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POWERUP PASS MANAGEMENT SYSTEM

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ABSTRACT

This article presents the demonstrator's own application framework for a BLDC motor drive. This demonstration is designed to fulfill the promises made by ST Microelectronics about the R3-PowerUP initiative. As a result, ST devices—particularly the STM32 ARM microcontroller—are employed primarily. The application structure, drivers and peripherals utilized, and the developed cascade control mechanism are all described in the paper. As a consequence, live variables acquired from the MCU are used to display the step responses of both control loops.

Keywords: cascade control, R3-PowerUP, STM32, ARM, motor control, and BLDC.

I. INTRODUCTION

The revolutionary "PowerUp Pass" bridges the gap between the cutting-edge technology found in electric car charging stations and the common requirement for on-the-go charging of electronic devices. This revolutionary technology, in contrast to traditional charging methods, allows customers to conveniently schedule times for charging their electronic devices via an easy-to-use mobile application. People may schedule a charging time and pay according to the amount of power used and the time it takes to charge their device thanks to the user-friendly interface.

Figure.1: Charging Stations

Central to the functionality of PowerUp Pass are key components such as the nodemcu, relay, and an OLED display. The nodemcu serves as the central intelligence, facilitating smooth communication between the user's mobile app and the charging station. The relay, acting as a power controller, ensures the secure and efficient flow of energy to the charging ports. The OLED display plays a pivotal role in providing real-time information to users, including details such as the amount spent, remaining charging time, and the charging percentage.

PowerUp Pass marks a significant advancement in enhancing the accessibility and convenience of charging solutions for everyday electronic devices. By integrating state-of-the-art technologies into a user-friendly mobile application and incorporating essential components like nodemcu, relay, and OLED, PowerUp Pass not only simplifies the charging process but also redefines the user experience in the realm of electronic gadget charging. This introduction sets the stage for a deeper exploration of PowerUp Pass, delving into its intricacies and highlighting the transformative impact it holds in reshaping the landscape of on-the-go electronic device charging.

1.1: Problem Statement:

The surge in our reliance on electronic devices has underscored the critical need for accessible and efficient charging solutions, marking a significant shift in the way we integrate technology into our daily lives. While electric vehicle charging stations have become commonplace, a notable gap persists in

adequately addressing the charging requirements of everyday electronic gadgets. The ubiquity of smartphones, tablets, and other portable devices has created a demand for dedicated charging infrastructure tailored to the needs of users seeking a reliable and convenient means to charge their devices on the go.

This identified gap forms the core of the problem statement, revealing a substantial challenge in the current technological landscape. The absence of a dedicated and streamlined charging solution for electronic gadgets hinders users from seamlessly incorporating charging into their daily routines, presenting an opportunity for innovation and improvement. Recognizing this challenge, the development of an innovative system like "PowerUp Pass" becomes imperative to fill this void and meet the evolving needs of the digital era.

The overarching goal is to bridge this gap by introducing a charging infrastructure that integrates seamlessly into users' daily lives. The envisioned solution, "PowerUp Pass," aims to redefine the charging experience for electronic gadgets, offering a user-friendly, efficient, and secure platform. Users will have the ability to book charging slots conveniently through a mobile app, facilitating a more organized and predictable approach to device charging.

The integration of key technologies, including nodemcu, relay, and an OLED display, enhances the functionality and user experience of "PowerUp Pass." The nodemcu acts as the central intelligence, facilitating communication between the user's mobile app and the charging station. The relay ensures secure and efficient power flow to the charging ports, while the OLED display provides real-time information, including the amount spent, remaining charging time, and charging percentage.

Successfully addressing this problem statement holds the promise of significantly enhancing the overall accessibility and user experience within the realm of on-the-go electronic device charging. The development of "PowerUp Pass" represents not just a solution to a pressing problem but a step towards creating a more connected, technologically empowered, and user-centric society. This innovative system aims to contribute to the seamless integration of charging solutions into the fabric of our daily lives, addressing the evolving needs of the digital era and fostering a more sustainable and convenient approach to powering our electronic devices.

1.2: Problem Scope:

The scope of the identified problem is expansive, encompassing the increasing reliance on electronic devices and the growing demand for efficient charging solutions. The ubiquity of smartphones, tablets, and other portable gadgets has given rise to a pressing need for dedicated charging infrastructure. While electric vehicle charging stations have proliferated, there remains a conspicuous gap in addressing the unique charging requirements of everyday electronic devices. This gap poses a challenge for users who seek a reliable and convenient means to charge their devices on the go, hindering the seamless integration of technology into their daily routines.

The problem scope extends to the absence of a streamlined and user-friendly charging solution tailored specifically for electronic gadgets. The current limitations in charging infrastructure prevent users from maximizing the potential of their devices without disruptions. The identified problem is not confined to a specific demographic; instead, it resonates with a broad spectrum of users who navigate their daily lives with an array of electronic devices. The lack of a dedicated charging system for these devices limits accessibility and convenience, necessitating an innovative solution.

In response to this problem scope, "PowerUp Pass" aims to redefine the charging experience

for electronic gadgets, presenting an opportunity for a comprehensive solution. By focusing on user-friendly mobile app interactions, seamless booking of charging slots, and efficient payment mechanisms, the proposed system endeavors to fill this gap in the charging infrastructure, offering users a more organized and predictable approach to charging their devices on the go.

The envisioned solution is not just confined to technical intricacies but extends to creating a paradigm shift in how users perceive and engage with charging solutions. The integration of technology components, including nodemcu, relay, and OLED display, further amplifies the potential impact of "PowerUp Pass" within the broad problem scope. Ultimately, the problem scope reaches beyond the technical realm, delving into the realms of user experience, accessibility, and the seamless integration of charging solutions into the fabric of daily life. Addressing this comprehensive scope will contribute to a more connected, technologically empowered, and user-centric society.

1.3: Advantages of using powerup pass

The development and implementation of "PowerUp Pass" present numerous advantages that address the identified problem scope and contribute to reshaping the landscape of on-the-go electronic device charging.

1. Enhanced Accessibility: "PowerUp Pass" brings a dedicated and user-centric charging infrastructure to electronic device users, ensuring accessibility for a broad spectrum of users who rely on gadgets in their daily lives.

2. Convenience and Predictability: The mobile app interface allows users to conveniently book charging slots, providing a predictable and organized approach to charging electronic devices. Users can plan and integrate charging seamlessly into their daily routines.

3. User-Friendly Experience: The streamlined mobile app interaction ensures a user-friendly experience, making the process of reserving charging slots, making payments, and monitoring charging status intuitive and efficient.

4. Efficient Resource Utilization: Through the integration of technologies like nodemcu and relay, "PowerUp Pass" optimizes resource utilization by efficiently controlling power flow to charging ports, ensuring a secure and efficient charging process.

5. Real-Time Information: The OLED display component provides users with real-time information, including the amount spent, remaining charging time, and charging percentage, enhancing transparency and allowing for informed decision-making.

6. Technological Integration: Leveraging components such as nodemcu, relay, and OLED display, "PowerUp Pass" represents a seamless integration of cutting-edge technologies, enhancing the overall functionality and reliability of the charging system.

7. User-Centric Paradigm Shift: "PowerUp Pass" contributes to a paradigm shift in how users perceive and engage with charging solutions, emphasizing user-centric design and providing a solution that aligns with the evolving needs of the digital era.

8. Sustainable Charging Practices: By allowing users to pay for both the charging time and the electricity consumed, "PowerUp Pass" promotes environmentally conscious charging practices, contributing to sustainability and responsible resource usage.

9. Broad Applicability: The proposed solution is designed to cater to a diverse user base, offering a charging infrastructure that meets the needs of individuals ranging from professionals to students, ensuring broad applicability.

10. Technological Empowerment: Through its innovative approach and use of technology, "PowerUp Pass" empowers users by providing them with a solution that not only meets their charging needs but also aligns with the

increasing integration of technology into daily life.

In essence, the advantages of "PowerUp Pass" extend beyond mere technical efficiency, encompassing user experience, sustainability, and the broader integration of charging solutions into the fabric of daily life, contributing to a more connected, efficient, and empowered society.

1.4 Proposed Solution:

The proposed system, "PowerUp Pass," represents a comprehensive solution to address the identified problem scope of the lack of streamlined and user-friendly charging infrastructure for everyday electronic devices. This innovative system is designed to revolutionize the landscape of on-the-go electronic device charging, offering a host of features and functionalities that enhance accessibility, convenience, and user experience.

1. User-Friendly Mobile App: "PowerUp Pass" introduces a user-friendly mobile app interface, allowing users to effortlessly reserve charging slots, make payments, and monitor charging status. The intuitive design ensures a seamless and engaging experience for users.

2. Dedicated Charging Infrastructure: The system establishes a dedicated charging infrastructure tailored specifically for electronic gadgets, filling the existing gap in charging solutions and providing users with a reliable means to charge their devices on the go.

3. Seamless Booking and Payments: Through the mobile app, users can conveniently book charging slots, enabling a more organized and predictable approach to charging. Payments for both the charging time and electricity consumed are seamlessly integrated into the booking process.

4. Technological Components: The integration of key technological components, including nodemcu, relay, and an OLED display, forms the backbone of "PowerUp Pass." Nodemcu facilitates communication, relay controls power flow, and the OLED display provides real-time information to users.

5. Real-Time Information Display: The OLED display presents users with crucial real-time information, including the amount spent, remaining charging time, and charging percentage. This enhances transparency and empowers users to make informed decisions about their charging needs.

6. Enhanced Accessibility: "PowerUp Pass" ensures enhanced accessibility for a broad spectrum of users who rely on electronic gadgets, catering to professionals, students, and individuals from diverse backgrounds.

7. Sustainable Charging Practices: By allowing users to pay for both the charging time and the electricity consumed, "PowerUp Pass" encourages sustainable charging practices, aligning with the global emphasis on responsible resource usage and environmental consciousness.

8. Efficient Resource Utilization: The system optimizes resource utilization through the efficient control of power flow to charging ports, ensuring a secure and efficient charging process for electronic devices.

9. Paradigm Shift in User Experience: "PowerUp Pass" contributes to a paradigm shift in how users perceive and engage with charging solutions, emphasizing a user-centric design that aligns with the evolving needs of the digital era.

10. Broad Applicability and Technological Empowerment: With its innovative approach and technological integration, "PowerUp Pass" is poised to empower users by providing a solution that not only meets their charging needs but also contributes to a more connected, efficient, and technologically empowered society.

The proposed system, "PowerUp Pass," is a forward-thinking solution designed to fill the existing gap in on-the-go electronic device

charging. By combining a user-friendly mobile app, dedicated charging infrastructure, key technological components, and sustainable practices, the system aims to redefine the charging experience, offering users a solution that seamlessly integrates into their daily lives.

1.5 Aim and Objectives

Aim:

The aim of the proposed system, "PowerUp Pass," is to revolutionize on-the-go electronic device charging by introducing a dedicated and user-friendly charging infrastructure. This system aims to address the existing gap in streamlined charging solutions for everyday electronic gadgets, enhancing accessibility, convenience, and sustainability.

Objectives:

1. Develop a User-Friendly Mobile App: Design and develop an intuitive mobile app interface that allows users to easily book charging slots, make payments, and monitor charging status.

2. Establish Dedicated Charging Infrastructure: Create a dedicated charging infrastructure tailored specifically for electronic gadgets, providing users with reliable and accessible on-the-go charging solutions.

3. Enable Seamless Booking and Payments: Implement a seamless booking system through the mobile app, allowing users to efficiently reserve charging slots and make payments for both charging time and electricity consumed.

4. Integrate Technological Components: Integrate key technological components, including nodemcu for communication, relay for power flow control, and an OLED display for real-time information presentation.

5. Provide Real-Time Information Display: Implement an OLED display to present users with real-time information, including the amount spent, remaining charging time, and charging percentage, enhancing transparency and user control.

6. Enhance Accessibility: Ensure the system is accessible to a broad spectrum of users, catering to professionals, students, and individuals with diverse electronic gadget charging needs.

7. Encourage Sustainable Charging Practices: Promote sustainable charging practices by allowing users to pay for both the charging time and electricity consumed, aligning with global initiatives for responsible resource usage.

8. Optimize Resource Utilization: Optimize resource utilization through efficient control of power flow to charging ports, ensuring a secure and efficient charging process.

9. Foster a Paradigm Shift in User Experience: Contribute to a paradigm shift in how users perceive and engage with charging solutions, emphasizing user-centric design and integration into daily routines.

10. Ensure Broad Applicability and Technological Empowerment: Design the system to be applicable to a diverse user base and empower users through innovative technological integration, contributing to a more connected, efficient, and technologically empowered society.

The objectives outlined above collectively work towards achieving the overarching aim of "PowerUp Pass" — to redefine on-the-go electronic device charging, filling the existing gap and enhancing the overall user experience.

II. LITERATURE SURVEY

The literature survey explores the existing body of knowledge surrounding on-the-go electronic device charging solutions and identifies key insights that inform the development of "PowerUp Pass." Studies in the field highlight the increasing reliance on electronic devices in daily life, emphasizing the need for accessible and efficient charging infrastructure. Existing research reveals a gap in dedicated charging solutions for everyday gadgets, contrasting with the prevalence of electric vehicle charging stations. Literature also underscores the

challenges users face in finding reliable and convenient on-the-go charging options, emphasizing the significance of user-friendly interfaces and streamlined processes.

Technological integration is a focal point in the literature, with studies showcasing the role of components like nodemcu, relay, and OLED displays in optimizing charging systems. The importance of sustainable charging practices is highlighted, aligning with global initiatives for responsible resource usage. Furthermore, research emphasizes the role of mobile apps in enhancing user experience and convenience, providing valuable insights into the design and functionality aspects that should be considered in the development of "PowerUp Pass." The literature survey establishes a foundation for the proposed system, drawing from existing research to address the identified problem scope and contribute to the evolving landscape of on-the-go electronic device charging.

The literature survey delves into the realm of on-the-go electronic device charging, shedding light on the burgeoning demand for efficient charging infrastructure amid the escalating reliance on electronic gadgets in daily life. Extant studies underscore the pressing need for accessible and user-friendly charging solutions, a demand that stands in stark contrast to the proliferation of electric vehicle charging stations. Researchers highlight the notable gap in dedicated charging infrastructure for everyday gadgets, underscoring the necessity for streamlined processes and intuitive interfaces in addressing users' evolving needs.

The literature extensively discusses technological integration as a cornerstone in the evolution of charging systems. Components such as nodemcu, relay, and OLED displays emerge as pivotal elements in optimizing charging efficiency and user experience. Sustainable charging practices garner attention in the literature, aligning with global sustainability initiatives and emphasizing responsible resource utilization. Moreover, research accentuates the pivotal role of mobile applications in enhancing user convenience and interaction, offering valuable insights into design considerations and functional requirements pivotal for "PowerUp Pass" development.

Through synthesizing existing research, the literature survey lays the groundwork for "PowerUp Pass," drawing on insights to bridge the identified gap in on-the-go electronic device charging. By leveraging technological advancements and prioritizing user-centric design principles, the proposed system aims to redefine the charging experience, catering to the diverse needs of contemporary gadget users. The literature survey thus serves as a catalyst for innovation, shaping the trajectory of electronic device charging and contributing to the ongoing evolution of charging solutions in the digital era.

III. BLOCK DIAGRAM

The methodology for developing "PowerUp Pass" follows a systematic and informed approach, drawing insights from the comprehensive literature survey conducted. The initial phase involves a meticulous requirement analysis, synthesizing the identified challenges in on-the-go electronic device charging and the desired features derived from existing research. Stakeholder engagement is crucial during this phase to ensure the system addresses diverse user needs effectively. Following this, the selection and integration of technological components, including nodemcu, relay, and OLED displays, are prioritized, leveraging insights from literature emphasizing their pivotal roles in optimizing charging systems.

The system's architecture is meticulously designed to incorporate these components seamlessly, ensuring the efficient control of power flow and real-time information display, aligning with the technological integration

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highlighted in the literature. The development of a user-friendly mobile app takes center stage, with an emphasis on insights gleaned from the literature regarding the significance of streamlined processes and intuitive interfaces. Sustainability principles derived from the literature guide the incorporation of features encouraging responsible resource usage.

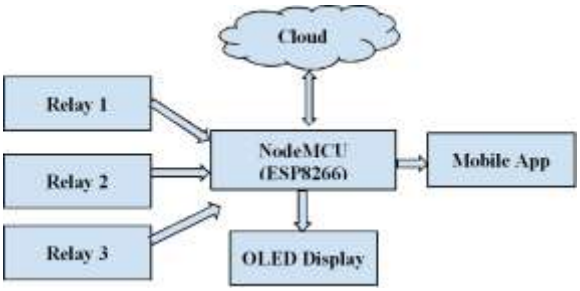

Figure.2: Block diagram

Usability testing and continuous improvement, based on feedback from potential users, play a critical role in refining the user interface and overall system functionality. The methodology also includes a pilot deployment with select users to gather real-world feedback and identify areas for improvement before a full-scale implementation. Rigorous testing and quality assurance measures are implemented to ensure the functionality, security, and reliability of "PowerUp Pass."

The methodology synthesizes findings from the literature survey, leveraging insights to inform the development process systematically. By combining technological integration, user-centric design principles, and sustainability considerations, the methodology aims to deliver a transformative on-the-go electronic device charging solution in the form of "PowerUp Pass."

IV. HARDWARE COMPONENTS

4.1 NodeMCU (ESP8266)

The NodeMCU ESP8266 is a powerful and versatile platform designed for Internet of Things (IoT) development. The ESP8266 is a cost-effective Wi-Fi microchip known for its capability to enable wireless communication in IoT applications. NodeMCU, on the other hand, is an open-source firmware and development kit that simplifies the process of prototyping and programming the ESP8266. With built-in Wi-Fi connectivity, the NodeMCU ESP8266 allows devices to connect to the internet wirelessly, making it suitable for a wide range of IoT projects. One notable feature is its support for the Lua scripting language, providing a high-level programming environment for developers. Additionally, it is compatible with the Arduino IDE, allowing those familiar with Arduino to use the NodeMCU platform. Equipped with General Purpose Input/Output (GPIO) pins, the ESP8266 facilitates interfacing with various electronic components, making it ideal for applications such as home automation and sensor networks. The NodeMCU ESP8266 has garnered significant community support, resulting in an extensive collection of libraries and documentation, making it a popular choice for rapid IoT prototyping and development.

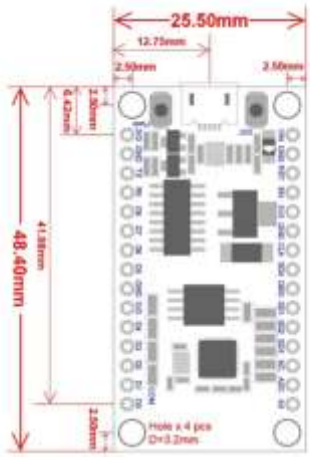

Figure.3: NodeMCU 2D View

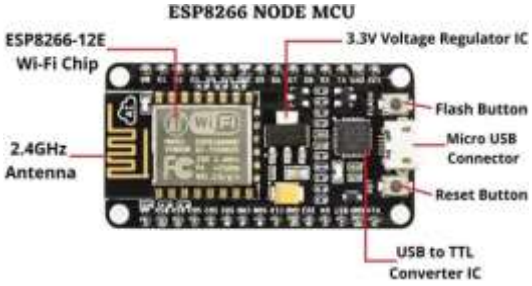

Figure.4: NodeMCU Parts

The NodeMCU ESP8266 development board typically has GPIO (General Purpose Input/Output) pins that can be used for various purposes, including interfacing with sensors, actuators, and other electronic components. Below is a common pinout configuration for the NodeMCU development board

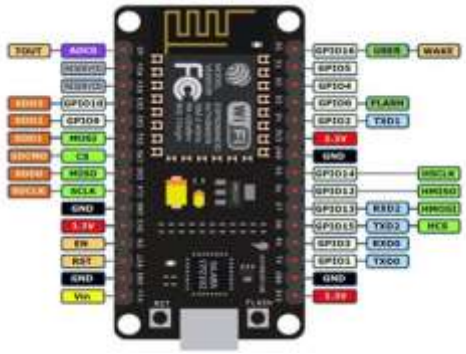

Figure.5 : NodeMCU ESP8266 Pinout

4.2 Relay Module:

Figure.6: Relay Module

A relay sensor, also known as a relay switch or simply a relay, is an electrical component that functions as an electromagnetic switch. It operates by using a small control signal to activate a larger load or circuit. Relays are commonly used in various applications to control high-power devices or circuits using low-power signals. They are widely used in automation, industrial control systems, automotive systems, and more.

4.3 OLED Display:

OLED displays are available in a range of sizes (such as 128×64, 128×32) and colors (such as white, blue, and dual-color OLEDs). Some OLED displays have an I2C interface, while others have an SPI interface.

One thing they all have in common, however, is that at their core is a powerful single-chip CMOS OLED driver controller – SSD1306, which handles all RAM buffering, requiring very little work from your Arduino.

In this tutorial, we'll be using both I2C and SPI 0.96-inch 128x64 OLED displays. Don't worry if your module is a different size or color; the information on this page is still useful.

Figure.7: OLED Display

An OLED display, unlike a character LCD display, does not require a backlight because it generates its own light. This explains the display's high contrast, extremely wide viewing angle, and ability to display deep black levels. The absence of a backlight reduces power consumption significantly. The display uses about 20mA on average, though this varies depending on how much of the display is lit.

The SSD1306 controller operates at 1.65V to 3.3V, while the OLED panel requires a 7V to 15V supply voltage. All of these various power requirements are fulfilled by internal charge pump circuitry. This makes it possible to connect the display to an Arduino or any other 5V logic microcontroller without requiring a logic level converter.

OLED Memory Map

In order to control the display, it is crucial to understand the memory map of the OLED display.

Regardless of the size of the OLED display, the SSD1306 driver includes a 1KB Graphic Display Data RAM (GDDRAM) that stores the bit pattern to be displayed on the screen. This 1 KB memory area is divided into 8 pages (from 0

to 7). Each page has 128 columns/segments (block 0 to 127). And, each column can store 8 bits of data (from 0 to 7). That certainly proves that we have:

8 pages x 128 segments x 8 bits of data = 8192 bits = 1024 bytes = 1KB memory

The entire 1K memory, including pages, segments, and data, is highlighted below.

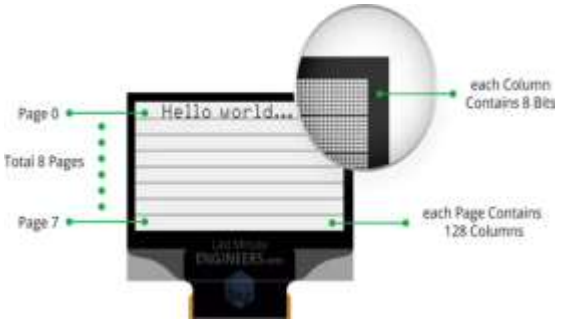

Figure.8: OLED Rows and Columns

OLED Display Module Pinout

Figure.9: OLED Pinout

GND is the ground pin.

VCC is the power supply for the display, which we connect to the 5V pin on the Arduino.

SCL is a serial clock pin for the I2C interface.

SDA is a serial data pin for the I2C interface.

V. CONCLUSION

The BLDC motor driver software structure implementation using cascade control structure into the STM32 ARM MCU is shown in this work. A few enhancements were discovered during development and will be included to our next controller prototype. Since a sensor-less algorithm must first have a well-tuned current and speed loop, the project's end results are presented in the last chapter as the step response of both control loops. Subsequent software work will focus on putting these enhancements into practice, using sensor-less algorithms, and comparing the results with encoder signals.

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