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## **Wireless Power Transfer for Electrical Vehicle**

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**ABSTRACT:** With the increasing adoption of electric vehicles (EVs), efficient and convenient charging solutions are crucial for their widespread use. This project focuses on implementing a Wireless Power Transfer (WPT) system for EV charging, eliminating the need for physical connectors and enhancing user convenience. The system is based on Inductive Power Transfer (IPT), utilizing a transmitter coil embedded in the charging station and a receiver coil installed in the vehicle. The proposed WPT system operates on the principle of electromagnetic induction, where power is transferred wirelessly through resonant coupling. High-frequency AC power is generated, transmitted through the primary coil, and received by the secondary coil and then converted into DC for battery charging.

#### I. INTRODUCTION

We are using an electronic device perhaps a mobile phone and we need to recharge the battery then you will probably have to get a charger and connect the phone to the wire. But what if we could charge it without having to connect it to wire? Meaning power will be transferred wirelessly. This is possible through a concept called Wireless Power Transmission.Research and studies have been done ever since the 19th century but it is only recently that this concept has begun to be implemented. Currently engineers are trying to discover how to increase the efficiency of power transmitted wirelessly and also methods that that are safe to human beings and the environment and notwithstanding, methods that are cheaper and hence can be commercially viable. Though still in the early stages, several electronic companies are beginning to roll out devices that can wirelessly transmit power.Wireless power transmission (WPT) is based on the principle of electromagnetic induction. Electromagnetic induction works on the concept of a primary coil generating a predominantly magnetic field and a secondary coil being within that field so a current is induced within its coils. This causes the relatively short range due to the amount of power required to produce an electromagnetic field.

#### **II. LITERATURE SURVEY**

Anis Maisarah Mohd Asry, Farahiyah Mustafa, Sy Yi Sim, Maizul Ishak, Aznizam Mohamad, "Study on footstep power generation using piezoelectric tile" Indonesian Journal of Electrical Engineering and Computer Science Vol. 15, No. 2, August 2019, pp. 593~599 ISSN: 2502-

Electrical energy is important and had been demand increasingly. A lot of energy resources have been wasted and exhausted. An alternative way to generate electricity by using a population of human had been discovered When walking, the vibration that generates between the surface and the footstep is wasted. By utilizing this wasted energy, the electrical energy can be generated and fulfill the demand.

The transducer that use to detect the vibration is a piezoelectric transducer. This transducer converts the mechanical energy into electrical energy. When the pressure from the footstep is applied to the piezoelectric transducer, it will convert the pressure or the force into the electrical energy. The piezoelectric transducer is connected in series-parallel coonection. Then, it is placed on the tile that been made from wood as a model for footstep tile to give pressure to the piezoelectric transducers.





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#### **III. METHODOLOGY**



#### Fig 3.1: Methodology

This diagram illustrates an electric vehicle (EV) charging and power conversion system. Here's a breakdown of the key components and their roles:

#### Three-Phase Source:

The diagram begins with a three-phase AC source, which provides electrical power to the system. This power must be converted for different purposes within the EV system.

#### AC/DC Conversion & DC/AC Conversion:

The AC/DC conversion process converts the incoming AC power into DC power, which can be used for battery charging or other applications.

The DC/AC conversion process converts DC power back into AC power, likely for use in motor drive applications or feedback into the grid.

#### **Compensation Systems:**

The diagram includes compensation units, which help in power quality management, voltage regulation, and efficiency improvement in both charging and discharging operations.

#### **Rectifier/Power Regulator:**

The rectifier/power regulator ensures efficient power conversion and management. It is responsible for regulating voltage and current during charging and discharging to optimize battery performance and longevity.

#### **Battery Storage:**

The battery stores the converted DC power, which will later be used for driving the vehicle or powering onboard electronics.

#### Vehicle Power Flow:

Inside the vehicle, compensation and rectification systems regulate the energy flow, ensuring stable operation. The AC/DC conversion inside the vehicle is crucial for managing different voltage levels required by various electrical components.





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**III. HARDWARE AND SOFTWARE REQUIREMENTS** 

#### HARDWARE DETAILS

#### 3.1.1 DHT11 Sensor

Humidity is the measure of water vapour present in the air. The level of humidity in air affects various physical, chemical and biological processes. In industrial applications, humidity can affect the business cost of the products, health and safety of the employees. So, in semiconductor industries and control system industries measurement of humidity is very important. Humidity measurement determines the amount of moisture present in the gas that can be a mixture of water vapour, nitrogen, argon or pure gas etc. Humidity sensors are of two types based on their measurement units. They are a relative humidity sensor and Absolute humidity sensor. DHT11 is a digital temperature and humidity sensor.

#### **3.1.2 Piezoelectric Footstep**

The piezoelectric footstep is a key component in your system, as it converts mechanical energy, generated from the force of footsteps, into electrical energy using piezoelectric materials. These materials generate a voltage when subjected to pressure or vibration, which can then be harvested and stored for later use. This technology is highly suitable for energy harvesting in environments like busy roads, public spaces, or even wearable devices that use human movement to generate energy.

#### 3.1.3 Inverter

An inverter is necessary because the power generated by the piezoelectric footstep is DC (direct current), but many devices, such as appliances and electric vehicles, typically require AC (alternating current) for operation. The inverter's job is to convert the harvested DC energy from the piezoelectric system into AC power. This process involves switching the DC voltage back and forth to create an alternating waveform. In the case of an electric vehicle (EV) charging system, for instance, the inverter is especially important if the harvested energy needs to be integrated into the vehicle's charging system, which may require AC input. Even if the energy isn't used immediately, it might be necessary to use AC for other applications in the system. For instance, a home or public charging station might require AC to charge EVs or power other electrical equipment.

#### 3.1.4 LCD Display

An LCD display serves as a visual feedback interface for the system, providing users with crucial information such as the battery status, the power generation rate from footfalls, and system diagnostics. The display can also show other parameters like the voltage levels and current power output, which are essential for understanding the performance of the energy- harvesting system. The LCD display can be configured to show real-time updates or even display alerts for issues such as low power generation or low battery charge. For example, in a scenario where the piezoelectric footstep system is used for charging an electric vehicle, the LCD display could show the charging percentage of the vehicle's battery or the amount of power being generated at any given time, helping users monitor system efficiency.

#### 3.1.5 Pulse width modulator

The Pulse Width Modulator (PWM) plays a crucial role in controlling the power delivered from the piezoelectric system and managing the charging process. It works by varying the width of the pulse sent to the load, adjusting the amount of energy that's being transferred in a given time period.For example, in your system, PWM could be used to adjust the voltage and current delivered to the battery during the charging process. This ensures that the battery is charged optimally, preventing overcharging or undercharging, which can damage the battery over time. Similarly, PWM can be used to regulate the energy harvested from the piezoelectric footstep system to ensure that power delivery is efficient and matches the energy requirements of the connected device or battery.

#### 3.1.6 ESP32

This is ESP WROOM 32 MCU Module. ESP WROOM 32 is a powerful, generic WiFi-BT- BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming, and MP3 decoding. At the core of this module is the ESP32S chip, which is designed to be scalable and adaptive. There are 2 CPU cores that can be individually controlled or powered, and the clock frequency is adjustable from 80 MHz to 240 MHz. The user may also power off the CPU and make use of the low-power coprocessor to constantly monitor the peripherals for changes or crossing of thresholds. ESP32S integrates a rich set of





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peripherals, ranging from capacitive touch sensors, Hall sensors, low-noise sense amplifiers, SD card interface, Ethernet, high-speed SDIO/SPI, UART, and I<sup>2</sup>C.

#### SOFTWARE DETAILS

#### 3.1.7 ThingSpeak

The data visualization and storing will be done in MathWorks's Thingspeak platform

Real-Time Data Visualization and Analysis: The platform provides instant visualizations of incoming data and integrates with MATLAB, enabling users to perform online analysis and process data as it arrives. This integration facilitates tasks such as plotting data trends, performing statistical analyses, and developing predictive algorithms.

#### 3.1.8 ACTIVITY DIAGRAM

#### SCHEMATIC DIAGRAM



Figure 3.2.1: Schematic diagram

Here is the circuit diagram of a 100 watt inverter using IC CD4047 and MOSFET IRF Z44. CD 4047 is a low power CMOS astable / monostable multivibrator IC.Here it is wired as an astable multivibrator producing two pulse trains of 0.01s which are 180 degree out of phase at the pins 10 and 11 of the IC. Pin 10 is connected to the gate of Q1 and pin 11 is connected to the gate of Q2.Resistors R3 and R4 prevents the loading of the IC by the respective MOSFETs. When pin 10 is high Q1 conducts and current flows through the upper half of the transformer primary which accounts for the positive half of the output AC voltage.The center terminal of the copper coil will be connected with the positive (+ve) terminal of an AA battery. When then the receiver coil is placed 1 inch above of the transmitter coil, then the LED will blink.To accomplish this, power source (DC current) is changed into high frequency AC (Alternating Current) by particularly designed electronics erected into the transmitter. The AC boosts a copper wire coil in the transmitter, which produces a magnetic field. When the receiver coil is placed in proximity of the magnetic field, the magnetic field can make an AC (alternating current) in the receiving coil. Electronics in the receiving coil then alters the AC back into DC which becomes operating power.

The main intention of this project is to design a WPT system in 3D space (transfer power within a small range) and the block diagram of this project is shown below. The block diagram of the wireless power transfer mainly builds with HF transformer, capacitors, diode, rectifier, inductor coil filled with air and lamp. The person is mandatory to be worked every year to change the battery. This project is designed to charge a rechargeable battery wirelessly. Since charging of the battery is not possible to be demonstrated, we are providing a DC fan that runs through wireless power. Oscillator The royer oscillator was chosen because of its simplicity yet powerful design. It is capable of generating very high oscillating current which is necessary to increase the strength of the magnetic field. This is achieved by the semiconductor used. In this case, the IR 540 power mosfets. However due to the large current, heating occurred in the





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MOSFETs thus heat sinks were attached to them

. When the voltage was stepped up to 30V dc, upon doing the initial test the transmitter circuit didn't oscillate yet the first MOSFET was rapidly heating up. It was discovered that due to voltage being fed rising too slowly on power up a short circuit occurred. To solve this issue, a reset switch was introduced between the power supply and the oscillator circuit. The switch also enabled the circuit to be reset once the MOSFETs heated up. It was also observed that as much as the voltage to the oscillator had been stepped up, the power being received on the load coil wasn't enough to power the battery charging circuit

#### **IV. RESULTS AND DISCUSSION**



Figure 4.1: Project Model - Showing the result for Humidity and Temperature

#### **Efficiency of Wireless Power Transfer (WPT)**

The power transfer efficiency was observed to be highest when the receiver coil was directly aligned with the transmitter coil (0 cm separation).

As the distance increased, the efficiency dropped significantly after 5 cm, demonstrating the exponential decay of power transmission over distance.

The brightness of test lamps was used as an indicator, showing the strongest illumination at minimal separation.

#### Performance of IoT-Based Monitoring System

The ESP32 module successfully transmitted real-time battery and motor parameters to the ThingSpeak cloud. Temperature, humidity, and voltage readings were accurately displayed on an LCD screen and remotely monitored. The system successfully sent alerts when temperature levels exceeded a set threshold, improving vehicle safety.

#### Wireless Charging Feasibility for Electric Vehicles

The system was able to charge a 9V battery wirelessly, proving the validity of inductive power transfer for batterypowered applications.

For real-world application in electric vehicles, higher power levels and optimized coil design would be necessary.

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The placement of the receiver coil outside the passenger zone was successful in reducing electromagnetic exposure to humans

#### Limitations and Challenges

Power loss due to misalignment: If the vehicle was not perfectly positioned above the transmitter coil, efficiency dropped.

Limited range: The system is currently effective for short distances; further improvements are needed to support higher vehicle speeds and highway applications.

Seasonal variations: The system's efficiency may reduce in extreme weather conditions, such as heavy rain or snow.

#### **Practical Applications Beyond EV Charging**

The technology can be adapted for wireless medical implants (e.g., pacemakers) to eliminate the need for battery replacement surgeries.

Consumer electronics like smartphones and laptops can benefit from long-range wireless charging.

Smart road infrastructure can be developed for future autonomous electric vehicles to enable continuous, on-the-go charging.

#### V. FUTURE ENHANCEMENT

The future of wireless power transfer (WPT) for electric vehicles (EVs) holds immense potential for transforming the way vehicles are powered. As technology advances, several key areas can enhance the efficiency, scalability, and adoption of wireless charging systems. Below are the major future developments and research areas that can further improve WPT for EVs:

#### **1.Dynamic Wireless Charging**

One of the most promising advancements is dynamic wireless charging, where EVs can charge while driving on specially equipped roads.

This would eliminate range anxiety and reduce the need for large battery capacities, making EVs more cost-effective. Smart roads embedded with wireless charging coils could be deployed on highways, enabling continuous power supply without stopping

#### 2. Increased Charging Efficiency and Range

Current wireless power transfer systems suffer from energy losses due to misalignment and distance constraints. Research in advanced coil materials, magnetic resonance coupling, and metamaterials can improve energy efficiency and longer-range charging capabilities.

Adaptive resonance tuning can ensure optimal power transfer even if the receiver coil is not perfectly aligned

#### 3.High-Power Wireless Charging for Faster Charging Times

Current wireless charging systems have limitations in power delivery compared to wired fast-charging stations. High-power WPT systems (over 100 kW) need to be developed to allow for faster charging times comparable to wired DC fast chargers.

#### 4. Integration with Renewable Energy and Smart Grids

Future EV charging infrastructure will be integrated with solar panels and wind energy systems, making charging stations self-sufficient and reducing grid dependency.

T and AI-Based Smart Charging Management

Wireless EV chargers will be equipped with IoT-enabled sensors and AI algorithms to optimize charging schedules, prevent overloading, and ensure energy-efficient charging cycles.

AI-driven charge prediction models will assess traffic conditions and vehicle routes to optimize charging locations and reduce waiting times.

#### **5.Standardization and Global Adoption**

Currently, wireless charging lacks universal standards, leading to compatibility issues between different manufacturers. Efforts by organizations such as SAE International, ISO, and IEC are working towards developing standardized wireless charging protocols for seamless interoperability.

#### 6.Application in Autonomous and Commercial Vehicles

With the rise of autonomous vehicles (AVs), self-charging EV fleets will be crucial for uninterrupted operation. Public transportation systems like electric buses and taxis can integrate wireless charging at bus stops to reduce downtime.





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Logistics and delivery EVs can benefit from automated wireless charging, enhancing supply chain efficiency. The objectives of the project were met. An electronic device that wirelessly transmits power and then charges batteries was developed. We were able to design discrete components such as the royer oscillator, coils and a full bridge voltage rectifier for the system design process. Conclusions that were drawn from the project study are as follows: Based on the theory of wireless charging via inductive coupling, which was the method used in the project, it was seen that various aspects i.e. distance, resonant frequency, quality factor; coil turns ratio determine the efficiency of WPT. In addition there is an exponential decay for power versus the distance of separation. From the analysis it was seen that at 0cm separation distance, the power transfer was most efficient as seen by the brightness of the test lamps. From the project WPT for short range or near field occurred up to a distance of 5cm after which the power transferred began to significantly drop.

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