsof whole system.

The objectives of this paper is to: i) Design and develop a line tracking robot prototype for patrolling hydroponic room. ii) Implement a hydroponic shelf monitoring system via Network Attached Storage (NAS). iii) Apply image processing technique for the plant health and growth analysis. The workers able to work with a distance from farm. For example, they can sit in office room and check the quality of crops. The workers do not need to work into the big farms and checking every shelfs. They can show copy of reports to their clients, introduce their corps with solid evidence and data supports. Moreover, the workers able to keep their hydroponics farm environment clean as they do not need to enter the farm every day to keep crops qualities on track.

The project scope is to study the possible image processing techniques applied on indoor hydroponic farming for plan growth rate monitoring. The plants growth rate will be recorded into proper report format. In addition, suitable method of robot car platform will be investigated.

II. Related Work

A. Robot Car Prototype

Figure 1 showed the algorithm of robot car. The robot car also used two LM393 as a comparator to toggle the led when the IR sensors detects the white plane [2]. This is because the LM393 acted as analog current to digital current converter which only provide high and low signal to the motherboard. The IR sensors were placed like the world "W". The distribution provided the better detection during line following process. To control the speed of two DC motors, PWM signal will generate and input to L293N DC motor driver hence control the speed of the motors. The flowchart as shown in Figure 1. The IR sensors placed the front and back side of the robot car [3]. Moreover, during the controlling step, the reading of IR sensors will represent in the form of "0" or "1". The ambient condition of the IR sensors will be "11011" mean while the robot car is on the center line. Hence, if the output of IR sensors is another form such as "11101", meaning the robot car is at the left side of the center line. Thus, the program will change the variants speed of left-side and right-side DC motor to adjust the position of robot. In some cases, for example at the left corner, the output of IR sensors may distribute "00011" stated the robot reach the left corner, the robot car has to turn left vice versa.

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