DESIGN DEVELOPMENT OF MOBILE FERTILIZER DISPENSER (MDF)

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ABSTRACT

In the new era of technology today, most of the mechanical system which is previously controlled manually has been changed into an automatic system. These revolutions are mainly to help human or user to upgrade their efficiency of working system. In this project, the aim is to build a robot which is able to move in uneven surface also can carry an amount of fertilizer and inject an amount of fertilizer into the soil. Mobile Fertilizer Dispenser (MFD) that being developed is made by using the concept of robotic where the robot can carry an amount of fertilizer it also is equipped by a mechanism that can inject the fertilizer into the soil. Mobile Fertilizer Dispenser is controlled by Radio Frequency (RF) remote control with a suitable frequency depends on the distance. The power supply for this robot is also not exceeding 24V DC and it is rechargeable. This robot using wheel mechanism to improve the stability and it can move in uneven surface. Higher force is used to the injector to inject the fertilizer into the soil. This Mobile Fertilizer Dispenser can be functioned systematically and perfectly compared to manpower. Mobile Fertilizer Dispenser is able to dispense fertilizer for 1 acre before battery charging is required and time taken for each dispensing process is 10 seconds.

Keywords: robot design, radio frequency, fertilizer dispenser, servo motor.

1. Introduction

The main idea to produce Mobile Fertilizer Dispenser (MFD) is to create a new technology for agriculture sector based on nowadays technology. Beside, this project will make an improvement in agriculture field from traditional to a modern type of ways. Modern machinery is used to harvest crop, seeding and fertilizing the crop but the modern machinery is huge and expensive that not suitable for small estate or farm (Robert & Tristan, 2014). New innovation on small scale machinery, automated mechanical device or robot are trending to solve the agriculture fertilizing process. The type of robots that available most frequently are robots that do work that is too dangerous, boring, onerous, or just plain nasty (Yeoshua & Shimshon, 2005). The robots are found in auto, medical, manufacturing and space industries. In fact, there are over a million of these types of robots working today, however agriculture field the robot used for replace the man power (Field et al., 2007). Most of the machine built in the agriculture is for liquid fertilizer dispensing Dosatron Injector that can dispense 26.53 L/min of liquid fertilizer (Retrieved February 18, 2016 from Hydro system website, *http://hydrosystemsco.com/dosmatic*). While, huge Dosmatic Injector that is not portable can dispense up to 100 gpm (Retrieved February 18, 2016 from Hydro system website, *http://hydrosystemsco.com/dosmatic*). While, on the solid pallet fertilizer dispenser design, a simple and cheap concept two wheeler with hopper is designed driven by human force to fertilize the solid fertilizer using gravity method, thus improvement of time saving of 50% and labour cost of 70% achieved (Narode et al., 2015). A rotary dispenser and seeding

with coulter device operated manually also claimed to be time saving by 50% (John, 2008). Advancement in rotary dispenser also being done by simulating the distance fertilizer dispense with various size and fertilizer type (Hatem, 2013).

In the other round, robot is also used to increase the amount of product by reduce the time taken for the fertilization process and to improve the quality of product by supplying the constant amount of fertilizer that has been set 20 grams of fertilizer. Mobile Fertilizer Dispenser (MFD) been equipping with an injection mechanism whereas this mechanism injects the fertilizer into the soil with the constant amount of fertilizer. Besides, this prototype also equips with 4 units of 2.5 cm diameter grooves tyre to provide stability during fertilization process and it able to move in uneven surface. This robot has been design with a tank that will supply 65 kg of fertilizer.

The aim of this mobile fertilizers dispense project is to build mobile injector for agriculture sector mainly on pineapple plantation using injector mechanism to inject fertilizer into the soil with a constant amount of fertilizer that is 20 grams of fertilizer for make sure that the growth of the plants.

2. Methodology

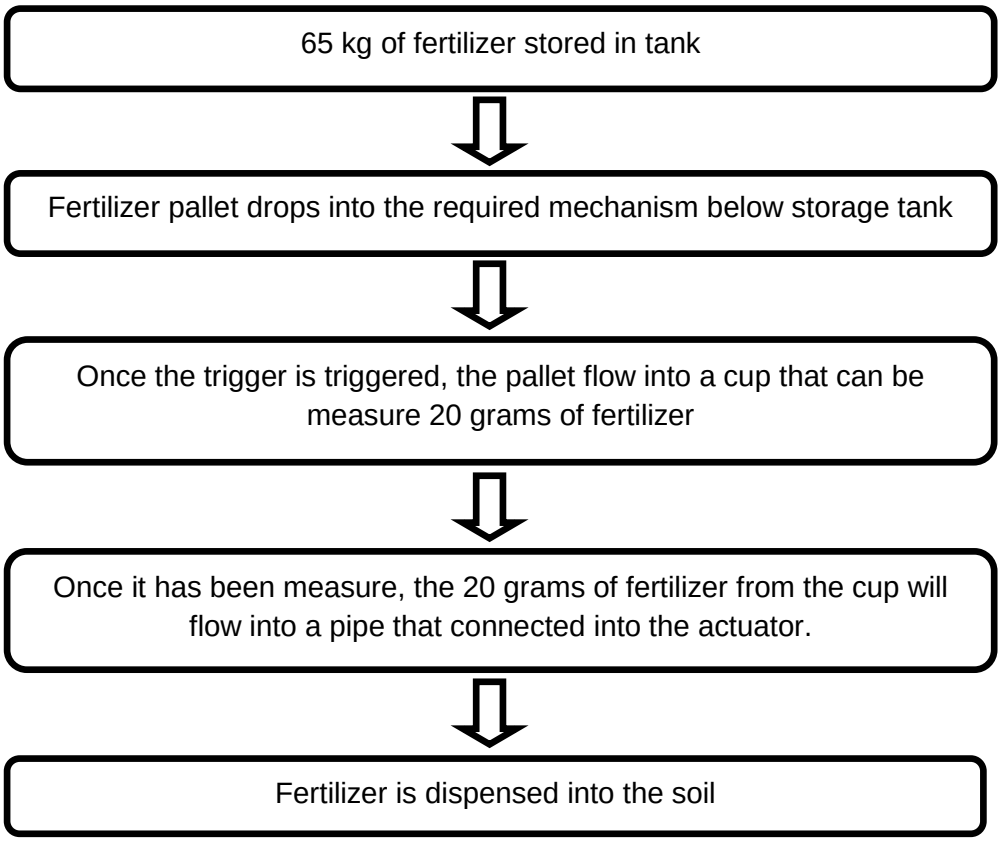

Figure 1. Flow Process of MFD

Figure 1 shows the flow process of the Mobile Fertilizer Dispenser (MFD). A remote control robot or mobile robot is built to carry 65 kg of fertilizer to dispense 20 grams of fertilizer at each pineapple plant. This is to ease the farmer burden to carry 25 kg of fertilizers in a bag for fertilizer dispenser work currently. The robot frame is built using low carbon steel with dimension of 30 cm width x 0.5 meter length. The height of the robot is 35 cm. The maximum weight capacity that can be carried by the robot is 65 kg. At this moment, the robot can only dispense 20 grams of fertilizer each time triggering the injector. All the mechanism is controlled by motor.

2.1. Mechanism of Controlling the Mobile Fertilizer Dispenser

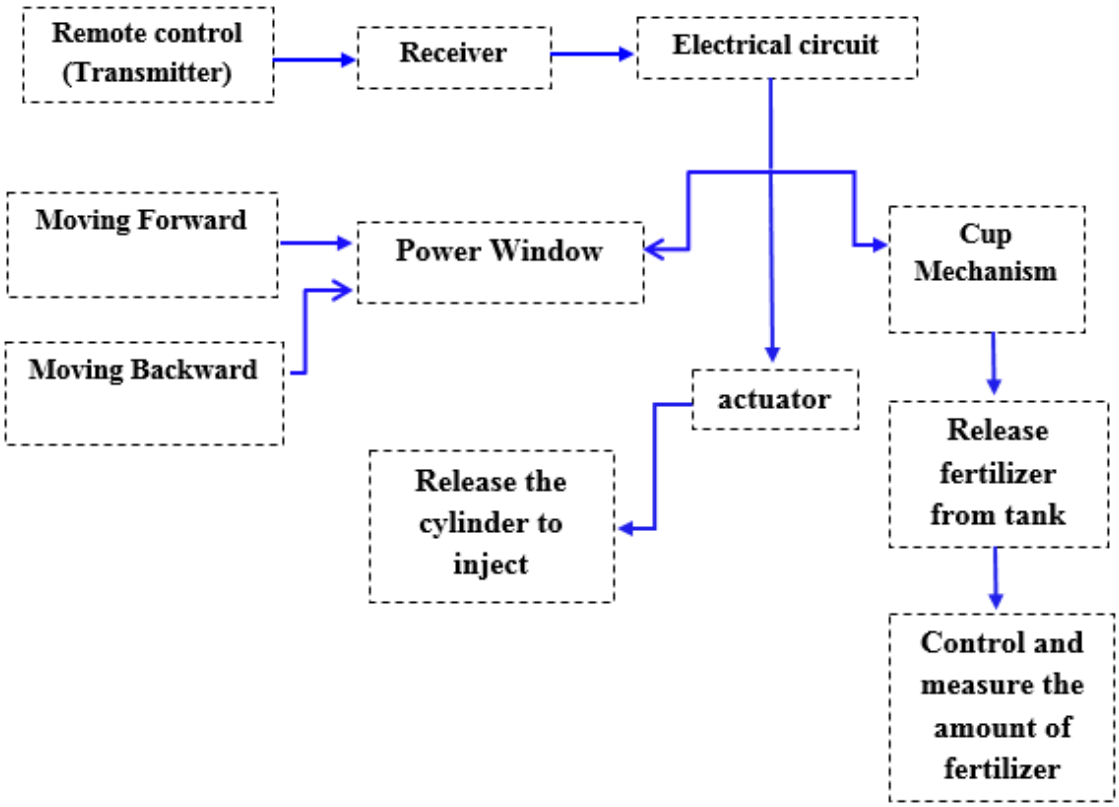

Figure 2. Controlling mechanism of MFD

There are two controlling methods in the dispensing mechanism as shown in Figure 2. The first controlling method is to send RF signal from transmitter to receiver, while the second controlling method is to execute the signal. Radio Frequency of 2.4 GHz is used in this project that is stated at the remote control and receiver. Power window and actuator is used to execute the signal to control the movement of the robot. The details of the triggering mechanism are explained in the next paragraph.

When the limit switch 1 on it will trigger the relay 1 to normally open so that no current is activate the motor and at the same it will trigger the relay 2 to normally close so the current will activate the motor. When the limit switch 2 on it will trigger the relay 2 to normally open so that no current is activate the motor and at the same it will trigger the relay 1 to normally close so the current will activate the motor.

The remote control, control the robot to transmit frequency from transmitter to the receiver. The receiver receives the frequency and transfers the data to the electrical circuit. The electrical circuit will activate the servo motor and limit switch. The power window will control the movement of robot when moving forward or backward. The servo motor will control the fertilizer that want to be release from tank. The servo motor controls the cylinder that injects fertilizer into the soil. The servo motor releases the cylinder that contains fertilizer into the soil. The cup mechanism controls the flow and measure the fertilizer.

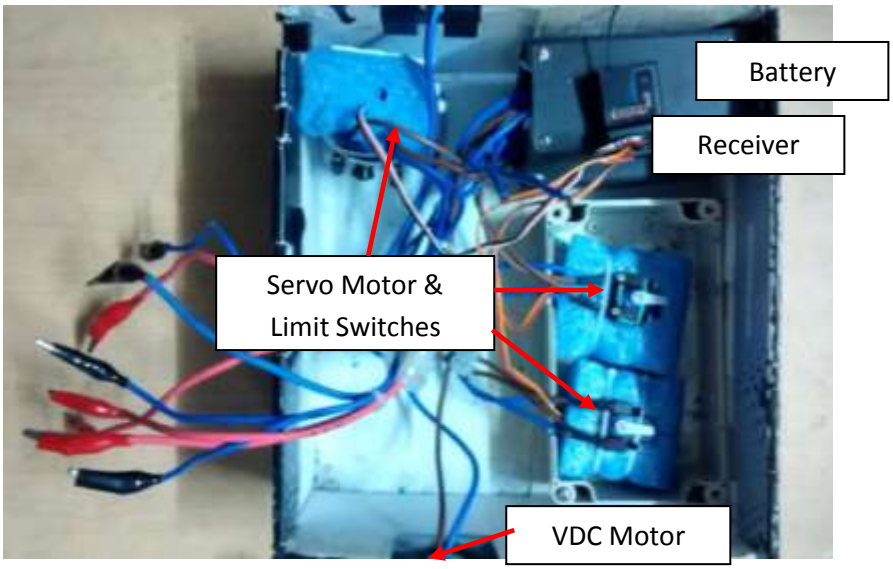

Figure 3. Assembling electronics components of MFD

Figure 3 shows the control box consist of battery, servo motor, limit switches and receiver.

2. Design of Project

The design of the prototype as depicted in Figure 4 - 6. On top of the robot is the fertilizer tank; while at the bottom of the tank is the fertilizer sorting mechanism as referred in Figure 4 and Figure 5. Figure 6 shows the injector is attached at the back of the robot; hence the control box is placed at the base of the robot. The robot is back wheel driven and attached with 2 power window motors.

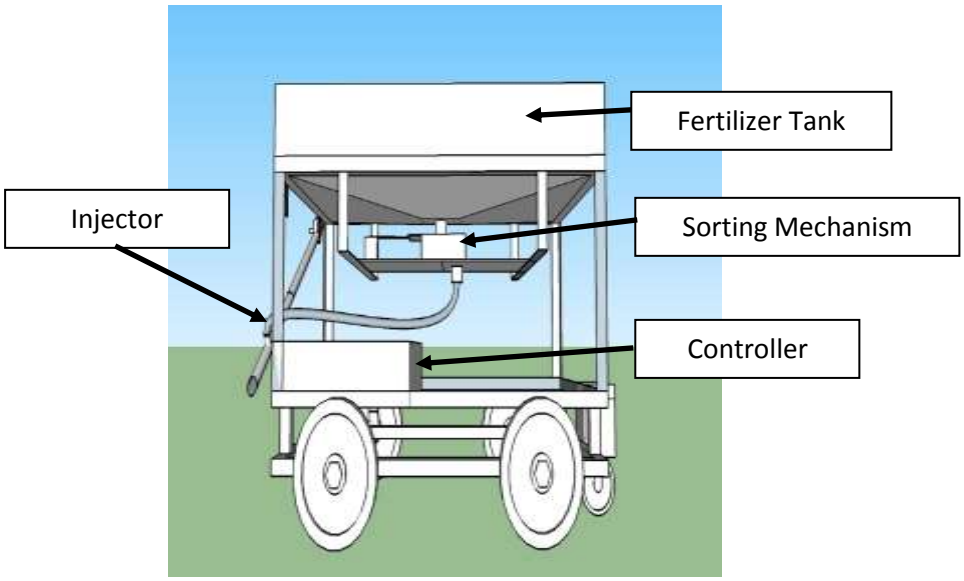

Figure 4. Side View of the Design

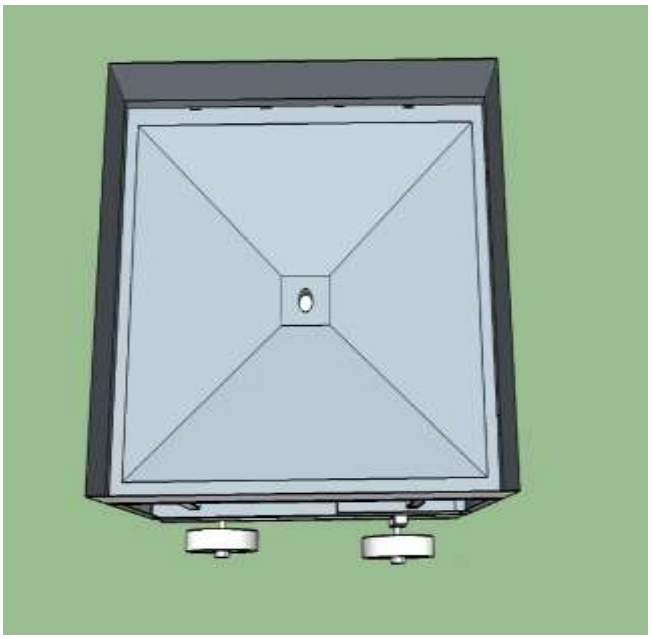

Figure 5. Top View of the Design

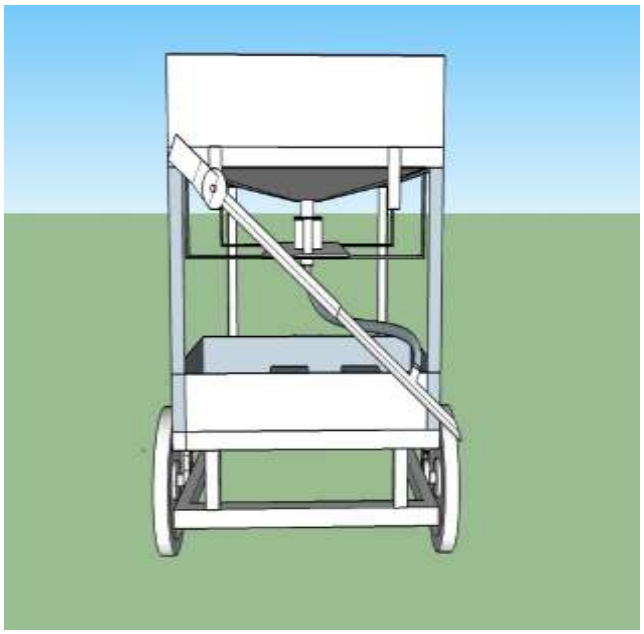

Figure 6. Front View of the Design

Figure 7 shows the prototype of MDF. Two front wheels have taken out and replaced with a multi-axis wheel in front of the MDF to make the robot easier to turn 360 degree. While, Figure 8 shows the side view of MDF machine with attachment of a multi-axis wheel in the front.

Figure 7. Prototype of MDF

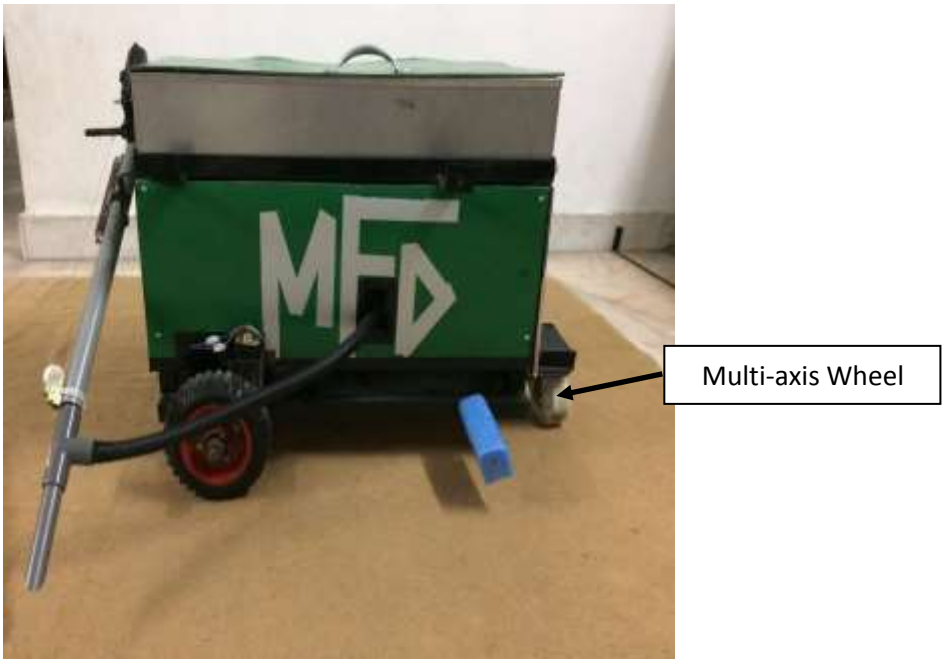

Figure 8. Side View of MDF Prototype

4. Results

Test run has been done on MDF and compared with two manual dispensing methods that are conventional manual dispensing and manually using Solid Fertilizer Dispensing Machine (SFDM) as listed in Table 1. The results show that Solid Fertilizer Dispensing Machine (SFDM) use only 6s to dispenser the fertilizer while, MDF needs 10s. However, the time taken only comprised of dispensing process but not inclusive of trailing from one plant to another plant. Fertilizer tank of 25 kg is heavy and it will increase the trailing time from plant to another plant, hence MDF can carry almost 65 kg of fertilizer, it is 50 kg more than SFDM for the farmer that will reduce the energy used. Thus by normalizing to 25kg for MDF, the time taken for dispensing for each pineapple plant is 3.8s compared to SFDM 6s.

Table 2 shows that the area of the farmer needed to travel is 1 acre (10 000 pineapple plants) according to the owner of the pineapple estate. Manual dispensing method

use walk to travel while MDF is using remote control to control motor to travel. An approximately 3150 meters have to be travelled by farmer or robot to dispense 10 000 pineapple plant since the pineapple estate has 50 rows of pineapple plant in 1 acres where 1 row is 63 meters length. In this case, the battery supply to the MDF needs to charge after 1 acres of travelling. MDF also tested to move at rough surfaces such as mud road, inclined pavement and stoned pavement. Thus, MDF can move on all the rough surfaces mentioned.

Table 1. Time taken to Dispenser Fertilizer

No.	Dispensing Mechanism	Time (seconds)
1.	Manual (25 kg)	13 s
2.	MDF (65 kg) *(normalizing to 25 kg)*	(10 s) *(3.8 s)*
3.	SFDM (25 kg)	6 s

Table 2. Comparison area covered by MDF

No.	Dispensing Mechanism	Travelling Method	Area
1.	Manual	Walk	1 acres (4046.68 m^2)
2.	MDF	Mobile Robot	Charging battery after 1 acres
3.	SFDM	Walk	1 acres (4046.68 m^2)

5. Conclusion

Mobile robot has been innovated to replace the manual fertilizer dispensing method. Current mobile robot can carry up to 65 kg for each dispensing and cover as far as 1 acre of the pineapple plantation. An estimation of 16.7 hours needed by SFDM whereas MDF needed 10.6 hours to dispense fertilizer for 1 acre pineapple estate. This is showing by using MDF, fertilizer dispensing time can be saved 6.1 hours or improvement by 36.5% compared to walking method. Using robot, automated device or modern agriculture machine can improve the agriculture fertilizing process and save time, hence for future recommendation 6 injectors can be installed instead of 1 to improve the efficiency of fertilizer dispensing.

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