SolarComm: Dynamic Energy Harvesting and Charging for EV's

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Abstract.

Solar energy, a crucial source of renewable energy, plays a crucial role in sustainable development in the modern world. The electric vehicle, EV, is becoming the mode of transport of choice and that means zero carbon emissions; therefore, integrating solar energy into EV charging solutions is essential. This paper proposes SolarComm: Dynamic Energy Harvesting and Charging for EV's, a new and innovative system combining solar energy harvesting with wireless charging technology to promote convenience and sustainability in EV usage. SolarComm's dual-axis solar tracker optimizes solar energy collection, powering electric vehicles. It employs inductive coupling technology for dynamic charging, increasing driving range and lowering grid power reliance.

Keywords. Solar energy, Electric vehicle, Inductive coupling, Dynamic Energy harvesting.

1. INTRODUCTION

The "SolarComm: Dynamic Energy Harvesting and Charging for EVs" project aims to address the challenges of EV usage, particularly in energy harvesting, storage, and charging infrastructure.[1] The system includes a contactless charging module and a dual-axis solar tracker, enhancing solar capture and allowing EVs to charge continuously without physical connections. Despite advancements in electric vehicle and solar energy technologies, challenges still hinder the efficient utilization of sustainable energy sources and EV charging infrastructure [2][3]. The key issues include limited efficiency of fixed solar panels: Traditional panels often fail to capture maximum solar energy, reducing energy output and inefficient utilization [4], EV charging infrastructure challenges: Most EV charging infrastructure is wired, making it expensive, cumbersome, and challenging to scale. Energy Losses in Wired Transmission: Significant power losses over long distances contribute to higher energy costs and reduced effectiveness [5], Intermittent nature of solar energy: Solar energy's variable nature poses a challenge for maintaining constant energy supply, especially for EV charging [6].

Solar energy is a potential solution to enhance energy efficiency, store collected energy safely, and wirelessly charge electric vehicles (EVs) [7]. Studies have indicated that wireless charging can ease grid stress and enhance energy storage devices. Merging solar energy with wireless charging systems, e.g., solar-powered EV charging stations, has the potential to enhance user experience and increase system scalability [8][9]. IoT and AI can also be used to maximize real-time monitoring, predictive charging management, and system scalability. Solar-based EV charging with IoT can maximize energy collection efficiency, while IoT maximizes monitoring and user accessibility [10][11]. As a whole, solar energy is a viable solution for green on-the-go charging solutions. Thus, the objectives of this work are as follows:

1. Design and install a Dual-Axis Solar Tracker System for maximum solar energy collection.
2. Install a battery storage system for energy storage and harvesting.
3. Employ an LCD display to display real-time energy readings.
4. Create a wireless power transmission system for frictionless, contactless electric vehicle charging.
5. Enhance EV charging infrastructure for scalable, efficient, and dynamic charging cases.

8. METHODOLOGY

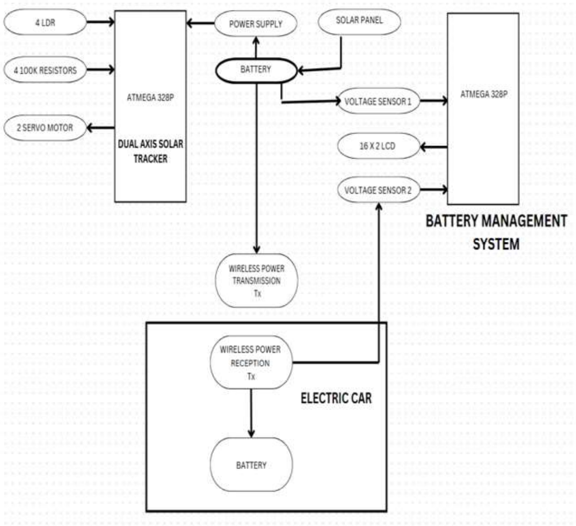

Fig. 1: Block diagram of the proposed system.

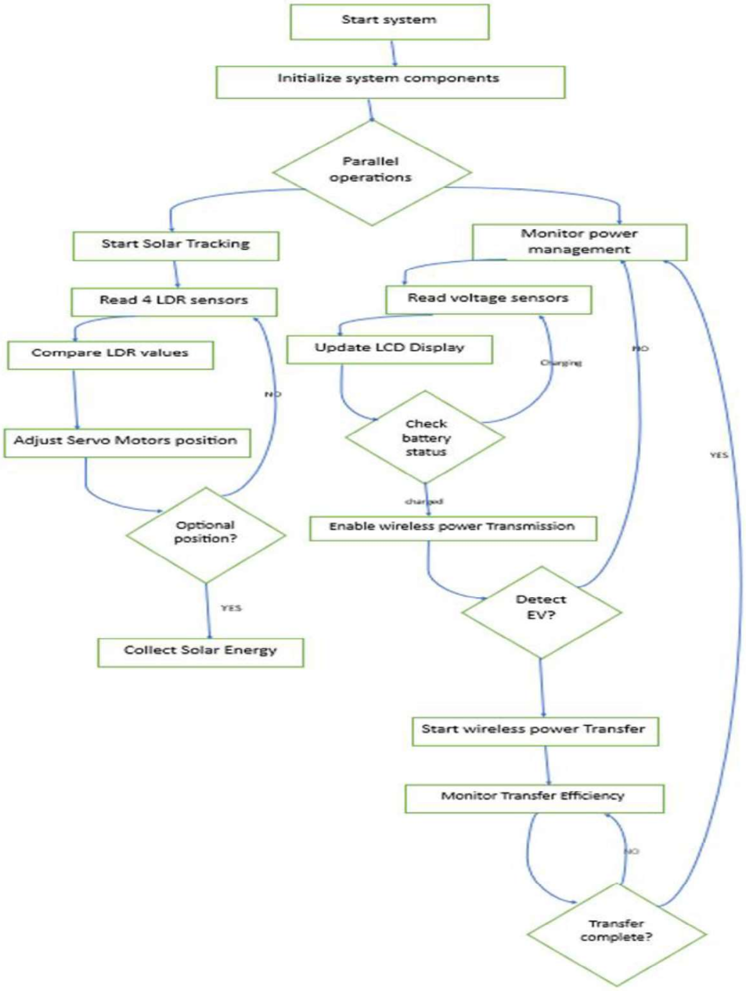

Fig. 2: Flow chart of the proposed system

Fig 1 represents the block diagram and Fig. 2 represents the flow chart of the proposed model. SolarComm presents a comprehensive system for efficient solar energy collection, storage, and wireless power transmission for charging electric vehicles, utilizing an ATMEGA 328P microcontroller and servo motors.[12][13] The solar panel used in SolarComm has an efficiency of approximately 0.13%, with a peak power output of 0.6W under standard test conditions. The dual-axis solar tracking system increases energy capture by 40-50% compared to fixed solar panels, leading to an effective output improvement to 1.47W. Once it is converted into electricity, the solar power is stored in a battery. The system utilizes a 12V, 1.3Ah lithium-ion battery with an energy storage capacity of 10.92Wh. Under peak sunlight conditions, the charging rate is 200mA, resulting in a full charge time of approximately 7.5 hours [17][18]. The system features a 16x2 LCD for battery charge monitoring, voltage sensors for efficient power control, and wireless power transfer for efficient energy storage in EVs [14][15][16]. The wireless power transmission system achieves an efficiency of 70% under optimal conditions, whereas existing stationary inductive charging systems typically range between 70-85%. Misalignment of coils reduces efficiency to 60%, which can be improved using real-time AI-based coil alignment tracking.[19][20] All things considered, the SolarComm system, which combines cutting-edge solar tracking with wireless charging technology, offers a realistic and sustainable solution for energy harvesting and EV charging.[21][22][23]

9. RESULTS AND DISCUSSIONS

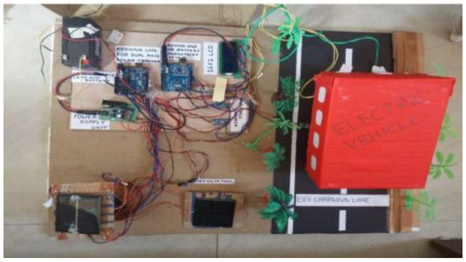

Fig. 3: The project prototye

Figure 3 shows the prototype model. The electric vehicle will get charged from the coils that have got their energy from solar panels.

3.1 Calculations

The following calculation were carried out:

For fixed solar panel	Voltage = 6 V Current = 100mA Power = 6 x 100mA = 0.6 W -- [1]
For a solar tracker with two axes	Voltage = 6 V Current = 100mA Power = 6 x 100mA = 0.6 W -- [2]
For a solar tracker with two axes	40% to 50% more power will generate Power = 0.6+45% = 0.87 W -- [3] Total current = 200 mA (100 +100) Total power = 0.6+0.87 W = 1.47 W -- [4]
Battery:	Voltage = 12 V Capacity = 1.3Ah/20Hr = 1300mA -- [5] Charging time = Battery capacity /(Charging Current * Efficiency) = 1300 / (200 * 0.85) Charging time = 7.65 hours -- [6] Percentage formula: (present battery voltage / Total battery voltage) * 100 = (10 / 12) * 100 Battery % = 83.33 % -- [7]
Power consumption by the SG90 servo motor:	Operating voltage: 4.8 V to 6 V Current: 0.6A at 6 V Power = 0.6 x 6 = 3.6 W for 1 servo -- [8] For 2 motor, 3.6 x 2 = 7.2 W -- [9] Servo motor won't run continuously at maximum power. Thus, let us assume that motors operate intermittently and for around 10% for an hour. Power = 7.2 W x 0.1 =0.72 W If the panel operates for 6 hours in a day,

	0.72 x 6 = 4.32 W 1.47 W x 6 = 8.82 W -- [10] Therefore, Energy gained = 8.82 – 4.32 = 4.5 W -- [11]

Equations [1] to [11] represent the parameters calculated in the work.

- Battery Energy: Battery capacity is measured in Amp Hours (Ex.-200 AH). To convert it to Watt Hours is should be multiplied by the battery voltage (48 V), then multiply the result by 0.7 (for 70% discharge). For 200 AH,48V battery the watt Hours is: -
  Voltage*Ampere*hours = Watt Hours =48*200*0.7 = 6720 WH
  12*300/1000*0.7 = 10.92 WH (Compared with our project values).This mean that the battery can supply 6720 Watt for 1 Hour i.e., for more energy, the battery discharges fast.
- Charging Rate: The Charging Current: 200mA (0.2A), Charging Efficiency: 85%, Charging Time: 7.65 hours (using the formula: Capacity / (Charging Current × Efficiency)).
- Solar panel generation over a period: A solar panel's power generating rating is also expressed in Watts (175 W). To calculate the energy, it can supply to the battery, multiply Watts by the hours exposed to the sunshine, then multiply the result by 0.67 (for natural system losses).For 4 solar panels each of (175 W) exposed to sunshine for 7 hours: -
  175*4*7*0.67 = 3283 WH
  1.47*7* 0.67 = 7 WH (Compared with our project values).This is the amount of energy the battery can receive from the solar panels.

10. CONCLUSION

SolarComm's dynamic tracking enhances solar energy capture efficiency, reducing grid power reliance and promoting sustainability, integrating renewable energy sources into existing wireless charging solutions. While the system improves charging efficiency and sustainability, infrastructure costs for implementing dynamic wireless charging remain high.. The system uses a dual-axis solar tracker and wireless power transmission for sustainable, efficient, and contactless charging of electric vehicles. It addresses solar collection efficiency, infrastructure constraints, and interruptive power supply issues. The system is optimized for deployment on highways with long uninterrupted stretches of road to maximize charging duration. Urban applications require integration with smart traffic systems for efficient utilization. Future iterations will incorporate AI-driven solar tracking for real-time optimization and predictive energy harvesting.

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Biography

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