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Hi-Tech Battery Charger for Modern EV's Using IOT

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Abstract

Many electric vehicle batteries are now exploding or burning because they were overcharged or left charging for too long. It is possible for the battery's body temperature to increase under these conditions, causing them to burst. In this case, we have a unique battery charger that uses cutting-edge tech to charge the battery wirelessly while simultaneously monitoring its voltage and internal temperature data through an embedded system. This way, we can avoid these kinds of accidents. An integral part of the system is an alert that activates when the battery's internal temperature rises above a certain level. This mechanism promptly cuts power to the battery. When turned on, the alarm won't go off until you press the reset button.

An LCD connected to an Arduino board will show the current battery status, which is being measured digitally. Complete data transmission to the concerned mobile phone via WiFi module using IoT technology is another significant enhancement to the system. The data will be sent immediately to the phone via the established wireless connection between the system and mobile phone. It is now possible to charge batteries over short distances without the need for connections thanks to a new technology called wireless charging. Wireless charging is convenient since it eliminates the need to constantly plug in and unplug the device; all that's needed to start charging the battery is to park the car in the designated spot, and the coil will do the rest. For the sake of the demonstration, we will build a 4-wheeler chassis and place all of the components, including the battery, on top of it. To get the most current out of the wireless charger, the power receiver coil will be mounted underneath the chassis.

Major building blocks: Main processing unit built with Arduino Uno board, LM35 Temperature sensor, Relay, alarm, WiFi module, 12V DC power source, Oscillator circuit designed with power Mosfets, Resonating inductive coils, LCD, Rechargeable power battery, etc.

Introduction

The topic has now shifted to include a wireless charging for EVs. In order to increase the distance between the power transmission and receiving coils and the effectiveness of this technology, several tests are being carried out by experts worldwide. Currently, the system's biggest flaw is its inefficiency and short range; however, as these issues are resolved, this technology will gain popularity and these chargers will be widely available. If you want to charge your electric car's battery using this approach, you'll need to position the power receiving coil below the vehicle's chassis. The car is not built here, but it may be replicated to serve as a demonstration. Whether the battery is charging or not in use, its voltage and internal temperature may be tracked using an Arduino-based digital monitoring system. The terminal voltage of the 12v-2Ah rechargeable battery is continually monitored by an LCD interfaced with the Arduino board.
The primary source of heat released while charging electric vehicle batteries in hot environments, particularly during the summer, is the battery cathodes. Particularly in our nation, where the ambient temperature is high, it is necessary to protect the battery with effective thermal management. In order to prevent the battery from overheating when charging, this project is being evaluated.

When it comes to wireless chargers, the two most important components for charging batteries are the power transmitting and receiving coils. This technique eliminates the need for conducting wires by directly transferring energy from one coil to another. One

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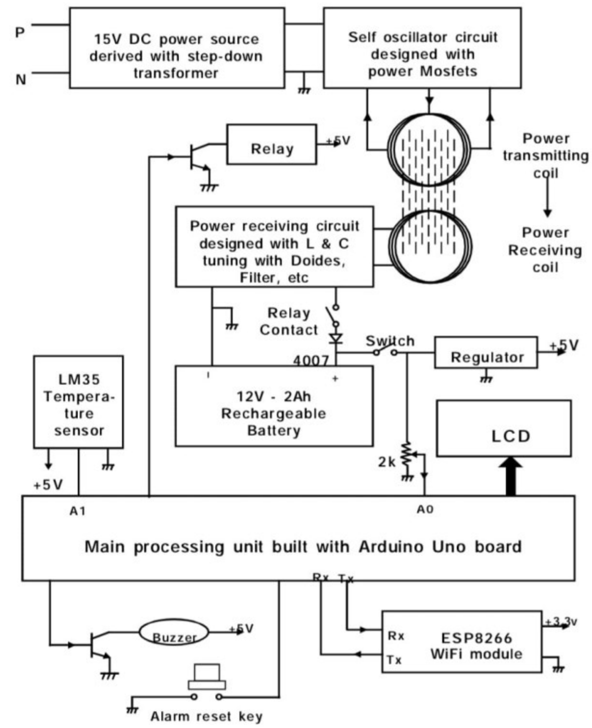
approach is to use resonant inductive coupling, which is also called electro-dynamic induction. This involves two coils that are magnetically connected and adjusted to resonate at the same frequency. The energy may be sent wirelessly, near the field. For resonant transfer to take place, an oscillating magnetic field must be generated by winding a coil with an oscillating current. Bringing a secondary coil close to this magnetic field will capture the most energy, which may then be utilized to charge the battery as a pure DC source. Since the output is unregulated, the voltage may be adjusted by changing the gap between the coils. Since the project's Arduino CPU already has an ADC, no external ADC is needed to transform the temperature sensor's analogue data. Just like that, an LCD connected to the Arduino may likewise show the voltage at the battery terminals.

Methodology

Little energy will be transported to a distance of approximately 3.5 cm's, but this project effort verifies the fundamental notion of wireless energy sources by adding electromagnetic field coils. During our trial runs, we discovered that a source voltage of 12 produces a current of roughly 300 milliamps. The electric vehicle's battery can be charged by this amount of electricity. Charging this battery will take 6.6 hours since its rating is 12V/2Ah (Ampere hour). This is calculated by dividing the battery rating by the charging current rating, which in this case is 0.3. The power source utilized is 300ma. Charging the battery takes less time when a high-power source is utilized. The following are the main components of this system, and the next chapter provides a thorough overview of its functionality.



Block diagram

In this case, we use the Resonant Inductive Coupling technique, which allows us to transfer electrical energy from one inductive coil to another across a distance of more than 10 cm. Discrete man-made conductors aren't always necessary or desirable for transmitting electrical energy from a source to a consumer product, but there are numerous situations when this isn't an option. If you're looking for a method to charge your car's battery, this theme is a great pick for short-range energy transmitters.

Because they produce such a large electromagnetic field, wireless power systems often have extremely low efficiency. A large amount of current has to be injected into the energy transmitting coil in order to produce such a large field, and the power receiving coil may not be able to absorb all of the energy that is created there. The amount of energy received by the secondary coil depends on the distance between the two coils. More than 70% of the energy may be collected by the secondary coil if it is maintained near to the primary coil. Power losses will also rise in proportion to the distance. In this case, we want to charge a battery without using any conducting wires, so we can demonstrate that the fundamental idea of wireless power transmitter technology is irrelevant. To

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that end, the power transmission coil is powered by a 12V, 1A secondary step-down transformer. This battery may be charged by connecting it to a re-chargeable battery at the output of the power receiving coil. This is accomplished by using a 12v-1Ah lead acid battery and a small embedded system that is programmed with a PIC16F676 controller chip. The voltage at the battery terminals can then be shown on an LCD screen.
At a distance of around 50 mm between the two coils, a single high-glowing LED light will illuminate to demonstrate that the power-receiving coil can receive enough energy from the power-transmitting coil to charge the battery. Here, a mode switch allows you to connect it either to the light source or the battery. When you choose the battery option, the charging process begins, and you can watch the terminal voltage of the battery slowly increase through an LCD and microcontroller circuit-designed digital monitoring system. Because this microcontroller chip already has an ADC built in, a separate ADC isn't needed to transform the analog data into digital form. It is necessary to convert the DC voltage from the battery terminals to digital form since the microcontroller cannot process analog data. So, we went with this budget-friendly PIC series controller.

This is a prototype module, thus it has a low power transmitter and a range of around 4 to 5 cm. Using electromagnetic field coils, this study aims to demonstrate the fundamental theory of a wireless energy source. Radiative and non-radiative wireless power methods are the two main types. In near-field or non-radiative methods, magnetic fields are used to transmit power over small distances by inductive coupling between wire coils. There are several uses for this kind of device, the most common of which is charging the battery.
Beams of electromagnetic radiation, such as microwaves or lasers, are used to transport power in radiative or far-field methods, which are also known as power beaming. These methods can transmit energy across greater distances, but they need precise targeting of the recipient. Protecting humans and other organisms from harmful electromagnetic fields is a major concern with any wireless power system. However, this issue may be resolved with the right amount of attention, much as in an oven. This is a prototype module, thus it uses a low-power wireless transmitter that won't hurt any living creatures. In what follows, you'll find a comprehensive analysis of this wireless energy technology.
The gadget that measures the terminal voltage of the battery and the temperature of the battery itself is built using an Arduino Uno board. The data is sent to the relevant smartphone via an ESP8266 WiFi module. The data is sent straight to the cell phone instead of being uploaded to the internet since it is a prototype module.

Many different kinds of monitoring and control systems, instrumentation, and process automation systems have been created for use in diverse industries as a result of technological advancements, especially in electronics. This project's overarching goal is to install a more sophisticated battery protection system while charging, which is especially important in the electric vehicle industry where a wide variety of electronic control systems are required for a variety of uses.

Autonomous control of electrical and mechanical processes is what we mean when we talk about automation. The term "field automation" may be used to describe the process of "monitoring and controlling the various electrical equipments used for charging the heavy duty battery chargers." An automated system for preventing batteries from overheating is built using components listed in the abstract: an Arduino Uno board, an LCD, a temperature sensor, a wireless power charger with a self-oscillator circuit, and an ESP8266 Wi-Fi module. In order to transfer data from the system to the concerned mobile phone, a WiFi module is used to set up a wireless communication connection. You can see the battery life status on the LCD.

Getting back to the WiFi module, any microcontroller may get access to the WiFi network using the ESP8266, a self-contained System on a Chip (SOC) with an integrated TCP/IP (Transmission Control Protocol/Internet Protocol) stack. You may host an application on this device or have it handle all of your WiFi networking needs. A WiFi transceiver and a 32-bit microprocessor make up the ESP8266. There is an analog input in addition to its eleven general-purpose input/output (GPIO) pins. With the 2.4GHz band, these devices can communicate up to 150 feet away. The following chapters provide a comprehensive explanation of this apparatus.
Anywhere in the globe, people may now take use of IoT technology, which allows for the exchange of data between different smart devices. Research on smart application services is discussed in this project work. One of the features is the ability to monitor the battery state. When the battery temperature reaches 450 C, the charging circuit will be immediately turned off. Through an Internet of Things link, this data may also be sent to the relevant mobile device. As this gadget is meant to function at 3.3V DC, a separate power source is constructed using a 3.3V regulator chip. It is interfaced with the Arduino microcontroller and uses an IoT 8266 WiFi module.

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A single-chip microcontroller from Atmel's mega AVR family, the ATmega328, forms the basis of the Arduino Uno module, which houses the device's central processing unit. Its 8-bit RISC processing core is based on a variant of the Harvard design. The idea behind RSIC (Reduced Instruction Set Computer) is that a combination of a simpler instruction set and a microprocessor architecture that can execute the instructions with a certain number of microprocessor cycles per instruction leads to improved performance. Internally, the ATmega-328 can handle data up to 8 bits in length and contains 32 KB of RAM. In addition, it has 1 kilobyte of electrically erasable programmable read-only memory (EEPROM), which means that the data saved in it will remain intact even if the power goes off. The ATmega 328 is the most sought-after product on the market right now because of its many useful features. Features such as a real-time counter with a separate oscillator, support for pulse width modulation (PWM) principles, a built-in analog-to-digital converter (ADC), a programming lock to ensure software security, and an advanced RISC architecture are all part of these characteristics.

The open-source electronics platform Arduino's software and hardware are designed to be user-friendly. A motor may be activated, an LED can be turned on, or anything can be published online using an Arduino board as an input. The board can read a light from a sensor, a finger's touch on a button, or even a tweet. With its 20 digital I/O pins, 6 of which are PWM outputs and 6 of which are analog inputs, it offers a lot of flexibility. The user-friendly Arduino software makes it straightforward to load programs onto it. The Arduino Uno has undergone three revisions, the most recent of which is the R3. In addition to its 14 digital I/O pins, 16 MHz quartz crystal, power connector, USB port, ICSP header, and reset button, the ATmega328P also has a power jack. The Arduino programming language is nothing more than a collection of C/C++ functions. Functions enable programmers to break code down into smaller, more manageable parts that may do certain tasks and then return to their original, "called" location. When an operation has to be repeated in a program, the usual situation for defining a function is to do so.

Description of wireless power transmission

An effective method of transmitting electrical power from one location to another via air without the need of wires is known as wireless power transmission (WPT). When working with short-range inductive coupling or medium-range resonant induction, WPT allows for the transmission of power. This innovation makes it feasible to provide electricity to areas where traditional power lines would have a hard time reaching. Many researchers across the globe are focusing on creating more effective power transmitters since inductive coupling is a hot topic right now.

When it comes to wireless power transmission, electromagnetic induction is by far the most popular and widely used method. The three requirements for an effective wireless power transfer system are (a) high power, (b) a big air gap, and (c) efficient middle power transmission. Although it is inefficient, microwave power transmission can cover great distances. Since this approach uses electromagnetic wave radiation, it may not be the most efficient for near field power transmission. An inductively loaded electrical dipole—an open capacitor or dielectric disk—with two equal and opposing electric charges or magnetic poles of opposite signs positioned a little distance apart—this is what electric field coupling delivers, allowing for wireless power transmission.

LC circuit description

Connected together, an inductor (L) and a capacitor (C) form an LC circuit, which is also known as a resonant circuit, tank circuit, tuned circuit, or simply an electric circuit. The circuit has the potential to store energy that oscillates at the frequency at which it reverberates, thereby functioning as an electrical resonator—the electronic equivalent of a tuning fork. LC circuits may be used for two main purposes: first, to generate signals at certain frequencies; second, to extract signals at specific frequencies from more complicated signals. These are essential parts of a wide variety of electrical devices, including oscillators, filters, tuners, and frequency mixers. Since it is assumed that energy does not dissipate owing to resistance in an LC circuit, it is an idealized model. The loss that occurs in any real-world use of an LC circuit is due to the fact that the components and connecting wires all have tiny resistances that are not zero. To efficiently drive inductive loads, LC circuits often oscillate across DC sources and produce ac signals.

Both the inductor L and the capacitor C use their respective electric and magnetic fields to store energy. The L and C components begin charging and discharging in a clockwise and anticlockwise direction in this arrangement, causing the tuned circuit to oscillate at a rate of millions of times per second.

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An LC circuit has the ability to store electrical energy by vibrating at its natural resonant frequency. While an inductor's magnetic field (B) stores energy in relation to the current flowing through it, the electric field (E) between a capacitor's plates stores energy in relation to the voltage across them. A charged capacitor may have its voltage reduced by connecting an inductor across it; this will cause current to flow through the inductor, creating a magnetic field surrounding it. At some point, the capacitor will lose all of its charge and the voltage across it will be 0. But inductors resist changes in current, thus the current will keep flowing. The capacitor will start to charge at a voltage that is inversely proportional to its initial charge as the current flows through it. In order to charge the capacitor, one must first reduce the magnetic field, which, according to Faraday's equation, causes a reduction in the electromagnetic field (EMF) that drives the current. The current will cease and the charge will be stored in the capacitor once again, this time with the reverse polarity, after the magnetic field has been entirely dissipated. The next time around, the inductor will get a current going in the opposite direction, and the cycle will restart.

Temperature sensing circuit

The purpose of this LM 35 circuit is to detect the internal temperature of the battery. The LM35 is the first component; it is a temperature sensor that, when exposed to heat, produces a voltage that is proportional to the amount of heat it is measuring. An output voltage that is directly proportional to the Celsius temperature is produced by the LM35 family of precision integrated-circuit temperature devices. Interfacing to readout or control circuitry is made particularly straightforward with the LM35 device's low-output impedance, linear output, and perfect intrinsic calibration.

The LM35 is a three-pin temperature sensor that takes a VCC and GND as inputs and an analog output on the third pin. The Arduino processor's ADC pin receives this output and uses it to digitize analog data. The output voltage of the LM35 series of precision integrated-circuit temperature sensors is directly proportionate to the temperature in Celsius (Centigrade). If necessary, the software may be adjusted to translate this data to Fahrenheit.

Arduino

Digital devices and interactive things that can detect and control both physically and digitally may be built with the help of Arduino, an open-source hardware and software business, project, and user community. These products include microcontroller kits and single-board microcontrollers. The General Public License (GPL) and the Lesser General Public License (LGPL) are used to license its goods, which means that anybody may make Arduino boards and distribute the software. Preassembled or as do-it-yourself (DIY) kits, Arduino boards are sold commercially.

Multiple microprocessors and controllers are used in the designs of Arduino boards. You may connect these boards to other circuits and expansion boards using the digital and analog input/output (I/O) pins that come with them. You may load applications from personal computers onto the boards via their serial communications interfaces, which include Universal Serial Bus (USB) on some variants. The microcontrollers are usually coded using a combination of C and C++ features. The Arduino project offers an integrated development environment (IDE) built on top of the Processing language project, in addition to the standard compiler tool chains.

WiFi module

The fact that many individuals are unaware that WiFi stands for a shorthand is surprising. Not everyone is familiar with the acronym WiFi. The term's meaning has been variously proposed, but Wireless Fidelity has gained the greatest traction among techies.

We can stay connected almost anywhere these days, thanks to the widespread use of wireless technology. This includes our homes, places of employment, libraries, schools, airlines, hotels, and even some eateries. Since it encompasses the IEEE 802.11 technologies, wireless networking is often referred to as WiFi or 802.11 networking. Almost every operating system, gaming device, and modern printer is compatible with WiFi, which is its biggest benefit.

Relay

When the temperature goes higher, the relay in this setup will cut power to the battery, preventing it from being charged. Electromagnets and contacts form the basic electromechanical switch known as a relay. All types of devices conceal relays. Relays are an integral part in the operation of the vast majority of high-end industrial application equipment. Simple switches that can be turned on and off electrically and mechanically are known as relays. A collection of contacts and an

electromagnet make up a relay. The electromagnet is responsible for executing the switching mechanism. Its operation is also guided by other concepts. Their uses, however, make them distinct. The majority of the gadgets make use of relays.
In situations when a weak signal is all that is needed to operate a circuit, a relay comes into play. In situations when a single signal may operate several circuits, it is also used. The introduction of the telephone sparked the first widespread use of relays. They were crucial in telephone exchanges for the purpose of call switching. Additionally, they found utility in long-distance telegraphy. They were used for the purpose of transferring signals from one location to another. They were also used to execute Boolean and other logical operations after the introduction of computers. Powerful electric motors and other high-end uses of relays are necessary. Contactors describe these types of relays.

LCD

The Liquid Crystal Display modules are crucial components of embedded systems designed using the Arduino platform. Therefore, understanding how to connect a 16×2 Arduino to an LCD is crucial for embedded system designers. In the realm of human-machine communication, the display units play a crucial role. It makes no difference whether the display is large or tiny; the underlying idea is the same for all display units. We are mostly dealing with 16×1 and 16×2 units, which are basic forms of display. There are 16 characters on one line in the 16×1 display unit, and 32 characters on two lines in the 16×2 display unit. Each character requires 5×10 pixels to be shown. So, all fifty pixels need to be in the same place for a single character to show. You may control the pixels of characters to show using the built-in controller of the panel, which is HD44780.

IOT

A network that allows physical and digital items, animals, and people to exchange data with one another and with computers in a system known as the Internet of Things (IoT) eliminates the need for direct human or computer contact.

As a result of the coming together of several technologies, including embedded systems, real-time analytics, and machine learning, the concept of the Internet of things has changed. Embedded systems, control systems, automation (including home and building automation), wireless sensor networks, and other traditional areas all play a role in making the Internet of things possible. Within the consumer market, Internet of Things (IoT) technology is most commonly associated with "smart home" products. These products include lighting fixtures, thermostats, home security systems, cameras, and other appliances that are part of one or more common ecosystems and can be controlled through devices that are also part of that ecosystem, like smart speakers and smartphones.

Conclusion

We studied the functions of electromagnetism, resonant inductive coupling, LC networks, synchronization between two inductive coils, etc., before beginning this project so that we could safely charge electric car batteries using wireless battery charging technology while protecting the batteries themselves. The majority of the data came from several online sources. Our exclusive thermal protection approach prevents batteries from overheating and subsequent fires.
An essential topic that generates a lot of excitement throughout project construction is wireless power transfer. A great deal of experimentation is needed to improve the outcomes in the area of wireless electrical energy transfer between two magnetically connected coils. During our trial runs, we experimented with a wide variety of magnetic coils, including those of varying sizes, kinds of wire, and turn ratios. Our last concentration is on a single set of coils that utilize 21 SWG wire and have a ring size of 8". The main and secondary coils each have six turns. We noticed a little improvement in range while using these coils compared to others. Lastly, we established a 50 mm space between the coils; at this distance, the battery charges at a lower current; and when we reduced the distance by less than 30 mm, we found that the battery charged at around 300 mA.
Due to the limited power supply on the main side, the prototype module's low power transmitter is built. We have done a lot of tests, and we are convinced that we can create a high power transmitter and improve the range proportionally. However, we are also considering the economics as a criterion. Tuning resonant circuits made of inductance and capacitance is the most crucial part of this endeavor. The outcome is dependent on these two components, and the pace at which they are functioning efficiently is also critical. We learned the hard way that formulae aren't very effective; instead, what really matters is carrying out realistic experiments with a lot of trial runs and a lot of patience.

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By Oswald Jumira, Sherali Zeadally
2 – Electromagnetic Field Measurement in the near field
By Hubert Trazaska
3 – Electromagnetics for Engineers
By Steven E. Schwarz
4 – Fields from Electric Power
By Prof. M. Granger Morgan
5 - Beginning Arduino – Michael Mc Roberts
6 – Getting started with Arduino – Mossimo Banzi
7 - The Internet of Things (IoT) is about innovati functionality and better productivity by seamlessly connecting devices. But a major threat is the lack of architecture standards for the industrial Internet and connectivity in the IoT. This article reviews recent IoT architecture evolution and what it means for industry projects.

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