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MONITORING FOR UNINTERRUPTIBLE POWER SUPPLY (UPS) SYSTEM.

AFIQ RAHIMI BIN ROSMANI

Thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Engineering Technology in Electrical

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ABSTRAK

Dalam proses perindustrian hari ini, repotasi peralatan adalah sangat penting. Bekalan kuasa mestilah mampu memenuhi keperluan proses perindustrian. Sekiranya berlaku kegagalan kuasa, sistem bekalan kuasa sandaran mesti dapat menyokong loji proses utama. Ini adalah untuk memastikan kelancaran operasi dan kualiti produk. Untuk melakukan ini, uninterruptible power supply (UPS) boleh digunakan untuk memastikan kebolehpercayaan, kestabilan dan konsistensi keseluruhan sistem. Sistem UPS ini mesti dipantau untuk membolehkan mereka bertindak balas dengan sewajarnya sebagai tindak balas kepada kerosakan atau kegagalan kuasa. Dalam projek ini, sistem pemantauan untuk UPS telah direka bentuk dengan menggunakan battery management system (BMS) untuk menyediakan bekalan DC 24V yang selamat dan berterusan sekiranya berlaku gangguan kuasa. Bekalan kuasa utama, 24V AC telah ditukar kepada 220V DC sebagai voltan keluaran dan bateri akan digunakan sebagai sebahagian daripada sistem sandaran. Sistem ini akan dapat mengawal sumber kuasa yang menawarkan kuasa dari talian LIVE atau kuasa dari talian BATERI. Voltan keluaran utama ialah 24V DC dan paras bateri akan dipantau menggunakan perisian BMS.

ABSTRACT

In industrial process today, reliability of equipment is very important. Power supply must be able to cater the need of industrial process. In case of power failure, backup power supply system must be able to support the main process plant. This is to ensure smooth operation and product quality. In order to do this, uninterruptible power supply (UPS) system can be used to ensure the reliability, stability and consistency of the entire system. This UPS system must be monitored in order to enable them to react accordingly in response to a fault or power failure. In this project, monitoring system for UPS was designed by using battery management system (BMS) to provide a safe and constant 24V DC supply in the case of power disruption. The main power supply, 24V AC was converted to 220V DC as output voltage and a battery will be used as part of the backup system. This system will be able to control the source of power which offers power from LIVE line or power from BATTERY line. The main output voltage was 24V DC and the battery level will be monitored using BMS software.

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LIST OF SYMBOLS

F	Farad
°C	Celsius
A	Ampere
V	Volt
Ah	Ampere Hour
s	Second

LIST OF ABBREVIATIONS

IoT	Internet of Things
BMS	Battery Management System
CAN	Controller Area Network
LCD	Liquid Crystal Display
BT	Bluetooth
GPS	Global Positioning System
APP	Application
SIRIM	Standard and Industrial Research Institute of Malaysia
MOS	Military Occupational Specialty
AC	Alternating Current
SOA	Service-Oriented Architecture
UPS	Uninterruptible Power Supply
RM	Ringgit Malaysia
SPP	State Performance Plan
UART	Universal Asynchronous Receiver-Transmitter
SOC	State Of Charge
IP	Internet Protocol
RF	Radio Frequency
SMS	Short Message Service
PAN	Personal Area Network

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CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Uninterruptible Power Supply (UPS) devices keep computer systems and IT equipment secure and operational during power surges and failures. When the flow of electricity decreases to an insufficient voltage or ceases, an Uninterruptible Power Supply (UPS) provides battery backup power. In a mission-critical setting, an uninterruptible power supply is essential. Backup power is generated for a fixed period, depending on the size and technology of the UPS unit, before generators can be triggered or network components can be properly shut down. Computer and accessories are shielded from damage as energy flows freely. A UPS unit can effectively protect a single computer or an entire data centre.

1.2 PROBLEM STATEMENT

When it comes to UPS, it is important for the project to ready to be used when power failure. Power failure means completely loss of supply. Other than that, need to think about how to make it appropriate size, weight, convenience, and safety. All these aspects need to be focused on to ensure that this project can run smoothly and can be used by everyone.

1.3 OBJECTIVE

This proposed project is to achieve the following objectives:

1. To develop a system that detects presence of ammonia gas and its concentration.

2. To develop a working countermeasure that responds when the system detects ammonia gas leakage.

3. To come up with a working web application for distant monitoring of ammonia gas leakage.

1.4 PROJECT SCOPE

The scope of work of this project focuses on design, sizing, and development UPS for solar system. At the same time, the scope of work also involves the development of monitoring for UPS system to make sure that can be easy to notice by using IoT. Lastly, the scope of work also includes the development of solar system to charge the UPS system.

1.5 Thesis Outline

The backdrop of the IoT-based UPS monitoring system has been discussed in this chapter. It also briefly discussed the issue statement, the project's objectives, and the project's scope.

Chapter 2 This paper includes a literature assessment of a relevant project including an IoT-based UPS system, as well as monitoring and existing projects related to the project. There are limited comparisons of existing projects based on microcontrollers, systems, communication technology, and the project's benefits and drawbacks.

Chapter 3 explains the methods used to develop the UPS system monitoring project, with a focus on the Internet of Things (IoT). This chapter also includes information on how to choose materials for hardware and software to complete the project. The final system of the IoT-based UPS system is also detailed based on the methods stated in this chapter.

Chapter 4 describes the information gathered during the monitoring system's analysis. The data depicts the operation of an IoT-based UPS system. During the data collection, the problem was also discussed.

Chapter 5 Explain the project's general findings, including the system's effectiveness in this project. As a result, the completed objectives, limits, and recommendations are reviewed, as well as any future improvements that can be made to this project.

CHAPTER 2

LITERETURE REVIEW

2.1 Introduction

In this Chapter, will walk through the proposed approach for building incremental learning solutions that are easy to develop in an IoT environment. We will discuss what is Smart BMS as an application for monitoring and how its features have made the development of monitoring UPS system much easier.

2.2 SmartBMS

Smart BMS is a programmed that connects to any BMS system. The monitoring system for battery-powered Uninterruptible Power Supplies (UPS) has been implemented and evaluated in this work. The battery temperature, charging or discharging current, and State of Charge (SOC) for the selected model battery are all evaluated and shown by this system. Digital and analogue sensors with microcontrollers are utilized for monitoring. Photographs depict battery information and achieve data that describe the system's key qualities, while the LCD screen displays some testing results.

The precise estimation of the battery's State of Charge is one of the most critical and indispensable characteristics of a BMS. The SoC is defined as the battery's current capacity expressed as a percentage of a reference value. Because a battery's capacity is limited, new technologies must be utilized to precisely estimate the SoC of the battery to keep it securely charged and discharged at a reasonable level and to extend the battery's life cycle. However, determining SoC is not an easy operation because other factors such as battery voltage, current, temperature, and ageing must be considered Accurate SoC estimation helps protect the battery from damage or premature ageing caused by unintentional overcharge and over discharge.

The traditional method of SoC estimate, such as Coulomb counting [2], has an error accumulation flaw that leads to erroneous estimation [1]. Furthermore, the limited battery efficiency [1] and the chemical reactions that occur during charge and discharge cause temperature to rise, which has a negative impact on the SoC estimation. As a result, efficient methods are absolutely required for accurate SoC estimate. Furthermore, neither Coulomb counting nor voltage measurement alone are sufficient for high-accuracy SoC calculation because many other factors including as charge or discharge rates, hysteresis, temperature, and cell ageing heavily influence SoC estimation.

2.2.1 Bluetooth Module

To link the phone to the BMS for monitoring, Bluetooth is required. Since its invention by Ericsson in 1994, Bluetooth has been used as a wireless channel for connecting devices. Since then, Bluetooth has progressed to become the standard for wireless connectivity in wearables, gadgets, and other devices. Bluetooth may now be found in a variety of places, including automobiles, speakers, wearables, medical equipment, wireless headphones, and shoes. If you own a modern device, it's likely to assume you've come across and used Bluetooth technology at some point. In other terms, Bluetooth is a short-range wireless technology medium for transmitting data over a short distance between two electronic devices often mobile phones. The utilisation of wires for connectivity is no longer necessary thanks to this procedure. One example is how a phone can monitor a BMS while on the go without needing to hook it into a mobile device's cable.

Bluetooth uses UHF radio waves, also known as short wave radio, with radio bands ranging from 2.402 GHz to 2.480 GHz to create a Personal Area Network (PAN). A master Bluetooth device may often connect to up to seven devices at once. Even yet, certain Bluetooth devices are limited in their ability to connect to this many devices. This type of connection, however, is known as a piconet, which is an ad hoc computer network built at the time employing Bluetooth technology. Connected devices work in a master-slave relationship in this technology system. Consider establishing a link between a phone and a wireless headset via a headset. The headset becomes the master (the initiator) in this situation, while the phone becomes the slave. As a result, both devices can exchange roles, with the phone acting as the master and the headset acting as the slave. In the end, a master can have up to seven slaves in a Bluetooth piconet, and a slave can have several masters.

Bluetooth is the best wireless connection platform for combining apps, which is the path that most IoT advancements are heading in. Greater devices and apps will eventually benefit from astonishingly extended battery life and battery-free operation as engineers and developers continue to strive for more low-power designs and energy harvesting. By combining Bluetooth technology with cutting-edge solutions like On-Demand Wake-Up and Lowest Power Radio, typical internet of things devices can consume less power for longer periods of time.

All Bluetooth IoT devices have advertising, but the UPS technology is one of the most renowned applications that only works in this mode. UPS devices, such as the Daly BMS for LiFePO4 Battery 24V, remain in Advertising mode while broadcasting data to other devices for exploration and reading.

2.3 Liquid crystal display (LCD)

In the construction of this project, BMS was used as a component regulator in the charging process. Setting up a one channel relay module in the process of disconnecting the flowing electric current, monitoring the battery voltage status on the Solar Charge Controller LCD screen, and simultaneously charging the LiFePO4 lithium-ion battery are all components managed by BMS. The BMS, which has a 48-volt output voltage, provides the supply voltage required to charge the battery. Figure 1 illustrates this LCD.

The LCD is utilized in this system to display the value of the battery's incoming voltage, which is measured using a voltage divider circuit. To produce a lower voltage output value as compared to the input, this voltage divider circuit consists of two 1 k ohm resistors connected in series to the voltage divider referenced to ground. The output value generated from the voltage divider circuit is always smaller than the input. Calculation of the output value generated in this circuit can be specified in the formula [3]:

$$Vout=Vin*(R2/(R1+R2)$$

2.4 Related Work

According to the research done, there are various goods that are similar to this current project. "Automobile Battery Monitoring System" is one of the projects by (Ignatius Baraza). After observing, analysing, and reviewing their project, they discovered some areas for improvement and weaknesses that need to be addressed.

The Arduino Uno R3 Microcontroller Board was used as the main component in this project. The voltage sensing module was designed using the voltage divider theorem to measure the voltage. A hall effect current sensor was utilized to monitor the magnetic flux density generated around the current carrying wire and convert it into a proportionate voltage. For measuring the temperature, a programmable digital thermal, DS18B20, probe was employed. For the current and temperature sensors, as well as the Arduino microcontroller, a voltage regulator was utilized to scale down the 12V supply voltage to the required 5V.

The project's drawback is the gap between laboratory tests and real-time field applications, which needs to be bridged to produce more accurate monitoring equipment. In this study, the voltage threshold value was chosen based on automobile engine cranking simulations in the lab using a 500A fixed load battery tester that takes 10 seconds, whereas the real average car cranking time was 0.59 seconds. The performance of the BMS under operating conditions such as road vibration and temperature extremes from snow, rain, or summer heat must be investigated so that these external loads are reflected in the battery's available capacity. To improve the accuracy of the SoH indicator algorithm, the BMS should be placed in a car for at least one year to obtain a better deterioration trend of the starter battery.

Besides, another project that connected to this system is “Performance monitoring of UPS battery using IoT” by (K Vijaya Manasa, PRABU A V, PRABU A V, M Sai Prathyusha, S Varakumari) (K Vijaya Manasa, PRABU A V, PRABU A V, M Sai Prathyusha, S Varakumari). There are certain significant ideas that can be employed after monitoring, evaluating, and examining their project.

The proposed project focuses on developing an energy-efficient and cost-effective model for an automatic UPS monitoring and control system, using PDAs to connect to machine level and machine level to PDAs. Nowadays, information-based communication systems such as Bluetooth, ZigBee, and Wi-Fi rely heavily on RF. IoT-based UPS offers a balanced trade-off between remote monitoring and control of the system to improve energy efficiency and production rate. The proposed system automatically monitors the four factors that each UPS runs on: current, voltage, temperature, and power. If any of the parameters, such as voltage and current, deviate from the ideal conditions during the drain out or wear-out, the values will be automatically monitored and displayed on an Android app application before being uploaded to the cloud (IoT). The chief engineer, supervisor, and control room would be notified of UPS breakdown situations via SMS and IOT.

2.5 Summary

As a result of the survey, it was determined to add a few more features to this product to answer the problem statement. The user-friendly interface of SmartBMS application and Daly BMS via IoT system, for example, might assist users in monitoring UPS systems. Simultaneously, UPS system development will reduce the time required for maintenance. For example, if a UPS system's battery has a problem, it will be detected by SmartBMS. As a result, the user can repair and concentrate just on the battery that is malfunctioning.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The graphical design is done over the Smart BMS software of the BMS. The working of BMS is totally based on the input in a form of information by the devices such as sensors, once the information is collected it can be processed with the help of controller that will further instruct the system to perform a specific task, in this BMS, switching on and off of the plant can be controlled in the same manner, plant can be set to a respective temperature in order to provide heating and cooling with respect to the temperature outside the UPS[4]. Intrusions can be easily monitored with the help Smart BMS application and LCD.

3.2 Design Phase

The information feedback of the system will be utilizing IoT platforms for uploading readings from the sensor to a mobile phone app. The app can be accessed by phones both android and iOS devices if they are connected to the Bluetooth and in this case, the application is set as the host as shown in the figure 3.2 below where the device name at local IP of DL-40D63A322BD5 which is coincidentally the address of the Bluetooth where any user can access by using Smart BMS app in their phone. Once the server is set, we can design the web application layout and the expected application output is shown in figure 3.3.

Figure 3.1 Bluetooth Module

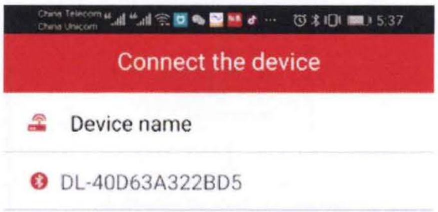

Figure 3.2 Connect the device via Bluetooth

Figure 3.3 Connect the device via Bluetooth

3.3 Flow Chart of the project

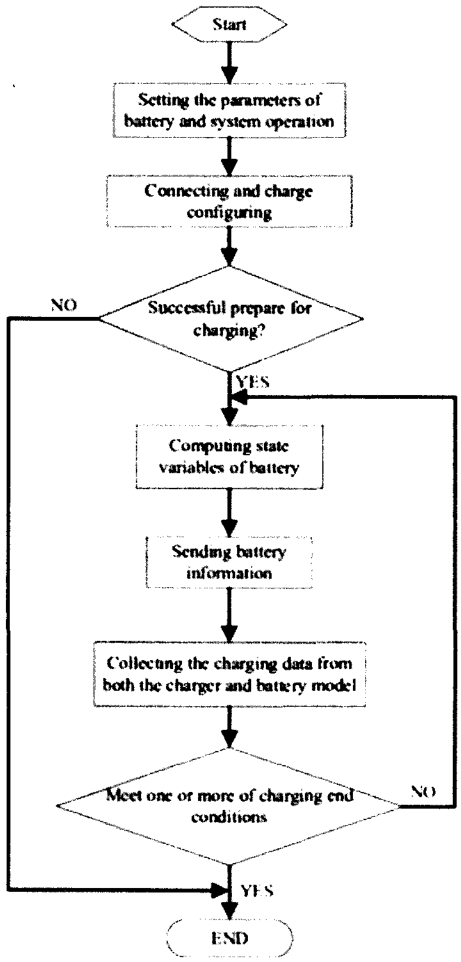

Figure 3.4 Flowchart of DalyBMS

3.4 System Design

The UPS monitoring system consists of five main important shown in Fig. 3.4.1.

The first component is a state of charge (SOC). In these applications, it is important to measure the state of charge (SOC) of the cells, which is defined as the available capacity (in Ah) and expressed as a percentage of its rated capacity. The SOC parameter can be viewed as a thermodynamic quantity enabling one to assess the potential energy of a battery.

The second component is Status Information. It used to get any information about the UPS system. It will show about any issue. Example, if the temperature is high it will tell at status information about it.

The third component is a temperature. Temperature is very important to be monitor for the safety issue. This provides for an optimum comfort vs. environmental benefit. This is in accordance with the LSE school policy, health and safety requirements and environmental recommendations. Therefore, cannot accommodate personal preferences that fall outside the above parameters.

Fourth is a battery string. For this part we can monitor every battery that has been used. It will show voltage every battery. It also shows the battery that has the highest voltage and the lowest voltage. The highest voltage battery will show in red colour and the lowest voltage will show in blue colour. The other will remain black.

Fifth is a parameter setting. The application design can set parameter of UPS system. The parameter that we can set such as temperature range, voltage range and switch for charging and discharging. The parameter can be set based on situation and environment.

3.5 Selection of Hardware Material

3.5.1 Daly 3.2V 32650 Smart BMS 16S 48V 60A LiFepo4 Battery BMS

There is no one-size-fits-all set of criteria that must be followed when it comes to battery management systems. The cost, complexity, and size of the battery pack are all related to the technology design scope and implemented features. The battery's use, as well as any safety, lifetime, or warranty concerns. Certification requirements stem from a variety of government regulations, with costs and penalties escalating if functional safety measures are inadequate.

BMS design characteristics include battery pack protection management and capacity management, which are two of the most important. Go over how these two features function in this section. Electrical protection, which involves passive and/or active temperature control to maintain or bring the pack into its SOA, and thermal protection, which involves passive and/or active temperature control to maintain or bring the pack into its SOA, are two key areas of battery pack protection management. Figure 3.5 shows Daly Smart BMS hardware that has been used.

Figure 3.5 Daly Smart BMS

Daly Smart BMS used as a gateway to the IoT-based for checking and updating the condition of UPS to user. In a compact package, LiFePO4 batteries carry a lot of power and value. The better performance of these batteries is mostly due to their chemistry. However, in addition to the battery cells themselves, all respectable commercial LiFePO4 batteries feature a properly built electronic battery management system (BMS). A well-designed battery management system safeguards and monitors a LiFePO4 battery, allowing it to perform better, last longer, and operate safely under a variety of situations. An internal or external BMS is included in all LiFePO4 batteries. First, consider how a Daly BMS safeguards and optimizes the performance of a lithium iron phosphate battery, including over and under voltage protection, overcurrent, and short circuit protection, over temperature protection, and cell imbalance protection.

3.5.2 Bluetooth Module

Bluetooth Functionality to SmartBMS with the module. Plugs into the UART port of BMS and connects to your Apple or Android Smartphone via Bluetooth. The Bluetooth Module is a simple Bluetooth SPP (Serial Port Protocol) module that allows for the construction of a transparent wireless serial connection. It communicates via serial communication, making it simple to connect to a controller or a mobile phone. The Bluetooth module allows you to switch between master and slave mode, which means you may use it for both receiving and delivering data.

3.5.3 LCD

Figure 3.6 LCD

Figure 3.6 is the LCD display that we used as a part of monitoring UPS system. LCD display the percentage of remaining battery power, voltage, temperature value. Liquid crystals have a structure that is halfway between that of liquids and that of crystalline solids. The molecules of a liquid crystal can flow past one another in the same way that they can in liquids. They do, however, arrange themselves in recognizable ordered patterns, just like solid crystals. Liquid crystals, like solid crystals, can display polymorphism, which means they can take on numerous structural patterns, each with its own set of attributes. Nematic or smectic liquid crystals are used in LCDs. As illustrated in the illustration, the molecules of nematic liquid crystals organize themselves with their axes parallel. Within distinct smectic phases, smectic liquid crystals, on the other hand, arrange themselves in layered sheets, as seen in the figure. The molecules may take on varied alignments relative to the plane of the sheets.

The direction light travels through a layer of liquid crystal determines its optical characteristics. An electric field created by a tiny electric voltage can impact the optical characteristics of a liquid crystal layer by changing the orientation of molecules in the layer. The electro-optical effect is the name for this type of operation, and it's what makes LCDs possible. The optical properties of nematic LCDs are changed by orienting the molecular axis either parallel or perpendicular to the applied electric field, with the preferred orientation controlled by the chemical structure of the molecule. To suit applications, liquid crystal materials that align parallel or perpendicular to an applied field can be used. LCDs' commercial success has been attributed to the low electric voltages required to orient liquid crystal molecules. Other display technologies have rarely come close to matching their low power usage.

3.6 Selection of Software Material

There is a software used in this project based on the specific function towards the process of making IoT based UPS system. The purpose of SmartBMS is to display and setting parameter for the UPS system. It also can be switch for charging and discharging. The application can be used Apple or Android Smartphone. The application can be download at google play store or apple app store. Figure 3.7 shows the application of SmartBMS.

Figure 3.7 SmartBMS Application

3.7 IoT based UPS system

Figure 3.8 UPS System architecture

3.8 Cost Analysis

Table 3.1 Cost Analysis Table for UPS monitoring.

ITEM	QUANTITY	PRICE(RM)
Daly 3.2V 32650 Smart BMS 16S 48V 60A LiFepo4 Battery BMS	1	RM306.50
Multi-function Battery Meter BMS LCD Digital Capacity Indicator Voltmeter	1	RM20.66
Total		RM327.16

3.9 Summary

Chapter 3 briefs about the flow of the methodology on how the system turn out once the systems start. Thus, explanation of the flowchart for the connection of the overall system and details of the terms for automatic section. Other than that, selection of the hardware and software material with details also discussed. Lastly, explained the final system and the final product of IoT based UPS system.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

In this chapter, the results of the monitoring UPS system are discussed in detail. We will discuss the interface of UPS monitoring system and the application setting parameter of UPS system.

4.2 Interface of UPS monitoring System

Firstly, must setup the Daly Smart BMS with the battery of UPS system. The reason connect wire to the battery because if detects any issue and BMS response it to the circuit for cut-off. Next, connect BMS to smart phone using Bluetooth. Enter the APP interface can see the corresponding Bluetooth serial number. The serial number is the same as the serial number posted on Bluetooth. The battery cannot be used until the problem settles. The problem will show in SmartBMS in status information part.

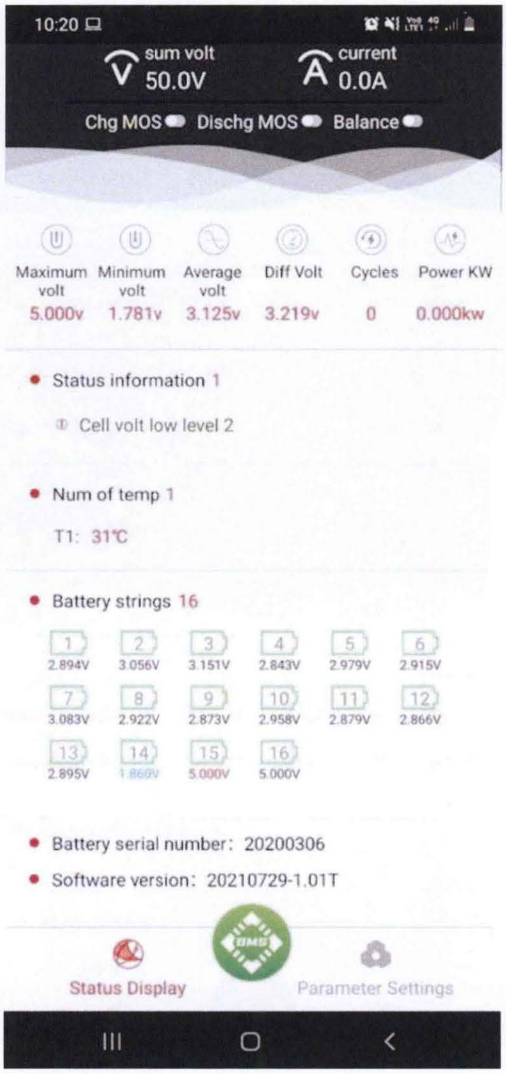

Figure 4.1 SmartBMS detect problem

In figure 4.1, the SmartBMS switch for charging and discharging is turn off because it has some issue on the battery. It also no current flow. The status information gives info that cell voltage low level 2. That information can be preferred on battery string. Battery 14 has the low voltage among other. It was easy to repair because the information given that there is some issue on battery 14.

Figure 4.2 SmartBMS shows no issue on UPS system

The figure 4.2. shows the SmartBMS detect good condition of UPS system. The switch for charging and discharging is turn on. So, the ups system can be charge and discharge. The current shown that 2.9A flow for charging purpose. The status information is empty because there is no issue in UPS system.

4.3 Parameter Setting

The protective system in a UPS system is crucial for maintaining the system's reliability and operability at the greatest levels. To attenuate and minimise areas affected by short-circuits caused by natural or planned faults in the system, the power protection is made up of several local and backup protection techniques. The faults should be addressed quickly by local protection for technical reasons, and the area affected by the service interruption should be limited to a minimum. The overcurrent relay is a common option for monitoring short-circuit currents, while the BMS is recommended for meshed systems since it can determine the fault currents' direction [1]. Typically, transmission line distance protection is designated as the primary protection system, with BMS serving as backup. BMS, on the other hand, can boost performance even more by fine-tuning its settings.

The reduction of the affected region is linked to the coordinated activity of several types of relays, which should result in the isolation of the smallest section of the system in the event of a short-circuit.

Various classical [4], [5], [6] and approximate computational approaches [6], [7], [8], [9], [10], [11], [12] have been developed to increase the speed, coordination, and selectivity of directional overcurrent protection relays by optimising their parameters. As a result, the best relay configuration is described as a nonlinear optimization problem with discrete variables.

For optimization, a performance index or expression that represents the quality of the relay setting is chosen, for example, the relay operation time, considering coordination constraints such as the operation of primary and backup relays, magnitude of short-circuit currents, system loading, and priority among protection systems.

The protection parameters, battery core characteristics, collection board settings, temperature protection, and charge and discharge control are the most important parameters in a UPS system. In the relays, these variables are represented as a continuous or discrete setting.

4.3.1 Protection Parameter Setting

Charging and discharging current limits are different for LiFePO4 cells, and both modes can withstand greater peak currents, albeit for short periods of time. Maximum continuous charging and discharging current limitations, as well as peak charging and discharging current limits, are normally specified by battery cell manufacturers. A current-protecting BMS will almost probably use a maximum continuous current. This might, however, be done first to accommodate for a sudden change in load conditions. By integrating the current and after delta time, a BMS can decide whether to limit the available current or interrupt the pack current entirely. This enables the BMS to respond almost instantly to severe current peaks, such as a short-circuit condition that has escaped the notice of any resident fuses, while also being forgiving of high peak demands if they are not sustained for an extended period. He gathered all the currents.

A LiFePO4 cell is required to operate within a specific voltage range. The intrinsic chemistry of the selected lithium-ion cell, as well as the temperature of the cells at any given time, will eventually decide these SOA bounds. Furthermore, because every battery pack undergoes extensive current cycling, draining owing to load demands, and charging from a variety of energy sources, these SOA voltage restrictions are typically further regulated to maximise battery lifespan. The BMS must know what these limitations are and will make judgments based on how close they are to being reached. When approaching the high voltage limit, for example, a BMS may request a gradual reduction in charging current or, if the limit is reached, a complete shutdown of charging current. To avoid control chatter regarding the shutdown threshold, this restriction is frequently complemented by extra intrinsic voltage hysteresis considerations. A BMS, on the other hand, will suggest that important active offending loads reduce their current needs when nearing the low voltage limit.

Enter the protection parameter setting interface, you can see five major sections which is cell volt high protect, celt volt low protect, sum volt high protects, sum volt low protects, different volt protect, charge overcurrent protect and discharge overcurrent protect. In the protection parameter interface, all data can be set. Figure 4.3 shows the interface of Protection parameter.

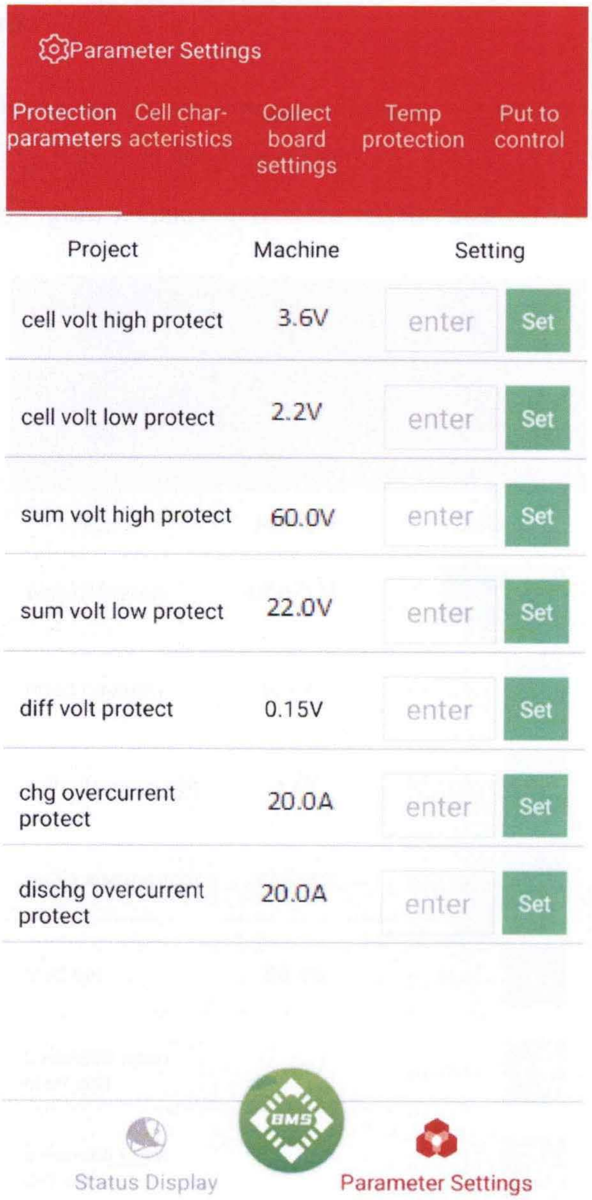

Figure 4.3 Protection Parameter Setting

4.3.2 Cell characteristic

In the battery cell characteristics, you can set the total capacity of the battery, the remaining capacity, and the balanced opening conditions. Set the sleep time to 65535S to cancel the sleep function. Figure 4.4 show cell characteristic that has been detect by BMS.

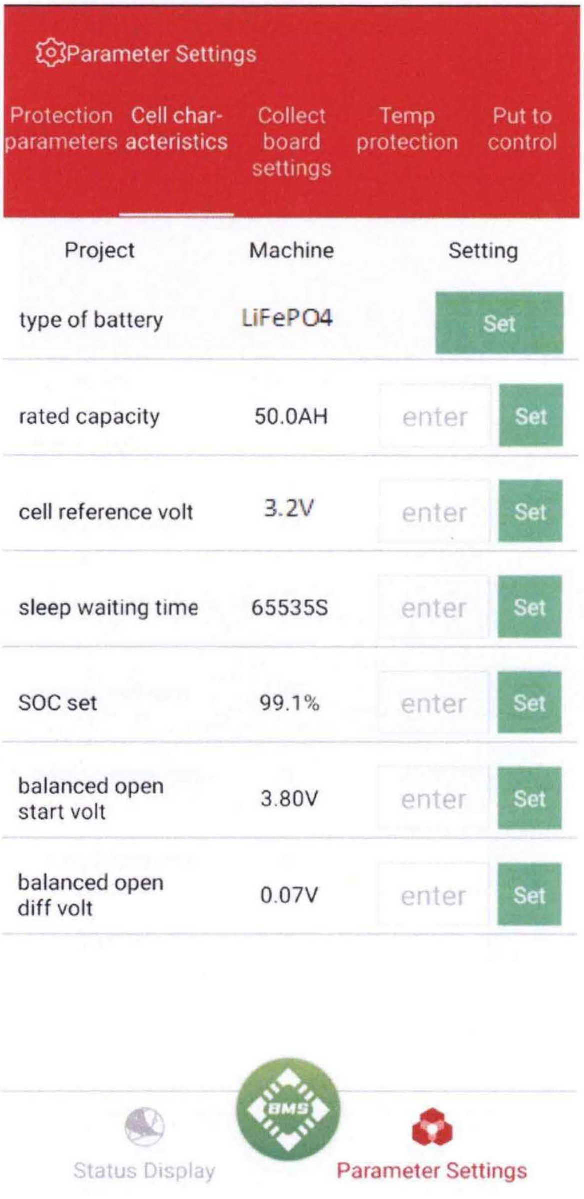

Figure 4.4 Cell characteristic

4.3.3 Collect board setting

In the acquisition board setting interface, it needs to be set together with the hardware device. It is not recommended that the user set this. Figure 4.5 shows the data that BMS collect and shows at Collect board setting interface.

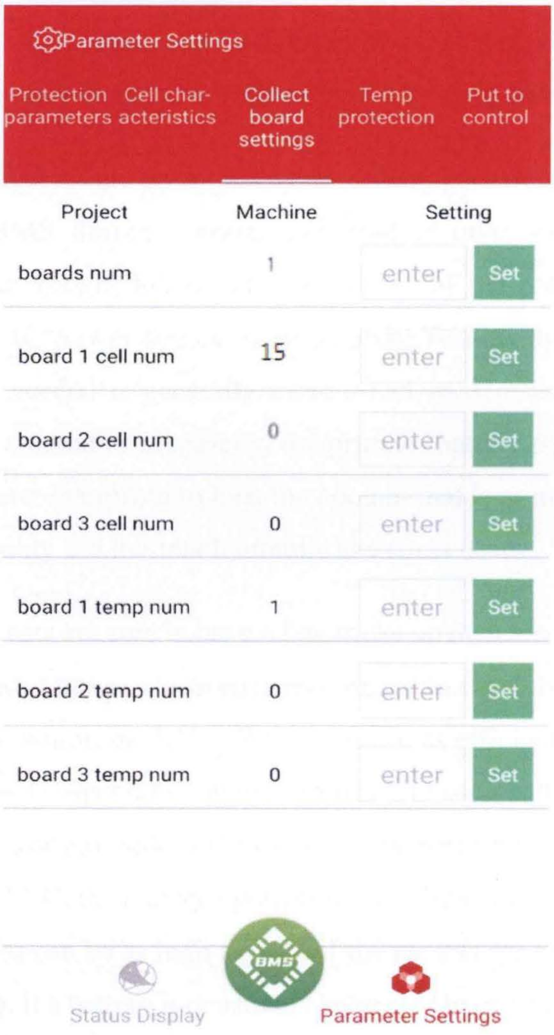

Figure 4.5 Collect board setting

4.3.4 Temperature Protection Setting

Although LiFePO4 cells appear to have a wide temperature operating range at first glance, their overall battery capacity decreases at low temperatures due to a significant slowdown in chemical reaction rates. They perform far better than lead-acid or NiMh batteries in terms of low-temperature capability. Temperature control is necessary, however, because charging below 0 °C (32 °F) is physically hazardous. During sub-freezing charging, a process known as metallic lithium plating can occur on the anode. This is irreversible damage that not only reduces capacity but also makes cells more sensitive to failure when exposed to vibration or other stressful situations. The temperature of the battery pack can be controlled by a BMS using heating and cooling.

Thermal management is entirely reliant on the battery pack's size and cost, as well as performance goals, BMS design criteria, and product unit, which may involve consideration of the target geographic region. Regardless of the heater type, drawing energy from an external AC power source or an alternate resident battery designed to activate the heater when needed is generally more effective. However, if the electric heater only draws a little amount of electricity, the primary battery pack can be used to heat itself. An electric heater is utilized to heat the coolant that is pumped and dispersed throughout the pack assembly if a thermal hydraulic system is used.

BMS design engineers are sure to have a few tricks up their sleeves to get thermal energy into the pack. Various power electronics specialized to capacity management, for example, can be turned on within the BMS. While it is not as efficient as direct heating, it can still be used. Cooling is especially important for lithium-ion battery packs to avoid performance degradation. For example, suppose a battery performs best at 20°C; if the pack temperature rises to 30°C, the battery's performance efficiency drops by as much as 20%. The performance loss can be as high as 50% if the pack is repeatedly charged and recharged at 45°C (113°F). If a battery is constantly subjected to extreme heat generation, such as during fast charging and discharging cycles, it can suffer from premature ageing and degradation. Cooling can be accomplished in one of two ways: passive or active, and both strategies can be used. The battery is cooled by passive cooling, which relies on air flow. In the case of an electric vehicle, this means it's just driving down the road. Air speed sensors might be added to strategically auto-adjust deflective air dams to optimum air flow, making it more complex than it appears. At low speeds or when the vehicle is stopped, an active temperature-controlled fan can help, but it can only equalize the pack's temperature with the surrounding ambient temperature. This could raise the initial pack temperature if it's a blistering hot day. Thermal hydraulic active cooling is a complementary system that circulates ethylene-glycol coolant with a specified mixture ratio through pipes or hoses, distribution manifolds, a crossflow heat exchanger radiator, and a cooling plate against the battery pack assembly via an electric motor-driven pump. The temperature of the total battery is monitored by a BMS, which opens and closes numerous valves to keep it within a tight temperature range for maximum battery performance.

In the temperature protection setting, the protection temperature of charge and discharge can be set. Figure 4.6 shows the temperature protection setting from SmartBMS app.

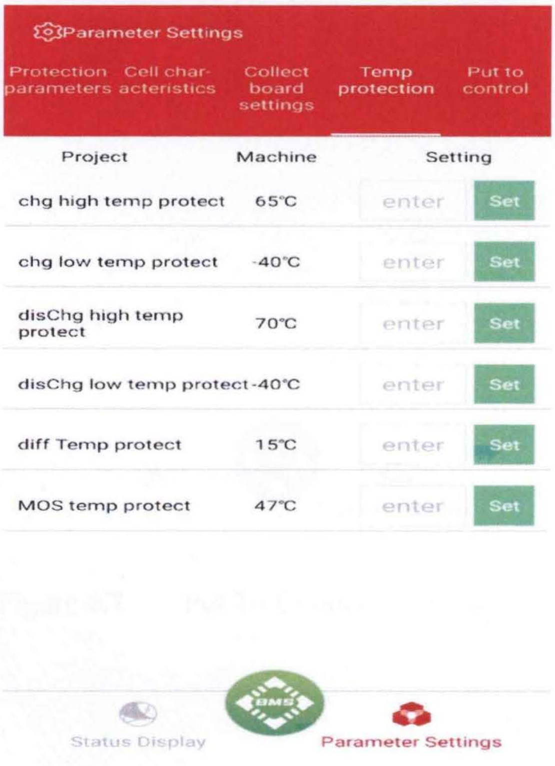

Figure 4.6 Temperature Protection Setting

4.3.5 Put To Control Setting

On the charge and discharge control interface, you can switch the charge and discharge MOS tube, and you can reset the password. Figure 4.7 show the Put to Control Setting interface.

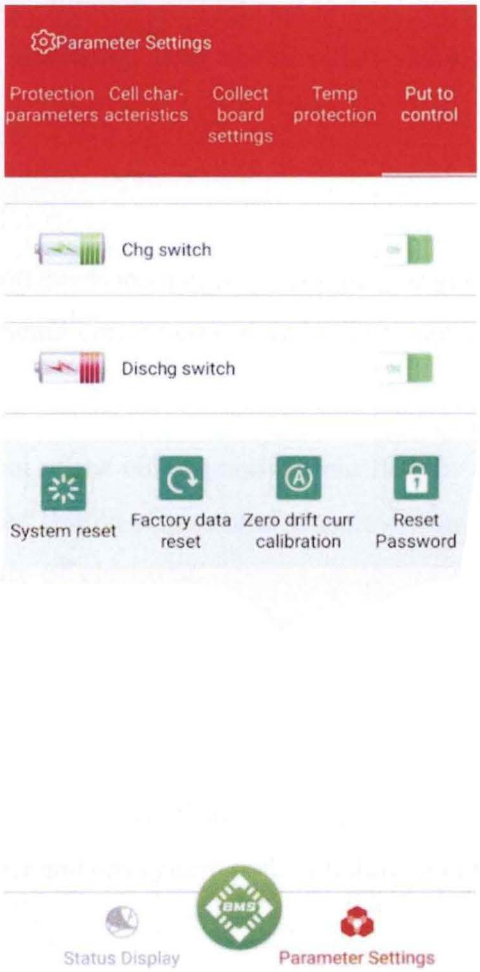

Figure 4.7 Put To Control Setting

4.4 Discussion

This project covers a fair number of technologies from hardware to software, and then combine them to produce an UPS monitoring system. A vast body of technical research and testing were done to find out appropriate technologies for this project. During development, there are several problems arising which help the developer learns not only technical but also problem-solving skills by finding out how to face those challenges. The whole project duration is supposed to be 7 weeks, but it takes shorter time to UPS system from scratching. It is obvious that many functions still can be developed further.

4.4.1 Obstacles

The mobile application meets most of requirements, but some problems still exist. Therefore, further developments can be considered. There are two obstacles that we found in doing this project.

First, the measurement of the voltage and current flow by the Sensor still shows some minor errors. During the testing stage, some sensors display an unusual value that can cause strange behaviours of electronic devices or severe damages for the whole system. In conclusion, it could be a calibration issue.

Lastly, the connection from the BMS to the application is deployed or bad connection. Even though BMS built with Bluetooth connection, there are a method to connect them directly. The data which flows from BMS to the application can be interrupted by the range of user and ups system make a failure of connection performance.

4.4.2 Limitation

The limitation of the cost makes some issue for the component of the UPS system project. Some component was expensive that made us to choose the best for the UPS system. If have a big budget, this project can be improved and can be marketed based on SIRIM specification.

CHAPTER 5

CONCLUSION

5.1 Introduction

In conclusion after reviewing the existing platforms for IoT application development, BMS as a tool that is aligned with our research goal of facilitating the development of stream processing applications.

presents a low-cost real-time UPS monitoring system. The BMS device is built with switch, sensor, UART,BT or GPS port, 485 port and CAN port. The UPS monitoring dashboard is implemented on BMS to receive and display UPS data. With BMS, can monitor the flow to manage and handle UPS, thus can set the condition parameter to notify users about the UPS issue through UPS monitoring system. The device and BMS communicate via Bluetooth in the publish and subscribe model.

5.2 Recommendation

To summarize, to improve this project in future, several recommendations have been identified there is still work that needs to be done for BMS to make it more powerful for building IoT applications. Can used RS485 port and CAN port as a part of monitoring system.

RS485 external box can provide communication slot for the inverter without intelligent slot. Via the communication between the inverter and lithium battery, it's able to re-configure the charging voltage, charging current, battery discharge cut-off voltage and max. It is connected to SmartBMS LCD Touch Screen. The price is a little bit expensive.

CAN port will allow to connect a CAN network with an USB network. It can be monitor easily using laptop at any distance. That make no issue about the user location or distance to monitor the UPS system.

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APPENDICES

Appendix A: Material List and their respective price

Table 5.1 Budget Analysis

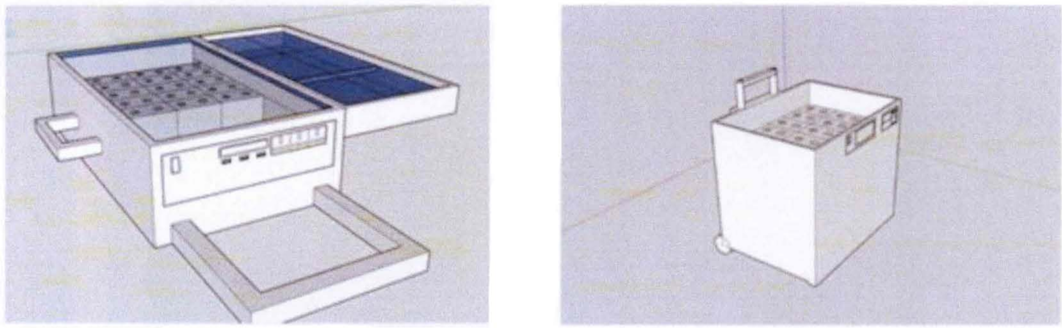
ITEM	QUANTITY	PRICE(RM)
Daly 3.2V 32650 Smart BMS 60A,w/B 485 CAN	1	RM306.50
JUXING Power inverter pure sine wave DC12V		
6000W 48V to 220V	1	RM311.49
48V 60A Solar Controller Intelligent Display	1	RM145.55
MCB C40	1	RM30.00
Casing DIY	1	RM58.63
	Total	RM852.17

Appendix B: Gantt chart project planning of SDP 2

Table 5.2 Gantt chart project planning SDP 2

TASK/WEEK	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
SDP 2 Briefing													
Project meeting													
Specify requirement													
Develop prototype													
Construct the Circuit and monitoring system													
Thesis first draft													
Draft correction													
Thesis second draft													
Finalize porotype and monitoring system													
Presentation SDP 2													

Appendix C: Design and prototype



Before After

Figure 5.1 Prototype design using SketchUp

Appendix D: Final project

Figure 5.2 Front view of the real project

Appendix E: Picture after finish presentation

Figure 5.3 Pictures with team group after finish presentation