Implementation Of Remote Hand Tractor Control Device With The Use Of Solar Panels As Battery Charging

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Abstract – Technological progress has developed very rapidly along with the times. The hand tractor is a form of technological progress in agriculture. The use of hand tractors for processing agricultural land has replaced the function of buffalo in tillage activities because they are far superior in terms of effectiveness and efficiency. The hand tractor with a remote control system using flysky is the latest innovation created with the hope of increasing effectiveness and efficiency, as well as safety. and operator comfort in operating the hand tractor. With the application of solar panels as a charger for remote tractor control devices, this can save the use of electrical energy, this tool has proven successful in trials. Thus, this automated solution has the potential to increase productivity and efficiency in agriculture. System Performance When Using a Tractor. Through testing with 3 trials (6 hours, 7 hours, and 8 hours), the battery voltage remained above 12V. The combination of batteries and solar panels used ensures the system operates well during tractor use.

Keywords: hand tractor, flysky fs-i6 transmitter, servo motor, power window, solar panel, pzem sensor

I. INTRODUCTION

Technological progress is experiencing very rapid development along with the times. Nowadays we encounter various kinds of modern technology which are the result of the latest innovations or modifications of previously existing technology. This technological progress has spread to all activities of human life, whether in the fields of education, offices, industry, security, even agriculture. Technological progress in the agricultural sector can be seen from the large number of machine tools which have now replaced the function of animals and humans in agricultural activities .

Hand tractors are a form of technological progress in the agricultural sector. The use of hand tractors for cultivating agricultural land has replaced the function of buffalo in land processing activities because they are far superior in terms of effectiveness and efficiency [1] .

The main task of a hand tractor is to cultivate the land. But this hand tractor has many features like water pump, moving equipment, trailer, etc. It is hoped that this tool can be used in Indonesia, which is known as an agricultural country. Being on the equator brings unique advantages to Indonesia's land conditions. Because Indonesian land can be processed into agricultural land, agriculture can become the main source of livelihood for all Indonesian people. However, it is increasingly difficult for farmers to till the land by hand. Therefore, tools and machines are needed to facilitate the work of farmers in plowing fields. One of them is a hand tractor or hand tractor / HT [2] .

Direct use of hand tractors has problems and obstacles, including noise and machine vibrations which are felt directly by the operator. Noise from the sound of the tractor engine can of course be used. To use agricultural equipment, of course you have to know how to prevent safety and work comfort problems caused by discomfort caused by agricultural tools and machines, so workers will feel tired and then accidents will occur when working. work [3] .

This hand tractor with a remote control system using flysky is the latest innovation created with the hope of increasing effectiveness and efficiency, as well as operator safety and comfort in operating a hand tractor. By using solar panels as chargers for remote tractor controllers, this can save electrical energy usage

This type of research is the design and manufacture of a remote tractor control device using solar panels to charge the battery. This research aims to calculate the power that comes out of the solar panels on the remote tractor controller to carry out the calculation process for voltage and current. When the solar panel receives sunlight and converts it into electrical energy, the pzem sensor will detect the amount of voltage and current produced by the solar panel. After knowing the power produced by the solar panel, the researcher will calculate how long it will take for the solar panel to charge the battery until it is fully charged [4] .

II. BASIC THEORY

Remote hand tractor control is a solution to all problems that can reduce the risk of work accidents during the process of plowing fields using a hand tractor. By using solar panels as a charger for remote tractor control devices, this can save on electrical energy usage. The manufacture of this tool is focused on controlling the gas lever and right-left clutch when operating a hand tractor engine and solar panels to charge the battery for remote hand tractor control tools. The use of a remote control system placed on the throttle and clutch lever can make it easier for hand tractor machine operators to control the speed and turn of the hand tractor machine which is controlled using a long distance wireless remote that is connected to the tractor.

1. Hand tractor

Figure 1. hand tractor

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2. Arduino uno

Figure 2. Arduino uno

Arduino uno has 14 digital output input pins (6 of which can be used as PWM output), 6 analog input pins, datasheet based microcontroller board. To use the microcontroller, simply connect the Arduino board to your computer or PC using a USB cable. Once programmed to work, simply connect it to a 5 Volt DC power supply. Each of the 14 pins can source or receive up to 40mA of current and has a breakable resistor (20-50k ohm) as standard [6] .

3. Flysky FS-i6

Figure 3. Flysky FS-i6

Flysky fs-i6 is a radio wave controller (controller) and controlled (controlled), former controller and controlled MHz AM or FM wave crystal system works using a long antenna and uses signal channels mostly 25,30,40,45,70, 90 Mhz . Flysky i6 is a fast transmitter with a maximum channel quality level of 6. The speed of Flysky i6 is 2.405-2.475 GHz.

4. Solar cells

Figure 4. Solar cells

A solar cell or photovoltaic cell is a device or component that can convert solar energy into electrical energy using the principle of the photovoltaic effect. The photovoltaic effect is a phenomenon when two connected electrodes in a solid or liquid system receive light energy, the junction or contact between them produces a voltage. Therefore, solar cells or photovoltaic cells are often called photovoltaic cells (PV cells). The current in the solar cell is caused by the energy of sunlight photons received by the solar cell, causing electrons to flow through the N-type and P-type semiconductor junctions. Similar to a photodiode, this solar cell has a positive leg and a negative leg which are connected to a circuit or device that requires current [7] .

5. pzem sensors

Figure 5. pzem sensors

The PZEM-004T sensor is a sensor that functions as an electrical measuring device because one of its advantages is that it can display voltage, current, power, energy and also electrical frequency values. This sensor also uses serial data communication between the sensor and the microcontroller, which operates via 2 pins, namely the RX (Receive) pin for receiving data and the TX (Transmit) pin for sending data [8] .

6. Servo motors

Figure 6. Servo motors

Servo motors are a type of electric motor that uses a closed loop system in its movement process. In other words, this motor works with a servo mechanism. In this case, the rotary drive (motor) in the device is equipped with a feedback system to facilitate adjustment of the section and angle of the motor shaft. Closed-loop technology also allows precise control of acceleration and motor speed. Electric motors can then surpass ordinary motors to rotate and propel objects with high precision. The servo controls are on the front, distinguishing it from other types of motorbikes.

7. Power windows

Figure 7. Power windows

The power window system is one of the features installed on the car. This system has a DC motor and window regulator to raise and lower the side door panels. The advantage is that opening and closing the glass is simple and easy. The driver simply presses the power window switch to open the window and pulls to close the window.

III. Method and Design

The research method stages can be seen in the following :

1. In the first step the author will read and analyze literature relevant to the problem to be discussed. Literature research is carried out by searching for information from various sources, including scientific journals, books and trusted sources on the internet. At this stage, problems were found in the design of the emergency button and unsatisfactory device testing results. Therefore, through this literature research, it is hoped that innovations and improvements can emerge which will become the basis for further research.
2. Next, namely the hardware design stage, the author will carry out a design that is in accordance with the requirements of the tools needed. In this system, the Flysky S-i6 remote control will be used as a device for sending movement command signals remotely. Apart from that, additional receiver hardware will be installed to receive movement signals which will then be processed by the Arduino. Hardware design details can be found in the following diagram .

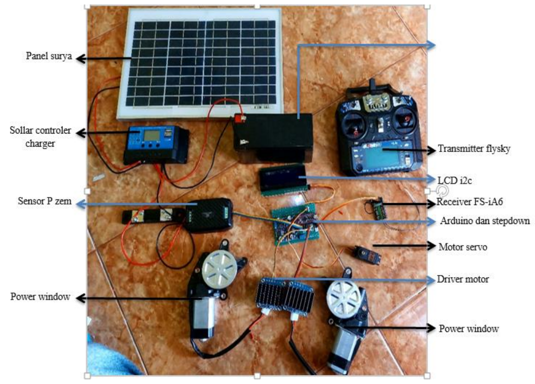

Figure 8. *Hardware design*

3. After the circuit is complete, the next step is to carry out measurements with the aim of assessing the value obtained from each measurement point of the tool that has been made, and by knowing the results, we can evaluate the performance of the tool that has been made. This measurement process will facilitate the author in carrying out further analysis and discussion.
4. The next step is testing the performance of the tool by applying action to the tool and then testing the tool with a load (after being attached to the hand tractor) which includes system response and energy consumption.
5. The final stage, namely Conclusion, in this phase is where the author describes and combines the aspects that have been discussed in the research, then draws brief conclusions.

IV. Results and Discussion

Designing hardware involves planning the manufacture of a device. In this planning, it is important to pay attention to the placement of components needed for the construction of the tool. By considering the unique characteristics of each component, you can reduce the possibility of errors in the design process.

Figure 9. *Splicing of all components*

In the picture above is the stage of connecting all the components needed to make a remote hand tractor controller using solar panels to charge the battery.

1. Solar Panel Testing

a. Charging when the sun is bright

When the sun is bright, battery charging will take place more quickly because the solar panels provide maximum power. Electrical energy produced by solar panels in excess of battery needs will be directed to the battery for charging.

To calculate how long a 10 watt solar panel would take to charge a 7.5 Ah battery in this situation, we need to take into account the total power consumption of the devices and how often they operate.

On this device, the device is not always active 24 hours and only a maximum of 6 hours a day. So, it can calculate the total energy consumption for 6 hours of operation and then use that value to estimate the battery charging time.

Total device power consumption:

Arduino Nano: about 20 mA (milliamperes)

- BTS7960 motor driver (total for 2 pcs): approx. 100 mA
- Power window motor (total for 2 pieces): for example 500 mA
- LCD 20x4: approx. 20 mA (without backlight)

So total power consumption = 20 mA + 100 mA + 500 mA + 20 mA = 640 mA

This power consumption in Ampere units needs to be converted into milliAmpere-hours (mAh) by multiplying by the operating time:

- Total energy consumption per day = Total power consumption × Operating time per day
- Total energy consumption per day = 640 mA × 6 hours = 3840 mAh

So in 6 hours of operation a day, the total energy consumed by the device is 3840 mAh. It can now use the ratio of solar panel output power to battery capacity to estimate how long a charge will take. In this example, the solar panel has an output power of 10 watts and the battery has a capacity of 7500 mAh.

Power to battery capacity ratio = Solar panel power (W) / Battery capacity (Ah)

Battery power to capacity ratio = 10 W / 7.5 Ah ≈ 1.33.

This means the solar panel needs around 1.33 hours to charge the battery to full power if optimal conditions continue to occur or in bright sunlight. However, in real situations, such as changeable weather and charging efficiency lower than optimal conditions, the charging time will be longer than this. So, in this case, a 10 watt solar panel will take longer to charge a 7.5 Ah battery.

b. Charging when the sun is cloudy

When the sun is cloudy, the intensity of sunlight decreases because the clouds absorb and scatter the light. Under these conditions, the solar panels receive less light and produce lower electrical power. Solar panels can still produce some power, but not as much as when the sun is bright.

Figure 10. Results of the first experiment

When the sun is cloudy, battery charging will take place more slowly because the power produced by the solar panels is reduced. The electrical energy produced may not be sufficient to charge the battery quickly, especially if there are some devices that also require direct power from solar panels.

Solar Panel Energy Conversion Efficiency: 70% (assuming lower efficiency due to weather conditions and system efficiency) with a Battery Capacity of 7.5 Ah.

Daily Usage Capacity:

- Daily Capacity = Total power consumption × Operating time per day
- Daily Capacity = 640 mA × 6 hours = 3840 mAh

Charging when the sun is cloudy

- Power to light intensity ratio = Cloudy light intensity / Bright sunlight intensity
- Power to light intensity ratio = 0.5
- Effective efficiency = Conversion efficiency × Power to light intensity ratio
- Effective efficiency = 0.7 × 0.5 = 0.35
- Charging time in cloudy conditions = Battery capacity / (Effective efficiency × Daily capacity)
- Charging time in cloudy sunlight = 7500 mAh / (0.35 × 3840 mAh) ≈ 5.24 hours

In this test, assuming that the sunlight intensity is 50% overcast and the solar panel efficiency is 70%, the charging time for a 7.5 Ah battery when the sun is cloudy is around 5.24 hours. However, in testing under these conditions there are still other factors such as fluctuations in light intensity and real system efficiency which can influence the results and influence the charging time when the sun is cloudy.

From the calculation results, the battery charging time using a 10Wp solar panel and a 7.5Ah battery under bright sunlight conditions is approximately 1.33 hours and when the sun is cloudy or dark, the charging process takes 5.24 hours.

2. Testing power usage on remote hand tractor controllers
   - First try

In this experiment, the PZEM sensor was used to monitor the power used when the tractor was used for approximately 6 hours with the charging system continuously ON.

From the image above, the left side is the position where the system is still off or not yet used and the right side is the result of the power used during the process of using the tractor. After conducting experiments for approximately 6 hours, the battery condition was still in the 12V range and above, which means the system was working well and according to the power calculation used.

- Second try

In this experiment, the PZEM sensor was used to monitor the power used when the tractor was used for approximately 7 hours with the charging system continuously ON.

From the image above, the left side is the position where the system is still off or not yet used and the right side is the result of the power used during the process of using the tractor. After conducting experiments for approximately 7 hours, the battery condition was still in the range of 12V and above or 12.1 V, which means the system is working well and according to the power calculation used.

Figure 11. Results of the second experiment

- Third try

In this experiment, the PZEM sensor was used to monitor the power used when the tractor was used for approximately 8 hours with the charging system continuously ON.

From the image above, the left side is the position where the system is still off or not yet used and the right side is the result of the power used during the process of using the tractor. After conducting experiments for approximately 8 hours, the battery condition was still in the range of 12V and above or 12.02 V, which means the system was working well and according to the power calculation used.

From testing the power of the remote hand tractor controller using solar panels to charge the battery, it was used 3 times, namely for 6 hours, 7 hours and 8 hours, it was found that the battery voltage was still above 12V. Thus, if the battery is used and the solar panels are used, the system can run well.

V. CONCLUSION

Battery Charging with Solar Panels. The battery charging process using a 10Wp solar panel and 7.5Ah battery has quite a variable duration. In bright sunlight conditions, the charging time is around 1.33 hours. In low sunlight or dark conditions, the charging time increases to around 5.24 hours. Total Power and Circuit Current. The total power of the circuit, including Arduino, 20x2 LCD, motor driver, and pzem sensor is about 1.3 Watts. The total current consumed by the circuit in the test is about 0.243 A, which is much lower than the maximum capacity of the stepdown module and battery. Battery reliability depends on the power efficiency of the stepdown module. System Performance When Using a Tractor. Through testing with 3 trials (6 hours, 7 hours, and 8 hours), the battery voltage remained above 12V. The combination of batteries and solar panels used ensures the system operates well during tractor use.

VI. REFERENCES

[1] (Dzulfikar and Broto 2016) Dzulfikar, Dafi, and Vishnu Broto. 2016. "Optimizing the Use of Solar Electric Energy on a Household Scale." V:SNF2016-ERE-73-SNF2016-ERE-76. doi: 10.21009/0305020614.

[2] Effenberger, F., and G. Kiefer. 1967. "Stereochemistry of the Cycloaddition of Sulfonyl Isocyanates and N-Sulfinylsulfonamides to Enol Ethers." *Angewandte Chemie International Edition in English* 6(11):951–52. doi: 10.1002/anie.196709511.

[3] Finawan, Aidi, Muhaimin, Eliyani, and Hanafi. 2019. "Design and Build a Microcontroller-Based Remote Hand Tractor Controller Prototype." *Lhokseumawe State Polytechnic National Seminar* 3(1):A42–45.

[4] Handson Technology. nd "Datasheet: Motor Driver L298N." *Handson Technology* 1–7.

[5] Hidayat, Ta'lim Nur, and Sutrisno Sutrisno. 2021. "Power Output Analysis in Solar Power Plants with Capacity 10Wp, 20Wp, and 30Wp." *Crankshaft Journal* 4(2):9–18. doi: 10.24176/crankshaft.v4i2.6013.

[6] Ratnasari, Desi Arista, Bambang Suprianto, and Farid Baskoro. 2022. "Monitoring Electrical Power on Solar Panels Based on Internet of Things (IoT) Using the Telegram Application." *Indonesian Journal of Engineering and Technology (INAJET)* 5(1):1–10.

[7] Rizky, Ray Fathur, Ahmad Turmudi Zy, Aswan S. Sunge, Study Program, Informatics Engineering, Pelita Bangsa University, Bekasi Regency, and Smart Door Lock. 2023. "Smart Door Lock System Using Arduino-Based Voice Recognition." 4(2):239–44.

[8] Simbar, Ritha Sandra Veronika, and Alfi Syahrin. 2017. "Blood Detection System Prototype Using Arduino Uno R3." *Journal of Electrical Technology, Mercu Buana University* 8(1):80–86.

[9] Suparyanto and Rosad (2015. 2020. "Solar Panels."

Suparyanto and Rosad (2015 5(3):248–53.

[10] Prasetyo, Kurnifan Adhi. 2018. "Development of a Solar Panel Charging Control Device Using Aduino Nano for Commercial Electric Bicycles." *Journal of Electrical Education* 2(1):50–58. doi: 10.21831/jee.v2i1.19947.

[11] Pratama, Dhelmiga, and Asnil Asnil. 2021. "Realtime Solar Panel Monitoring System Based on Arduino Uno." *MSI Transaction on Education* 2(1):19–32. doi: 10.46574/mted.v2i1.46.

[12] Priatam, Putu Pawitra Teguh Dharma. 2021. "Analysis of Sunlight Radiation on 50 WP Solar Panels." *RELE:Journal of Electrical Engineering* 4(1):48–54.

[13] Kamal, Winda, Husain Syam, and Jamaluddin Jamaluddin. 2021. "Design of an Automatic Steering Control System for Two-Wheel Tractors Using FPV (First Person View)." *Journal of Agricultural Technology Education* 7(2):207. doi: 10.26858/jptp.v7i2.19057.

[14] Hasrul, Rahmat. 2021. "Active Versus Passive Cooling Systems in Increasing Solar Panel Output." *Journal of Science, Energy, Technology & Industry* 5(2):79–87.

[15] Setiawan, Bambang, Sulis Yulianto, Thomas Junaedi, and Ilham Efendi. 2021. "Design and Construction of a Solar Cell Powered Field Tractor Plowing Machine Driven by Remote Control." *Proceedings of the National Seminar on Science and Technology* (November):1–12.