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# IoT- Based Intelligent System for Farm Electric Fence

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**Abstract**: When humans or animals encounter a solar fence, they receive a brief yet powerful jolt. The shock provides a deterring impact while preventing any loss of life. The issue is that severed electrical cables may go unrepaired because of the electric fences constructed near secluded woods, farmers frequently replace the batteries that power electric fences. The objective of this study is to design an electric fence system prototype following a minimum safety standard. This study proposes an IoT-based electric fence notification system that enables farmers to monitor the state of the fence from their smartphones with a monitoring system to monitor the condition of the electric fence. The initial component is a traditional electric fence, consisting of a solar panel, solar controller, 12V battery, energizer, copper earth rod, and aluminum wire. The other component of this system is a control and monitoring box for the Internet of Things. The project was conducted for two days, from June 18th to June 19th, 2023, and the data output of solar-powered systems was measured every hour to determine the consistency of solar panel output. At Universiti Tun Hussein Onn in Cawangan Pagoh, Johor, Malaysia, the IoT based electric fence was assembled. The wire fence was set up with ratio 2:8 which is 2 meters between the poles. The maximum and minimum performance of an electric fence is determined by monitoring the lifetime of the electric fence system. The electric fence will be set to run with highest pulse and minimum pulse per minute. In summary, this initiative demonstrated the implementation of available technologies and the opportunity to create a new generation electric fence system for farms.

**Keywords**: Electric Fence, Notification System, Iot

## 1. Introduction

With the advent of the digital age comes the Internet of Things (IoT), which uses millions of embedded devices to provide intelligent, effective, low-cost, and real-time solutions. The Internet of Things removes the need for physical infrastructure or human presence. An electric fence is one of the measures utilized to safeguard food crops, particularly from wild animals. Modern and unique, solar fencing is one of the most effective and efficient means of providing security since it is both effective

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and efficient. Not only does solar fencing provide the security of one's home, but it also operates using renewable solar energy. Traditional electric fencing has proved effective as a crop protection measure.

However, the system has a few flaws. It can only be used as a defense against animals, and it cannot alert. The voltage that fluctuates occasionally due to entangled vines or overlapping weeds. In addition, the fence's owners must check the voltage, which they cannot determine without visiting the site. In this project, the electric fence management system employs wireless connection and enables the owners to safely monitor the electric fence from a distance while monitoring its condition.

### 1.1 Problem Statement

In Malaysia, several elephants and wild boar enter farms and destroy crops, causing over RM30,000 in losses [1]. The installation of electric fences near the forest is effective for preventing damage. It is a dire situation when branches or animals that touch electric fences cause the voltage to drop, allowing them to overrun crops. Field owners must physically inspect the voltage of electric fences at the actual locations. Because animal-repelling electric fences are built near secluded woodlands and steep slopes, it is impossible for the owners to frequent these areas [6]. Therefore, the owners of the fields must pay a worker to frequently inspect their farms. Furthermore, there are few troubles. One is that the fences are touched without knowing whether the power is supplied or not. The second issue is that severed electrical cables may go unrepaired. Aside from that, because of the electric fences constructed near secluded woods, farmers frequently replace the batteries that power electric fences. To ameliorate the issue, a system that automatically checks the voltage and transmits the information to the owners is required, but such devices are not already on the market.

### 1.2 Objective

This project's primary objective is to design an electric fence system that meets minimum safety requirements. This involves meticulously contemplating variables such as voltage levels, insulation materials, and grounding mechanisms to ensure human and animal safety. The second objective is to create a novel electric fence system based on the internet of things (IoT). This involves incorporating IoT technologies, such as sensors, actuators, and connectivity options, into the electric fence. The third objective is to evaluate the efficacy and effectiveness of a prototype electric fence. The project aims to evaluate the fence's ability to deter intruders, withstand environmental conditions, and operate reliably over time through a series of evaluations and tests.

### 1.3 Scope of Project

This project's primary objective is to defend crops from predators, which is accomplished using solar-powered, Internet of Things (IoT)-enabled electric fences. To achieve this, initial emphasis is placed on adhering to safety regulations and designing the electric fence with standard parameters. This involves considering safety guidelines, such as voltage levels, insulation materials, and grounding mechanisms, to ensure that the electric fence meets the required safety standards. The second step involves constructing a new electric fence system with components. Utilizing an ESP32S microcontroller, a relay module, a solar panel, and a solar controller are included. These components are combined to produce an advanced electric fence system with Internet of Things capabilities. Thirdly, simulation and measurement of the electric fence's current and voltage output using the Proteus software. This simulation aids in assessing the performance of the electric fence system and verifies that its functionality conforms to its intended design. Implementation of a current sensor to monitor and measure critical parameters including voltage, power, and current values. This monitoring is accomplished through the IoT platform Blynk [2]. By analyzing these parameters, the efficacy of the electric fence can be evaluated in terms of its ability to deter predators and protect crops.

## 2. Methodology

When a solar fence system's solar module produces direct current (DC) from sunlight to charge the system's battery, the system is ready to operate. A 12 V rechargeable battery powers the fence's framework. The system's battery can often operate for up to 24 hours a day, depending on sunlight hours and capacity. The controller, fencer, charger, or energizer receives the output of the charged battery. The energizer generates a quick but sharp voltage when it is powered. The energizer's main job is to generate sharp, brief pulses with a voltage of close to 8000 volts. To prevent any physical harm from being done to the intruder who attempts to climb the fence, these pulses are sent via the fencing system's wires at a rate of roughly one pulse every 1 to 15 seconds with each pulse lasting for close to three milliseconds. The system is activated when the acs712 current sensor detects and communicates the measured output current to ESP32S. The microcontroller of this project is an ESP32S, which measures the analogue pin's input, converts it to millivolts, subtracts the offset, and then divides the result by the scale factor of the current sensor. The data may be retrieved and sent to the cloud by using ESP32S. Blynk is an IoT platform solution that enables receivers to receive data from the cloud via the Blynk mobile application.[2] The relay module controls the ON/OFF status of fence wire in the system. Using the Blynk platform, the user can choose to turn ON/OFF the fence. The current sensor value will be transmitted by the ESP32S. The basis for the proposed system to receive cloud-based notifications is the Blynk application.

### 2.1 Solar Irradiance Pagoh, Malaysia

Solar irradiance is the quantity of solar radiation received per unit area on a surface and is typically measured in watts per square meter (W/m2). Data on solar irradiance helps in determining the capacity of the solar system. By comprehending the solar irradiance levels at a particular location, the quantity of solar energy available for conversion into electricity can be estimated. This information is necessary for sizing solar panels, inverters, and energy storage systems to meet the energy requirements of the intended application. Solar irradiance data provides the estimation of potential energy production. By analyzing historical and/or modeled solar irradiance data, it is possible to predict the quantity of electricity that the solar system can generate over various time periods (e.g., daily, monthly, yearly). This estimation helps in evaluating the solar project's feasibility and economic viability. In this project, the Meteonorm software are chosen to generate solar irradiance data for Pagoh, Malaysia. The software will collect data and predict solar irradiance data for the year 2023. The data from the software will be used to calculate the daily peak sun hour (PSH).

### 2.2 Operation IoT-based Intelligent System for Farm Electric Fence

Figure 1 shows the entire system procedure. The process is initiated by solar panels that absorb sun energy. By regulating the voltage and current flowing from the solar panel to the battery, a solar charge controller prevents the battery from being overcharged. The solar panel absorbs energy, which is then stored in a 12V battery to supply the entire system. The battery provides electricity to the grounded Energizer, which then transmits approximately one electrical pulse every second down the fence. Afterward, Copper earth rod is an important factor of an electric fence and is necessary for its correct operation. The fence charger or energizer is designed to convert the electric charge into a safe form for animals and humans. When an animal contacts an electrically charged fence wire, it feels the electric current passing through its body. In furthermore, the ACS712 current sensor can measure the current of an electric fence. ACS712 current sensor is a suitable current transform for measuring DC voltage. It provides great precision and consistency for measuring current up to 30A. ESP32S will process the data before transmitting it to the Blynk app via Wi-Fi connection. BLYNK is an IoT platform solution that enables receivers to receive data from the cloud via the Blynk mobile application. In addition, a relay module with four channels is used in this system to manually control the electric fence wire via the user's smartphone.

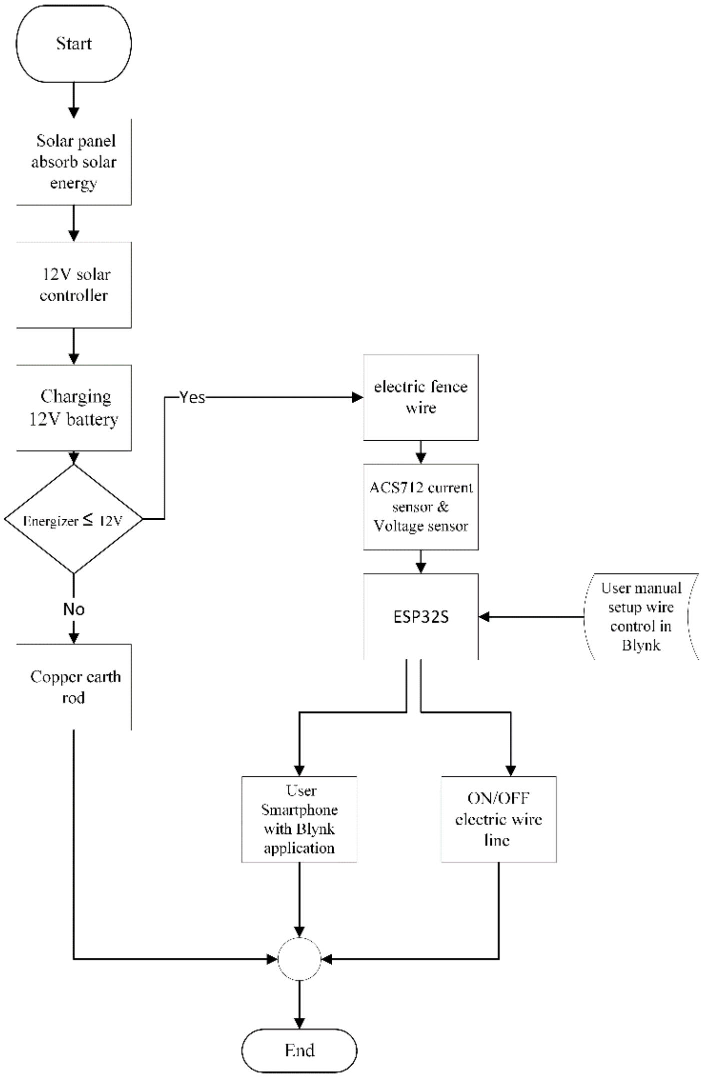


**Figure 1 Flow Chart of Process IoT-based Intelligent System for Farm Electric Fence**

### 2.3 Safety Regulations

Essential to the construction of a safe and effective electric fence system is the careful selection and application of suitable materials. Wires must be adequately insulated to prevent accidental contact with people, animals, or vegetation. All wires must be adequately insulated and securely attached to posts or insulators to reduce the possibility of them becoming unsecured or collapsing. Regular inspections should be performed to identify any wire corrosion or damage, and immediate repairs or replacements should be made to maintain the electric fence's integrity. As shown in table 1, as current increases, shock becomes relatively more severe. For currents exceeding 10 milliamps, muscular contractions are so intense that the victim cannot release the stunning wire. At values as low as 20 milliamps, respiration becomes labored, and at values below 75 milliamps, it ceases entirely. As the current approaches 100 milliamps, ventricular fibrillation of the heart occurs, resulting in mortality. Ventricular fibrillation is an uncoordinated quivering of the walls of the ventricles of the heart. Above 200 milliamps, the muscular contractions are so intense that the heart is constricted during the electric shock. This compression prevents the heart from entering ventricular fibrillation, and the victim has a high chance of survival.

**Table 1 The Physiological Effects of Various Currents**

| Current (Amp) | Effect |
|---|---|
| 0.001-0.01 | Threshold sensation to mid sensation |
| 0.01-0.1 | Painful shock and muscular paralysis |
| 0.1-0.2 | death |
| 0.2-1.0 | Severe burns and breathing stop |

### 2.4 IoT-based Intelligent System Circuit Connection

Figure 2 shows the connection between the ESP32S and each electronic component. The ESP32-S is a wireless module that is based on the ESP32 chip, supports Wi-Fi and Bluetooth 4.2, and has 32Mbit Flash and an SMD38 form factor. In addition, there is a PCB antenna and metal shield onboard. It is a wireless module with a compact form factor and relatively high-cost effectiveness. The connection starts with voltage sensor, which is connected to pin 30 to give the data to ESP32S. The positive pin is connected from voltage sensor to current sensor. The output from pin 15 is connected to relay module to control ON/OFF system. The ACS712 current sensor is analogue. Connect the analogue pin of the sensor to pin 15 at ESP32S.

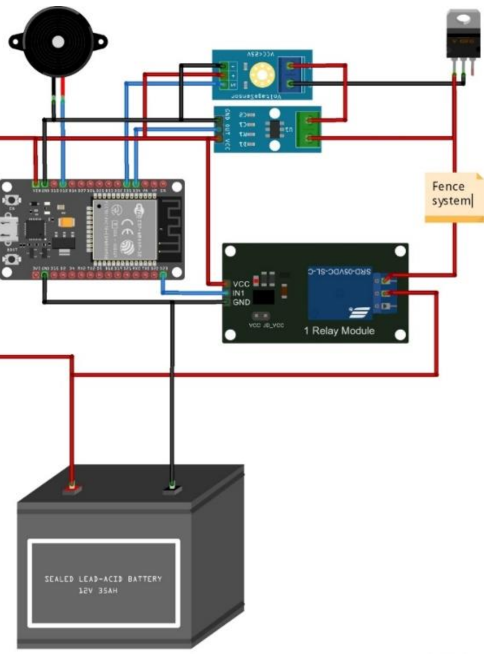


**Figure 2 The IoT-based Intelligent System Circuit Connection**

## 3. Results and Discussion

Analyzing the performance and effectiveness of an electric fence necessitates the consideration of several crucial factors. First, it is essential to measure the voltage output because it indicates the effectiveness of the deterrent. A barrier with a higher voltage is typically more effective. It is essential to ensure that the voltage falls within the manufacturer's recommended range. The actual deterrent effect can then be determined by measuring the current flowing through the fence. A higher current can impart a larger shock, thereby enhancing the fence's ability to deter intruders. For optimal performance, it is essential to achieve a balance between voltage and current. It is essential to inspect the physical integrity of the fence's components. Wires, insulators, posts, and connectors must be inspected for damage or fatigue to maintain effectiveness. To ensure proper operation, it is essential that there are no loose or damaged wires and that all connections are secure.

### 3.1 Hardware Prototype

Figure 3 shows the prototype of IoT-based Intelligent System for Farm Electric Fence starting with the solar system. The solar panel is used to charge the 12V battery to make sure the whole system can operate more than 8 hours. The solar panel is connected to solar charger controller. The solar charger controller is used to monitor the charging process of 12V battery. For safety purpose, the system is programmed to ON/OFF using Blynk application. The user can control and monitor the system from Blynk application without attend to the electric fence system. The panel is combined with electric fence energizer which gives a high voltage pulse to the electric fence. The panel is complete with the voltage and current sensor for monitoring purposes. This experiment the performance of solar system is tested by measuring the value of voltage that can be supplied to 12V battery in short time. The charge controller will regulate the voltage and current flowing from the solar panel to the battery, ensuring safe and efficient charging. It will monitor the battery's state of charge and adjust the charging parameters accordingly. After that, Figure 4 shows the Blynk application notified the user when the current is high.

**Figure 3 Hardware Prototype**

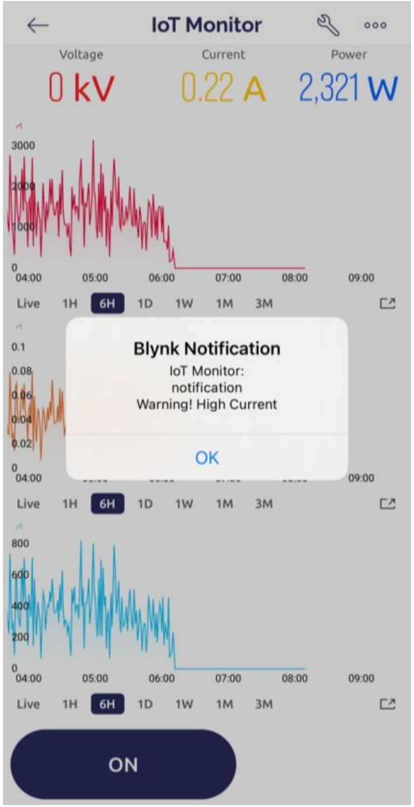


**Figure 4 Blynk Application Sending a Warning Notification**

### 3.2 DC Output Voltage and Current of Solar System

The objective of the test was to ascertain the output voltage (V) and current (A) of the solar panel to the 12V battery over a specified period. Using a multimeter and indicator on the solar charger controller, the output voltage (V) of the solar panel was measured, while the current (A) was measured using a multimeter. The test was conducted for two days, from June 17th to June 18th, 2023, and the data output of solar-powered systems was measured every hour to determine the consistency of solar panel output. At Universiti Tun Hussein Onn in Cawangan Pagoh, Johor, Malaysia, the IoT based electric fence was assembled.

### 3.3 Tables

Table 2 shows the data collected from the solar system. From the data collected, the solar system is compatible to charge the 12V battery, but it takes more than one day to fully charge the battery. Table 3 shows the irradiation data generated by Meteonorm software. The global horizontal radiation for 2023 provided by Meteonorm is 1698 which is good to generate electric using solar system. From this test, it can be concluded that the time taken for solar system fully recharge is too long even though the daily peak sun hour (PSH) for location Pagoh, Johor is around 4.7 hours per day.

**Table 2 The data of Solar System**

| Time (H) | Voltage (V) | | Current (A) | Power (Watt) |
|---|---|---|---|---|
| | Battery | Solar panel | Solar panel | Solar panel |
| 9:00 AM | 11.60 | 11.60 | 0.24 | 2.78 |
| 10:00 AM | 11.70 | 11.80 | 0.26 | 3.06 |
| 11:00 AM | 11.60 | 11.70 | 0.40 | 4.68 |
| 12:00 PM | 11.70 | 11.60 | 0.40 | 4.64 |
| 1:00 PM | 12.07 | 12.17 | 0.49 | 5.96 |
| 2:00 PM | 12.00 | 12.10 | 0.46 | 5.56 |
| 3:00 PM | 12.27 | 12.37 | 0.41 | 5.07 |
| 4:00 PM | 12.20 | 12.80 | 0.30 | 3.84 |
| 5:00 PM | 12.10 | 12.20 | 0.11 | 1.33 |
| 6:00 PM | 11.50 | 11.30 | 0.10 | 1.13 |

**Table 3 The Data of Irradiation in Pagoh, Johor Generated by Meteonorm Software.**

| | GH KWh/m | GK KWh/m | Dh KWh/m | Bn KWh/m | Ta KWh/m | Td KWh/m |
|---|---|---|---|---|---|---|
| January | 146 | 157 | 76 | 106 | 26.8 | 22.8 |
| February | 152 | 158 | 80 | 102 | 27.4 | 22.9 |
| March | 161 | 160 | 91 | 98 | 27.8 | 23.6 |
| April | 157 | 149 | 77 | 111 | 28 | 24.5 |
| May | 147 | 133 | 79 | 100 | 28.2 | 24.6 |
| Jun | 126 | 113 | 76 | 73 | 28 | 24.4 |
| July | 143 | 128 | 80 | 92 | 27.6 | 24 |
| August | 140 | 131 | 84 | 78 | 27.5 | 24.1 |
| September | 139 | 135 | 85 | 76 | 27.4 | 23.9 |
| October | 141 | 143 | 83 | 80 | 27.5 | 23.9 |
| November | 125 | 132 | 74 | 77 | 27 | 24 |
| December | 121 | 129 | 73 | 72 | 26.9 | 23.5 |
| Year | 1698 | 1667 | 957 | 1065 | 27.5 | 23.9 |

### 3.4 Results of Maximum Performance of System

Figure 5 and figure 6 show the graph of maximum performance of system for voltage, current and power. The test is running with full capacity of 12V battery. The test starts at 9:00 AM until the 12V battery runs out of power. The pulse regulation at energizer box is set to maximum to produce maximum pulse per minute. The pulse period is adjusted by rotating the knob at the energizer from a discharge cycle between 0.75 seconds and 0.3 seconds. In this test, the knob is rotating to maximum pulse which is 30 to 50 pulse per 0.3 seconds. From the graph at figure 4.11, the highest voltage recorded by system is 3KV per minute which is around 2:00 PM. For comparison, the voltage supply from the solar system during 3:00 is 12.37V which means that the system is in peak performance. As a result, the higher voltage levels provide a more effective deterrent by imparting a more perceptible and unpleasant electric shock to animals that encounter the fence. This discourages their attempts to penetrate the fence while helping in containing livestock and excluding undesirable animals.

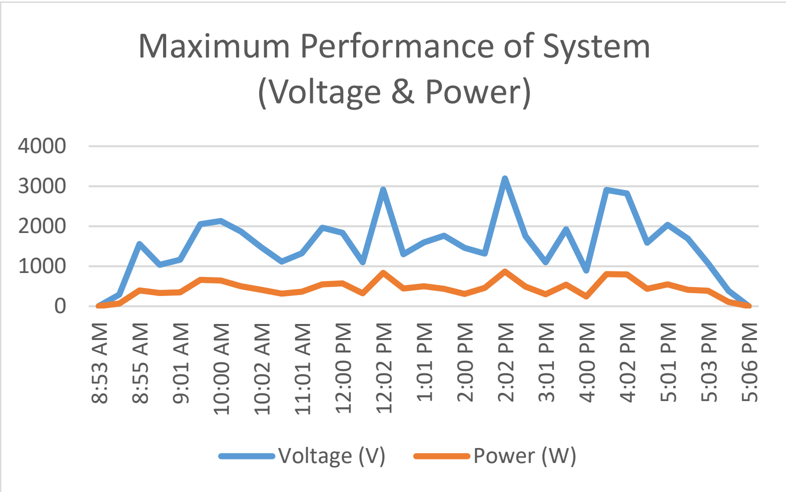


**Figure 5 Graph Maximum Voltage and Power Performance of The Electric Fence System**

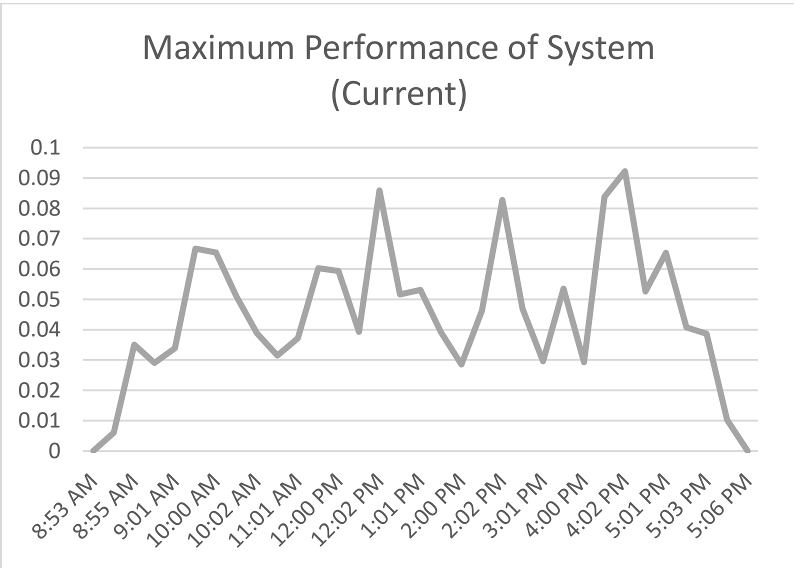


**Figure 6 Graph Maximum Current Performance of The Electric Fence System**

### 3.5 Results of Minimum Performance of The System

Figures 7 and 8 show the minimum system performance graphs for voltage, current, and power. The test is being performed with a fully charged 12V battery. The test begins at 5:00 PM and continues until the 12V battery dies. The pulse regulation at the energizer unit is set to a minimum to generate the lowest possible pulse rate per minute. Adjusting the pulse period by turning the knob on the energizer from a discharge cycle of 0.75 seconds to 0.30 seconds. In this measurement, the knob is rotated to its maximal pulse setting, which is between 30 and 50 pulses per 0.75 seconds. Figure 4.13 shows that the greatest voltage recorded by the system is 3KV per minute, which corresponds to 8:03 p.m. while the highest current recorded during the test is 0.09A which is at 8:00PM. operating at minimum capacity reduces the energizer's power consumption. This significantly increases battery life. By conserving energy, the battery can power the fence system for a longer period before requiring recharging or replacement. This is especially advantageous in remote areas or locations where frequent access to a power source for recharging is difficult.

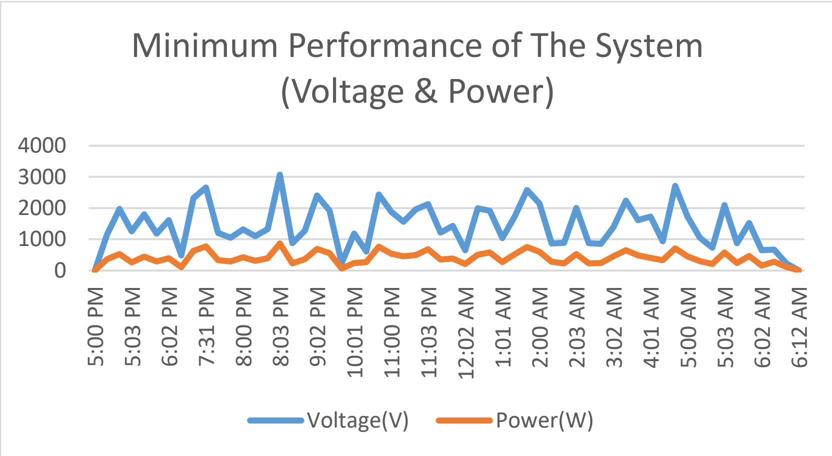


**Figure 7 Graph Minimum Voltage and Power Performance of The Electric Fence System**

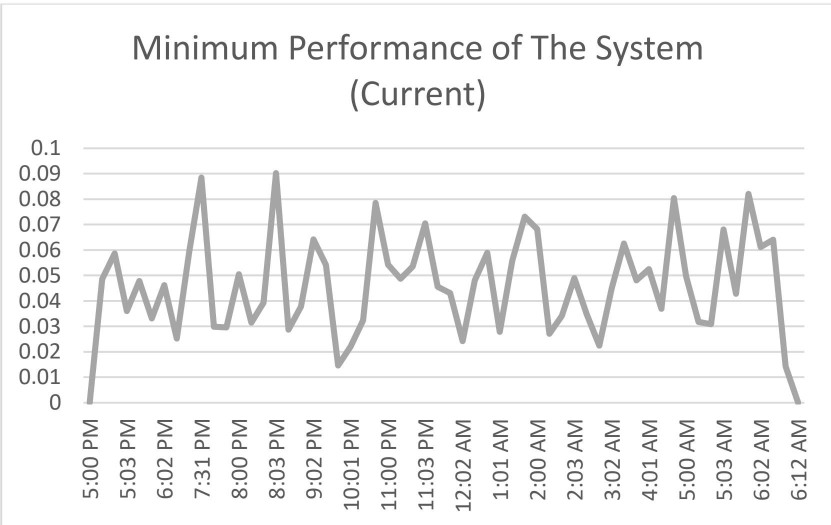


**Figure 8 Graph Minimum Current Performance of The Electric Fence System**

## 4. Conclusion and Recommendation

In conclusion, IoT-based Intelligent System for Farm Electric Fence with a minimum safety standard is successfully developed. Even though the capacity of the battery is smaller than the traditional electric fence, which is 24V, the system is successful in delivering effective current to secure the farm. A fence energizer converts mains or battery power into a discharge of high voltage. Once per second, the energizer discharges this pulse onto an insulated fence line. The duration of the pulse is approximately 30 to 50 per minute. This pulse is commonly known as the "shock" and is felt by all animals that contact an electrified fence. When an animal touches the fence, the circuit is completed. At this juncture, the animal receives an electric charge. From a previous study about electric fence, the performance of the electric fence only dependable on the battery lifetime. The bigger the capacity of the battery, the longer the lifetime of the electric fence. In this study, the system was developed in three main parts, which is using solar system to generate power source and charge the 12V battery, using ESP32S as a microcontroller to monitor value of voltage, current and power of electric and using Blynk application to ON/OFF the system. Using a 12V battery to store energy and power the electric fence energizer with DC current. With supply from battery and solar panel, the new prototype of electric fence is successfully operated with maximum performance and minimum performance. The voltage and current sensor are used to monitor voltage, power, and current values.

This initiative demonstrated the implementation of available technologies and the opportunity to create a new generation electric fence system for farms. Therefore, the electric fence uses an energizer to produce a high voltage discharge to the fence wire, the voltage and current are difficult to measure due to the impossibility of measuring the high voltage with a standard multimeter. By automatically monitoring voltage, current, and power, the microcontroller in this project to construct an electric fence will increase safety. Also, the inclusion of a microcontroller in this project allows the user to easily detect any problems with the electric fence and take action to do quick troubleshooting and maintenance.

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