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The Development of the Fruit Palm Fall Collector Machine (FPFCM)

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Abstract:

The agricultural activities are always associated with dangers and injuries especially in oil palm farms. This is because most workers are still using the old ways to collect the leafy fruits. This may result in Musculoskeletal Disorder (MSD) and may take a long time. The project focuses more on the development of automated collector robots using intelligent sensors and is developed to assist the collection of fragmented fruits with their own moving mechanism without human assistance. In order for the robot to work properly, motor movement and sensor sensitivity need to operate at maximum speed. These robots are a great help to oil palm businessmen, carrying out complex tasks and taking short time automatically.

Keywords: *auto robot collector, loose fruit, color sensor, technology, palm*

I. INTRODUCTION

Agriculture is known as one of the earliest industries explored and implemented in Malaysia. In order to perform their duties in agriculture, it requires very physical, heavy and large amounts of energy. These field workers are more exposed to ergonomic problems in their work. Palm oil harvesters are not expected to be exposed to various ergonomic risk factors that result in musculoskeletal disorders (MSD).[1]

Common tasks performed by oil palm workers are cutting fresh fruit bunches (FFBs), collecting, loading and unloading FFBs for processing. In addition, loose fruit collection which is a major topic of daily oil palm operations (Palm Oil Facts, 2013) also needs to be processed. When there are unripe fruits found on the ground, the bunches are ready for harvest according to visual cues. Workers need to bend and straighten their bodies while collecting loose fruit. This action is repeated over and over and over while performing loose palm fruit collection.[2]

In addition, loose oil will also fall to the ground when the cutter cuts FFB. The mature fruit will fall and it is also categorized as loose fruit. It is difficult for collectors to collect loose palm fruit because workers need to bend their bodies and it will cause back pain if repeated and repeated work is done. The results of this study show that workers spend about 30% of their harvest time on loose fruit.[3]

Most palm oil farms in Malaysia still use the conventional method of collecting systems to collect loose oils, that is, manually by hand, it will take a long time. According to the study, it is found that the prevalence of musculoskeletal disorders among workers is one of the major issues in the agricultural industry. Because the purpose of this project is to reduce the use of manpower and to improve the time of collecting loose fruit by using a machine that can be operated automatically. Therefore, the aim of the project is to automatically analyze the movement of the robot and the color

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detection system in collecting the remaining palm fruit for recording.

II. METHODOLOGY

This section discussed and explain the method used to design the FPFCM. In this section the block diagram and the flow chart will be discussed in detailed with the information about project works and the components used.

Block diagram in Figure 1 shows how the process of the project designed. While in Figure 2,it shows the working principle that explain the flow of block diagram. The explanation about these figures will be elaboration in following the subsection.

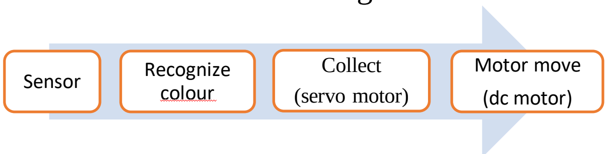

Fig.1. Block diagram.

Figure 1 shows the block diagram of the project. In this project, there are several main components that have been used. RGB color sensor as an inputis used to detect the color of the loose fruits. Then Arduino Mega 2560 is used to control the sensor. At the same time, 12V battery has been used to supply the power to the sensor and motor of the robot. Finally, the motor is used to move the robot arm and body robot.

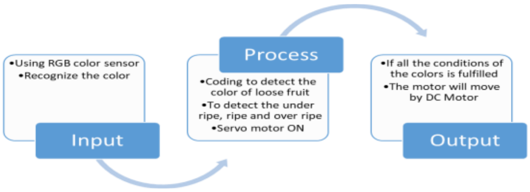

Fig. 2. Working principle.

In Figure 2, RGB color sensor is the main component for this project. It will be use as input to recognize the different color of the loose fruits. The uses of this sensor to this project is to detect the right color of the ripe loose fruits. The sensor will identify any number of color with an accurate programming code. With a specific set of coding to ensurethe process of detecting right color can run smoothly using the suitable Arduino that can be used to interface the hardware part which is the motor as an output of the project.

A. *Fresh Fruit Bunch (FFB) Grading*

When the FFB was under ripe grading the fruit will be orange in color and reddish or reddish-purple fruit mesocarp yellowish orange color outer layer. Besides, the fruit will have yellowish and reddish outer layer while its mesocarp are in yellow color for a ripe bunch. At the same time, the condition of the over ripe bunch is in dark red color. Figure 3 shows the different in the color of the FFB grading. [9]

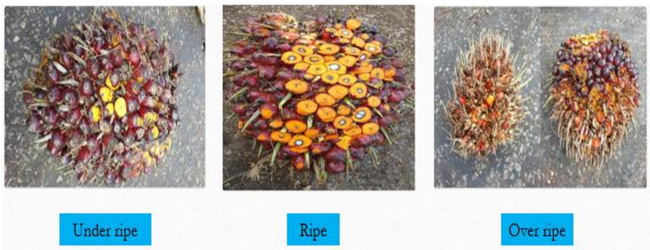

Fig. 3. FFB Grading.

B. *Materials*

i. *TCS3200 RGB Color Sensor*

This sensor is the main component for this study. This Arduino compatible TCS3200 color sensor module consist of TAOS TCS3200 RGB sensor chip and 4 white LEDs, shows in Figure 4. The TCS3200 sensor can detect and measure a nearly limitless range of visible color. This sensor has an array of photodetectors, each with either a red, green or blue filter or no filter (clear). Internal to the device is an oscillator which produce a square-wave output whose frequency is proportional to the intensity of the chosen color. The uses of this sensor to this project is to detect the right color of the ripe loose fruits. The sensor will identify any number of color with an accurate programming code. Figure 4 shows the image of color sensor use.

This sensor has 16 photodiodes that are connected in parallel. By using the two control pins S2 and S3, which of the color will be read based on the user can be selected. For example, if the red color wants to be detected, the 16 red filtered photodiodes can be used by setting the two pins to low logic level. While, pins S0 and S1 is the selection for the output frequency scaling. As example, if 20% frequency wants to be selected, set the control pin S0 to High and S1 to Low.

Fig. 4. RGB Color sensor.

ii. *Arduino Mega*

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital

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input/output pins and 16 analogue inputs incorporated on the board, a 16 MHz frequency is added on the board, a USB connection, a power jack, an ICSP header, and a reset button. It has more memory space and input/output pins compared to others board. This board have many inputs/outputs that can be used at the same time. This Arduino need a specific set of coding to ensure it can run smoothly. Figure 5 shows the suitable Arduino that can be used to interface the hardware part and the software part of the project.

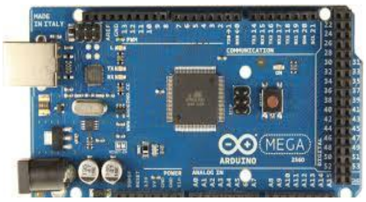

Fig. 5. Arduino Mega 2560 Board

C. Methods

i. Layout components connections

The layout component and the connection of each components of the devices such as Arduino, sensor, and servo motor of this projectshowsin figure 6. This layout was designed by using Fritzing application.

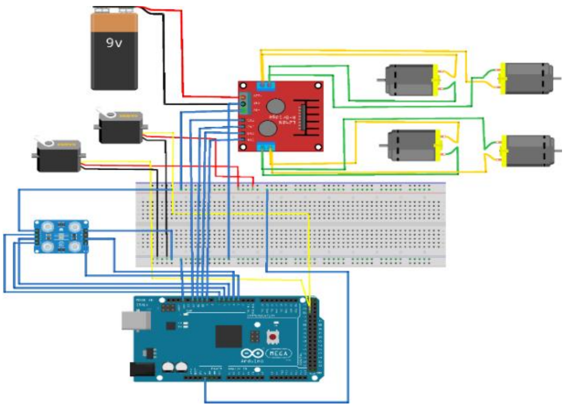

Fig. 6. Layout components diagram of the project

ii. Construction of the prototype

The components of this circuitas shown in Figure 6 are manually constructed until become the complete prototype. To avoid the harmlessof components the data sheet of each components must be referred.

iii. Connection of color sensor and DC motor

All the port must be connected in the right place in the Arduino to make sure the sensor can function well. This is important because the sensor is the main part of this project. If the connection is wronglyconnected, it will affect the reaction of the sensor. Figure 7 shows the connection of the sensor.

Fig.7. Color sensor connection

The correct connection between L298N motor driver and DC motor is important to make sure the robot can move smoothly according to the coding that has been programmed. L298N have been used because it consist of dual H-bridge circuit.

iv. Product design

The 3D image preliminary and the actual designof this project using the Tinkercad web, shows in Figure 8. The design using three different views which is from the side view, back view and front view.

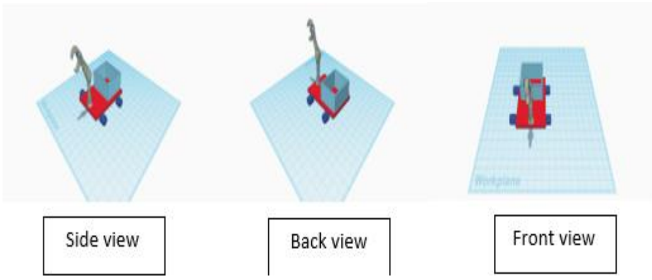

Fig.8. The 3D image view of the project

The hardware and software development has been elaborated clearly. Good planning is necessary to ensure that the project can run smoothly without any problems.

III. RESULTS AND DISCUSSION

The successful of this project can help to reduce time and human labor at the oil palm plantation and also to eradicate MSD problems among workers.

The project has been tested by three parts of mechanism. The three parts of mechanism are movement of the robot systems, sensitivity of the sensor and weight of fruit collection.

i. Robot (motor) movement

The motor movement controlling according to the instruction in Table I. All four motors attached in the prototypemoving forward, backward, right and left direction.

TABLE I. MOTOR MOVEMENT

Movement	Motor 1	Motor 2	Motor 3	Motor 4
Forward	ON	OFF	ON	OFF
Reverse	OFF	ON	OFF	ON
Right	ON	ON	OFF	OFF

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Left	OFF	OFF	ON	ON
Stop	ON/ OFF	ON / OFF	ON/ OFF	ON/ OFF

At first, the prototype movement was tested by moving all motors attached in the prototype. The movement of the motor was followed the requirements as shown in Table 1. While the sensitivity of the sensor is one of the studies that need to be observed because color sensor is one of the main components despite being one of the objectives in this project. The sensitivity of the sensor was measured with the distance of the sensor to the object with the frequency output that has been observed by using serial monitor of the Arduino software. The sensitivity of the sensor was measured by the distance of the sensor to the object (cm) and the different data of output frequency (Hz) from serial monitor that have been collected.

ii. Robot (motor) movement

The color sensor sensitivity has been tested to make sure it can work very well (functioned). The sensitivity of the sensor was measured by using the distance and the output frequency of the sensor. Table II shows the average of the sensitivity of the sensor detectionand also shows the results by graph in Figure 9.

TABLE II. THE SENSITIVITY OF THE SENSOR

Distance (cm)	Average Output Frequency (Hz)
1	97.6
2	171
3	262.7
4	386.9
5	545
6	697.4

From the data collected as shown in Table II, the average of output frequency can see the distance of sensor effectiveness. When the distance of the sensor to the object has been increased, the output frequency also increases. The graph sensitivity of the sensor as shown in Figure 9 has proven that when the sensor is further, the frequency output will bigger. This color sensor sensitive towards lighting and it might affect the result. To get the accurate data, the average data have been collected.

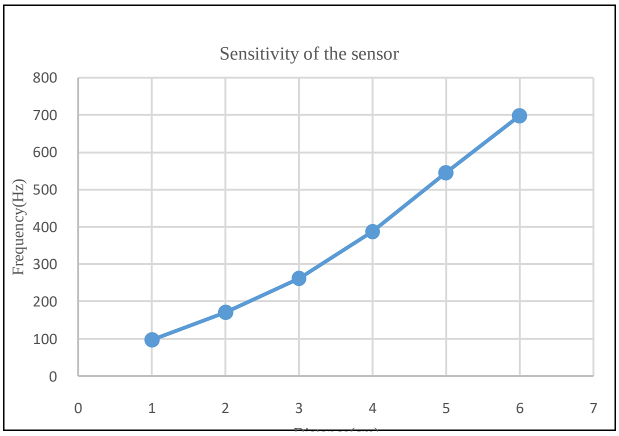

Fig. 9. Graph of the sensitivity of the sensor

iii. Robot (motor) movement

The weight of the collection is one of the main factorsfor this project has been produced. The prototype has been examined in every one minute to collect loose fruit (in kg). The results collected were tabulated in Table III while the graphs of the result of the collection was plotted in Figure10.

TABLE III. WEIGHT OF LOOSE FRUITS COLLECTED IN 60 SECONDS

Time(s)	Weight (kg)
00 – 60	0.25
60 – 120	0.60
120 – 180	1.10

Another result was collected is the weight of the loose fruits in every 60 seconds. From the testing, the weight collected for every 60 seconds is different from time to time but the weight still increases. From the observation, when the sensor works well then, the robot will collect more of the loose fruits as shown in Table III and Figure 10. The weight of loose fruits collected was recorded and obtained from this test have been proven by hardware and software.

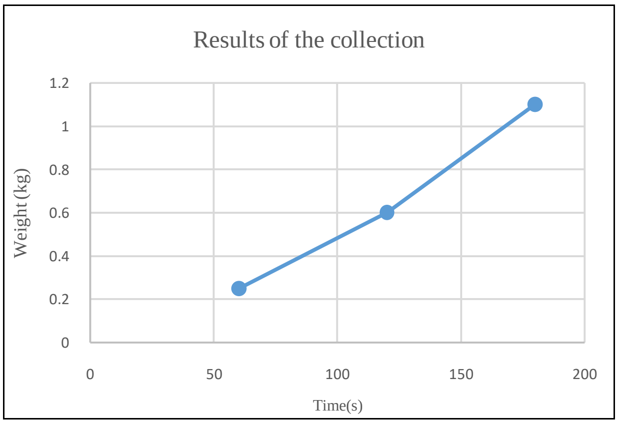

Fig. 10. Graph the results of the collection

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IV. Conclusions and Recommendations

The findings of this study will give advantage to the oil palm workers and agriculture industry to collect loose fruits of palm oil. By using robot mechanism technology, it will give more benefit to the user because it can save cost and time. Nowadays, people used the technology to make their life easier. This is one of the ways that can help the mankind in doing the works especially for the manual work that had been done by the oil palm workers. The system can help to reduce MSD that always occurred to the oil palm workers who still using manual way to collect loose fruits. This system makes life more convenient by using advance technological systems compare to other projects.

The prototype can be made some improvements,particularly with the RGB color sensor section, as the color of the sensor can accurately and precisely analyze it can work quickly and smoothly.Color sensors are also sensitive to light sources,if sensor can withstand light sensitivity, better results can be produced. In addition, the sleeve robot can be replaced with a 360-degree rotation, as the machine can only move up and down for 180 degrees due to the position of the oil palm that has been placed behind the machine.

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