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UPI Based Mobile Charging System

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Abstract: *This paper presents the design and implementation of a UPI Based Mobile Charging System for public applications. The proposed system integrates digital payment technology with an embedded control unit to provide a secure and automated charging solution. Users initiate the process by scanning a QR code and completing the transaction through the Unified Payments Interface (UPI). Upon successful payment, a confirmation message is received via a GSM module and processed by an Arduino Uno microcontroller. Based on payment verification, the controller activates a relay module to enable the charging circuit. A timer relay is incorporated to regulate the charging duration, ensuring controlled energy consumption and preventing unauthorized usage. The system employs a regulated power supply using a buck converter and voltage regulator to maintain stable operation of all components. Experimental implementation demonstrates that the proposed system is reliable, cost-effective, and suitable for deployment in public environments. The integration of cashless payment and embedded automation enhances user convenience, reduces manual intervention, and supports efficient energy management.*

Keywords: UPI, Arduino Uno, GSM Module, Embedded System, Mobile Charging, Relay Control, Automation

I. INTRODUCTION

The rapid growth in smartphone usage has increased the demand for accessible and reliable mobile charging facilities, especially in public places such as railway stations, bus stands, and educational institutions. Mobile devices are now essential for communication, navigation, and digital transactions, making uninterrupted battery availability crucial. However, existing public charging solutions are limited and often rely on manual operation or cash-based systems, which are inconvenient and inefficient in a digital economy.

Conventional systems like coin-operated chargers lack flexibility and require physical currency, while also offering minimal control over usage. These limitations can lead to energy wastage, unauthorized access, and the need for continuous monitoring. With the increasing adoption of digital payment methods, there is a need for a more advanced, automated, and secure charging system that aligns with modern cashless transaction practices.

To address these challenges, this paper proposes a UPI Based Mobile Charging System that integrates digital payment with embedded system automation. The system uses an Arduino Uno and a GSM module to verify payment confirmation and control a relay-based charging circuit. A timer mechanism ensures that charging is provided only for a predefined duration, enabling efficient energy usage and fair access. The proposed solution is cost-effective, user-friendly, and suitable for real-time deployment in public environments.

II. SYSTEM ARCHITECTURE

The proposed UPI Based Mobile Charging System is designed as an integrated embedded system that combines digital payment processing, communication, and controlled power delivery. The overall architecture consists of three main layers: the input/payment layer, control layer, and output/charging layer, supported by a regulated power supply unit. The process begins when the user scans a UPI QR code and completes the payment using a mobile application, which serves as the input mechanism for accessing the charging service. The control layer is centered around the Arduino Uno microcontroller, which acts as the main processing unit. A GSM module is interfaced with the Arduino to receive

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payment confirmation messages via the cellular network. Upon receiving the message, the Arduino verifies the transaction status and generates appropriate control signals. A BC547 transistor is used as a driver to safely operate the relay module, ensuring that the microcontroller is protected from high current loads. The output layer consists of a relay module, timer relay, and mobile charging circuit. Once the payment is verified, the relay module is activated to connect the charging unit to the power supply. The timer relay controls the duration of charging by automatically disconnecting the supply after a predefined time interval. A 12V DC power source is used as the primary supply, which is regulated using a buck converter to provide 5V for the GSM module and a voltage regulator (IC 7809) to supply stable power to the Arduino. This architecture ensures automated operation, efficient energy utilization, and secure access to the charging system.

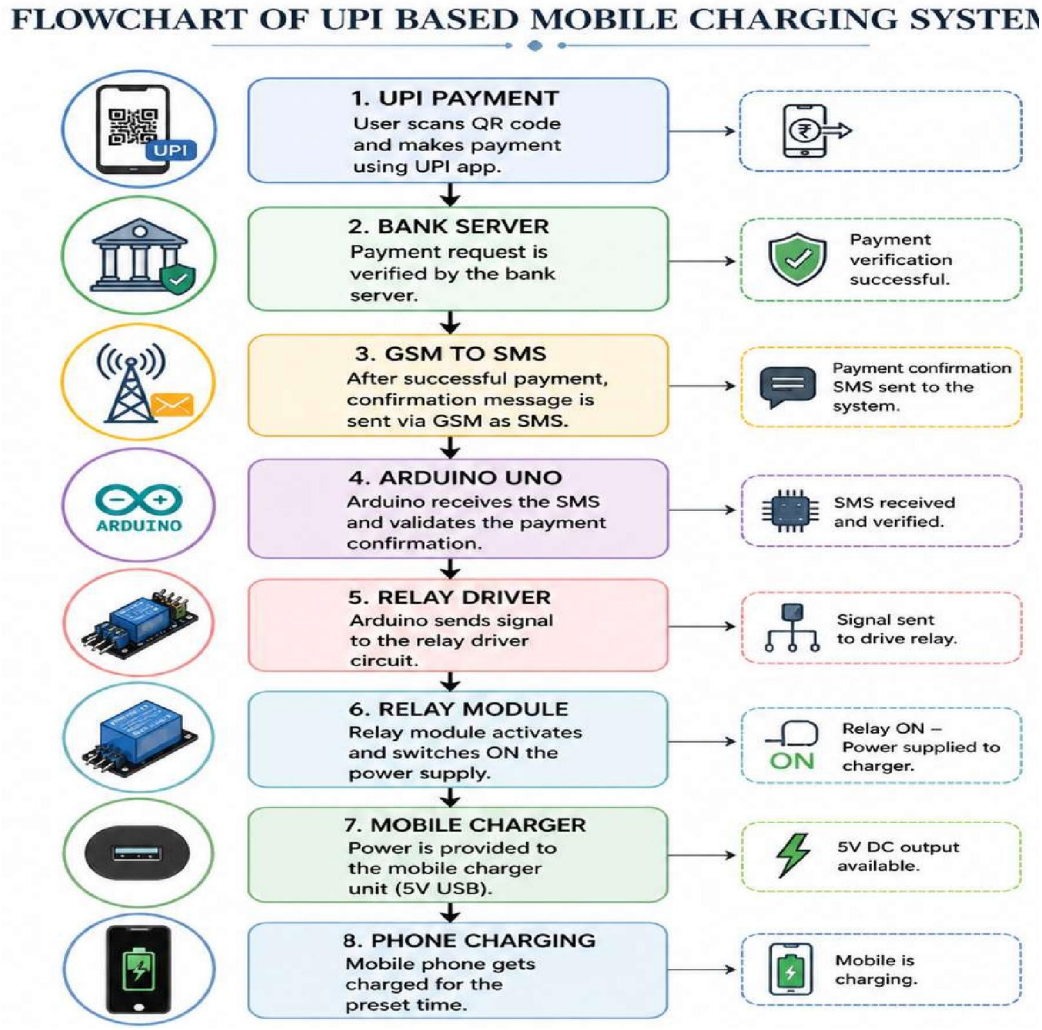

Fig. 1 WORKFLOW MODEL

The Arduino Uno acts as the main controller of the UPI based mobile charging system. It remains in standby mode and waits for a payment confirmation signal from the GSM module. When the user scans the QR code and makes the payment using any UPI application, the bank server verifies the transaction. After successful payment, a confirmation message is sent through the GSM network as an SMS to the GSM module connected to the Arduino. The Arduino receives this confirmation message and processes it to verify that the payment is successful. Once verified, the Arduino

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sends a signal to the relay driver circuit. The relay module gets activated and switches ON the power supply to the mobile charging unit. The mobile charger provides 5V DC output through the USB port, allowing the mobile phone to charge for a preset time. After the fixed charging time is completed, the relay automatically turns OFF, and the system returns to waiting mode for the next user. This ensures automatic, safe, and cashless mobile charging based on successful UPI payment.

III. METHODOLOGY

The proposed system is designed as an IoT-based UPI mobile charging unit that provides mobile charging service only after successful online payment. The main objective of the system is to integrate digital payment verification, control circuitry, and power switching into a single automated platform. This allows users to charge their mobile phones in public places without the need for cash handling or human supervision. The system combines GSM communication, microcontroller processing, and relay control to ensure that charging is activated only when the payment is confirmed. This makes the system secure, automatic.

3.1 Working Principle

The working of the UPI based mobile charging system is fully automatic and depends on successful digital payment verification. Initially, the system is powered ON and the Arduino Uno initializes the GSM module, relay driver circuit, and charging unit. The system then enters standby mode and waits for a payment confirmation. A QR code is displayed on the charging unit. When a user wants to charge a mobile phone, they scan the QR code using any UPI application and complete the payment. Once the payment is successful, the bank server generates a confirmation message and sends it as an SMS through the GSM network to the GSM module installed in the system.

The GSM module receives this SMS and forwards it to the Arduino Uno through serial communication. The Arduino reads the message, checks for the confirmation keywords, and verifies that the payment has been successfully completed. This verification step ensures that charging is allowed only for valid transactions. After successful verification, the Arduino sends a control signal to the relay driver circuit. The relay driver energizes the relay module, which connects the power supply to the mobile charging socket. As a result, 5V DC supply is made available at the USB port, and the user's mobile phone starts charging. A timer is programmed inside the Arduino for a fixed charging duration. During this time, the relay remains ON and charging continues. Once the preset time is over, the Arduino automatically turns OFF the relay, disconnecting the power supply to the charger. The system then returns to standby mode and waits for the next user. This entire process ensures secure, cashless, and automatic mobile charging based on UPI payment without any manual intervention.

3.2 Circuit Diagram

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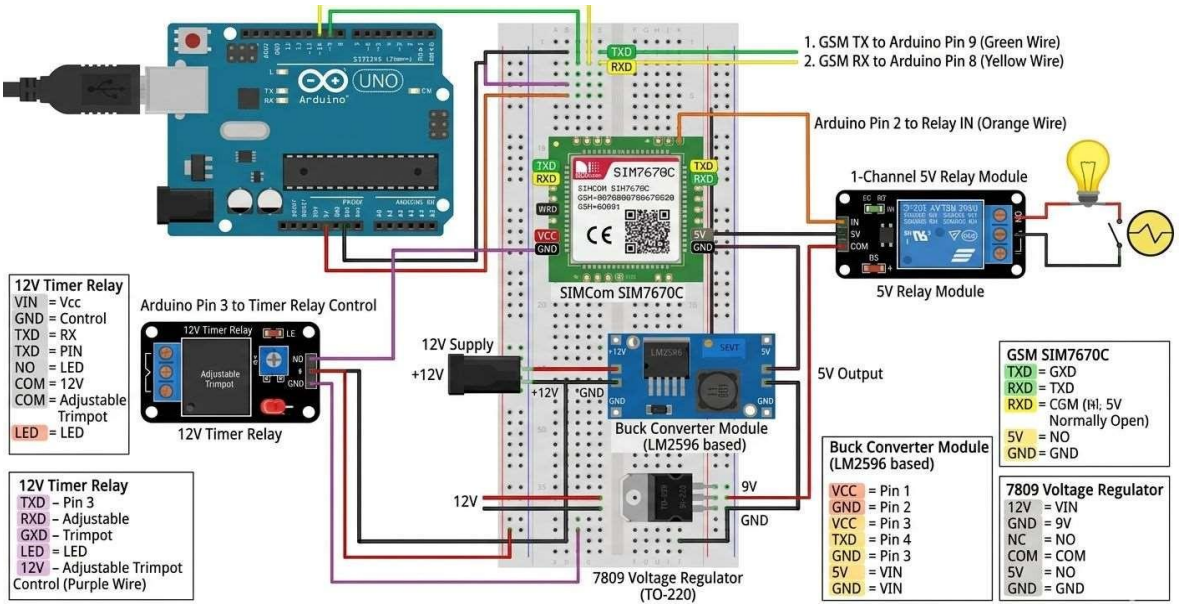

Fig. 2. CIRCUIT DIAGRAM

IV. IMPLEMENTATION

The UPI based mobile charging system is implemented using Arduino Uno, GSM module, relay circuit, timer control, and a mobile charging unit. All these components are connected to the Arduino which controls the complete working of the system.

A regulated power supply with a buck converter is used to provide stable voltage to the Arduino, GSM module, and relay. The GSM module is interfaced with the Arduino to receive payment confirmation messages. The relay driver circuit is connected to the Arduino to switch the mobile charging unit ON and OFF automatically after payment verification.

The program for the system is written in Arduino IDE to handle GSM communication, payment verification, timer operation, and relay switching. The role of the Arduino is that of a brain. It is responsible for setting up communication and initializing all sensors when it is powered on. It then goes on to read information from all sensors, including voltage, current, and temperature sensors. It ensures that it gets accurate information by stabilizing the current sensor first. Once it has this information, it is then sent to the ESP32 in a format, together with a small error check for accuracy. The ESP32 then goes on to connect to Wi-Fi, log in to Firebase, and send the information to the real-time database.

4.1 Firmware Development

The Arduino Uno acts as the brain of the system. When the system is powered ON, it initializes the GSM module, relay module, and timer settings. The Arduino continuously checks for incoming SMS messages through the GSM module using serial communication. When the user makes payment using a UPI application, either by scanning the QR code or by sending payment to the registered UPI mobile number, a confirmation SMS is sent by the bank server. This SMS is received by the GSM module. There is no need to refresh the page; instead, the values are updated in real-time.

4.2 User Interface (QR Code and UPI Mobile Number)

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The system provides two simple methods for payment. A QR code and a registered UPI mobile number are displayed on the charging unit. The user can scan the QR code using any UPI app or directly enter the UPI mobile number in the app to make the payment. After successful payment by either method, the confirmation SMS is received by the GSM module, and the charging process starts automatically.

V. RESULTS AND DISCUSSION

5.1 Charging Time vs Battery Percentage

The integration of the Firebase system ensures that the information displayed on the online dashboard is updated in real-time. This allows the user to be able to monitor the battery system without having to physically be at the substation.

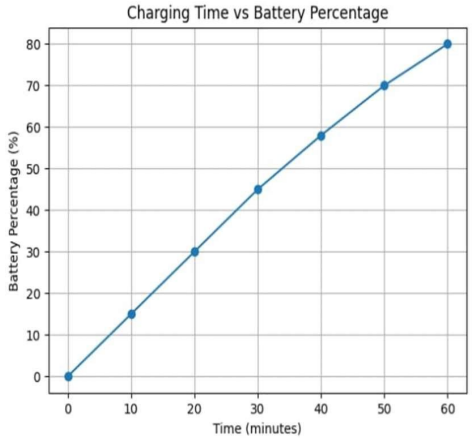

Fig. 3. CHARGING TIME VS BATTERY PERCENTAGE

5.2 Money vs Charging Time

This graph represents the relationship between the amount paid and the charging time provided. The system follows a fixed model of ₹5 for 10 minutes of charging. As the amount increases, the charging time increases proportionally. This proves that the timer control in the Arduino works correctly according to the payment received.

Fig. 4. MONEY VS CHARGING TIME

5.3 Payment Confirmation Message (SMS)

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The GSM module receives a payment confirmation SMS similar to a bank credit message. This message is read by the Arduino to verify successful payment before starting the charging process. This confirms that the system operates only after valid UPI transaction confirmation, ensuring secure and cashless operation.

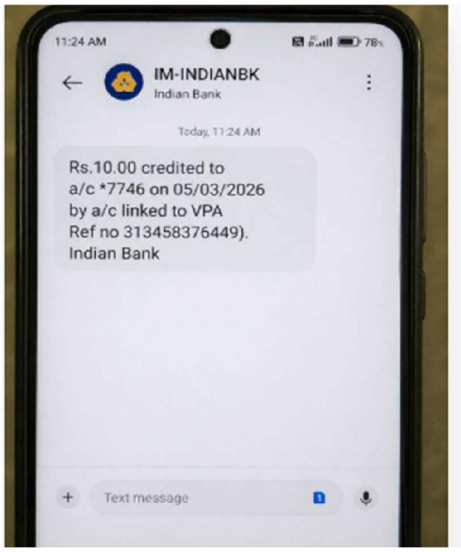

Fig. 6. PAYMENT CONFIRMATION MESSAGE (SMS)

5.4 Experimental setup of for Upi Based Mobile Charging System

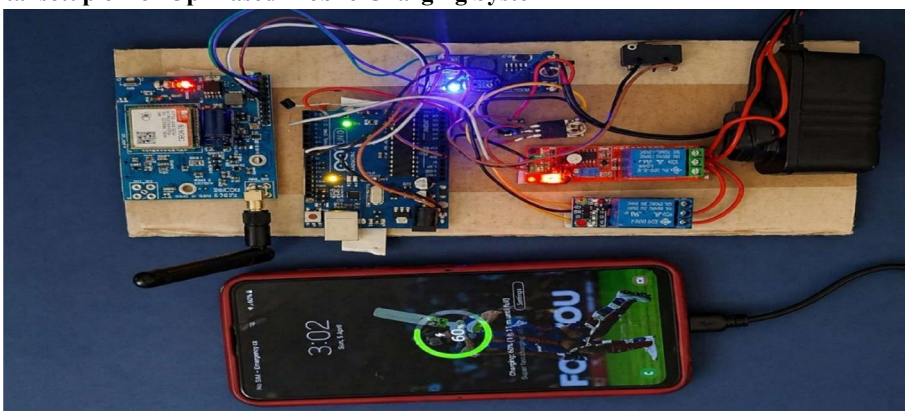

Fig. 7. EXPERIMENTAL SETUP

VI. CONCLUSION

The proposed UPI based mobile charging system provides a simple and effective solution for automatic mobile charging using digital payment technology. The system ensures that charging is activated only after successful UPI payment confirmation received through the GSM module and processed by the Arduino Uno. This solution removes the need for manual supervision and cash handling, making the charging process secure, cashless, and user-friendly. The relay and timer control ensure that charging is provided only for the allowed duration based on the payment made.

The system can be very useful in public places such as bus stands, railway stations, colleges, and markets where people require emergency mobile charging facilities. In the future, this system can be further developed into smart public charging stations with fully automated operation.

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