Power Management using Wireless Power Transfer and IoT

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Abstract

Objective of this paper is to combine the concept of solar power, wireless power transfer concept used for the generation of power and Internet of Things (IoT) based power management. A solar power inverter is designed to produce AC power required for the circuit. The generated power can be used in the application of power management where the devices are controlled by the technology called Internet of Things. The proposed design concept is used to monitor and control electrical energy consuming devices like switches, bulb, television, etc., in order to effectively balance energy generation and usage. Renewable energy sources are utilized for system working to show effectiveness in design. The obtained AC power is utilized further in wireless power transfer circuit to again recharge the battery through a rectifier circuit. The hardware demonstration for home automation made in this paper will help in reducing energy wastage by continuously monitoring and controlling the electrical appliances.
Keyword- Solar Power, Wireless Power Transfer, Internet of Things

I. INTRODUCTION

The main objective of this paper is to manage power efficiently and to automate all the devices i.e., home appliances through internet using Raspberry Pi and IoT, as well as we can have the security for the system by using sensors like PIR, gas sensor, temperature sensors and camera module. The supply for the automation is provided by one of the renewable resources i.e., solar panel. Wireless power transfer technique is used to recharge the solar battery.

Due to tremendous growth in the present day emerging technology, humans are adapted to IoT technologies in many ways. Communication is the process of transferring information from one point to other point. It can be done in two ways i.e., either by wireless communication or wired serial communication. Among these two types of communication wireless communication have proved to be more popular among everyone which received huge appreciation from all parts of the world. The main reason behind this is to provide security to the users. Among different wireless technologies, IoT using rasp technology stands on the top as it is able to provide a communication between devices and users in a simple and efficient manner. With the increasing development of modern technology and Smartphone, smart way of living has turned out to be a major part in the present era of human life. Due to rapid growth in Technology, Wi-Fi has brought a revolutionary change. Internet of Things, or IoT in short, is the idea of making devices and objects smarter by linking them to the internet. Not only helps to reduce human efforts but is also energy efficient and time saving. The main objective of home automation is to help handicapped and old aged people that will enable them to control home appliances and alert them in some immediate situations.

II. EXISTING WORK

In the actual era of smart grid and smart homes advanced technological systems that allow automation of domestic task are developing rapidly. This paper utilizes renewable resource such as solar energy which generates the required power for carrying out the home automation.

Today, scientists are searching for an efficient way to use renewable energy. Recently they have been searching to collect sun's radiation and use it efficiently through solar panels. Solar cells have great potential as an alternative energy and its distributed nature may enable a distributed power generation grid. Solar cell integration with the IoT concept provides greater advantage as solar cells are renewable in nature and provide year around distributed power generation.

IoT provides a greater facility for controlling different home appliances from remote locations. In IoT concept, a server zone and user zone is created and a communication medium is set up between them through which controlling of various home appliances can be done successfully. IoT is basically two types: Bluetooth based and Wi-Fi based system. Wi-Fi based system provides greater advantage compared to Bluetooth based system, when different appliances are controlled from a remote location. Bluetooth based applications are applicable only for a small distance. They presented one of its day to day application i.e., home automation.

III. PROPOSED WORK

IoT is nothing but the internet of things in which where daily life things are all connected to internet and can be monitor & can be operate remotely from anywhere. Daily life things like green agriculture, environmental monitoring, industrial wireless sensor network or industrial management, urban management, Tele-medicine, intelligent transportation and smart homes etc. IoT devices can be used to monitor and control the electrical and electronic system used in various types of buildings (e.g., Industrial, Institutions or residential). Home automation and power management systems are typically used to control ventilation, air conditioning, lighting, heating, appliances, entertainment and home security devices, communication systems to improve comfort, security and energy efficiency. Here we are designing solar based power management and home automation, where all equipment's i.e. fan, light, all plug points and sensors like PIR sensor, gas sensor, camera module, temperature sensor are interfaced with Raspberry Pi Board. And this information of home automation, owner directly monitors and control through their mobile phone using IOT (Internet of Things). Here in this application all gadgets are controlled by Solar panels power. Here we are using for finding the room temperature, gas leakage, motion detection and control of all devices. The battery of the solar panel is then recharged using a new concept called wireless power transfer. If there is any leakage in gas pipe it will also automatically indicate through sensor controlling Raspberry Pi. And also send the message to the owner to take action on it. Also, here we are using human detecting indicator, if any one come inside the room, Camera will detect the object and show on mobile phones of owner through IoT. And alert message will also be given so that the owner will be able to know the misbehaviour and take some action regarding it immediately.

In the figure. [1] The power for the operation of the Raspberry pi is taken form the non-renewable energy resource solar panel. When motion is detected using PIR sensor the camera module is used to take picture and immediately alerts it to the user's app through cloud database. Humidity and temperature of the room is monitored updated continuously. Leakage of gas is detected using MQ2 gas sensor. User can control the devices using the android application.

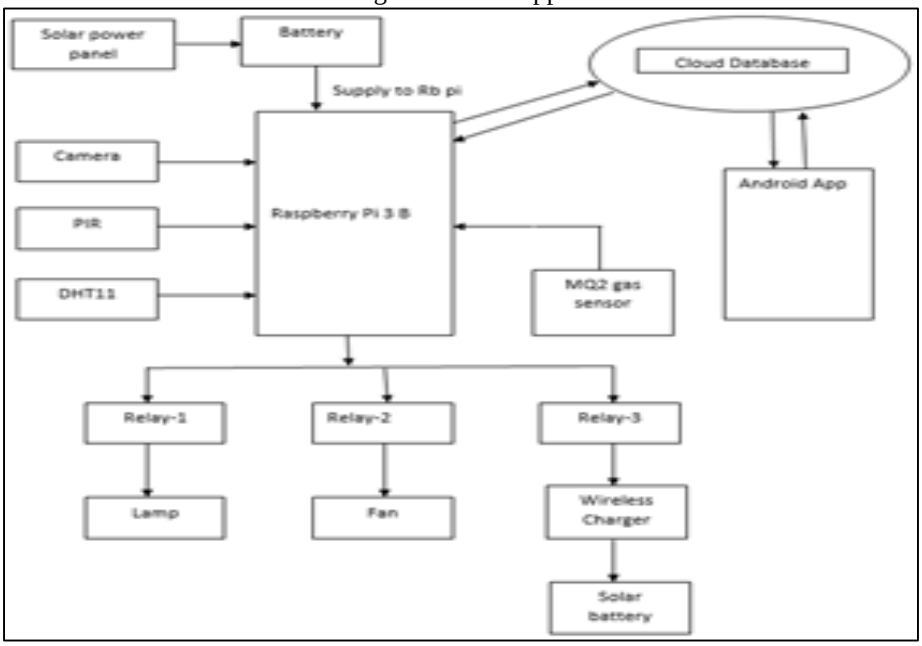

Fig. 1: Raspberry pi operations

IV. RASPBERRY PI 3 B

The Raspberry Pi is a series of small single-board computers developed in the United Kingdom by the Raspberry Pi Foundation to promote the teaching of basic computer science in schools and in developing countries.

The Raspberry Pi 3 Model B is the third generation Raspberry Pi. This powerful credit-card sized single board computer can be used for many applications and supersedes the original Raspberry Pi Model B+ and Raspberry Pi 2 Model B.

Whilst maintaining the popular board format the Raspberry Pi 3 Model B brings you a more powerful processor, 10x faster than the first generation Raspberry Pi.

Additionally, it adds wireless LAN & Bluetooth connectivity making it the ideal solution for powerful connected designs.

Raspberry Pi 3 – Model B Technical Specification

- Broadcom BCM2387 chipset
- 1.2GHz Quad-Core ARM Cortex-A53
- 802.11 Wireless LAN and Bluetooth

A. Bluetooth Classic and LE

- 1GB RAM
- 64 Bit CPU
- 4 x USB ports
- 4 pole Stereo output and Composite video port
- Full size HDMI
- 10/100 Base Ethernet socket
- CSI camera port for connecting the Raspberry Pi camera
- DSI display port for connecting the Raspberry Pi touch screen display
- Micro SD port for loading your operating system and storing data
- Micro USB power source

V. INTERFACING HARDWARE

A. Temperature and Humidity Sensor

Figure. [2], DHT11 digital temperature and humidity sensor is a composite Sensor contains a calibrated digital signal output of the temperature and humidity. Application of a dedicated digital modules collection technology and the temperature and humidity sensing technology, to ensure that the product has high reliability and excellent long-term stability. The sensor includes a resistive sense of wet components and an NTC temperature measurement devices and connected with a high-performance 8-bit microcontroller.

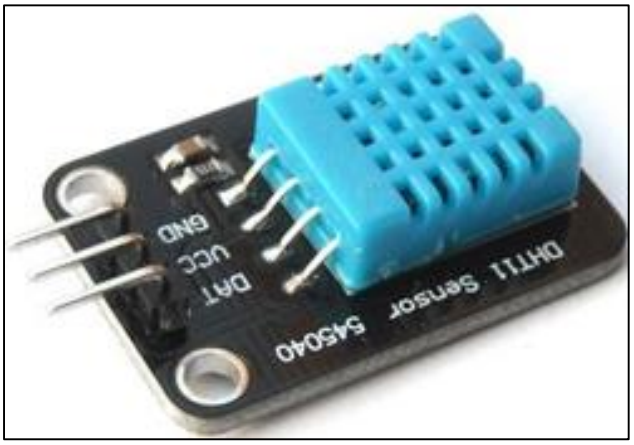

Fig. 2: DHT11 digital temperature and humidity sensor

B. Interfacing Camera with Raspberry Pi

Python-pi camera is a pure Python interface as shown in the figure. [3] to the Raspberry Pi camera module for Python 2.7 (or above) or Python 3.2 (or above). The library is written and maintained by Dave Jones.

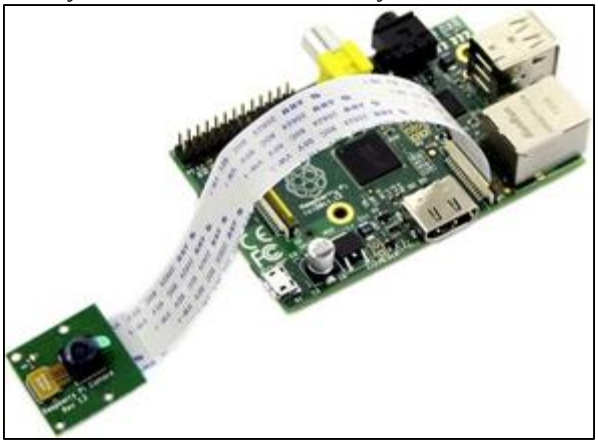

Fig.3: Python-pi camera is a pure Python interface

C. PIR Sensor

As shown in the figure. [4] PIR sensors allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range. They are small, inexpensive, low-power, easy to use and don't wear out. For that reason, they are

commonly found in appliances and gadgets used in homes or businesses. They are often referred to as PIR, "Passive Infrared", "Pyroelectric", or "IR motion" sensors.

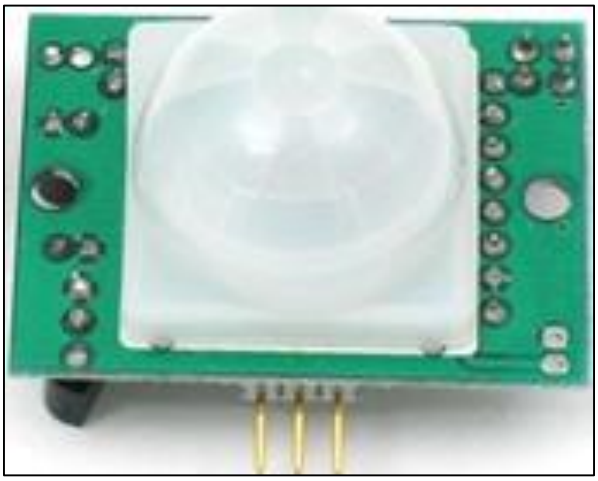

Fig. 4: PIR sensor

D. Relay

A relay is an electrical device which is generally used to control high voltages using very low voltage as an Input. As shown in the figure. [5], this consists of a coil wrapped around a pole and a two small metal flaps (nodes) that are used to close the circuit. One of the node is fixed and other is movable. Whenever an electricity is passed through the coil, it creates a magnetic field and attracts the moving node towards the static node and the circuit gets completed. So, just by applying small voltage to power up the coil we can complete the circuit for the high voltage to travel.

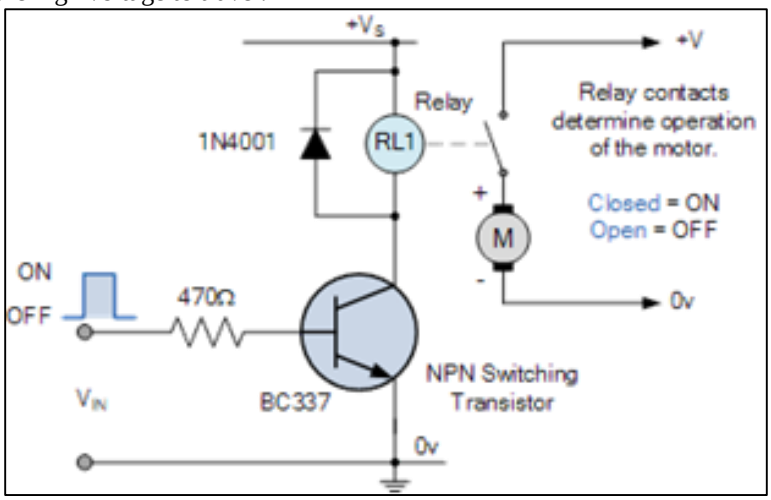

Fig. 5: Relay

E. Gas Sensor

Sensitive material of MQ-2 gas sensor is SnO2, which with lower conductivity in clean air. When the target combustible gas exists, the sensor's conductivity is more higher along with the gas concentration rising.

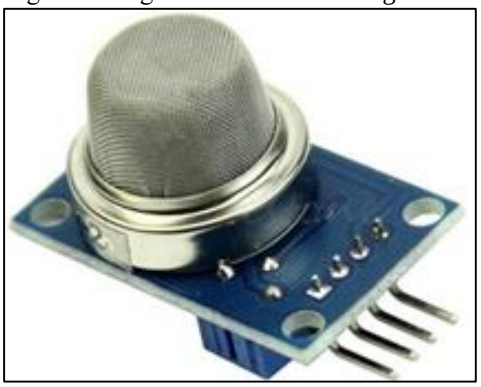

Fig. 6: Gas Sensor

Please use simple electro circuit, convert change of conductivity to correspond output signal of gas concentration. MQ-2 gas sensor has high sensitive to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application.

VI. WIRELESS POWER CHARGING

A block diagram of wireless power charging system based on magnetic resonance. As shown in the figure. [7] it is consisting of three parts a transmitter to generate the AC signal to be transferred, transmitting and receiving radiators to transfer the power of AC signal wirelessly, and a receiver to convert the received AC signal into DC voltage for charging the battery of mobile device. Based on the concept of magnetic resonance coupling, the power of AC signal from the transmitter is transferred to the receiver through radiators based on magnetic coupling

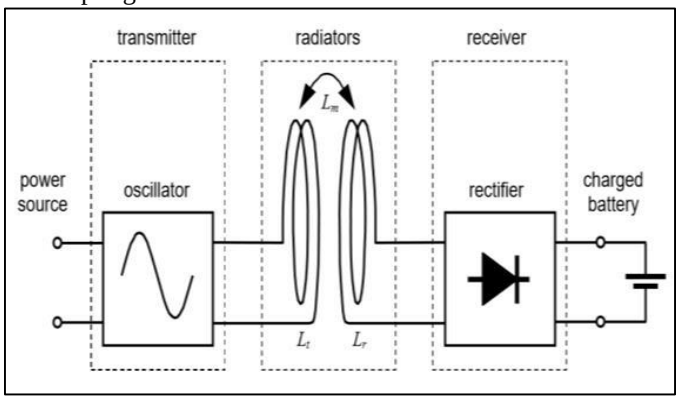

Fig. 7: A block diagram of wireless power charging system

The current change in the transmitting radiator which influences the magnetic field around it will induce the voltage in the receiving radiator. The mechanism of power transfer occurs due to the mutual coupling of magnetic field between 2 radiators. Whilst the efficiency of power transfer, it is determined by the value of coupling coefficient where the separation between 2 radiators is one of the essential factors. The coupling coefficient between 2 radiators where Lm is a mutual inductance representing the mutual magnetic coupling between 2 radiators, Lt and Lr are self-inductance for transmitting radiator and receiving radiator, respectively. The main objective of the proposed system is to deliver electrical energy from a power source as much as possible to the load where in the implementation it is manifested as a battery of mobile device. Therefore, the efficiency of power transfer from the transmitting radiator at transmitter to the receiving radiator at receiver should be maximized to produce sufficiently DC power at the output of receiver circuit.

VII. CLOUD

Cloud is a database storage. It can access by using mobile application with the help of internet. All the sensor data will be stored in cloud. We create cloud using PHP and my SQL. The individual database can be accessed using html links. We can retrieve the data in the cloud.

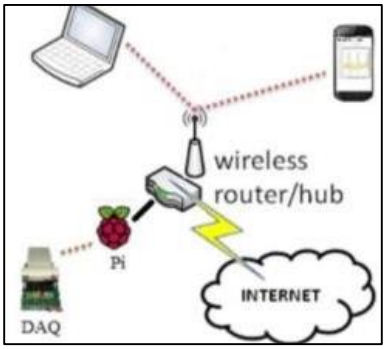

Fig. 8: Cloud Storage

VIII. MOBILE APPLICATION

All the sensor data can be seen in mobile application. We can control the water sprinkler and fence electricity through mobile application. It can be use both manually and automatically. All the data can be stored in this mobile application. Some of the data in the sensor can be retrieved in this application.

We can update the app if needed. A refresh button is also available in these applications. We can monitor the field easily and access by using this mobile application.

Fig. 9:

Fig. 10:

Fig. 11:

IX. RESULTS AND DISCUSSION

As shown in Figure No: [12], the model consists of all sensors, and camera. These are interfaced with raspberry pi-3 model. And the data are stored in cloud where as if can be retrieve through internet by mobile application and can also control all devices anywhere and anytime.

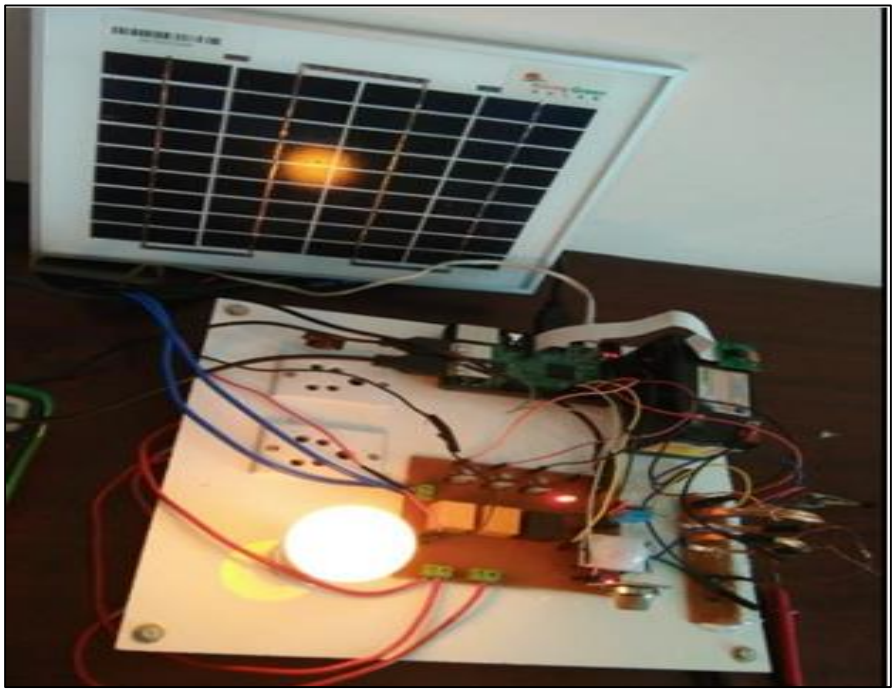

Fig. 12: The model consists of all sensors, and camera

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X. APPLICATION

Following are the applications of Home Automation and Security System

1) Detection of fire, gas leaks.
2) Smoke detector can detect a fire or smoke condition, causing continuous vibration alert in the android mobile of the user intimating the user to take action immediately.
3) In terms of lighting control, it is possible to save energy when hours of wasted energy in both residential and commercial applications by auto on/off light at night time in all major city office buildings, say after 10pm.
4) Security cameras can be controlled, allowing the user to observe activity around a house or business right from a their android mobile phone.
5) Wireless power charger can be used for mobile charging and other battery charging applications.
6) The user can be able to monitor the room temperature and humidity easily anywhere using the application provided with their own login and password for the security purpose.
7) The user can be able to control all plug points (ON or OFF) that is connected to the corresponding electrical and electronic appliances.
8) The Raspberry pi can be modified for further additional application at any time, since it is provided with the OS inside it. No other PC is required for programming.

XI. CONCLUSION

The implementation of the Internet of Things based home automation and power management is explained in this paper. Renewable energy application to the system described makes the proposed topology more energy efficient. Solar power is fed into a battery which is used for the working model. For running the system without any interruption wireless power transfer technique is also used here to the change the battery.

The designed system not only monitors the sensor data like temperature, gas, light, motion, but also actuates the process according to the requirement. This in addition helps to analyse the condition of various parameter in home, anytime and anywhere. It also effectively stores the sensor parameters in the database with timely manner. The user interface is an android application through which they can monitor and control the devices anytime and anywhere. The security system is accomplished by providing them a separate username password to login the application.

XII. FUTURE SCOPE

The application can be further developed to control the home security purpose like locking doors and windows. When the system detects any danger like gas leakage or fire, we can program the Raspberry pi to ON the emergency system to call fire engine office and in case of any detection of some persons inside the home it can be programmed to call police station and can share the location through SMS.

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