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# The Use of Intelligent Systems for Determining Planting Distance on Corn and Soybean Planters and Remote Monitoring

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ABSTRACT

Indonesia is a country that heavily relies on corn and soybeans, making increased cultivation vital for achieving high productivity. Proper planting distance and hole depth are crucial factors to ensure uniform growth and optimize land use. Planting distances that are too tight lead to non-uniform growth due to root competition for nutrients, while excessively wide spacing reduces productivity by leaving land underutilized.This study aims to address these challenges by developing a planting tool using a backpropagation artificial neural network. The HC-SR04 ultrasonic sensor detects seed capacity in the container, while the TCS3200 sensor identifies seed color. Data is processed by an Arduino Mega microcontroller, with an LCD displaying information and the Mit App Inventor application enabling remote monitoring. A DC motor serves as the wheel and planter driver, and a servo motor handles seed rationing. Testing showed promising results. For corn seedlings, the average planting distance was 23.6 cm, with a hole depth of 2.18 cm. For soybean seedlings, the average planting distance was 35.47 cm, with a hole depth of 2.04 cm. This tool demonstrates potential to enhance planting efficiency and uniformity, contributing to improved agricultural productivity

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## INTRODUCTION

Maize and soybean are still strategic commodities after rice, because in some areas maize and soybean are still the second staple food after rice (Tangkilisan et al., 2013). Maize also has an important meaning in the development of industry in Indonesia because it is a raw material for the food industry and the animal feed industry, as well as Soybeans are widely used as raw materials for making foods such as tempeh and tofu, but the need for soybeans still has to be imported (Bantacut et al., 2015). The development of the food processing industry in Indonesia will increase the need for corn and soybean. To obtain high productivity in growing corn, planting distance is one of the factors that play an important role (Magfiroh et al., 2017). Planting distance that is too tight causes corn and soybean plants to grow non-uniformly due to greater root competition for food between each other (Bolly, 2018). However, if the spacing is made too wide, low productivity will be obtained because there is still land area that is not utilised (Yudianto et al., 2015).

Therefore, uniformity of spacing and hole depth must be considered in the process of maize planting (Antonisfia et al., 2022). Agricultural land in Indonesia is generally patchy and very few have large areas of privately owned land, so planting corn and soya is mostly done manually using tugal. The tugal process is the making of planting holes using a wooden stick, after which the seeds are inserted into the holes using human labour (Nopriandy F ,2018). The seed planting stage requires considerable time and labour at a significant cost. Until now, the existing planting tools for corn and soybean seeds on the market are intended for large agricultural areas of up to thousands of hectares and soil conditions that are different from agricultural land in Indonesia. The differences in the characteristics of existing planting tools cause Indonesian corn and soybean farmers to not dare to use existing corn and soybean planting tools.

Based on these problems, a corn and soybean planting tool was designed to determine the distance and depth of planting holes. This tool can also overcome planting problems such as labour requirements and lack of precision in planting. Related research has been done before, using round iron pipes, hollow pipes, and iron plates Safridatul, et al made a peanut seed planting tool (Audah et al., 2017) the results showed the tool could plant by opening the soil two lanes but the tool could not determine the size of the planting distance and the depth of the groove opener to suit the needs of peanut seeds. Using the same concept Sorowako, et al developed a rice planter with a manual drive system and a combustion motor (Ristiawan et al., 2018)the results showed that the rice planter machine could plant with the plug method.

Corn seed planting and watering tools were developed by Sianipar, et al (Sianipar & Fatoni, 2019). In this study, the watering process used 2 types of watering tools, namely using a pump and not using a pump, but this tool only works well on soil that has been processed and cannot determine the size of the planting distance. The corn and soybean planting tool designed in this study can detect the capacity of corn and soybeans so that seed rationing works well. Using a planting distance of 20-22 cm with the expectation of seed allotment of 1 seed per hole at a depth of 2.5-5 cm. To form a hole with a planting distance of 20-22 cm with a depth of 2.5-5 cm, the seeding process is carried out using a tugal eye as a planting hole maker and left and right motor wheels as a tool drive to determine the distance of the seed fall.

The use of this maize seed planting tool is expected to improve the performance of maize farmers so that they can achieve high work efficiency and effectiveness. In addition, the popularization of this tool is intended to increase the enthusiasm of the Indonesian population, especially corn farmers in the context of agricultural intensification by reducing production costs to achieve maximum profit.

## LITERATURE REVIEW

Corn plants, known as Zea mays L., are monocotyledons (single-seeded) and belong to the grass family (Hidayah et al., 2022)(Sidharta et al., 2024). Corn plants are seasonal and have a life cycle of approximately 3 months**.** The corn kernel (caryopsis) has the ovary wall or pericarp fused with the seed coat or testa, forming the fruit wall. The corn kernel consists of three main parts: endosperm, pericarp, and embryo (Khairiyah et al., 2017). The starch in the endosperm is composed of anhydroglucose compounds, primarily consisting of two types of molecules: amylopectin and amylose**.**

Artificial Neural Networks (ANNs) are widely used in various agricultural fields, such as for detecting plant diseases (Susanti, Nofendra, et al., 2023) and processing food materials (Susanti et al., 2022). Artificial Neural Network (ANN) is an information processing system that has characteristics similar to biological neural networks (BNN). Each input signal for receiving data on each connection has a weight, and each neuron has a threshold value and an activation function. This weight influences the intensity of the signal on a connection. A neuron will only transmit a signal if it exceeds the neuron's threshold value.

The activation function in Artificial Neural Networks (ANNs) operates on the same principle as synapses in Biological Neural Networks (BNNs) (Wibowo et al., 2017). The activation function processes the input data into output data (Ihsan, 2017)(Pustaka DWT Pmbahasan.Pdf, n.d.). ANNs are one of the most widely used techniques in artificial intelligence (AI) (Kim et al., 2014) and and using sensors as the dataset for ANN (Susanti, Aidha, et al., 2018)(Susanti, Zaini, et al., 2023). ANNs consist of neurons and computational elements called nodes (Dixit & Londhe, 2016).

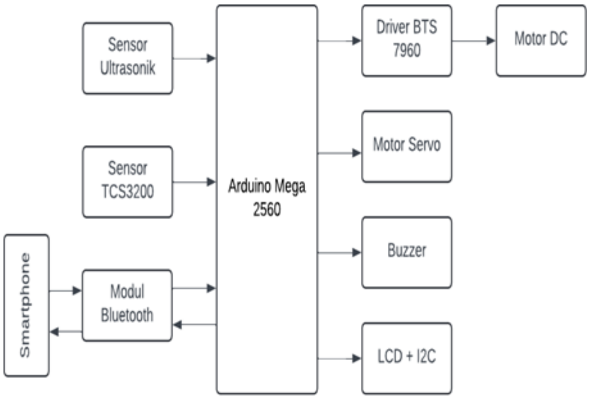
## METHODOLOGY

### *Research Methodology*

The method used in this research is the manufacture of prototype tools starting from literature study, system design, hardware design, software design, hardware testing, software and analysis of test results.

Perancangan Sistem

The design of this system consists of hardware design and software design. The block diagram of the tool is shown in Figure 1. HC-SR04 ultrasonic sensor is used to detect the capacity of seeds in the seed container. The TCS3200 sensor is used to determine the type of seed based on colour. The Arduino Mega microcontroller functions as the overall system controller to perform data processing to control all blocks of the system so that the system can work synchronously. To control the PWM and the direction of rotation of the DC motor, the BTS 7960 Driver is used. 3 DC motors function as drivers. left and right wheels of the tool. and the drive of the planter / hole wheel. The servo motor is used to adjust the rotation of the seed rationing in a container. LCD and App inventor are used to display information on the tool and the buzzer is used as an indicator on empty containers.

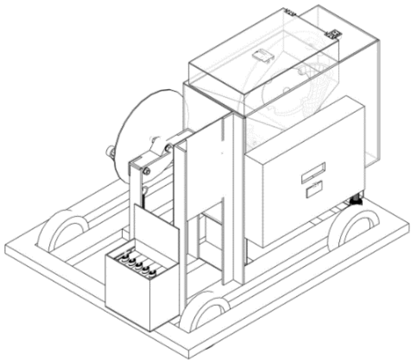



Picture 1. Blockdiagram of the Device

The electronic circuit in this tool consists of a series of HC-SR04 sensor, TCS3200 sensor, BTS7960 motor driver and DC motor, servo motor, LCD and I2C, Bluetooth HC-06 module, Buzzer shown in Figure 3.

The HC-SR04 sensor is used to measure the distance between objects (Annabil et al., 2024) which is connected to Pins 22, 23, 24, 25 of the microcontroller. The TCS3200 sensor is connected to Pins 4, 5, 6, 7, 8 of the microcontroller. The BTS7960 motor driver functions as a driver to regulate the direction of rotation of the DC motor and also the strength of the DC motor rotation. The BTS7960 motor driver is capable of handling an input voltage of 6-27 V DC with an input current of 43 amperes (Yapriono & Dewanto, 2015) connected to pins 9, 10, 11 and 12. The Servo motor is used to adjust the direction of rotation and angle on the seed rationing which is connected to pins 2, 3, and 13 of the microcontroller.

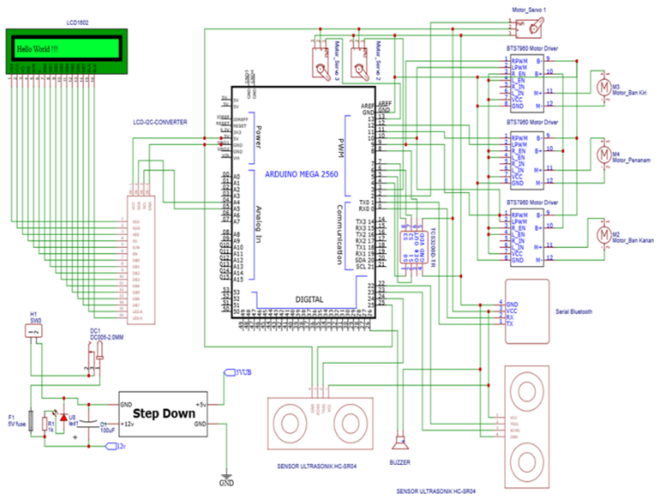
The LCD circuit displays information on the settings and processes of the tool system. The LCD pin is connected to the I2C pin and the I2C pin is connected to the SDA, SCL pin of the microcontroller. The buzzer is used as a container indicator on the corn seed connected to pin 26 and the microcontroller ground pin. Bluetooth HC-06 module as for remote monitoring is connected to padan pins 0 and 1 microcontroller. The pin placement of the whole circuit is shown in table 1. The design of the device can be shown in Picture 2.



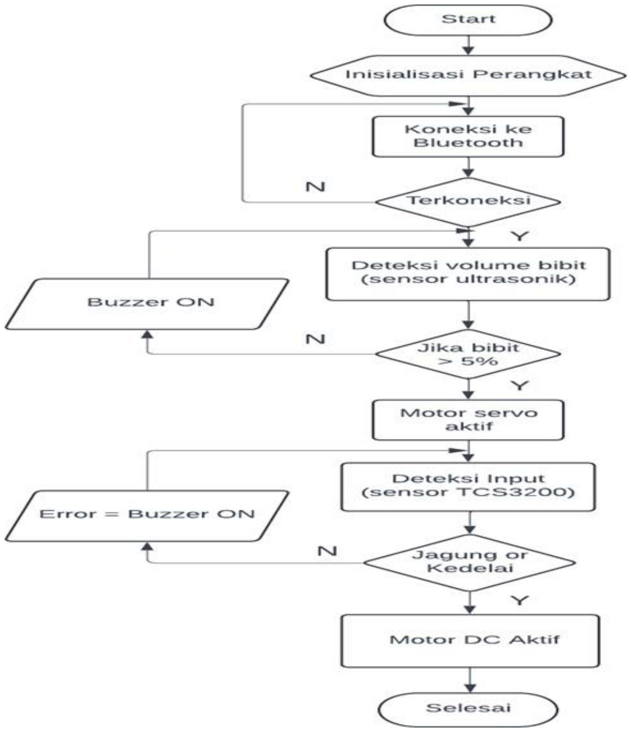
Picture 2. Tool Prototype Design

Table 1. Connections Between Pins on the Arduino Module, Sensor, and LCD

| **Komponen** | ***Pin mikrokontroler Arduino*** | **Keterangan** |
|---|---|---|
| Sensor TCS3200 | 4, 5, 6, 7, dan 8 | difungsikan untuk menentukan jenis benih berdasarkan warna |
| Sensor Ultrasonik HC-SR04 | Echo (0) | *input* |
| | Trigger (1) | *output* |
| *LCD* | SDA, SCL | menampilkan informasi pengaturan dan proses sistem alat |
| Motor *Driver* BTS7960 | 9, 10, 11 dan 12 | mengatur arah putar motor DC |
| Motor servo | 2, 3 dan 13 | mengatur penjatahan benih |
| *Buzzer* | 2 dan ground | sebagai indikator wadah pada benih jagung |
| *Module Bluetooth HC-06* | *0 dan 1* | *Untuk melakukan monitoring jarak jauh* |




Picture 3. Overall Circuitry of the Device



Picture 4. Flowchart of Tool Usage

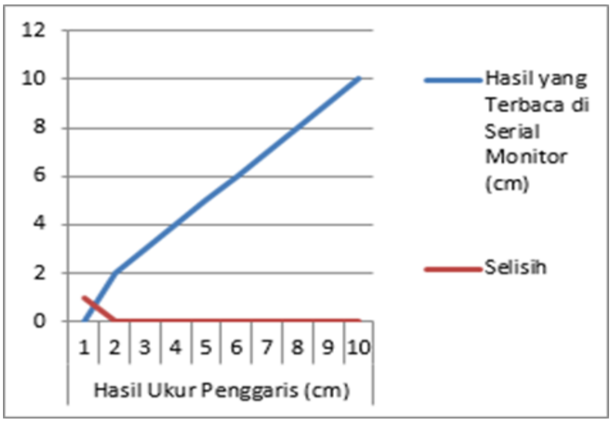
Algorithm of Maize Planting Tool with planting distance control and seed quality based on size can be seen in Figure 4. The process starts from I/O initialisation. 2. Next is the process of reading the HC-SR04 ultrasonic sensor to detect the capacity of the seeds based on the height of the container and the TCS3200 sensor detects the colour of the corn/soybean seeds. After the HC-SR04 ultrasonic sensor will detect whether the seeds are filled > 5% in the container, the servo motor will work to ration the seeds. Then the colour sensor will detect the corn/soybean seeds, if the colour sensor has detected the seeds, the servo motor will be active as a rationer based on the size of the corn/soybean seeds and the power window motor will determine the distance/planting soybeans based on the delay that has been set in the program. If the TCS3200 sensor does not detect corn/soybean, the buzzer will sound and the display will show an error.

## RESULTS AND DISCUSSION

Furthermore, testing the tool aims to determine the advantages and disadvantages of the tools that have been made. The prototype tool is shown in Picture 5.

Picture 5. A Prototype Maize Planter with Control of Planting Distance and Seed Quality Based on Size

Measurements on the HC- SR04 ultrasonic sensor module and Arduino Uno Tests were carried out on the HC- SR04 ultrasonic sensor module to test the performance of the sensor when used to detect the amount of corn seed capacity which was placed on the container lid and measured based on the height distance between the lid and the bottom point of the container and compared to the measuring rod. Based on Figure 6 at the measurement at the 1cm point the error value is 100% which indicates that when the ultrasonic sensor reading is too close there is a distance reading error. And at the measurement at point 2 cm the error value is 10% which is close to the actual measurement value while for distance readings on the ultrasonic sensor at points> 2 cm can be said to be constant to the actual distance based on this the average percentage error obtained in the HC-SRF04 ultrasonic sensor reading is 11%.




Picture 6. Testing Results of HC SRF04 Ultrasonic Sensor

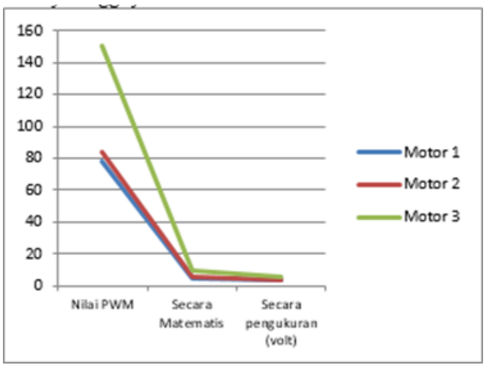
*Testing and Analysis of BTS 9760 Motor Driver and DC Motor*

In this corn planting tool, a motor driver is used on the seedling planting lever. The type of motor used is BTS7960. This DC motor measurement is carried out to check whether the BTS7960 motor driver works according to the system work description and is able to control the pulse width modulation (PWM) and the direction of rotation of the DC motor properly.

As a control, Arduino is used to control the PWM input in accordance with the designed program listing with the PWM output of the DC Motor as follows (i) Motor 1 = Running the rear right wheel with a delay of 3000 ms, (ii) Motor 2 = Running the rear right wheel with a delay of 3000 ms, (iii) Motor 3 = Rotating the mechanical planter / hole with a delay of 2000 ms. The mathematical calculation is as follows:

PWM motor 1 = PWM motor 2 = 110
Input Voltage = 12 V DC PWM(255) = 12 V DC
PWM(80) = (110/255) x 12 V
= 5,18 V
PWM motor 3 = 220 Input Voltage = 12 V DC
PWM(255) = 12 V
PWM(150) = (220/255) x 12 V
= 9,88 V

The measurement results of the DC motor with PWM values are shown in Picture 7.




Picture 7. Measurement Results of DC Motor with PWM Value

Based on the measurements of the three DC motors, the average percent error using equation [13] is 15%. Measurement and Analysis of Corn and Soybean identification using Artificial Neural Network through Matlab.

Measurement in this identification process uses the weight and bias values that have been obtained during the training process. This identification process is carried out during the seed planting process and the colour sensor will detect the seedlings using the JST algorithm. The test results are shown in Picture 8 and Picture 9.


Picture 8. Response Graph of TCS3200 Sensor Identification of Corn

Based on Figure 8, the results of the Maize seed identification process are in accordance with the input given. Then from all the data obtained the success rate of the programme is:

$$\frac{54}{60} \times 100\% = 90{,}16\%$$

The success rate of maize seedling identification is 90.16%.


Picture 9. Response Graph of TCS3200 Sensor Identification of Soybean

Based on Figure 9, the results of the soya seed identification process are in accordance with the input given. Then from all the data obtained the success rate of the programme is :

$$\frac{51}{60} \times 100\% = 83{,}61\%$$

The success rate of soybean seedling identification was 83.61%.

*Overall Testing and Tools*

Overall testing aims to ensure that all components function as expected. The parameters observed in testing the overall working system of this tool can be seen from Table 2 and Table 3.

Table 2. Overall Test Results of Maize Seedlings

| Percobaan ke- | Kapasitas Benih pada wadah (%) | Jarak Tanam (cm) | Kedalaman Lubang (cm) | Jumlah Bibit (buah) | Hasil Deteksi Bibit | Waktu Tempuh (detik) |
|---|---|---|---|---|---|---|
| 1 | 20 | 20 | 2 | 1 | Jagung Betras | 2,1 |
| 2 | 20 | 22 | 2 | 1 | Jagung Betras | 2,2 |
| 3 | 20 | 20 | 2,1 | 2 | Jagung Betras | 2 |
| 4 | 20 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |
| 5 | 20 | 20 | 2,2 | 1 | Jagung betras | 2,2 |
| 6 | 20 | 21 | 2,1 | 1 | Jagung betras | 2,1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | 20 | 41 | 2 | 1 | Kedelai Grobogan | 4,2 |
| 8 | 10 | 20 | 2,1 | 2 | Jagung Betras | 2 |
| 9 | 10 | 20 | 2 | 1 | Jagung Betras | 2,1 |
| 10 | 10 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |
| 11 | 20 | 21 | 2 | 1 | Jagung Lokal | 2,2 |
| 12 | 20 | 20 | 2,1 | 2 | Jagung Lokal | 2,1 |
| 13 | 20 | 40 | 2 | 1 | Kedelai Grobogan | 4 |
| 14 | 20 | 21 | 2 | 1 | Jagung Lokal | 2 |
| 15 | 20 | 21 | 2 | 1 | Jagung Lokal | 2,1 |
| 16 | 20 | 20 | 2,2 | 1 | Jagung Lokal | 2 |
| 17 | 20 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |
| 18 | 20 | 22 | 2 | 1 | Jagung Lokal | 2,2 |
| 19 | 10 | 20 | 2,2 | 1 | Jagung Lokal | 2 |
| 20 | 10 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |

From the results of testing the entire tool, 20 trials were carried out, namely on the capacity of the seeds read by the ultrasonic sensor with a percentage of 20% and 10% of the tool system working. This shows that the performance of the tool runs optimally. In experiments 8,9,10,19 and 20 4 it can be observed that the capacity of seeds read by ultrasonic sensors with a percentage of 10%. In experiments 4,10,17,20 the colour sensor did not detect the seeds, so the motor did not work. In experiments 7 and 13 the colour sensor detected grobogan soybeans, this shows that the sensor does not read according to the predetermined seeds.

And from the results of testing the entire tool, the data obtained is the average planting distance of 23.6 cm. the average depth of the hole is 2.18 cm, the seeds that come out of the allotment are less than 1-2 seeds, the accuracy of the sensor detecting the seeds correctly is 70% and the average planting distance travel time is 2.10 seconds.

Table 3 Overall Test Results of Soybean Seedlings

| Percobaan ke- | Kapasitas Benih pada wadah (%) | Jarak Tanam (cm) | Kedalaman Lubang (cm) | Jumlah Bibit (biji) | Hasil Deteksi Bibit | Waktu Tempuh (Stopwatch) |
|---|---|---|---|---|---|---|
| 1 | 20 | 41 | 2 | 1 | Kedelai Grobogan | 4 |
| 2 | 20 | 20 | 2 | 1 | Jagung Lokal | 2 |
| 3 | 20 | 39 | 2 | 1 | Kedelai Grobogan | 4 |
| 4 | 20 | 40 | 2,1 | 1 | Kedelai Grobogan | 4,2 |
| 5 | 20 | 40 | 2,1 | 1 | Kedelai Grobogan | 4 |
| 6 | 20 | 38 | 2 | 2 | Kedelai Grobogan | 3,9 |
| 7 | 20 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |
| 8 | 20 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |
| 9 | 10 | 42 | 2 | 1 | Kedelai Grobogan | 4,1 |
| 10 | 10 | 38 | 2,2 | 1 | Kedelai Grobogan | 3,8 |
| 11 | 20 | 42 | 2 | 2 | Kedelai Hitam | 4,1 |
| 12 | 20 | 40 | 2 | 2 | Kedelai Hitam | 4 |
| 13 | 20 | 42 | 2 | 1 | Kedelai Hitam | 4,1 |
| 14 | 20 | 0 | 0 | 0 | Tidak Terdeteksi | 0 |
| 15 | 20 | 40 | 2,1 | 2 | Kedelai Hitam | 4,1 |
| 16 | 20 | 41 | 2,1 | 1 | Tidak Terdeteksi | 0 |
| 17 | 20 | 20 | 2 | 1 | Jagung Betras | 2,2 |
| 18 | 20 | 38 | 2,1 | 1 | Kedelai Hitam | 3,9 |
| 19 | 10 | 40 | 2 | 2 | Kedelai Hitam | 4,1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 20 | 10 | 42 | 2,1 | 1 | Kedelai Hitam | 4,2 |

From the results of testing the entire tool carried out 20 times the experiment, namely on the capacity of the seeds read by the ultrasonic sensor with a percentage of 20% of the tool system working. This shows that the performance of the tool runs optimally with the buzzer marked in an inactive state. In experiments 9,10,19 and 20 it can be observed that the capacity of the seeds read by the ultrasonic sensor with a percentage of 10%. In experiments 7,8 and 14 the colour sensor did not detect the seeds, so the motor did not work. In experiments 2 and 17 the colour sensor detected local corn and betras corn, this shows that the sensor does not read according to the specified seeds.

And from the results of testing the entire tool, the data obtained is the average planting distance of 35.47 cm. the average depth of the hole is 2.04 cm, the seeds that come out of the allotment are less than 1-2 seeds, the accuracy of the sensor detecting the seeds correctly is 75% and the average planting distance travel time is 3.81 seconds.

Artificial Neural Networks (ANN) are applied in various aspects of agricultural product processing, including identifying the aroma and quality of coffee products, particularly Arabica and Robusta coffee. (Susanti, Hidayat, et al., 2023)(Susanti, Ressy Aidha, et al., 2018)

## CONCLUSIONS

Based on the results and discussion in accordance with the research objectives, it can be concluded that this tool can be used in planting seedlings with an average planting distance of 23.6 cm and a hole depth of 2.18 cm in corn seedlings and an average planting distance of 35.47 cm and a hole depth of 2.04 cm in soybean seedlings. In testing the HC-SR04 ultrasonic sensor with a distance of 0 - 10 cm, the percentage error is 11% and testing the DC motor obtained the percentage error is 15%. This corn and soya bean planter can identify the type of corn seedlings with an average identification success of 90.16% and soya beans with an average identification of 83.61%.

## FURTURE STUDY

This research still has limitations, so further research is needed related to the topic of The Use of Intelligent Systems for Determining Planting Distance on Corn and Soybean Planters and Remote Monitoring in order to perfect this research and increase insight for readers.

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