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IoT Based Smart Home Automation using Wireless Power Transfer

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ABSTRACT

Access to power is a prerequisite for the efficient operation of any electrical / electronic circuit. The power transmission channel can be either physical (wires, cables, etc.) or non-physical (i.e. wireless). Wireless power transmission is a broad term used to describe any method used to transmit energy to electrical-based systems and devices. Wireless power transmission is one of the modern approaches in the field of electrical engineering. With the increasing demand for electronic devices, the need for their charging equipment has also increased. In this paper, a wireless power transmission system is developed to provide an alternative to the use of power cords for electrical /electronic devices. With this technology, challenges such as damaged or tangled power wires, spark hazards and extensive use of the plastic and copper used in wire production are solved, and the need for batteries in non-portable devices is eliminated. Moreover, an inductive coupling method for wireless power transmission system is developed through IoT (internet of things) data sharing at the web domain through the internet. In the perspective of IoT, an additional part of home automation is added with this work so that we can control any type of load (lighting, entertainment system, and appliances, home security) remotely via the internet. If we want to charge a battery, the device system will show the status of all the parameters of battery (charging status, battery status, voltage, current, humidity, temperature) via the internet. The performance achieved is a good indication that power can still be transferred across a medium range. In addition, possible approaches to improve the system's efficiency are discussed.

Key words : Internet of Things, Voltage Sensor, Arduino Mega, and Raspberry Pi

I. INTRODUCTION

Technology has revolutionized the overall system from wired to wireless system and from manual to the auto system. This revolution has connected all fields to work together especially the computer field which is involved in all other fields like Electronics, Electrical, Mechanical, etc. This field has become advantageous due to the Internet of things, machine learning, Deep Learning, and Artificial intelligence. Today's era Internet of things has been used for controlling and monitoring the electrical and electronic devices. IoT has made the system very much smart due to the interconnection and communication of different devices together having intelligence on the backside[1, 15].

As the demand for electronic devices increases, the consumption of dc power and recharging or their storage devices increases. Same to prevailing electronic devices, a modern concept of electric cars is introduced in developed countries. According to a rough idea, within three to four decades, all transport will shift to electric energy (green energy) instead of liquid or gas fuels. There will be electric energy storage devices within the vehicle that require frequent charging [2]. To charge the batteries of these vehicles, multiple charging points will be installed at home and public parking places. Far more than this, the modern approach is to charge these vehicles in while they are moving. This term is called "dynamic wireless charging systems". This system allows the vehicle to charge while in motion. This approach is useful for real-time charging. Engineers are working on the concept of solar nowadays which just not only produces clean and environment-friendly electric energy, it will have the capability to charge the vehicles dynamically. Obviously this will require a wireless charging scheme [3, 4]. A great benefit of this approach is to reduce the storage capacity requirement of battery backup, also do not require the high reservoirs for electric energy because we can charge instantly on a real-time basis.

Despite concerted efforts to free basic communication devices from wires and mobile devices such as cell phones, laptops and tablets, which are well equipped with rechargeable batteries, they still require a manual connection to the wired charging system when it runs out of charge. To completely free portable electronic devices from wires, a wireless power system must be developed [2].

Electrical energy can be transferred from one point to another without the use of connection cables, either through magnetic inductive coupling [3, 4], electromagnetic radiation [5-9], or resonant inductive coupling [10]. The magnetic inductive coupling used in transformers limits the transmission range as the primary and secondary windings need to be in close proximity due to the axial and angular misalignment between the coils. Although the transmission of wireless energy via electromagnetic radiation can cover a longer distance, this approach is difficult to implement and dangerous for objects in contact with electromagnetic waves. Moreover, the multi-directional characteristics reduce the efficiency of the system.

Electric power can be transmitted by resonant inductive coupling or electromagnetic radiation and magnetic inductive coupling. Magnetic inductive coupling works on the principle of mutual induction like transformer works. [5-9].This theme is used for a shorter distance transmission and charging. Whereas electromagnetic radiation coupling is used for long-distance transmission [10-12]. As its receiver is not close to the transmitter, so this is not an efficient way of transmission. Much energy is consumed because of its omnidirectional property [13-14].

However, setting the coils to the same frequency in resonant inductive coupling can improve the range at which power can be transmitted efficiently with low complexity and without harmful effect [10]. The system capacity can be further improved through the simultaneous use of both inductive and resonant couplings to reduce leakage induction in the power flow path. Dual mode theory (CMT) [9, 11] and reflected load theory (RLT) [13-15] give a detailed analysis of the operating principles of wireless power transmission coupled with resonance.

Wireless power transmission provides a more convenient and environmentally friendly alternative to traditional plug-in charging because it has the ability to recharge all electrical-dependent devices within a medium-sized room with a single power source. This technology becomes relevant for electric vehicles and wireless sensors where it is practically impossible to operate the cables due to critical environmental conditions. Interestingly, this contactless method of operating electrical appliances is not only convenient and safe, but it also increases mobility and reliability at a low cost because it reduces the use of plastic and copper in wires [2]. In [24] numerous investigates that addressed emerging smart systems use Arduino, Zigbee, and raspberry pi strategies to read inputs - light on a sensor, a finger on a button, or a Twitter message or in building facial and voice recognition model.

This work on electronic devices completely covers the design, construction, and testing of a wireless power transmission system. The transmitter and receiver circuits are designed and implemented on printed circuit boards.

In this paper, an innovative IoT based communication infrastructure is proposed, and it provides two-way communication between the power block systems and the control system. The Power block defines how power is transmitted wirelessly transmitted by inductive coupling, we have two inductive coils, and power is transmitted like a transformer and also it depends on the number of turns and distance between coils In controlling block simply, we are charging our battery by observing the relative parameters such as charging current, battery temperature, and device humidity level and to control three loads through IoT.

Section II discusses the methodology, Section III provides results and discussions and finally conclusion is given.

2.METHODOLOGY

The detailed architecture of IoT has been discussed by Author in [1]. Author has also highlighted applications of IoT such as its development in industrial Wireless Sensor Network (WSN) and especially its vast usage in smart home applications. Smart homes are those where household devices/home appliances could monitor and control remotely. When these household devices in smart homes connect with the internet using proper network architecture and standard protocols, the whole system can be called as Smart Home in IoT environment or IoT based Smart Homes.

Figure 01: Architecture of IoT

The IoT-based wireless energy transfer system with Home automation consists of two blocks.

I. Power block

II. Block control and IoT (internet of things)

A. Power block

The power block consists of two modules: the transmitter module and the receiver module. The transmitter module which consists of 220-volt AC supply which is step down by the help of step-down transformer into 26-volt AC supply and then convert this AC Supply into DC by means of rectifier. Now that DC supply is converted into pulsating DC (in square wave form) through oscillator. The pulsating DC voltage (24.6 V) is transmitted through transmitting coil. In the receiver module, a receiver coil that receives the pulsating DC from the transmitting circuit in a square wave of 24.6 Volt and then filters the DC supply which is converted to pure DC 24.6 V.

The pure Dc supply output of receiver circuit is given to the controlling circuit where we charge our battery by the help of controlling circuit, but here we are waiting few seconds because, after transmitting the receiving module we have another controlling circuitry which is power up from battery, basically power up circuit measured the value of current and also creates the impedance. And the purpose is that, when we give battery current, it instantly sucks the current that affects the IC's (integrated circuits), SMD components either heat the IC's or raise the torque current, this is why we are waiting for impedance to meet the current 1.5 Amp and don't raise the voltage from 24 Volts, because of after rectification we are decrease the current and we are charge the battery. When the supply comes to relay coil, the relay coil does Work and the battery is charged. Once the battery starts charging a shunt, the resistor is also connected in series to the battery, which gives the voltage power current (1.5 amps needed to charge the battery). This is the charging cycle of battery. The Wireless Power Transfer System is composed of two independent transmitter and receiver circuits based on Proteus Software. The figure.2 and figure.3 demonstrate that the hardware is designed for the circuit of the transmitter module and the receiver module circuit, respectively, with its circuit components.

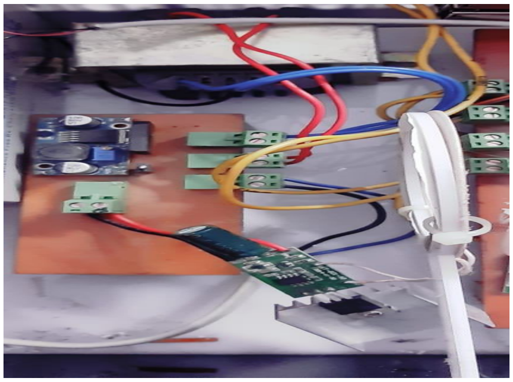

Figure-01: Transmitter module circuit

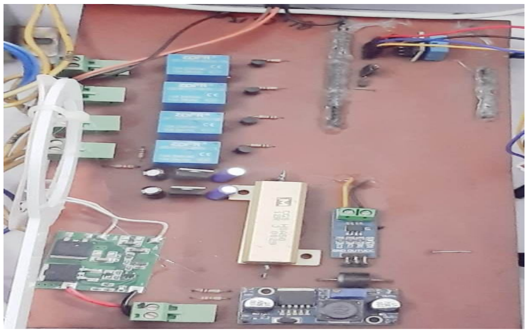

Figure-02: Receiver module circuit

Figure 14: Outside view of wireless power transfer based home automation

B. Control of blocking and the Internet of Things (Internet of Things)

First, in controlling the block section, we simply charge our battery by observing the relative parameters such as current charging, temperature of the battery and humidity level of the device. Then we use the graphical touch LCD for display purposes that involves a battery with a simple GUI (graphical user interface) for human access. We have shared hosting for our website in the IoT section where we have introduction page and then we have a monitoring page to show our results and manage the loads for our required condition by using our web app and monitoring the results in real time.

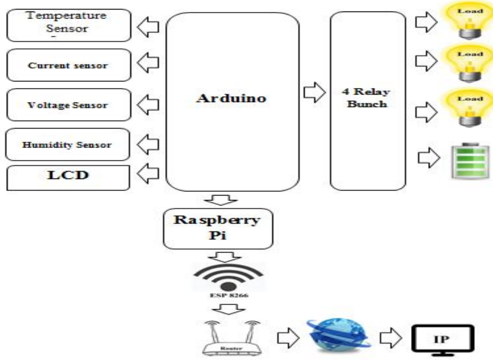

Figure 04: IOT Block Diagram

Figure: 4 shows the control block where Arduino mega controller is used and connected with humidity sensor, temperature sensor, current sensor, and voltage sensor and relay module. LCD is used for shows parameters, while Raspberry pi is connected to Arduino via serial communication which collects data and sends it to the domain proposed Home Automation System Functions

3.RESULTS AND DISCUSSIONS:

In this paper, the analysis of power circuit and control circuit done manually as well as IOT based. In the first part we measured all parameters manually with the help of multimeter and then in the second part we measured results internet of things based and showed them on Next Touch LCD and web domain as well as hardware structure is displayed.

C. Manually Results

In this section we have manually presented our results Table: 3 describes the performance of output Voltage Measurement of transmitter module

Table-03: Output Voltage Measurement of transmitter module

Parameters	Transformer Output	Rectifier Output	Oscillator Output
Voltage AC/DC	AC	DC	DC in Square wave
Actual (Volts)	26V	24.6V	24V

Transmission range was determined by varying the transmitter-receiver distance. A meter rule used to monitor the transmitter-receiver gap while a volt meter was used to determine voltage.

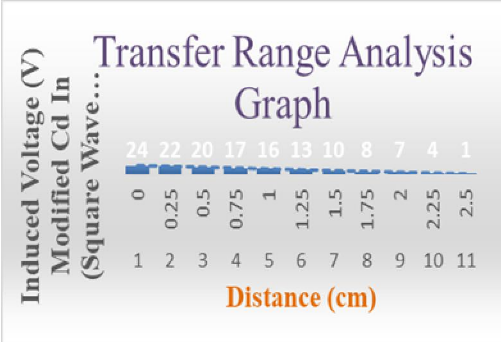

Figure-03. Transmission Range Analysis Graph

Table-04: Transmission Range Analysis

S.NO	Distance (cm)	Induced Voltage (V) Modified DC in (square wave form)
1	0	24
2	0.25	22
3	0.5	20
4	0.75	17
5	1	16
6	1.25	13
7	1.5	10
8	1.75	8
9	2	7
10	2.25	4
11	2.5	1

D. LCD Display Results

By LCD we can measure the (Voltage, Current, Temperature and Humidity), control the load, and can also Monitor Battery Status. The three modes touch LCD consist of consist of

I. Desktop mode

II. Control mode

a) Battery mode

Figure: 4: Main Menu

b) Desktop mode

In desktop mode control we can control the following components in users home and monitor the following alarms as shown in figure: 8

- Voltage
- Current
- Temperature

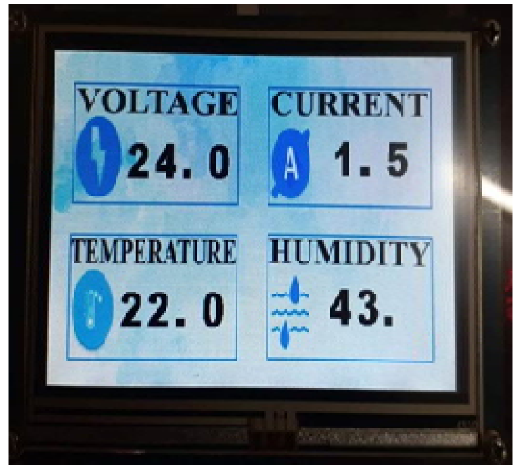

Figure 8. Desktop Mode

c) Control mode

In Control mode control the following appliance:

- Lights on/off/dim
- Fan on/off
- On/off different appliance by touching buttons on touch screen LCD as shown in figure:9

Figure: 9. Controlling Mode

E. Battery mode

In battery mode we check the battery level and status either for charging or discharging and also check the battery percentage level as shown in figure:10 and figure:11 respectively

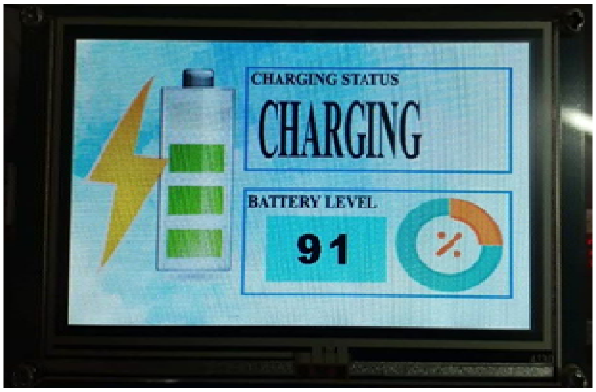

Figure.10. Battery Mode (Charging Status)

Our own domain (Private Domain) is used. We are building website print-end based on HTML / CSS and backend through PhP. From our hardware controller an API hit to the database from there and the second API hit to the front end indicates that we are having a full duplex of two APIs in short in our project, we are using two databases which implies that one database collects data from the controller and sends the data to another domain monitoring the data in a short one database used for monitoring another for monitoring purpose. We have an introduction page on the website, then we have a monitoring page for displaying our results and controlling the loads for our required condition by using our web app and monitoring the results in real time. Figure 12: shows the results on Domain

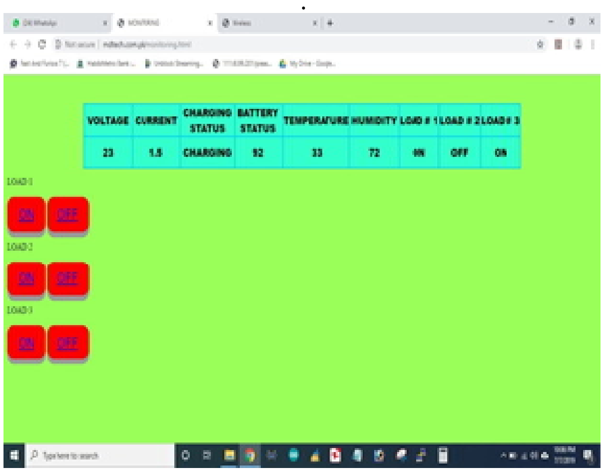

Figure 5. Results on Domain

4. CONCLUSION

The home automation using Internet of Things has been experimentally proven to work satisfactorily by connecting simple appliances to it and the appliances were successfully controlled remotely through internet. The designed system not only monitors the sensor data, like temperature, gas, light, motion- sensors, but the condition of various parameters in the home anytime anywhere.

The research is carried out on IoT wireless power transfer network with home automation in which we transmit and receive electrical signal through transmitter and receiver coils and charge our battery. Here we also monitor and control all battery parameters and the best thing about our project is that we minimize wire costs and can charge several charging devices at a time as well as eliminates the environmental threat posed by bad cord and cable disposal and short of circuits and we are the facility of charging of electric vehicle and smart lightning (home Automation) and we can control this all things from everywhere or every time 24/7 through internet, we can control and monitor loads on touch screen LCD as well as web domain, we can access domain by laptop, PC as well mobile phone through Wi-fi means doesn't matter that we are present near system or not we can control loads and monitor battery from every easily.

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