1. Arman Hadi AZAHAR[1], 2. Mohamad Haniff HARUN[1], 3. Muhammad Izzat Zakwan Mohd ZABIDI[1], 4. Md Ashadi Md JOHARI[1], 5. Adila Aida AZAHAR[2], 6. Mohd Nurul Al Hafiz SHA'ABANI[3]

Universiti Teknikal Malaysia Melaka (1)
Universiti Sains Malaysia (2)
Universiti Tun Hussein Onn Malaysia (3)
ORCID: 1. 0009-0000-1020-0477; 2. 0000-0001-8759-8196; 3. 0000-0002-2461-7342; 4. 0000-0001-8793-5236; 5. 0000-0001-5092-8681; 6. 0000-0002-1801-1424

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Performance Evaluation of Paddy Seed Distribution using Cylindrical Seed Container Spreader Robot

***Abstract**. Agriculture is evolving in lockstep with technological advancements. Agricultural activities are facilitated by its development. This paddy planter is utilised in paddy farming where paddy seeds are employed. Rice cultivation has historically impacted cultivation lengths, resulting in an excess of used paddy seeds, and cultivation processing has historically consumed the majority of manpower requirements. As a result, increased emphasis should be placed on automating these procedures in order to reduce manpower requirements in rice cultivation and hence improve profitability, and There are numerous dangers associated with conventional rice production. The purpose of this project is to address this issue. Additionally, this project reduces the leasing cost of the existing machine, which has a significant maintenance cost. This robot is controlled by a remote control. When the engine is driven by a paddy storage container and the tyres are concurrently moved, the paddy seeds will fall out of the storage container.*

Streszczenie.** Rolnictwo rozwija się wraz z postępem technologicznym. Jego rozwój ułatwia działalność rolniczą. Ta sadzarka do ryżu jest wykorzystywana w uprawach ryżu, gdzie wykorzystuje się nasiona ryżu. Uprawa ryżu w przeszłości wpływała na długość uprawy, powodując nadmiar zużytych nasion niełuskanego, a przetwarzanie uprawy pochłaniało w przeszłości większość zapotrzebowania na siłę roboczą. W rezultacie należy położyć większy nacisk na automatyzację tych procedur, aby zmniejszyć zapotrzebowanie na siłę roboczą przy uprawie ryżu, a tym samym poprawić rentowność. Z konwencjonalną produkcją ryżu wiąże się wiele zagrożeń. Celem tego projektu jest rozwiązanie tego problemu. Dodatkowo projekt ten zmniejsza koszt leasingu istniejącej maszyny, która wiąże się ze znacznymi kosztami utrzymania. Robotem tym steruje się za pomocą pilota. Gdy silnik napędzany jest przez pojemnik do przechowywania ryżu i jednocześnie poruszane są opony, nasiona ryżu wypadną z pojemnika do przechowywania.* (Ocena wydajności dystrybucji nasion ryżu przy użyciu robota rozsiewającego cylindryczne pojemniki na nasiona***)

Keywords: paddy seeds, receiver/transceiver, Arduino, paddy field and traditional rice cultivation
Słowa kluczowe: nasiona ryżu, odbiornik/nadajnik, Arduino, pole ryżowe i tradycyjna uprawa ryżu

Introduction

After industry and services, agriculture is a critical sector for Malaysia's economic growth [1]. Since the 1960s, agriculture has played a critical role in producing food to a growing population, decreasing unemployment through export revenues, supplying raw materials to agro-industrial production, and etching [1]. The Plant Statistics are depicted in Figure 1.

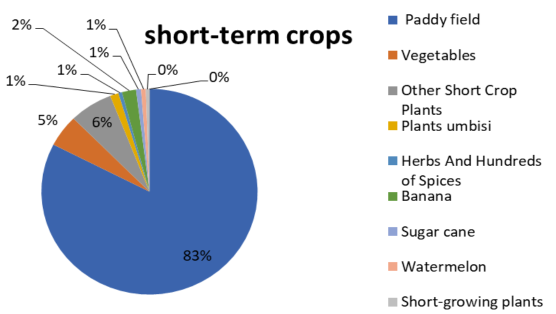

Fig. 1 Plant Statistics

Paddy growing has provided employment for 150,000 people in Malaysia. Those participating relied entirely on paddy cultivation as a source of income. Paddy cultivation has provided employment for 150,000 people in Malaysia [2]. Those participating relied entirely on paddy cultivation as a source of income [2]. In this country, there are two types of paddy: wetland paddy (paddy field) and dry land paddy (upland and lowland). Wetland Paddy is paddy that is grown on waterlogged fields, whereas Dry Land Paddy is paddy that is grown on dry terrain, whether highland or lowland, and relies entirely on rainfall to meet its water requirements. However, only wetland paddy is cultivated since it is particularly desirable for agriculture and is well-suited to farmed plains and fertile deltas. As we learned, Kedah, Kelantan, Perlis, Terengganu, and Perak all have a variety of rice crops. As a result, Kedah's and Kelantan's plateaus are already known as rice paddy [3]. The Wetland paddy is depicted in Figure 2, whereas the Dryland paddy is depicted in Figure 3.

Fig. 2 Wetland paddy

Fig. 3 Dryland paddy

Paddy is Malaysia's third most extensively grown crop, behind oil palm and rubber. Paddy was cultivated on 679,239 hectares in 2014, including those planted twice a year [4]. Rice has two distinct seasons: seasoned and unseasoned. The Main Season is the best period to grow paddy without relying exclusively on irrigation. For administrative purposes, the primary season is defined as the period from 1 August to 28/29 February of the following year, when paddy planting begins. The dry season is considered the off-season, and paddy planting is normally done through irrigation. Off-Season is defined as the period between 1st Mac and 31st July of the year when paddy planting begins for administrative purposes [4]. Malaysia, on the other hand, has a big paddy field that cannot support the population, necessitating the import of rice from other nations. Fig. Present a pie chart depicting rice imports by country.

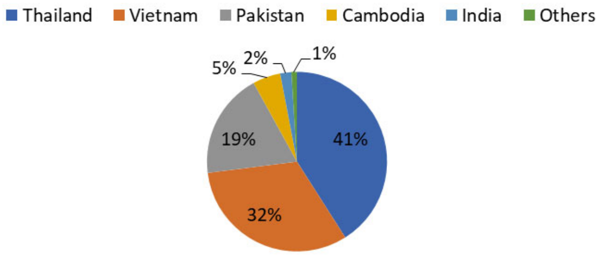

Fig. 4 Percentage import of rice by country

Related works

Additionally, the Direct Seeds mist blower is a technology for spraying pre-fertilized rice straight into the field at a rate of 120-150 kg/ha in a single day [3]. The seeds are first submerged in clean water for 24 hours, then dried and stored in a dim (shady) location until the eyes shatter (12-24 hours). Maintain a uniform distribution of seeds throughout the field. Seeding operations were conducted using gasoline or diesel engines [3].

A manually driven drum seeder model with optimised variables was constructed for performance evaluation [5]. The seed drum, main shaft, ground axle, floats, handle, and furrow openers are all included in the machine. The hyperboloid is used to create the seed drum (truncated cone). The cone slopes facilitate seed flow to the metering holes [6]. Variability in seed discharge should be minimal at the moment to ensure a consistent seed flux from the tank. To accomplish the aforementioned purpose, baffles of varied configurations were placed between the drum's holes in order to minimise the bridging effect while maintaining flow uniformity [7]. The wheel diameter of 150–180 cm, the row spacing of 20–25 cm, and the grain hole size of 10–8 mm all promote mechanical weeding by weeders [8].

The rice planting machine operates on the basis that when the crank is manually twisted, it continues to rotate through the chain and then to the main shaft. The main shaft is utilised to rotate the planter arm plate using a crank plate mechanism. Move up the arms to collect the rice seeds, and then down the functions to plant them. The combustion engine functions as a secondary drive system, taking the place of the manual crank drive and making it easier for the operator to operate the planting machine [9].

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Direct seeding is stitched simultaneously with fertiliser using an air-assisted strip seeder. The injection port of this system has been relocated to the right and left, and twin pairs of spray systems have been alternately mounted to spray seeds and fertiliser. A labor-saving and effective growing procedure has developed into a system that utilises air-assisted strip sowing to apply fertiliser simultaneously [2]. Due to the theoretical field capacity of 2,34 ha / h and the actual field capacity of 0,84–1,37 ha / h over the same period, unit field production was 35,9–58,5% greater. The time required to turn the seeder onto the field, fill it with seed, inspect it prior to seeding, and resolve operational problems accounted for less than 60% of the theoretical potential for successful field capacity.

The labour requirements for modern transplantation methods are decreased by 50%, and the yield is comparable to or greater than that obtained in the traditional system [10]. Traditional transplantation techniques require labourers to spend considerable time entering the remote field, lowering their work productivity [11]. A single farmer could plant three acres in less than half a day using the current approach, whereas it takes an average of 15-20 labourers half a day to accomplish a one-acre transplant operation using the conventional method [6].

Hardware conFiguration

System Construction

The entire construction of the created paddy planter robot is depicted in Figure 5, which was previously published in a publication. The design is carried out with SolidWorks software, and the paddy planter robot is developed from the design. Table 1 details the specs of the paddy planter robot. The integrated control design is depicted in Figure 6.

Fig. 5 Paddy Planter Robot

Table 1. Paddy planter robot

Item	Specification
Robot dimension	77 cm x 48.2 cm x 48.2 cm (L x W x H)
Robot weight	3 kg
Drive system	4-wheeled drive system
Power supply	12V
Ground clearance	20 cm from the ground

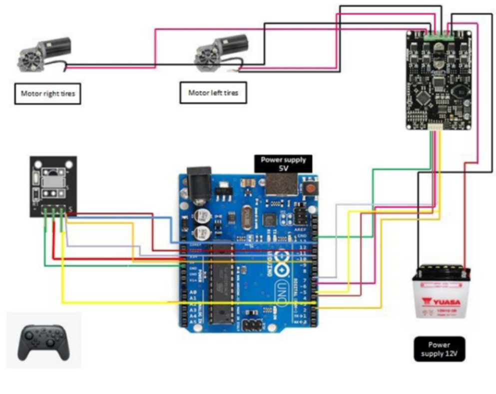

Fig. 5 Paddy planter pobot control design

Navigation system

Arduino is a powerful microcontroller board that is frequently used in robotics and other electronic applications. It is an open-source platform for creating a new electronic workmanship since it has a large community of programmers who have shared their masterpieces via online forums. A tech engineer who specialises in software or is new to electronics will theoretically improve significantly. Numerous electronic devices, such as alarms, GPS systems, motors, cameras, and even cell phones, can communicate efficiently with the board. The Arduino Uno system used to develop this project is depicted in Figure 7.

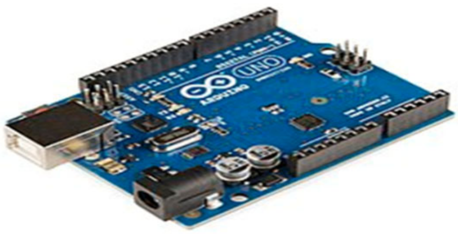

Fig.7 Arduino Uno

Motor drivers serve as a link between control circuits and motors. While the controller operates on low-current signals, the motor requires a large current. Thus, the motor drivers' role is to transform a low signal to a higher signal capable of controlling a motor. Figure 8 illustrates the Smart Drive Duo-10 that was utilised to construct this project.

Fig. 8 The Smart Duo-10

Additionally, the NRF24L01 is a wireless transceiver module that is utilised for data transmission and reception. A frequency controller, a shocked bursting processor, a power amplifier, a crystal oscillator, and a demodulator comprise this transceiver component. This RF NRF24L01 module has a 1000 metre range. It operates between -40°C and 85°C and is stored between 40°C and 125°C. Figure 9 illustrates the NRF24L01 receiver/transceiver utilised in this project.

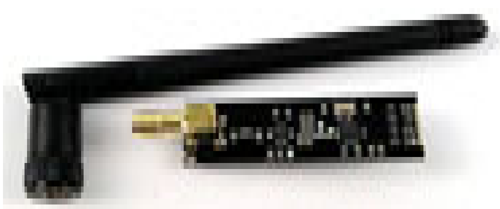

Fig. 9 Receiver/Transcevier

The block diagram in Figure 10 depicts the general configuration of the project's pieces, including the microcontroller and I/O units. The power supply is connected to the Arduino Uno microcontroller device utilised in the project. The receiver is used to detect a remote control signal. It was used to move the right and left tyre motors, as well as to move the motor to extract the paddy seeds, ensuring that the paddy seeds were identical.

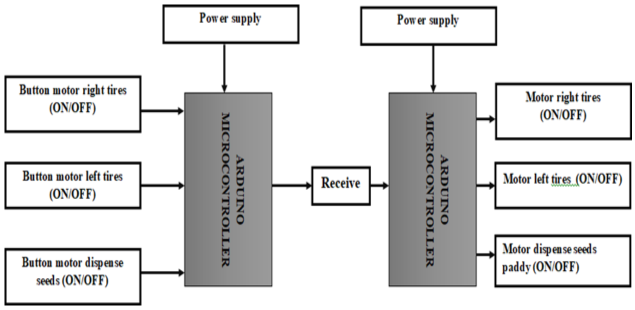

Fig. 10 Hardware Block Diagram

Operation Flowchart

While the microcontroller is executing the navigation system's condition. As the paddy planter robot must be capable of doing both actions concurrently, the programming code sequence plays a crucial part in the proposed project. The integration of projects is depicted in Figure 11, and the flowchart for entire projects is depicted in Figure 12.

Fig. 11 Illustration of Project Integration.

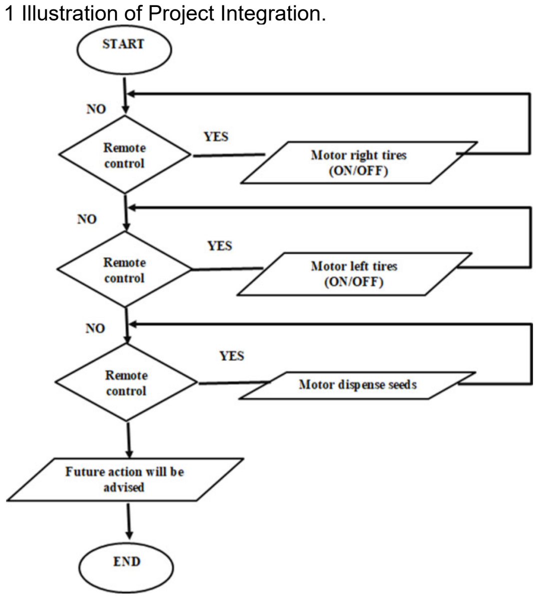

Fig. 12 Flowchart for whole projects.

Experimental setup

Mechanical design procedures are utilised to create the project's components. The paddy field machine experiment utilised two drum seeds for every four rows of rice seeds sowed. Apart from that, the robot is propelled by four tyres. Two 19-inch tyres are linked to the motor to propel the Paddy Planter Robot, while two 6-inch tyres assist the robot's movement. The wiper motor was utilised to drive the right and left tyres and remove the paddy seeds for the paddy planter robot project, as shown in Figure 13. The remote control transmits a signal to the receiver that activates the power window motor, which enables the driver to effortlessly rotate the right and left tyres and remove paddy seeds. This motor driver's primary source of power is a battery. It provides 12 volts of electricity to power the wiper motor.

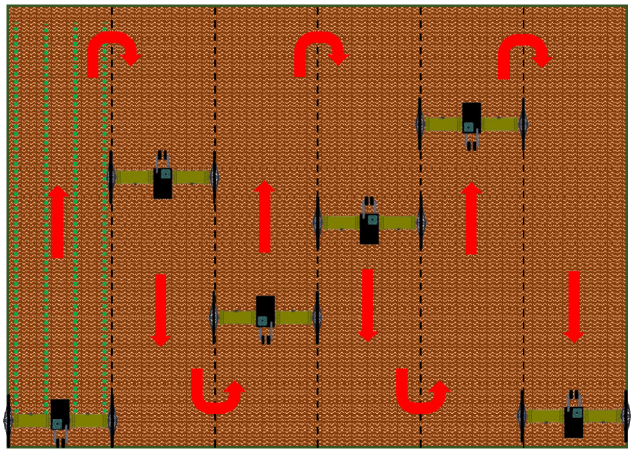

Fig. 13. Experimental floor layout in paddy field.

Experimental results

The purpose of this experiment is to determine the distance between seeds. It demonstrates that utilising the Paddy Planter Robot is more organised than the conventional technique, even though the distance is not 100% exact due to the factor of seeds falling from the drum seeder. However, it is better than the traditional method, which is disorganised and scattered. Table 2 illustrates the seedshill to hill distribution of paddy seeds.

Table 2. Seeds Hill to Hill for Paddy Seeds.

No.	Distance seeds hill to hill (inch) d.		
	Left drum seeds	Seeds hill to hill Between left and right drum seeds	Right drum seeds
1	 d = 9 inch	 d = 9 inch	 d = 8.8 inch
2	 d = 9 inch	 d = 9 inch	 d = 9 inch
3	 d = 8.8 inch	 d = 9 inch	 d = 8.8 inch
4	 d = 9 inch	 d = 8.8 inch	 d = 9 inch

As a result of this experiment, the maximum distance over which this robot paddy planter can be controlled is 1000 metres without encountering any obstructions. The receiver/transceiver signal connection is shown in Table 3.

To determine the seed count and determine the walking pace for pulling the seeder in field conditions, the seeder was run at five different speeds and three drum fillings. The seeders were calibrated for five distinct speeds: 0.5 km/h, 0.7 km/h, 1.0 km/h, 1.3 km/h, 1.5 km/h, and for starting drum fill percentages of full, half, and quarter. The mean number of seeds per hill is presented in Table 4 for various velocities and drum fill levels.

Table 3. Receiver/Transceiver Signal Connection.

No.	Distance (m)	Signal Status
1	100	Connect
2	200	Connect
3	300	Connect
4	400	Connect
5	500	Connect
6	600	Connect
7	700	Connect
8	800	Connect
9	900	Connect
10	1000	Connect

Table 4. The Average Number of Seeds Per Hill at Different Speed and Drum Fill Level.

Speed (km/h)	The average number of seeds per hill at a different speed and drum fill level			The accepted number of seeds
	Full	Half	Quarter	Minimum to maximum
0.5	5	6	7	3 - 7
0.7	5	6	7	
1.0	4	6	7	
1.3	4	5	6	
1.5	3	5	6	

The goal of this experiment was to compare the entire cost of paddy cultivation and the quantity of labour required in three different approaches: conventional methods, paddy planter robots, and paddy cultivation machines. This project can run at a range of 37m x 22m on a single charge of the robot's and remote control's batteries. The cost of a single charge for both batteries is RM 10.00. Five times the size of 37m x 22m equals one acre; charging the battery for one acre costs RM 50. The cost of paddy planting and paddy planting personnel is depicted in Figure 13, and the cost of paddy planting and paddy planting manpower is depicted in Table 5.

Table 5. Cost of Paddy Planting and Paddy Planting Manpower.

Area (Acre)	Cost of paddy planting (RM)			Paddy Planting Manpower (Labour)		
	Traditional	Robot	Machine	Tradional	Robot	Machine
1	350	50	500	1	1	1
2	700	100	1000	2	1	1
3	1050	150	1500	3	1	1
4	1400	200	2000	4	1	1
5	1750	250	2500	5	1	1

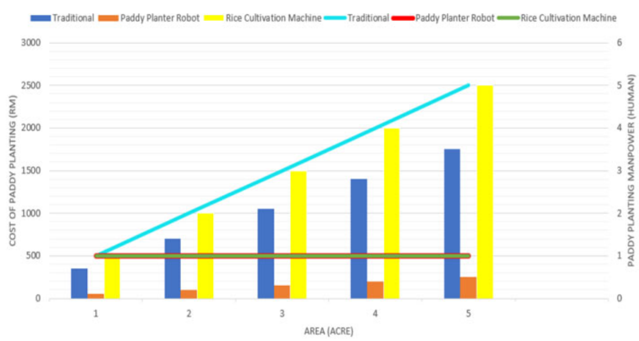

Fig. 14. Graph of Cost of Paddy Planter and Paddy Planting Manpower

The danger of accidents or modifications in the rice growing process varies according to the variety utilised. The paddy cultivation method employing the Paddy Planter Robot does not require workers or labourers to be present in the paddy field; they must be outside the planting location to sow paddy seeds. In comparison to traditional cultivation, the seeds are sown remotely by a paddy planter robot, and Rice Cultivation Machine must be present in the rice field during the paddy cultivation process, resulting in a larger risk of accidents or injuries. Table 6 compares the risk associated with paddy planting.

Table 6. Comparison of Paddy Planting Risk.

Type of paddy planting	Paddy planting risk
Traditional	High risk
Paddy Planter Robot	Lower risk
Rice Cultivation Machine	Medium risk

Conclusions and future tasks

This project discusses the construction of a paddy planter robot designed exclusively for rice seeds. The project's primary objectives are to assist farmers in increasing their paddy output and growth efficiency through the control of attack pests, grasses, aeration, and pollination.

Additionally, the work of fertilising is more convenient due to the presence of a route between the paddy trees. According to Tables V and VI, the robot can also reduce risk for farmers by avoiding exposure to pesticides and fertilisers, preventing farmers from slipping into mud during the paddy planting process, and lowering operational costs.

Acknowledgment

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Authors*: Arman Hadi Azahar, Fakulti Teknologi dan Kejuruteraan Elektrik, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia, E-mail: arman.hadi@utem.edu.my; Mohamad Haniff Harun, Fakulti Teknologi dan Kejuruteraan Elektrik, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia, E-mail: haniff@utem.edu.my; Muhammad Izzat Zakwan Mohd Zabidi, Fakulti Teknologi dan Kejuruteraan Elektrik, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia, E-mail: izzat.zakwan@utem.edu.my; Md Ashadi Md Johari, Fakulti Teknologi dan Kejuruteraan Elektronik dan Komputer, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia, E-mail: ashadi@utem.edu.my; Adila Aida Azahar, School of Mathematical Sciences, Universiti Sains Malaysia, Malaysia, E-mail: adilaazahar@usm.my; Mohd Nurul Al Hafiz Sha'abani, Center of Diploma Study, Universiti Tun Hussein Onn Malaysia, Malaysia, E-mail: nhafiz@uthm.edu.my.*

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