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Smart Electricity Monitoring System Using Wireless Sensor Network

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Abstract— The energy asset the executives is a noteworthy concern around the world. Vitality the executives exercises limit ecological effects of the vitality creation. The push to save vitality made at a grass root level will help tackle the current assets in progressively normal way. In this manner, checking electric vitality utilization has been proposed as a significant procedure which makes quick decreases in vitality use. It is an approach to screen the cost of vitality and direct the utilization if it's made in territories regarded unessential. Lately, propels in hardware have permitted the usage of numerous mechanical arrangements that can lessen vitality utilization however the changes have an extent of progress. The framework portrayed in this venture is the structure and prototyping of a home electric vitality observing framework that furnishes occupants with continuous data about their power utilization. The use can be checked by means of their mobiles and can have a superior comprehension of where the power is being utilized or squandered. The framework planned can be utilized to screen electrical parameters, for example, voltage, flow and intensity of family machines which makes the checking angle valuable for the clients. The framework comprises of a shrewd detecting unit that recognizes and controls the home electrical apparatuses utilized for day by day exercises by following distinctive levy rates. The client can check the utilization of different apparatuses by means of the portable application and can likewise work different machines associated with the framework through the versatile application. This will ensure that no assets are squandered while there is utility of the apparatuses in an appropriate way too. The framework utilizes remote correspondence and presentations the data on android application, alongside highlights, for example, Smart ready framework and Home mechanization through android application.

Keywords: Electric energy monitoring, energy management, home automation.

INTRODUCTION:

Seeing how energy is spent and realizing how to screen and control it are key requirements for private energy preservation. Research has appeared, in general, when given the fitting data on energy use, normal property holders will change their utilization conduct to diminish their month to month electrical utilization and power bill. The size of the reserve funds relies upon the sort of input or data offered, cost of intensity, interface type and position, and other social and financial elements.

In a universal period, data becomes day by day fundamental simply like water, power and transportation and will almost certainly get vital data when it is required. Thus, it is basic to establish an omnipresent condition where giving all the administration over different media at whenever anyplace, empowers the client to utilize the substance with any terminal or gadgets. Such omnipresent and low carbon green development turned into a worldwide undertaking the idea of brilliant lattice rose as a focal point of efficient power vitality industry transformation. Shrewd lattice joined existing force supply matrix with universal innovation and improved power network validity, proficiency and security and ended up cutting edge control framework innovation by trading power creation and utilization data in two different ways and progressively.

Cutting edge control framework innovation is created by every nation as indicated by their own needs, the US conveying forward to propel their out of date control framework, Europe is to initiate the utilization of vitality and Japan is for proficient administration of vitality. Korea has recommended another national advancement worldview called "low carbon green development" and proposed an arrangement to lead worldwide collaboration as a main brilliant power framework nation by creating a keen network by 2030. In this theory, savvy SEMS which is a piece of the keen network has been planned and general family control use data exchanged to the server or Smartphone has been estimated. What's more, by estimating month to month, yearly vitality yield put away in the service, we have looked into and created to empower family unit and a government office to oversee vitality top time and vitality utilization effectively. SEMS explored and created Wireless correspondence and inserted control framework empower to control estimating sensor for the family unit and a government office to quantify control utilization progressively.

SYSTEM COMPONENTS

In the venture titled "Real-Time Electricity Monitoring and Control System Using Wireless Sensor Network," a microcontroller and modules perfect with them were utilized.

A. Arduino Uno

The Arduino Uno is likewise a microcontroller board not at all like Arduino Mega. In the wake of getting diverse perusing from Arduino Mega, it forms those qualities and performs followings task-

1. To start the Wi-Fi Module.

2. To set up a stable real-time monitoring framework.

3. To show the ongoing perusing in the display device.

4. To guarantee room shrewd observing utilizing the display device.

It has 14 advanced information/yield pins, 6 simple sources of info, a 16 MHz precious stone oscillator, a USB association, a power jack, an ICSP header, and a reset catch. It contains everything expected to help the microcontroller; essentially interface it to a PC with a USB link or power it with an AC-to-DC connector or battery to begin. The Uno varies from every single going before the board in that it doesn't utilize the FTDI USB to-sequential driver chip. Rather, it includes the Atmega8U2 modified as a USB-to-sequential converter. The Arduino Uno can be controlled by means of the USB association or with an outer power supply. The power source is chosen consequently.

B. USR232 (Wi-Fi Module)

USR232 (Serial to Wi-Fi Module) is used to transmit data between RS232 and Wi-Fi TCP/IP transparently, User can update the product to WIFI control without knowing the WIFI and TCP/IP details. All the convert work is done by the module. For Users, the RS232 side is only as a serial device, the WIFI side is TCP/IP Socket data. Users can set up the work detail by sample settings which can be set up via inside web pages or RS232 ports. The setup only needs to be done once, then it will save the setting forever.

C. Hall Effect ACS712 (Current Sensor)

A flow sensor is a gadget that recognizes electric flow (AC or DC) in a wire and produces a sign relative to it. The produced sign could be a simple voltage or present or even computerized yield. It very well may be then used to show the deliberate current in an ammeter or can be put away for further investigation in an information obtaining framework or can be used for control reasons. The 20A current sensor which is utilized is a Hall-impact current sensor and the model is ACS712-20A. It gives a simple yield sign of 0-5V by getting associated in an arrangement associated with the line of which current should be estimated. The explanations behind picking this model are less expensive, irrelevant power utilization and Arduino good.

D. PIR Motion Detection Sensor

PIR sensor identifies an individual moving around inside roughly 10m from the sensor. This is normal esteem, as the genuine discovery range is somewhere in the range of 5m and 12m.PIR is generally made of a pyroelectric sensor, which can recognize dimensions of infrared radiation. For various basic activities or things that need to find when an individual has left or entered the territory. PIR sensors are mind-blowing, they are level control and negligible exertion, have a wide focal point run, and are easy to interface with.

Most PIR sensors have a 3-stick association along the edge or base. One stick will be ground, another will be signal and the last stick will be controlled. Power is generally up to 5V. Once in a while greater module don't have direct yield and rather simply work a transfer which case there is ground control and the two switch affiliations. Interfacing PIR with a microcontroller is exceptionally simple and straightforward. The PIR goes about as a computerized yield so you should simply be tuning in for the

stick to flip high or low. The movement can be identified by checking for a high sign on a solitary I/O stack. When the sensor heats up the yield will stay low until there is movement, at which time the yield will swing high for a few seconds, at that point return low. In the event that movement proceeds with the yield will cycle thusly until the sensor's observable pathway is still once more. The PIR sensor needs a warm-up time with a particular true objective to limit fittingly. This is a result of the settling time incorporated into contemplating nature's area. This could be wherever from 10-60 seconds.

E. 30ARelay

The diode is there to brace the voltage/current spike the transfer curl produces when it is turned off. The 33-ohm resistor shields the yield from extreme current and enables the diode to do the clipping. At the point when a computerized yield is killed, it doesn't go open circuit rather it associates the yield stick to GND by means of a low opposition. Without the extra 33-ohm opposition, the present spike from the curl would especially return into the chip to GND.

Along these lines, for either board, interface the transfer GND to one of Arduino's GND pins, what's more, the transfer 5V for Arduino's 5V stick and the hand-off into one of ARDUINO advanced yields. The transfer's contacts comprise of a Normally Closed (NC) and Normally Open (NO) association and a COM association. At the point when the transfer is un-controlled by the NC, the terminal is associated with the COM terminal and the NO terminal isn't associated. At the point when the hand-off is worked, the COM terminal switches over and is currently associated with the NO terminal and NC terminal isn't associated. The screw terminals are either denoted NO, NC and COM or little illustration are demonstrated like the picture underneath. In the picture underneath, the top terminal is the NO one, the middle terminal is the COM and the base terminal is the NC one.

F. Voltage Sensor

The essential capacity of voltage sensors is to identify and gauge AC as well as DC voltage levels. At the point when the nearness of voltage is identified, the sensors give a yield as simple voltage signals, current dimensions, recurrence and regulated recurrence yields or perceptible sounds.

The voltage sensor can quantify the nearness of a voltage without reaching for example on protected wires. A voltage sensor comprises a resistive voltage divider. The incorporated resistors, implanted in a threw tar (for voltages between 1-72kV), have a low esteem inductance. The course of action, for the most part in a crisscross plan, together with the pitch permittivity, results in a capacitance. This capacitance is more than any capacitance straying to the ground.

G. 5V and 9VAdapter

An adapter can be used when the wrapper must respect a particular interface and must support polymorphic behaviour. In this project, we have used ARDUINO Uno as the microcontroller and WIFI module to enable two-way communication by using WIFI connection between consumers and the service provider. All the equipment such as display devices, sensors, WIFI module etc. are connected to the ARDUINO. Therefore, to ensure 100% power supply to the ARDUINO Uno and WIFI module we have used an adapter and connected that equipment parallel to the output voltage of the adapter.

H. Android Mobile

In this task Android cell phone is utilized as a presentation gadget. The fundamental motivation behind the showcase is to show devoured Current, Line Voltage, Cost, Real-time Power and most critically devoured Energy. The user can check the usage of various appliances via the mobile application and can also operate various appliances connected to the system through the mobile application. This will make sure that no resources are wasted while there is the utility of the appliances in a proper manner as well. The system uses wireless communication and displays the information on android application, along with features such as Smart alert system and Home automation through android app.

PROPOSED ARCHITECTURE

The developed system consists of two electronic devices: data acquisition device which includes the smart switches and a custom micro-controller and a data display device which includes the smartphone. The data acquisition device measures power and energy consumed by loads and the data display device displays measured data and sends results to the smartphone/computer.

The main features of this monitoring system are wireless communication between acquisition and display devices, monitoring capability at the appliance and switchboard circuit's level, average hourly energy use and electricity cost information display, and data recording on the computer. Wireless communication between devices ensures greater flexibility and system's ease of use. The system's ability to monitor both appliance level and switchboard circuit's level informs the consumer about the balance of each appliance or circuit load. The knowledge of average hourly energy use and electricity cost provides important information that motivates changes to consumer's behaviour.

General Architecture:

The data acquisition device diagram block is represented in figure 1. This device consists of five major blocks: power integrated circuit (IC), microcontroller, wireless transceiver, signal conditioning and smart switches. The data acquisition device measures line voltage and current signals through appropriate sensors. These analogue signals are then conditioned and used by a power IC, which measure voltage, current, power factor and active power. This information is transmitted to a microcontroller that computes the energy consumed by a load and communicates with a wireless transceiver. The transceiver is responsible for sending the measured data to the data display device and for receiving commands from the user. The data display device receives measured data from the data acquisition device through a wireless transceiver. The transceiver sends the received information to a microcontroller.

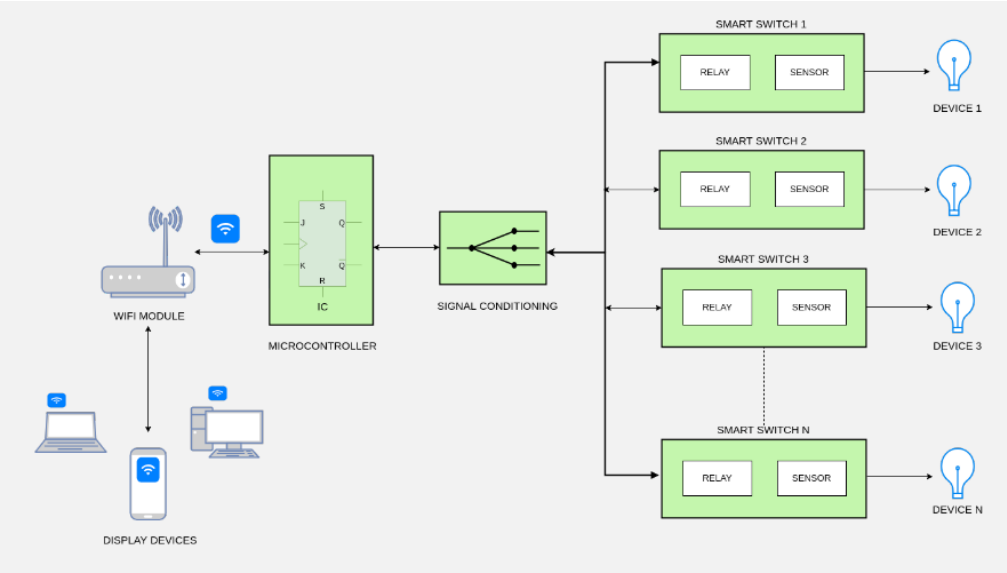

FIGURE 1: FLOW OF PROPOSED SYSTEM

This microcontroller is responsible for several operations, including data driving, communication with different appliances and electricity cost calculation. The device allows the user to select and perform many functions, such as data measurement initialization, power IC calibration, electricity tariff definition, statistics and analytics, alert systems, report generation and home automation.

RESULT AND PERFORMANCE ANALYSIS

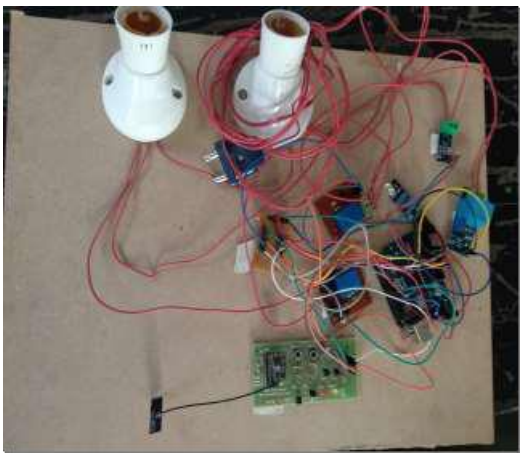

Figure 2: System Design

A wireless sensor has three technical components, an MCU (Microcontroller Unit), a sensing unit, and a wireless transceiver. The sensing unit is the most important part of a sensor. A hall effect-based sensor, ACS712, is used to measure AC in our system. We tested the sensors from a 100-Watt load to 1000-Watt load. In this testing, we assume the power factor is 1. A Relay is included for remote on/off control. The incoming data from each sensor contain the actual status of the device, the power consumption and a unique sensor ID. We store the received data in an SQLite database. The system receives several values per second from the sensors which are stored in the database for later use in a mobile application. When a user wants to switch on/off a device from a mobile application, the reaction time is below one second. As a prototype system, two services, monitoring and remote on/off control, are implemented in our system. Users can set the range of dates to check the energy consumption of a specific home appliance. Further works will include smart or intelligent services like statistical analysis, tariff comparison, and recommendation for usage, time-based on/off-control, etc.

The Mobile Application will communicate from the Microcontroller Unit through Wi-Fi. To prevent unauthorized access, it will first ask for credentials (login/password). Then as required by the user, it will send command for specific data and after that, it will display the data send by MCU (Microcontroller Unit) in a different form.

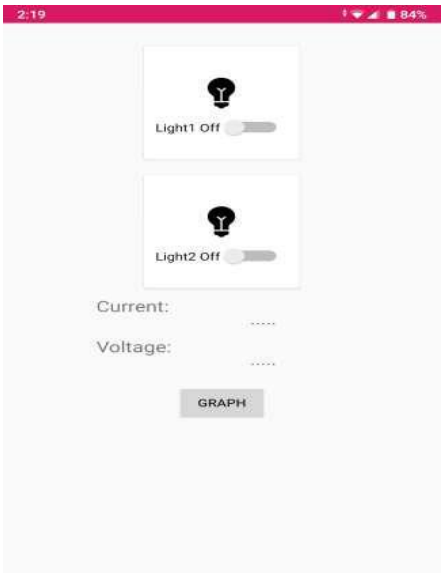

Figure 3: Android Application

To display the data, there are various types of buttons, on each click a specific command will be sent so that MCU (Microcontroller Unit) will recognize that which data to be sent to user from Database. It also leverages the feature for turning ON and OFF the appliances according to user needs from Android Application.

Figure 4: Implementation with 2 Bulbs

Also, we can enable switchboard 1 while switchboard 2 is not, thus we will be able to use buttons of switchboard 1 only. Also, there are several buttons to previous day data consumption, send commands for retrieving current usage data and data usage of previous weeks of the current month. For each switchboard there is also a switch to turn it ON and OFF, this will turn ON/OFF appliances. The current usage will be shown on the same screen and the data that will be shown is Power, Voltage, Current, and Energy. The other commands will cause data to be displayed on different Activity in the form of graphs.

A. Current Analysis

Table 1: Current Analysis

Ammeter (A)	Meter Reading	Error (%)
0.18	0.19	5.55
0.27	0.26	-3.46
0.46	0.45	-2.17
0.52	0.54	3.84
4.99	5.00	0.20
4.71	4.72	0.21
3.44	3.45	0.30
0.84	0.86	1.17

As indicated by producer Acs712-20A has a goal of 100mV/An and it has a clamour of 11mV which means there will be a commotion of 110mA. To limit the blunder as numerous as potential examples have been taken. Their normal esteem gives altogether less mistakes. This information demonstrates that the meter perusing gives a blunder of 20mA most noteworthy. Be

that as it may, it peruses somewhat higher in certain seconds again peruses a bit lower in certain seconds. Subsequently we can say that it gives practically exact perusing.

B. Voltage Analysis

Table 2: Voltage Analysis

Voltmeter (V)	Meter Reading	Error (%)
200	215	7.5
220	221	0.45
222	222	0
224	223	-0.44
226	228	0.88
230	230	0
235	231	-1.7
237	235	-2.11

The voltage perused by meter from 0-100V is viewed as a 0V. This has been finished by the calculation to limit mistakes. That is the reason for 0-50V in the electrical cable there was no meter perusing. As indicated by the circuit and our picked current through the circuit the working voltage was 220. The increase factor was set in the calculation as indicated by that. To have the working voltage extend from 220-230V two increase factors were set. That is the reason the mistake in this range is fundamentally lesser than others.

We have carried out several tests, in order to ensure a suitable data accuracy measurement, and to validate the system and verify its accuracy. Outcome of these tests showed that this device has a less than 1% measurement error. Few of the functional tests were also performed, to validate the system's behaviour in real life situations. The system was tested on both appliance level and switchboard circuit's level. It was possible to validate all the system's devices and components, which have a proper operation and integration.

CONCLUSION

Awareness of electricity consumption in the home or building is a first step towards saving energy. The combination of alternative energy and pervasive technologies for monitoring and controlling energy consumption is a powerful vehicle for reducing energy demand. With effective feedback about energy consumption and control of household appliances, users can be motivated and encouraged to change their behaviour on energy use such as turning off lights or reducing heat. These small changes in behaviour can lead to significant energy savings. This paper presents a smart energy management system for homes and buildings. The proposed system can monitor and measure electricity usage in real-time. With the proposed system, users can remotely control real-time electricity usage through the web and other mobile devices such as smartphones or smart pads. The main lines for future work are related to improving the automation features of the proposed system, integrating computational intelligence/machine learning for pattern detection, and developing more powerful planning algorithms. The proposed system can also be extended to other public services.

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