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Development of Wireless Planting Robot for Sowing Seeds, Watering and Fertilizing Plantations

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Abstract: Agriculture is the art and science of cultivating soil, growing crops, and raising livestock. At present, agriculture is developing rapidly, and the production of various machinery and equipment has encouraged the development of agriculture. The main objective of this project is to develop an economical agriculture robot for smallholders that use advanced technology to make local agriculture more sustainable. The combination of wireless controller technology and the robot is to help humans to do multi work at the same time and to reduce the time but increase the production. A portable robot that works for seeding, watering and fertilizing as well as being controlled using a wireless PS2 controller. The data generated through the tests conducted show that all the specified functions are running smoothly. Instructions received through the wireless controller are also well received by the robot. Based on the results and analysis done, this project shows positive results and is according to the objective. This robot can also be upgraded by increasing the amount of output available where this robot only uses a few buttons on the controller.

Keywords: Wireless Planting Robot, Wireless Controller, Agriculture Robot

1. Introduction

Malaysian agriculture accounts for 12% of the country's GDP. 16% of Malaysia's population is employed in some form of agriculture [1]. On average, Malaysian citizens consume 82.3 kilograms of rice each year [2]. The ever-increasing population requires more research and technological advancement to increase rice production for domestic consumption. Agriculture is considered to be one of the most extensive businesses in the domestic and international markets. Unfortunately, many farmers still use traditional farming methods, resulting in low yields of crops and fruits.

There is a design that has been created by Pankaj Kumar which he designs and fabrication of smart seed sowing robot [3]. This smart seed sowing robot consists of one robotic arm to sow the seeds from the seed container. The robot arm is controlled through the mobile application to get the desired

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positions of the arm. Although this robot can overcome the problems mentioned, but there is a disadvantage where this robot is only able to perform 1 task at a time. The concept applied in this project is that various tasks can be performed simultaneously and controlled through a wireless controller that uses an Arduino as the central processor. For future work on this project, this project can make a great improvement using the Wi-Fi technology that is now being developed at the forefront of innovation [4].

Agriculture is a combination of various processes that need to be carried out gradually making this job more difficult. For thousands of years, agricultural development has been very slow. One of the earliest agricultural tools was fire [5]. Native Americans use fire to control the growth of berry - producing plants, which they know grow quickly after forest fires. Farmers work a small piece of land by hand, using axes to clear trees and digging wood to break up and cultivate the soil [6]. However, this problem can be solved by deploying agricultural machinery to help carry out the agricultural process. The machine can perform repetitive daily tasks with excellence and at the same time it can improve the quality and yield of agricultural products. Although the machine is capable of solving the problem, farmers have to invest some money to pay for the cost of the machine. Some of these machines are heavy machines, made of many expensive parts and materials, and the cost of each machine is still expensive. To solve this problem, this system can reduce workload, operating costs as well as low maintenance costs to help small and medium farmers grow their businesses.

For this project, the first objective is to develop an economical multifunction agriculture robot based on Arduino for watering, seeding and fertilizing. Secondly, to implement the prototype of an agriculture robot in actual environment. Lastly to analyze the accuracy of the robot, processing time taken and also production rate.

2. Materials and Methods

Overview of a wireless planting robot system that uses an Arduino Uno to spread seeds, irrigate, and cultivate fields. The PS2 Controller delivers a signal to the receiver, which controls the robot's movement. Water pumps will pump and spray water to the ground and servo motors will manage seed or vegetable fertilizer production doors. and robots will use ultrasonic sensors to detect farm edges or impediments. This description is made after determining all the components required in the project. This methodology is important for project execution because it avoids errors and carelessness that may make the project more difficult. This is because a good project can be produced through a good implementation and proper planning system. The rules and procedures adopted must meet the requirements of this project. Figure 1 depicts the block design for this project, which includes a PS2 controller, SKPS, DC motor, Arduino Uno, and a water level sensor.

This agriculture robot is operated by the operator using a wireless PS2 controller SKPS where it sends instructions to the receiver that is connected to the Arduino Uno and then to the output that is directed. The manipulator is mounted on a servo motor. The main function of the servo motor is to control the division of the released seeds. Next, four DC motors work to make the rotating robot spin, and two DC motors water and fertilize. For watering and breeding, water pipes are installed on mobile robots.

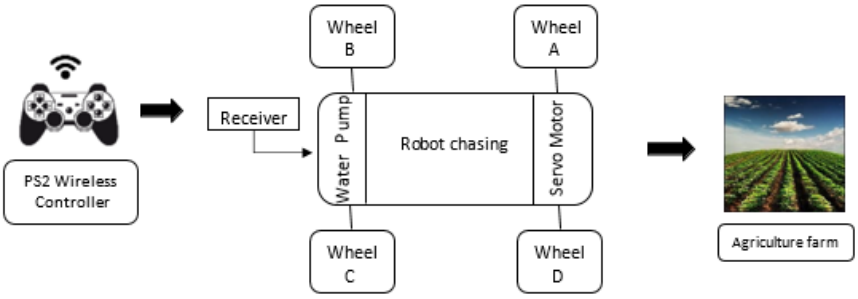

Figure 1: The overview of controlling mobile robot for wireless planting robot

2.1 Software Implementation

The evolution of computer software is closely following the development of computer hardware. This development is discussed in the system software and application software sections. System software is a set of general programs that manage computer resources, such as central processing unit, communication link, and peripheral equipment (Loudon and Loudon, 1995) [7]. System software has three main components: operating system, language translator, and utility programs.

2.2 Arduino Uno

Arduino was connected to several output units for this project, including a 12v dc water pump, a 5v dc servo motor, a 3v dc servo motor, a 12v dc battery, and a 7v 4 channel motor driver. Arduino is assigned as the main processor. Because this project uses wireless technology, all instructions are received from the PS2 controller. There are several outputs that will be produced by the Arduino where it controls the movement of the motor of the seeding and water level sensor as shown in Figure 2.

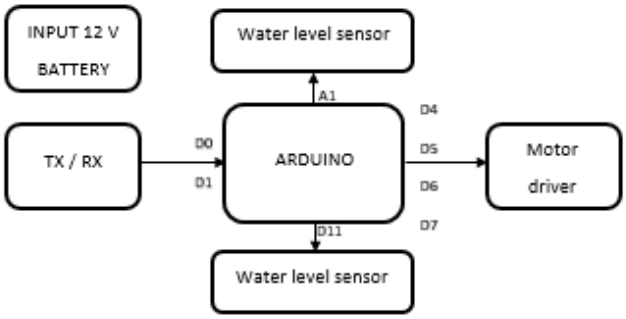

Figure 2: Connection for Arduino Uno

2.3 Driver DC Motor

This drive can drive up to four outputs, each of which can control a DC motor. Additionally, it enables bidirectional control of four DC motors ranging in voltage from 7 to 25V as shown in Figure 3. The FD04A connects to the Arduino Uno and controls the motor's direction, start, stop, and speed. This module has been programmed to communicate with the Arduino. It operates in response to commands from the Arduino and is limited to controlling the rods connected to the module's outputs.

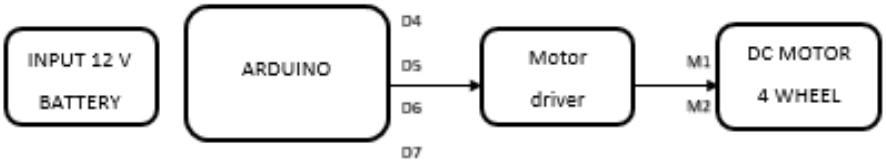

Figure 3: Connection for flexibot Driver 4 Channel (FD04A)

2.4 Water Level Sensor Module for Arduino

The sensor has a series of ten exposed copper effects, five of which are power effects and five are sensory effects. A water-level module has been used in this project. This module has been placed in the rear tank and directly connected to the Arduino as output as depicted in Figure 4. It serves as to monitor the remaining water level in the water tank.

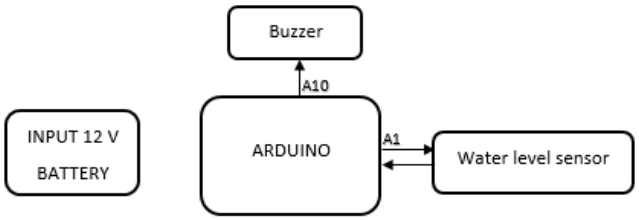

Figure 4: Connection for water level sensor module

2.5 Servo motor

Servo motors are used in this project to control the movement out of seeding in the seeding tank or fertilizer. It is connected to the Arduino as an output as shown in Figure 5. When receiving a command, it will move clockwise with a 90-degree movement.

Figure 5: Connection for Servo Motor

2.6 DC-12V Pneumatic Diaphragm Water Pump Motor R365

The R365 requires between 6 - 12V DC and between 0.5 - 0.7A. It is connected to the Arduino as output as depicted in Figure 6. The plastic tube is designed with two ends, one of which is connected to a water tank while the other is intended to spray water onto the plant. A sprinkler has placed the end of the inflatable outlet to ensure that the water coming out is not so sharp as to damage the soil. It works when the O button is pressed and will be off when the compartment button is pressed.

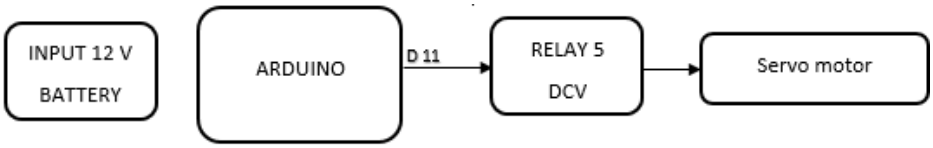

Figure 6: Connection for DC-12V Pneumatic Diaphragm Water Pump Motor R365

3. Results and Discussion

In this part, present the results and finding from the primary results which are using Arduino IDE and SketchUp to design the hardware part. This part also discusses on the results of the project which are analyzed to determine the effectiveness and accuracy of the development system in achieving the objectives.

3.1 Watering mechanism

The watering mechanism of the project are accomplished by the water tank container, plastic tube and water pump motor. The water tank container is designed to be 7 cm length, 7 cm height and 5.71 cm width while the no load weight was 0.28 g. This tank was made from acrylic which is commonly known as Perspex. The volume of water can be filled inside container was 279.8 ml. Next, the plastic tube was design with two ends which one of them connected to the water tank while the other one aim to spray water onto the plants. In between both of them, the water pump motor was connected for sucking water from the tank and pump it on the end that should facing the plants.

Expansion system dimensions that have tolerances that are not the same as the dimensions designed using SketchUp software because the clearances that have been made during frame cutting, assembly,

and precise items are not identical to the design. In general, the prototype produced is using Perspex as the main material in the design of this robot as shown in Figure 7.

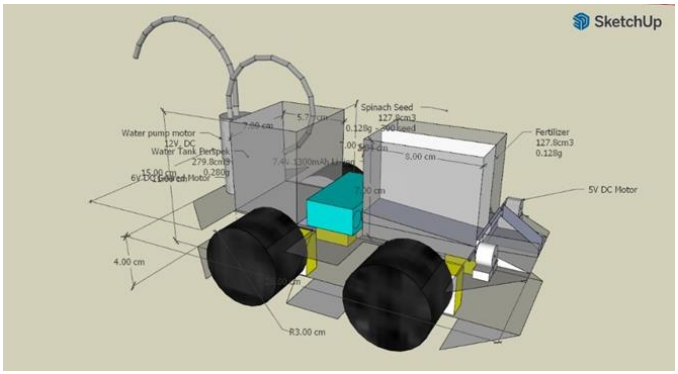

Figure 7: Overall 3D design of the project from perspective view

The water tank container is designed to be 11 cm length, 9 cm height and 12 cm width while the no load weight was 0.28 g. This tank was made from acrylic which is commonly known as Perspex as depicted in Figure 8. The volume of water can be filled inside container was 1200 ml. It takes 1.35 seconds to empty the tank without the sprinkler valve.

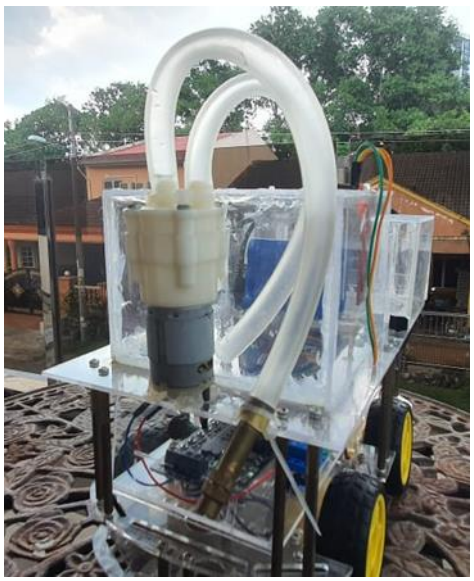

Figure 8: watering part with complete assemble

3.2 Seeding mechanism

The seeding container was placed besides fertilizing container as shown in Figure 9. The size and design for this container was same as fertilizing container. However, the DC motor configuration for gateway control was change to clockwise to open while anticlockwise to close.

3.3 Moving mechanism

The moving mechanism in the robot was leaded by 4 wheels where 2 of them, left and right side are connected directly to DC motor while the 2-left used to support the robot movement and weight. Moving the robot forward and backward can be simply achieve by activating the 2 DC motors connected to one left and one right wheel simultaneously. Next, to turn the robot to the right and left, only one of the left or right motor need to be activated depending on the direction of the robot want to go.

Figure 9: seeding part with complete assemble

Based on the result obtained in Table 1, the time for unloading process is having a little bit different base on the seed selected. But this may cause by the size of seed which the larger the size of seed which is carried by the unloader system which may slow down the speeds unloading process. The surface of the garden also plays a role in the smoothness of the seeding process.

Table 1: Time taken by the system to release the seed

Surface	Unloading time (s) base on type of seed	
	Mustard seed 2mm	Coriander seed 4mm
Off-road	20.1	40.5
Flat	25.4	46.1

Table 2 shows the time taken for the system to release the water base on the volume inside the tank. Total attempts for the testing are 2 type of method which the result is recorded in table 4.2. Base on the result on the table, the time for unloading process is having a different base on the flow of water by looking while using sprinkler or direct flow. This may cause if we add the sprinkler, the water flow getting slower than the other test which is without the sprinkler which may slow down the speeds unloading process. The volume of water inside the tank also become the reason in term of speed.

Table 2 Time taken for release the water from the tank

Sprinkler	Unloading time (s) base on method and the volume of water	
	Full tank (1200 ml)	Half tank (600 ml)
With	10.29	5.1
Without	3.36	1.47

4. Conclusion

The development of a wireless planting robot for seeding, watering, and fertilizing plantations met and exceeded all of the project's objectives and scopes. The primary goal of this project is to develop a multitasking robot capable of spraying seeds, watering, and fertilizing the farm simultaneously. Additionally, the project requires a minimum budget. In conclusion, we believe this project will help the agricultural industry because this robot is able to produce more production in a shorter time and can save time.

Acknowledgement

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