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Wireless Vehicle Charging Station Using Static Capacitive Charging

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A B S T R A C T

The Wireless vehicle charging station system consists of inductive power transfer using an electromagnetic field to transfer energy between a charging pad and the vehicle's receiver coil. The charging pad is placed on the ground meanwhile the vehicle is positioned directly above for charging. The charging pad is connected to a power source and an alternating current is passed through the pad creating a oscillating magnetic field. This technology provides advantages such as safety, convenience and ease of use. It reduces need for bulky wired charging infrastructure and increases feasibility of electric vehicle adoption. There are two types of power transfer such as dynamic and static. In this paper we will be creating a static power transfer vehicle charging station and how it can be implemented.

Keywords: Static power transfer, charging coil, induction, wireless charging.

Introduction

The static wireless vehicle charging stations are a type of electric vehicle charging infrastructure that eliminates the need for cables and wires for charging electric vehicles. This technology is based on the principle of inductive power transfer, which uses electromagnetic field to transfer energy between a charging pad and electric vehicle's receiver coil. These static wireless vehicle charging stations are installed in parking lots, garages, or other stationary infrastructure locations. They consist of charging pad that is installed on the ground and an electric vehicle equipped with a receiving coil is placed above the charging pad. This technology offers advantages such as safety, convenience, and ease of use. This in-turn eliminates the need for drivers to physically connect their vehicles to charging station, reducing maintenance and other electric accidents.

1.1 Hardware

1.1.1 Wireless vehicle charging station

Static wireless electric vehicle charging station (WEVCS) is the charging station used. The power source used for the station is a 9v Lithium-ion cell which powers the circuit with energy. The 9V (nine volt) battery is a rectangular dry cell classified by its 48.5mm x 26.5mm x 17.5mm dimensions and one-sided clasp terminal. It is a zinc carbon battery which has a discharge time of 9hrs and supplies about 1.2ah of current. It is further connected to two 5V 2A Wireless Power Supply Transmitter Receiver Charging Coil Modules. These coils will transmit power to the vehicle using wireless power and charge the battery located inside the vehicle. The figure is represented below in fig 1. In figure 1.1 is the circuit diagram that shows the connections.

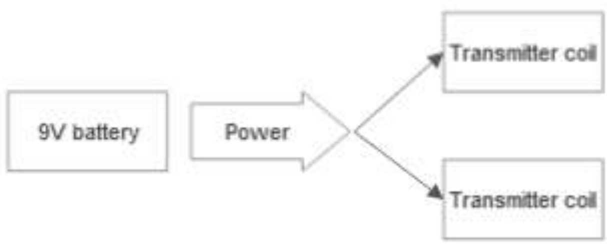

Fig 1. Block diagram of charging station

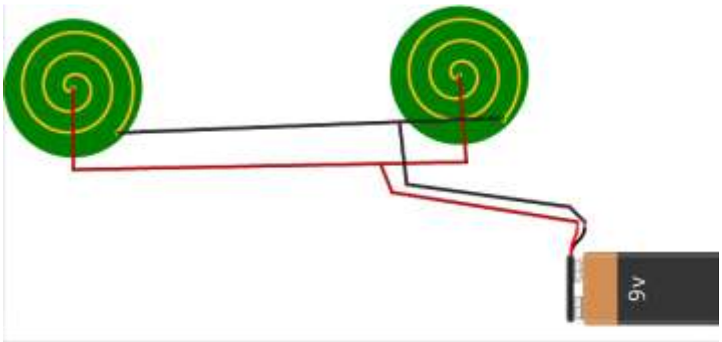

Fig 2. Circuit diagram of charging station

1.2 Vehicle detection station

The vehicle detection station will help with the detection of the vehicle if placed on the charging pad, and turning the power on to start the wireless charging. In this module Arduino Nano is used as the main microcontroller: ATmega328P. The Arduino Nano is programmed using the Arduino IDE, which is a free, open-source software development environment. It is used to detect the object in front of it using a IR sensor and relay the information back to the Arduino nano. A 16x2 LCD is used to display the information of charging status and object detection with the help of the Arduino nano. Vehicle detection using Arduino and IR (Infrared) sensor is a common and cost-effective method used in traffic monitoring systems, parking management systems, and security applications. The charging status will be shown on the (LCD). The IR sensor will glow red on detecting the object in front of it and relay the information to the Arduino nano. The code running on Arduino will ensure that both status of the vehicle detection and charging station is shown accurately. The LCD display is connected with a I2C Module. The I2C (Inter-Integrated Circuit) protocol is a widely used serial communication interface that allows multiple devices to communicate with each other using only two wires. One of the most common applications of I2C is in LCD (Liquid Crystal Display) modules, where it is used to interface with the microcontroller and display data. In the figure (fig 2.1) below is the basic block diagram of the vehicle detection station. The mounted hardware can be shown in the fig 2.2.

The Connections of the pins are as follows:

1.The SDA and SCL pins of the I2C module are connected to A4 and A5 of Arduino nano.

2.The output pin of IR sensor is connected to D6, D7.

3.The VCC of the IR sensor is connected to 3V of Arduino nano.

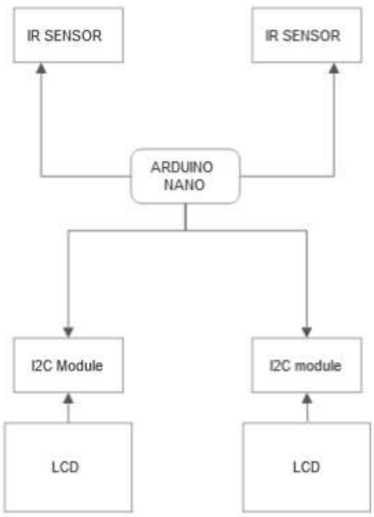

Fig 2.1: Block diagram of Vehicle station

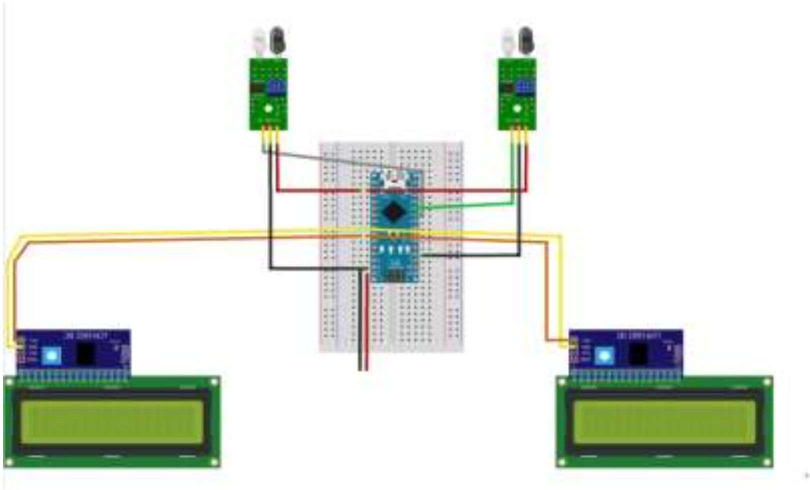

Fig 2.2: Circuit diagram of vehicle station

1.3 Electric vehicle model

The TP4056 is a popular lithium-ion battery charging module which is used to power the battery. It is commonly used in small-scale applications such as projects, prototyping, and electronic gadgets. The TP4056 module can charge a single lithium-ion battery with a maximum charging current of 1A, and it comes in different configurations, including with or without protection, with different charging voltages, and with different charging currents. The TP4056 module has a simple design and is easy to use. It requires an input voltage of 4.5V to 5.5V and can be connected to a USB port or a 5V power supply. The module has two input pins, one for positive and one for negative, and two output pins, one for positive and one for negative. It also has a charging status LED that indicates when the battery is charging and when it is fully charged.

The charging module is connected to three devices which are a 3.7V rechargeable lithium-ion battery, receiving wireless charging coil and a Battery level indicator. The connections of positive and negative are shown in the figure (fig:3.2) and the block diagram is shown in figure (fig 3.1). The Lithium-ion battery has a voltage range of 2.5V to 3.7V depending on their state of charge, also has a capacity of 2500 mAh.

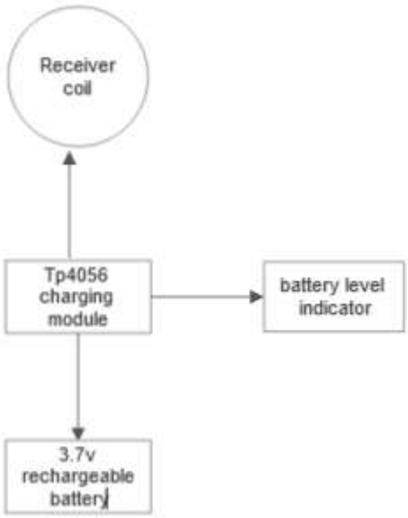

Fig 3.1: Block diagram of the vehicle

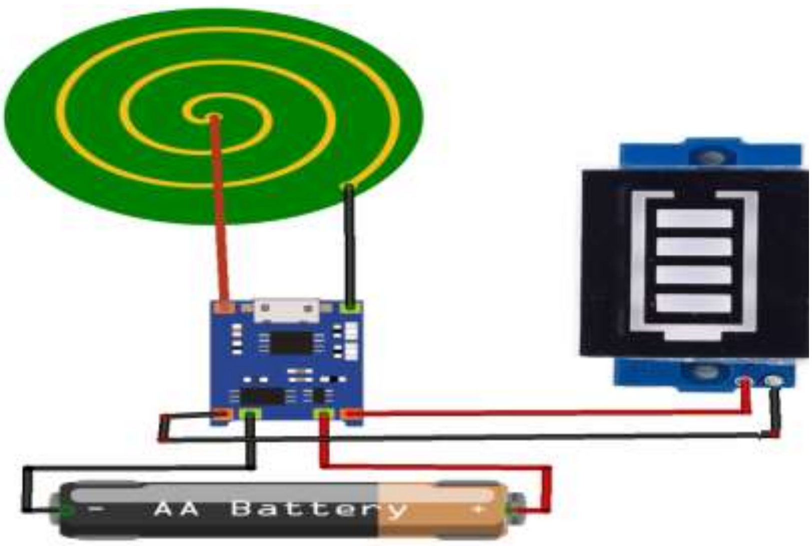

Fig 3.2: Circuit diagram of the vehicle

2. Software

The software includes the coding done using Arduino IDE. The Lcd will display charging animations using arrays. The code consists function such as void setup and void loop. Void setup is a required function that runs once at the beginning of an Arduino sketch. The pin modes are set for input or output, configure communication protocols, initialize serial communication, and perform other initialization tasks required for the operation of the sketch. In void loop we read the IR sensor data if the vehicle is present in front of it or not. The charging station value will increase the timer of the progress bar and if the vehicle is not present it will denote as vacant and progress bar will not increase.

3. Comparative

The results of this project performance on the wireless vehicle charging station are as follows:

Following practical investigation and theoretical analysis, the dependability and correctness of wireless charging were confirmed.

The efficiency of a wireless charging system ranges from around 70% to over 90%. This means that some of the energy transmitted by the charging pad is lost as heat or electromagnetic radiation, reducing the amount of energy that is actually transferred to the battery.

4. Future scope

The global market for electric vehicles is growing rapidly, and wireless electric vehicle charging is expected to play an increasingly important role in the future. Here are some potential developments and advancements that could shape the future of wireless electric vehicle charging globally:

Standardization: Standardization is important to drive down costs and ensure compatibility between different systems. Efforts to establish global standards for wireless charging could help to accelerate its adoption. Improved efficiency: There will likely be continued efforts to improve the efficiency of wireless charging systems, reducing energy losses and minimizing the charging time required. Integration with smart grid technology: Wireless charging systems could be integrated with smart grid technology, allowing for more efficient use of renewable energy and reducing strain on the grid. Autonomous charging: As autonomous vehicles become more common, wireless charging could be integrated into the charging process, allowing vehicles to charge themselves without human intervention. Increased adoption of electric vehicles: As more electric vehicles are adopted globally, there will be a growing need for charging infrastructure. Wireless charging could offer a convenient and efficient solution, especially in urban areas. Collaboration between tech companies and automakers: Collaborations between tech companies and automakers could lead to innovative wireless charging solutions and accelerate the development and adoption of the technology.

5. Results

The charging efficiency lies between 75%-89%, if the coils have no space in them the results increase. The vehicle charging using static capacitive charging are more efficient than dynamic charging. Energy losses are more than the traditional wired charging stations.

Below are some battery calculations observed after project completion,

Observations	**Values**
Capacity at cut-off voltage	~40%
Capacity with full saturation	~65%
Standard charging time	2 Hours

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