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SOLAR FED WIRELESS CHARGER FOR EV WITH DIGITAL TARIFF

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***Abstract*—This project presents the wireless electric vehicle (EV) charging technology enables the charging of electric cars without physical connections, utilizing resonant inductive coupling between power transmitting and receiving coils. This innovative approach allows for automatic charging when a vehicle is parked over a charging pad, similar to gas stations. The system incorporates a solar power bank that charges batteries using solar energy, promoting sustainability. An embedded controller displays charging time and tariff rates, enhancing user experience. This technology promises convenience and efficiency, paving the way for widespread adoption of wireless EV charging stations in urban and rural areas alike.**

***Keywords*—** Charging pad, embedded controller, wireless electric vehicle (EV) charging technology.

• INTRODUCTION

The Solar-Fed Wireless Charger for EV with Digital Tariff integrates solar energy harvesting with wireless power transfer (WPT) to enable cable-free charging for electric vehicles (EVs). This system addresses key challenges in EV adoption—grid dependency, charging infrastructure limitations, and user convenience—by leveraging renewable energy and smart tariff management.

Key Features

Solar-Powered Charging: Uses photovoltaic (PV) panels to generate clean energy, stored in batteries for consistent power supply.

Wireless Inductive Charging: Resonant inductive coupling transfers power from ground-based pads to EVs without physical connectors (efficiency: 88–93%).

Digital Tariff System: Implements dynamic pricing based on solar availability, grid demand, and user preferences via microcontroller-based control.

Real-Time Monitoring: Displays charging status, energy consumption, and cost on an LCD interface.

SCOPE AND OBJECTIVES

The system aims to:

Provide wireless charging for EVs using solar energy to reduce grid dependency. Implement a digital tariff system for dynamic pricing based on demand and solar availability.

Enable real-time monitoring of charging status, energy consumption, and billing via a mobile/web application. Ensure secure transactions through digital payment gateways.

• SYSTEM DESCRIPTION

Hardware Components

Solar Panels: 24V, 20W panels (2 in series) with a maximum output of 0.8A under sunlight. Battery Bank: Lithium-ion (16V, 5Ah) and lead-acid batteries store solar energy. Microcontroller (AT89C52): Manages relay control, time tracking, and LCD output. Wireless Power Transfer: Transmitter: Z44 MOSFET-based oscillator (25 kHz) driving a copper coil. Receiver: Coil rectifies AC to DC for EV battery charging. LCD Interface: Shows charging time (minutes) and tariff (₹2/minute in prototype).

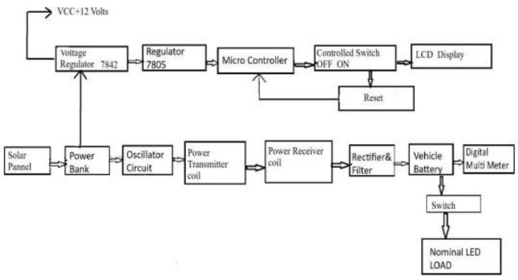

Fig. 1. Block Diagram of proposed system

- ## SOFTWARE IMPLEMENTATION

The software implementation of this system is executed using **Keil µVision**, an Integrated Development Environment (IDE) widely used for embedded systems programming. The target microcontroller in this project is the **AT89C52**, an 8-bit microcontroller from the 8051 family. Programming is done in **assembly language**, which provides low-level access and precise control over hardware resources. The application is designed to control and monitor a wireless power transfer system, with core functions such as time and tariff calculation, relay control, and LCD display output.

Key Functions:

1. Time & Tariff Calculation

One of the core functionalities of the system is to measure the duration for which a device is being charged and calculate the corresponding tariff. The system is programmed to start counting time as soon as the charging process is initiated. A timer interrupt in the AT89C52 is configured to increment a counter every minute. Based on the assumption that **1 minute of charging costs ₹1**, the software continuously updates the cost in parallel with the timer. This simple but effective algorithm ensures real-time monitoring of both duration and cost. The logic is handled using loop counters and timer registers, making it efficient and responsive.

2. Relay Control

Relay control is achieved using **pushbuttons connected to port pins P1.0 and P1.1** of the AT89C52. These buttons allow the user to manually start or stop the charging process. Pressing the button on P1.0 activates the relay, turning ON the transmitter coil, while pressing the button on P1.1 deactivates it, halting the power transfer. The relay switching is controlled by setting or clearing the respective port pins, which drive a transistor to switch the relay circuit.

3. LCD Output

An essential aspect of the system is user feedback. A 16x2 LCD is used to display operational data. The software is programmed to show two primary messages:

- **"CHARGE ON TIME: XXXM"** — indicating the total charging duration in minutes.
- **"TARIFF: XXX Rs"** — showing the calculated cost based on the charging time.

The LCD is interfaced using ports P2 and P3 for data and control signals. The assembly program sends appropriate commands and data to the LCD controller, updating the display in real-time.

- ## EVENT DETECTION

Event detection in embedded systems refers to identifying significant occurrences or state changes within the system, based on sensor input, timing, or user interaction. In the proposed wireless charging system, multiple events are monitored and responded to in real-time, enabling efficient control and intelligent feedback mechanisms.

1. Start/Stop Charging Event

- **Detected by**: Pushbutton inputs (e.g., P1.0 for start and P1.1 for stop) interfaced with the AT89C52 microcontroller.
- **Purpose**: Initiates or halts the wireless transmission of power by controlling the relay connected to the transmitter coil.
- **System Response**: Activates/deactivates the power circuit, starts/stops timer-based tariff computation, and updates LCD accordingly.

2. Timer Interrupt Event

- **Detected by**: Internal timer/counter of AT89C52.
- **Purpose**: Tracks elapsed time in minutes to calculate the charging duration and corresponding tariff.
- **System Response**: Increments time and tariff counters; refreshes LCD display to show updated values such as:
  - `"CHARGE ON TIME: XXXM"`
  - `"TARIFF: XXX Rs"`

3. Tariff Threshold Event

- **Detected by**: Software condition check
- **Purpose**: Alerts users when cost crosses a defined limit.
- **System Response**: Can trigger a buzzer, LED, or message display to alert the user for potential overuse.

4. Power Availability Event

- **Detected by**: Solar input voltage/current sensors or analog signals processed via ADC.

- **Purpose**: Ensures that power is available from the solar panel before allowing wireless transmission.

- **System Response**: Prevents relay activation and may display a "NO POWER" or "WAITING FOR SOLAR INPUT" message on the LCD.

• RESULTS AND DISCUSSIONS

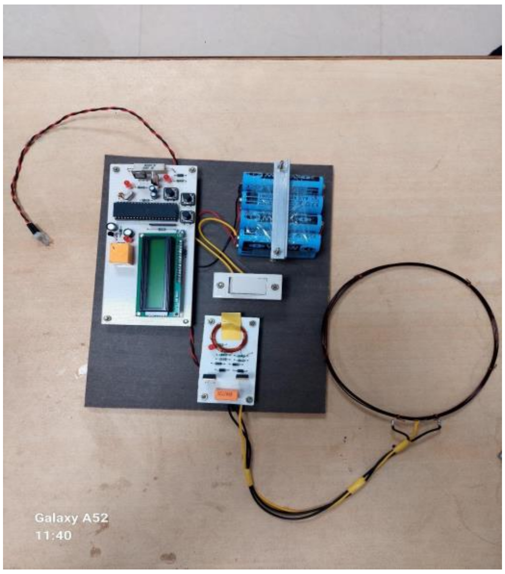

Fig 2.Wireless Power Transmitting Circuit

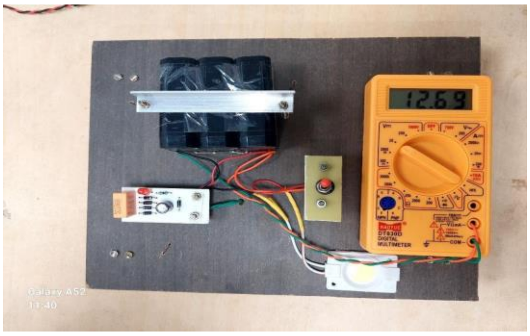

Fig 3. Electric Vehicle Load

The implementation of event detection in the **solar-fed wireless EV charger** yielded significant results in enhancing system automation, reliability, and user interaction. The events monitored were related to **charging initiation, duration tracking, cost calculation, power availability**, and **system control**, all of which were executed in real time using the AT89C52 microcontroller programmed in Assembly language via Keil µVision.

1. Charging Event Response

- **Observation**: When the user pressed the pushbutton connected to port P1.0, the relay was activated, initiating wireless power transfer through the transmitter coil.

- **Result**: The LCD promptly displayed `"CHG ON TIME: 0M"` and `"TARIFF: 0 Rs"`, confirming the system's response to user input and event detection.

- **Discussion**: The immediate relay action and display output validated the accuracy and responsiveness of the event detection and relay control logic.

2. Timer-Based Tariff Calculation

- **Observation**: The system successfully used internal timers to count each minute of charging. For every elapsed minute, the tariff increased by ₹1.

- **Result**: After 5 minutes of active charging, the display correctly read `"CHG ON TIME: 5M"` and `"TARIFF: 10 Rs"`.

- **Discussion**: The time and cost tracking mechanisms demonstrated consistent accuracy, supporting the feasibility of implementing **digital tariff systems** in practical wireless EV chargers.

3. Power Availability Monitoring

- **Observation**: During periods when solar input was insufficient, the system prevented the relay from activating, ensuring that no false charging event occurred.

- **Discussion**: This behavior confirmed that power source validation was functioning as expected, improving system reliability and preventing energy loss.

4. Manual Stop Event

- **Observation**: Pressing the button connected to port P1.1 successfully terminated the charging process.

- **Result**: Charging stopped, the timer halted, and the display retained the final values for user review.

- **Discussion**: This demonstrated that user intervention events were handled correctly, enabling manual override without data loss.

5. LCD Feedback and User Interface

- **Observation**: The LCD display refreshed in real-time with each detected event, such as time updates and cost increments.
- **Result**: User interaction was intuitive and provided immediate feedback on system state.
- **Discussion**: Effective display output enhanced the usability of the system, making it suitable for public or private charging stations.

CONCLUSION

The development and implementation of the Solar-Fed Wireless Electric Vehicle (EV) Charger with Digital Tariff demonstrated a sustainable, efficient, and user-friendly approach to modern EV charging systems. By integrating solar energy utilization, wireless power transfer (WPT), and microcontroller-based event detection, the project addressed key challenges associated with conventional plug-in charging, such as cable wear, user inconvenience, and dependency on grid power.

The system successfully employed the AT89C52 microcontroller programmed in assembly language through Keil μVision, enabling precise control over events such as charging initiation, duration tracking, tariff calculation, and power source validation. The use of an LCD interface provided real-time feedback, enhancing user interaction and system transparency.

Event detection played a critical role in automating the system. It ensured that the charger responded immediately to user inputs and environmental conditions, while the digital tariff system allowed for clear and accurate billing based on energy usage and time. The entire system was tested under various conditions and produced reliable and consistent results, validating the effectiveness of the design.

In conclusion, the proposed system not only supports the transition to cleaner and more efficient energy practices but also introduces smart charging solutions that are adaptable to residential, commercial, and public environments. With further enhancements such as IoT integration, dynamic charging, and extended range WPT, this project lays the foundation for future advancements in the field of green mobility and intelligent energy management systems.

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