

INNOVATIVE ELECTRICAL SAFETY EQUIPMENT: AUTOMATIC CUT-OFF SMART PLUG POINT IN RESIDENCIAL AREA.

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Abstract

This project proposes the development of a Smart Plug Point with an Automatic Cut-Off System to enhance electrical safety and energy management in households. The smart plug point plug aims to provide users with advanced control, monitoring, and protection features for their connected devices. The plug will continuously monitor parameters such as current and voltage through ACS712-30A current sensor. Through intelligent algorithms and sensors, it will detect abnormal conditions such as overloading, short-circuit and automatic cut-off system as safety mechanism. Its safety features, the smart plug point will offer energy monitoring capabilities, empowering users to track energy consumption for save cost and analyse the data to make sure there no fault occurs. Live current value will be visualize and warning notification will be shown in Blynk application which will be transmitted by ESP32.

Keywords: ACS712-30A current sensor, Alert notification, Cut-off system, ESP32.

INTRODUCTION

The smart plug point is built around the ESP32 microcontroller, overcurrent protector and ACS712-30A current sensor module. ESP32 microcontroller which is well-known for its robust processing power and built-in Bluetooth and Wi-Fi components, which allow for smooth data transfer. The Blynk IoT platform, which allows for user control, alarm notifications, and real-time data visualization, is integrated with the system. The incorporation of Internet of Things technology enables users to remotely monitor power consumption, identify irregularities, and take action using a smartphone application. The overcurrent protector worked as safety appliance for overcurrent situation and low current situation. The overcurrent protector will have its own sensitivity for the current value which can be adjusted by the users according to the appliance for an example in this plug point situation the minimum current is 0.1A and the maximum current value can be reach until 15A. The overcurrent protector will be cut-off the current when it is reached the maximum or minimum value as a safety precaution step. The data of current value will be detected or calculated by the ACS712-30A current sensor module. This current sensor module can be detect the current value bellow 30A.

This innovations's aim is to create an intelligent, user-friendly electrical monitoring system that improves energy efficiency and safety. In addition to reviewing up to 15 days of previous usage, users will have access to daily statistics on current and power consumption through a stand-alone application. Additionally, the system will use vibration and sound alarms to guarantee prompt attention in the event of a short circuit. In order to protect linked devices and avoid potential risks, the smart plug is also made to immediately cut off the current flow in the event of a short circuit,

overload, or overheating. In both home and commercial contexts, this project aims to provide a complete solution for electrical system monitoring, alerting, and protection.

The innovation's significance is power monitoring capabilities in a smart plug point can provide valuable insights into power consumption. Users are able to detect energy-hungry gadgets and make informed decisions about their usage with the help of real-time information as well as historical statistics. Through monitoring and streamlining their energy usage, consumers can cut down on waste, preserve energy, and even save money on power costs. A greener lifestyle is encouraged and sustainability goals are aligned with the integration of energy saving elements. Maintaining safety when working with electrical instruments is crucial. Surge protection and overload detection are two characteristics that a smart extension plug socket might provide to protect connected devices from power or voltage spikes. Overloading and related electrical risks can be avoided by the socket actively monitoring each device's power use. In order to guarantee quick action in the event of any safety problems, real-time warnings and notifications can also be put into place.

LITERATURE REVIEW

The **Smart Life Wi-Fi Smart Socket Smart Home Plug**, developed by the **Mybotic Team** in **2014**, introduced advanced features such as remote switching, smart timing control, and scheduling through smartphones compatible with both iOS and Android systems. It allowed users to automate home appliance operations, promoting energy efficiency, and supported Alexa voice control and integration with devices like Amazon Echo, Echo Dot, and Echo Show. Despite its innovations, it lacked an automatic cut-off system to address electrical hazards like short circuits. Similarly, the **Mini Wi-Fi Smart Plug**, created by the **Mydlink Team** in **2023**, offered long-distance control, voice control, and automatic scheduling while ensuring compatibility with Google Assistant, Alexa, and IFTTT. It provided users with the ability to control devices remotely with ease. However, like its predecessor, it also failed to include safety mechanisms such as short-circuit detection or automatic current cut-off. While these smart plugs demonstrate advancements in functionality and user convenience, both projects highlight a recurring gap in addressing critical electrical safety, emphasizing the need for more comprehensive protective features in future designs.

RESEARCH METHOD

The development of the automatic cut-off smart plug point involve several stages to optimize the operation of this innovation. As a first step we have done a basic research about the required electronic components and its capabilities. By conduct this research, we able to identify the components required and its requirement according to our planning of the project. The requirements considered in this research is load capability of the ACS712 current sensor module, range of ESP32 to transmit data and range of minimum and maximum current value of over current protector.

The designing stage of this project have been done by using tinkercad website. We have designed the basic structure and the schematic diagram of this innovation to ensure its optimum operation and correct connection between components. Then we moved to fixing stage by following the schematic diagram. This innovation have been divided in two different part which protection part and data transmission part. The protection part will be fixed at Distribution Box which will handle the incoming current for plug point. Over current protector will be fix next to the miniature circuit breaker (MCB) because the miniature circuit breaker will be the second layer protector for this innovation

which will not affect the function of RCB or ELCB and its sensitivity towards minimum current leakage. After that, we have moved on to the programme ESP32 wroom microcontroller by using Arduino ide application. The code has been created to connect the ESP32 microcontroller with Blynk IoT application and receive current value from ACS712 current module. The code also programmed to stabilize the current value according to the average value per minute and send alert notification to the user's mobile when fault occurs. Fault will be detected by the ESP32 when there is no current flow from overcurrent protect to plug point. In this case we are most probably focus on the electrical appliance run 24/7 at home such as refrigerator and aquarium pump because there will current flow always except fault like overcurrent occurs. As an important declaration in coding we need to declare the Wi-Fi SSID (name) and password to allow the ESP32 to connect with Wi-Fi and transmit through it.

The testing stage for this innovation involves validating the hardware and software integration for optimal functionality. The ACS712-30A current sensor is tested as hardware to guarantee precise current flow detection under various loads. To ensure appliance safety in situations such as overcurrent or no-load situations, the relay module is tested for appropriate cut-off functioning. Stable operation of the ESP32 microcontroller is assessed, with special attention to its Wi-Fi connectivity for smooth Internet of Things integration. On the software side, the Blynk IoT platform is examined for reliability in remote control, accurate notifications, and real-time data visualization. The system has several appliances linked to it in order to verify power management and multi-plug compatibility. The purpose of stress testing is to verify fault tolerance and robustness through extended operation, high-load scenarios, and network disruptions. Following confirmation of system safety and dependability by all of these tests, the configuration is put into operation in the real world, and user input is gathered for future improvements.

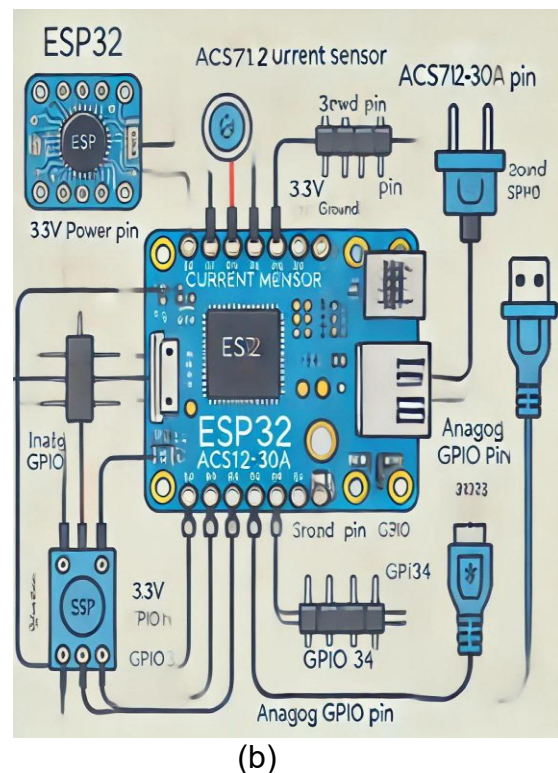
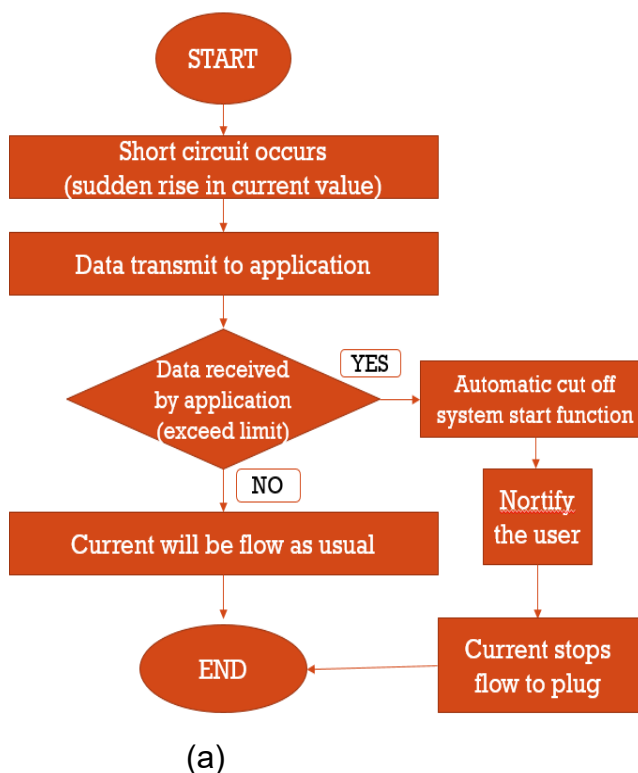


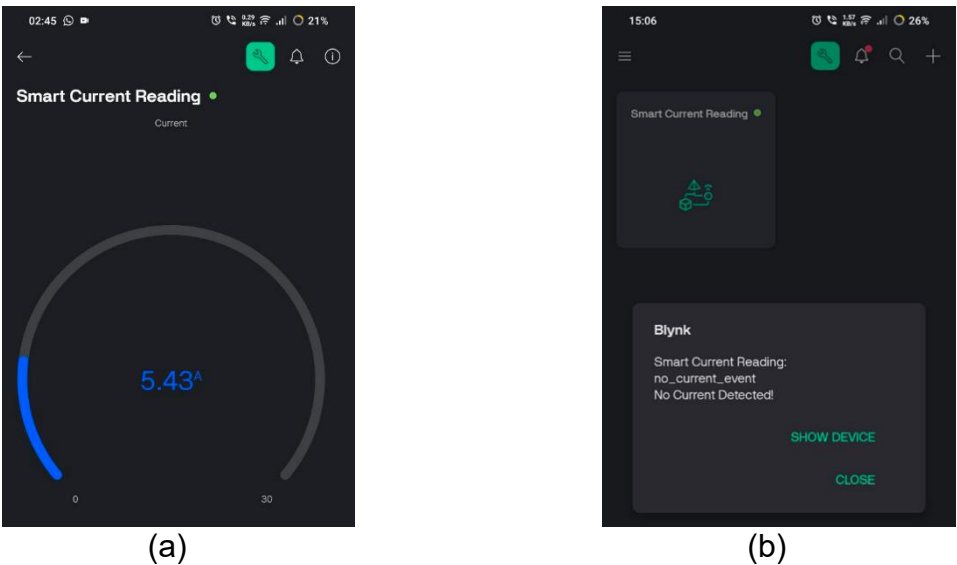
Figure 1. System flowchart (a); Schematic diagram (b)

RESULTS AND DISCUSSION

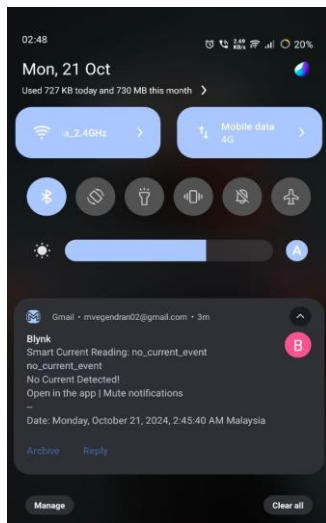
The Smart Current Reading Application effectively demonstrates its capability in monitoring and notifying users about electrical current usage in real time. By integrating the ESP32 microcontroller with the ACS712-30A current sensor module, the system ensures accurate detection and transmission of current data. The live readings displayed in the application align closely with the values shown on the overcurrent protector, verifying the reliability of the sensor module. This accuracy is particularly beneficial for home appliances requiring consistent monitoring, such as refrigerators and oxygen pumps. The ACS712-30A module is specifically designed for detecting AC current values, making it a suitable choice for household electrical applications. This integration not only supports real-time monitoring but also promotes energy efficiency and safety by providing precise data for users.

The inclusion of a dual alert notification system further enhances the application’s practicality. The system notifies users through push alerts in the mobile application and email notifications in cases of anomalies, such as low or no current detection. This ensures that users are promptly informed about potential issues, regardless of their location or availability. For example, while users are busy during working hours, email notifications serve as a reliable backup, ensuring no critical updates are missed. Such a feature proves particularly useful in homes where appliances need to run uninterrupted, reducing the risk of failures or hazards. The seamless integration of these features demonstrates the system’s focus on user convenience and safety.

An investigation into the characteristics of current sensors was conducted to identify the most suitable module for the system. The maximum current values were analyzed to ensure the sensor could detect a wide range of appliance currents. Based on this research, the ACS712-30A module was selected for its high accuracy, ability to detect AC current, and compatibility with home electrical systems. Its performance in the implemented system highlights its effectiveness in detecting and transmitting data with minimal errors. Overall, the combination of precise monitoring, reliable notifications, and the well-researched sensor module underscores the innovation's capability to provide a comprehensive and user-friendly solution for home electrical safety and efficiency.



(a) (b)
Figure 2. Current reading (a); Alert notification in application (b)



(a)



(b)

Figure 3. Alert notification in email (a); Demonstration video (b)

CONCLUSION AND RECOMMENDATIONS

In addition to improving user safety and lowering the possibility of damage from electrical abnormalities, this project effectively demonstrated its potential to safeguard household electrical appliances. The accurate and real-time current detection that was successfully delivered without delay was made possible by the integration of the ACS712 current sensor module. Furthermore, the Blynk IoT app was essential to the development of the Smart Reading System since it allowed for smooth user interaction via email and pop-up notifications. Together, these characteristics enabled timely alerts and encouraged the safe use of household appliances, so accomplishing the project's main goal.

Building on these successes, it is advised that further improvements be made to increase the system's functionality and efficiency even more. The ESP32's power source can be made more robust by adding a rechargeable or regenerative battery, which will guarantee steady functioning even in the event of a power interruption. Furthermore, each overcurrent protector can have numerous plug points with independent partitions, which can save expenses and make the system multi-load. As a result, the system would be more useful in both home and business settings since users could connect and keep an eye on several appliances at once.

Further addressing possible overheating problems, especially after extended use, could be accomplished by placing a little cooling fan close to the ESP32 microprocessor. When combined with a temperature sensor, such the DS18B20, the fan could only run when required, guaranteeing maximum energy efficiency. By enhancing stability and performance, this heat management solution would prolong the ESP32's lifespan and prevent problems. These developments can help the system develop into a more reliable, scalable, and energy-efficient way to control and safeguard electrical appliances.

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