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Coin Insertion based EV Charging System with Multimode Facility

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Abstract

In this paper, we propose a coin-operated EV charging system with dual modes: wired and wireless. A Raspberry Pi Pico, interfaced with a coin sensor, verifies payments (e.g., ₹5 per coin for 2 minutes of charging) and prompts users to select a mode via push buttons. Based on the selection, a relay activates either a wired circuit or a wireless transmitter paired with a receiver on the EV. This approach provides safe, controlled charging sessions and offers a cost-effective solution, particularly for areas with limited digital payment infrastructure, as demonstrated by experimental validation.

INTRODUCTION

The rapid adoption of electric vehicles necessitates the development of diverse and accessible charging solutions. Conventional charging systems primarily rely on digital payment methods and fixed charging modalities, which may not be ideal in regions with limited infrastructure. In this context, a coin-operated EV charging system offers an alternative that can function reliably in areas where digital transactions are less prevalent. Moreover, incorporating both wired and wireless charging options addresses different user preferences and technological environments. [7] This paper explores the design, integration, and validation of a coin-based payment system that controls dual-mode EV charging. [6] Leveraging a Raspberry Pi Pico as the central controller, the system offers flexibility, ease of use, and scalability, providing a foundation for future developments in cost-effective EV charging technology.

PROBLEM STATEMENT

Despite the growing number of electric vehicles, many regions still face challenges in offering accessible and versatile charging solutions. Current systems largely depend on digital interfaces, which may exclude users without access to such technology. Additionally, the lack of multimode charging facilities limits user

choice, particularly in scenarios where wired connections are impractical or where wireless charging could offer enhanced convenience. Therefore, there is a pressing need to develop an EV charging system that :

- Operates on a coin-based payment mechanism, ensuring ease of use in low-tech environments.
- Offers both wired and wireless charging modes, catering to a broader range of user needs.
- Ensures reliable and safe operation through precise control of charging sessions. This research aims to bridge these gaps by introducing a cost-effective, dual-mode charging solution that simplifies the payment process while enhancing charging flexibility.

LITERATURE REVIEW

Recent studies have highlighted the potential of wireless power transfer (WPT) for EV charging, emphasizing its advantages in terms of user convenience and installation flexibility [1]. Additionally, coin-operated systems have been explored in other domains such as public telephones and vending machines, demonstrating their reliability in cash-based transactions [2][4]. However, the integration of such a system with EV charging infrastructure remains relatively under explored. Research on micro controller based control systems, especially using compact platforms like the Raspberry Pi Pico, has shown promise in managing real-time operations in embedded systems [3]. Prior works have focused on either digital payment systems or single-mode charging technologies, leaving a niche for a combined system that can offer multiple charging options based on a simple coin insertion mechanism. [5] This paper builds on these studies by combining coin-based payment, dual-mode charging (wired and wireless), and efficient micro controller management into a single, cohesive system.

METHODOLOGY

The proposed system is structured around a central microcontroller (Raspberry Pi Pico) interfaced with several peripheral devices:

- Coin Insertion Mechanism: A coin sensor is employed to detect and count coins. Each detected coin corresponds to a fixed charging duration (e.g., ₹5 per 2 minutes of charging).
- User Interface: Two push buttons allow users to select between wired and wireless charging modes. The system's display (or indicator LEDs) shows the inserted coin count and the corresponding total charging time.
- Control Logic: The Raspberry Pi Pico processes coin input, calculates the total charging time, and waits for the mode selection input. Once the "ready" button is pressed, the microcontroller activates a relay corresponding to the selected charging mode.
- Charging Circuits:
  - The wired charging circuit directly connects the EV to a power source through controlled relay switching.
  - The wireless charging circuit comprises a custom-designed transmitter placed on the charging station and a receiver circuit integrated into the EV.
- Timing and Safety: The system monitors the charging duration via an internal timer. Upon completion of the allocated time, the relay automatically disconnects the power supply, ensuring safe termination of the charging session.

HARDWARE IMPLENTATION

- The hardware setup for the coin insertion based EV charging system includes:
- Raspberry Pi Pico: Serves as the central processing unit, handling inputs from the coin sensor and user buttons, processing logic, and controlling the relay.
- Coin Sensor: A sensor capable of detecting and validating coin insertions. This sensor is calibrated to register a coin of a specific denomination (e.g., ₹5).
- Push Buttons: Two buttons are used for mode selection (wired or wireless) and an additional "ready" button to initiate charging once the required coin value is inserted.
- Relay Module: Two relays are integrated into the system. One relay switches the wired charging circuit on/off, while the other controls the wireless power transmitter circuit.
- Wireless Power Circuitry:
  - Transmitter Circuit: Located at the charging station, it is designed to generate and transmit power wirelessly.
  - Receiver Circuit: Installed in the EV, it captures the transmitted power and converts it to a suitable form for battery charging.
- Power Supply & Safety Components: The design incorporates necessary voltage regulators, fuses, and other protective components to ensure safe operation.

The integration of these components is facilitated through a carefully designed printed circuit board (PCB) and wiring harnesses, ensuring robust communication between the microcontroller and the peripheral devices.

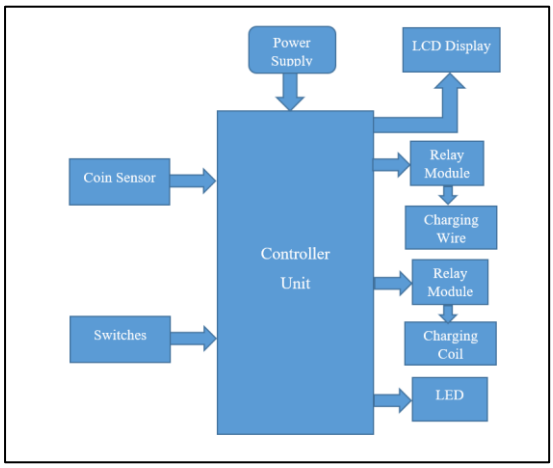

Figure 1. Block Diagram of Proposed System

The system revolves around a central Controller Unit (e.g., a Raspberry Pi Pico) which manages all inputs and outputs. A regulated Power Supply feeds the controller and the peripheral modules. Users interact with the system via Switches to select charging mode (wired or wireless) and confirm readiness. A Coin Sensor detects and validates coins, sending the count to the controller, which then calculates the total charging duration. The Relay Module for the wired mode activates the Charging Wire, while a separate relay drives the Charging Coil for wireless charging. An LCD Display shows real-time information such as coin count and remaining charging time. Additionally, an LED provides a simple status indicator (e.g., charging active or idle).

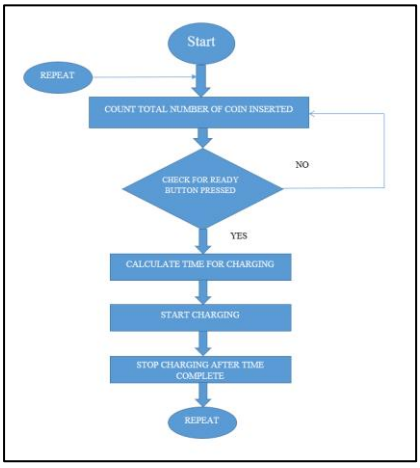

Figure 2. Flowchart of Proposed System

- Start: The system initializes, waiting for user interaction.
- Count Total Number of Coins Inserted: As coins are dropped into the sensor, the controller tallies them, converting the count into a corresponding charging duration.
- Check for Ready Button Pressed: The system continuously checks whether the user has confirmed to begin charging. If not pressed, it loops back, allowing more coins to be inserted.
- Calculate Time for Charging: Once the user presses the ready button, the system finalizes the total charging time based on the inserted coins.
- Start Charging: The controller activates the appropriate relay (wired or wireless) to commence charging.
- Stop Charging After Time Complete: When the allotted time expires, the relay automatically switches off, terminating the charging process.
- Repeat: The system resets, ready for the next user or charging session.

RESULT

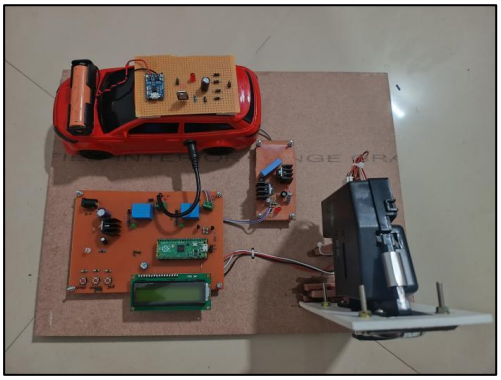

Figure 3. Working Model of Proposed System

CONCLUSION

This research demonstrates the successful development of a coin insertion based EV charging system that integrates both wired and wireless charging modalities. By employing a Raspberry Pi Pico to manage user inputs, payment validation, and mode control, the system offers a flexible and cost-effective solution for EV charging. The dual-mode functionality caters to diverse user needs and environmental conditions, making it particularly valuable in regions where digital payment infrastructure may be limited. Experimental results validate the system's operational reliability and safety, marking a significant step toward more inclusive and adaptable EV charging solutions.

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