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IOT BASED SOLAR POWER REPEATER STATION USING RASPBERRY Pi

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Abstract - If it is hard to imagine life without your smartphone or other wireless communication device then you are not alone,wireless technology has become an essential part of life. Repeaters play an important role in this. Now a days repeaters placed in wild and remote areas will affect the surrounding areas due to generators used to run them, connecting electricity wires are risky task , maintenance is difficult and the problem occurred in repeater station cannot be predicted from base station.

In the proposed system one of the most widely used renewable source solar energy is used to run whole repeater station. Repeater station fixed with stepper motor automatically changes direction and stops when it sense signal. In case of low battery and no RF signal the repeater station sends mail to base station through Raspberry Pi.

Index Terms**:** Raspberry Pi, Arduino Uno, Stepper motor, Voltage regulator, Solar panel, Lead acid battery, RF Transmitter and Receiver**.**

I.Introduction

The demand for telecommunication system has generated a considerable amount of research activities in order to cope with the requirements such as data throughput, mobility and cost. A technology that can cope with these requirements is smart antennas in order to achieve a maximum reception in specific direction; a smart antenna uses an adaptive beam forming technique. By using adaptive beam forming the direction of arrival signal can be estimates while rejecting signals of the same frequency from other directions. This can be achieved by varying the weight of each antenna element. This can be done by integrating the antenna and photovoltaic technology for terrestrial application owning to the smaller footprint and reduced costs, which improves the economic viability of renewable energy, various integration arrangement have been reported where the solar cell provided a ground plane function for micro strip antenna elements, but this resulted in a reduced efficiency solar cell owing to partial shading by the opaque antenna.

Point to point multiple input multiple output system offers wireless communication with high data rates , without requiring additional bandwidth or transmit power the demonstrated on growth in capacity to reach scattering environments by deploying multiple antenna at both transmitter and receiver sides. In many practical systems, a training based transmission scheme is usuallyadopted to acquire channel state information.in such systems, the transmitter send a data information. The receiver receives the proper signal .under ideal radio frequency hardware assumption; channel estimation is well investigated topic.

With the growing demand for mobile broadband services and the appearance of new high capacity mobile devices and application ,mobile networks users are requiring an ever increasing high quality consumer experience, thus putting today's networks under tremendous pressure. The deployments of micro or Pico cell alone will not able meet the capacity required to accommodate orders of magnitude increase in mobile data traffic. As a matter of fact, the spectrum from 300MHz-to 3GHz which is nowadays allocated for mobile communications is becoming inadequate. On the other hand, a large part of the spectrum in 3-300GHz frequency band remains underutilized because of technical limitation stability of high frequency RF oscillators and limited that the research in the wireless communication field is striving to solve. The composed of several small base stations which can achieve gigabit per second data rates at distance up to 1km, so the quality of received signal is designed in degraded in the high speed data information transmission the multipath fading. Therefore, the concern is concentrated on the development of the communication system and application including MIMO, using multiple transmission and reception antenna as the method for solving the problem described in the patch antenna andetc., In additional ,afterward ,in the mobile communication system ,the effect by multipath fading can increases due to the increase in the bandwidth increment of signal and answer frequency ,and etc. And the service radius of the base station can be reduced. And in this case, the enormous investment costs are the cell coverage required in base station construction if it is the line. Generally, in the repeater, the base station signal is received the signal from base station is amplified and transmitted to user terminal. To be weak the signal of the moreover weak terminal is amplified and it transmitted to the next repeater. the repeaters receive the input signal through air from a base station .In the case of radio repeater using the same frequency for signal reception and transmission, feedback interference signals, which are formed by reflection of the repeater's output signal on

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objects around the repeater, come into the receive antenna of the repeater. At the same time, multipath interference signals, which are generated by reflection of base station output signal on objects between the base station and the repeater, enter the same receive antenna of the repeater. Normally, the transmit antenna of base station and the receive antenna of the radio repeater are aligned to maintain a line of sight path between the base station and repeater. The reason for this is that the quality of the receiving signal at radio repeater side is critical for high quality relay service. Therefore, multipath interference signals that come into receive antenna of the radio repeater are usually neglected owing to their small amplitudes compared to that of the strong los signal.

The main idea is that , if a RF signals that occupy with 430-470Mhz frequency are transmitted from transmitter which can be received by receiving antenna is also design with the same frequency . These RF repeaters are deployed in macro cellular radio networks in order to improve the coverage and capacity, mainly at the cell edge .however another important radio network planning technique used to improve network performance is by tilting the repeater antenna. The tilting of repeater antenna results the in decrease of other to own cell interference and increase in isolation between cells.

II. Literature Survey

The signal received at the receiving antenna are consist of signal from base station and transmitted signals from other side of antenna in RF repeater [1] and the amplification rate of the RF repeater is limited byfeed backed signals from the same repeater .these smart antenna design reduces the hardware and computational complexity and reduces the effect of feedback signal by fine-tuned the selected beam direction.

The effect of air to air analog repeater [2] and tilt variation at base station antenna for HSDPA enabled WCDMA macro cellular network, for two different network topology based on numerical calculation .the main of aim of this is to determine the optimum base station antenna tilt angle for both the topology with or without repeaters with respect to different network performance matrices and achieve the maximum signals.

The integration of slot antenna in commercial photovoltaic panels [3]. Is addressed the basic idea of for autonomous communication system photovoltaic panels are usually physically separated from the antenna and the demands for a compromise in the utilization of available space .these type of arrangement used for several application such as monitoring, vehicular communication , and satellite system, using distinct element. The designing antennas that can be easily integrated into a commercial PV panels can resulting in low cost implementation of low data rate wireless link for the remote PV panel in large field and these antenna are low profile[4] ,comfortable to planar and non-planar surfaces, simple and inexpensive to manufacture using modern printed circuit technology. When the particular patch shape and mode are selected they are very versatile in terms of resonant frequency, polarization, pattern and impedance [5] the micro strip antenna offers the drawback of displaying a narrow bandwidth, low efficiency, low gain and low directivity.

III. Proposed System

The proposed system aims at continuously monitoring the repeater station at remote areas and detecting the changes caused by abnormal climatic conditions. The proposed repeater station consists of a power supply unit that includes a solar panel, dc to dc converter and a lead acid battery. Arduino Uno, RF receiver, stepper motor and stepper motor interface are used to monitor the repeater station directions towards the maximum RF signal strength. Raspberry Pi is used to send mail to base station from repeater station when battery is low and no RF signal so that the repeater stations can be maintained in the better way.

A. Raspberry Pi

The Raspberry Pi is a mini computer or a series of small single board computers. It has many features such as: Broadcom BCM2837 chipset running at 1.2 GHz CPU, 64-bit quad-core ARM Cortex-A53, 802.11 b/g/n Wireless LAN, Bluetooth 4.1 (Classic & Low Energy), Dual core Video core IV® Multimedia supply, 1 x 10/100 Ethernet port, 1 x HDMI video/audio connector, 4 x USB 2.0 ports and micro SD card slot. These features are used to store and run the raspier program and send mail to the base station.

B. Arduino Uno

Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MH.Its Operating Voltage: 5V, Input Voltage (recommended): 7-12V, Input Voltage (limits): 6-20V, It has digital I/O Pins: 14 (of which 6 provide PWM output), Analog Input Pins: 6. Arduino Uno is mainly programmed and used for stepper motor control.

C. Stepper motor

The stepper motor is an electromagnetic device that converts digital pulses into mechanical shaft rotation. Advantages of stepper motors are low cost, high reliability, high torque at low speeds and simple, rugged construction that operates in almost any environment, the stepper motor has an excellent and accurate starting, stopping and reversing response. In the proposed system the stepper motor has 4 coils and step size 1.7degree which is programmed with small delays to sense the signal.

D. Solar panel

Solar panel converts solar energy into electrical energy works by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity. Solar panels actually comprise many, smaller units called photovoltaic cells (Photovoltaic simply means they convert sunlight into electricity). The sun transmits energy in the form of electromagnetic radiation. When this radiation is absorbed by the solar cells, a chemical reaction occurs, causing rapid electron movement. Because of the way the cells are manufactured with layers of material with differing atomic structures, the electrons are forced to move in one direction, creating direct current, or DC.

E. DC to DC converter

A DC-to-DC converter is an electronic circuit or electro-mechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission). The key principle that drives the boost converter is the tendency of an inductor to resist changes in current by creating and destroying a magnetic field. In a boost converter, the output voltage is always higher than the input voltage

F. Lead acid battery

The lead-acid battery is the most widely used oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that the cells have a relatively large power-to-weight ratio. During the battery recharge cycle lead sulfate begins to reconvert to lead and sulfuric acid. During the recharging process as electricity flows through the water portion of the electrolyte and water, (H2O) is converted into its original elements, hydrogen and oxygen.

G. RF Transmitter and Receiver

An RF Module is a small electronic circuit which is used to receive, transmit or transceiver radio waves on one of a number of carrier frequencies. Most transmitters are used for radio communication of information over a certain distance. The information that is provided to the transmitter is in the form of an electronic signal. This includes audio from a microphone, video from a TV camera, or a digital signal for wireless networking devices.

RF transmitter generates an electric current—a signal that the electronic components inside my radio turn back into sound I can hear. Electricity flowing into the transmitter antenna makes electrons vibrate up and down, producing radio waves.

Unless you are sitting right beside the transmitter, your radio receiver needs an antenna to help it pick the transmitter's radio waves out of the air. ... The antenna will receive thousands of sine waves. The job of a tuner is to separate one sine wave from the thousands of radio signals that the antenna receives.

The radio waves travel through the air at the speed of light. When the waves arrive at the receiver antenna, they make electrons vibrate inside it. This produces an

electric current that recreates the original signal.

Transmitter and receiver antennas are often very similar in design. In radio and electronics, an antenna (plural antennae or antennas), or aerial, is an electrical device which converts electric power into radio waves, and vice versa. It is usually used with a radio transmitter or radio receiver.

IV. Methodology

The below block diagrams show the proposed system. Solar power is arguably the cleanest, most reliable form

of renewable energy available, and it can be used in several forms to help power your home or business

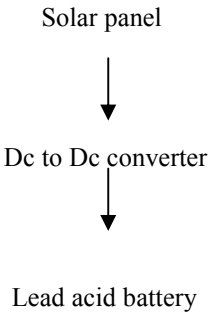


Fig.1. Power supply

Solar-powered photovoltaic panels convert the sun's rays

in to electricity by exciting electrons in silicon cells usingthe photons of light from the sun. The 12V 5W Solarpanel is used here to convert solar energy into electricalenergy. This energy is boosted by using DctoDcConverter then it is stored in lead acid battery of 12V

5AH. This stored power is used for the whole repeater

Stationthe RF transmitter and receiver frequency of the system is 430-470 MHz, FM modulation and the power output will be 100milliwatt. The RF transmitter is used

transmit the signal at the transmitting end. At receiving end when the signal is received by RF receiver it sends logical '1' to digital interface pin number 2 of the

Arduino Uno at this condition Arduino Uno is programmed to control the stepper motor in static condition and when the signal is not received by the RF receiver it sends logical '0' to digital interface pin number 2 of the Arduino Uno at this condition Arduino Uno is programmed to rotate the stepper motor in clockwise direction with small delay to recognize the signal. Stepper motor rotates to the certain degree and stops when it receives signal.

In Arduino Uno, pin number 2 is programmed as input pin and the pins 8,9,10 and 11 are programmed as output pins. Here output pins are connected to stepper motor interface. The output of Arduino Uno is 5V 5mA which is not sufficient to drive the stepper motor. So interface is used here which provides 12V 500mA to drive stepper motor.

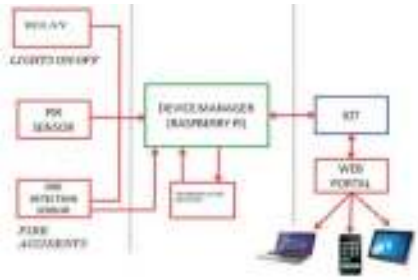
Raspberry Pi is a mini computer which is programmed and the email ids are stored in program. One will be sender mail id which will be sending mail from remote area and another one is receiver mail id this is considered as base station. RF receiver data wire and the lead acid battery is connected to the Raspberry Pi through the relays and programming is done in such a way that, when there is no RF signal received or battery power less than 8V mail with the particular problem specification

will be sent from the remote area to the base station through Raspberry Pi.

V. Result

If the solar power of remote station is less than 8 volt it will send mail to the base station.

Block Diagram



If there is no RF power at the remote station or any problem in the circuit it will send mail to the base station.

When there is no RF signal receiver station interfaced with stepper motor automatically rotates in clockwise direction and stops when it receives signal.

Produces constant solar power to the battery and RF power to the RF receiver as it is self automated.

VI. Conclusion

The above proposed system for advanced repeater station using Raspberry Pi and Arduino Uno is advantageous to the existing system and maintenance is easy. The Raspberry Pi making it easy to send mail to base station from repeater station in case of low battery and no RF signal thereby helping maintainers to take a proper control over the repeater. Arduino Uno is programmed for stepper motor in such a way that the repeater station fixed with stepper motor automatically rotates to the direction where it will receive signal. It is also cost inexpensive and does not require any external supply since renewable solar energy is used to run the whole repeater station which is reliable and eco-friendly making it more practical than the existing system with good result.

Solar panels allow communication system to be stand - alone, without the need of wired-feeding networks. That is they can be installed and used in wild and rural environment. Arranging small devices equipped with green power sources in outdoor scenarios could represent a valuable solution for remote control and management of isolated areas.

VII. Future Scope

Integrated sensors and antenna in the same autonomous device represent a challenge for the future Internet of Things.

The system can be implemented and programmed for number of repeaters where each repeater is given with number and the mail will be sent with respective repeater number and particular problem specification to base

station.

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