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Wireless Sensors Network based Metering and Alerting System for Residential Resource Consumption

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ABSTRACT: Resources plays a vital role in achieving desired economic growth. Even though renewable resources can be replenished in a short period of time, it cannot be taken for granted. Resource conservation promises to fill the gap between supply and demand. In the current scenario, there is no way to keep track the resources being consumed on a day to day basis. This project aims at overcoming this limitation by tracking the commonly used resources in our lives. Tracking of resources like water, electricity and LPG by individual houses using an embedded microcontroller, with IP connectivity for trailing resources and alerting the user about their daily usage using Smart phone application. Sensed data is stored in the cloud. By this people will be aware of their resource footprint and its cost.
Keywords: resource conservation, tracking, alerting, application, IP connectivity.

I. INTRODUCTION

Internet of Things(IoT)

The Internet of Things refers to uniquely identifiable objects and their virtual representations in an Internet-like structure. The term Internet of Things was proposed by Kevin Ashton in 1999. The concept of the Internet of Things first became popular through the Auto-ID Center at MIT and related market analysts' publications. If all objects and people in daily life were equipped with identifiers, they could be managed and inventoried by computers. The IOT is a technological revolution that represents the future of computing and communications, and its development [1].

The Internet is one of the most important and powerful creations in all of human history. IoT represents the next evolution of the Internet, taking a huge leap in its ability to gather, analyze, and distribute data that we can turn into information, knowledge,

and, ultimately, wisdom. IoT projects are under way that promise to improve distribution of the world's resources to those who need them most and help us understand our planet so we can be more proactive and less reactive.

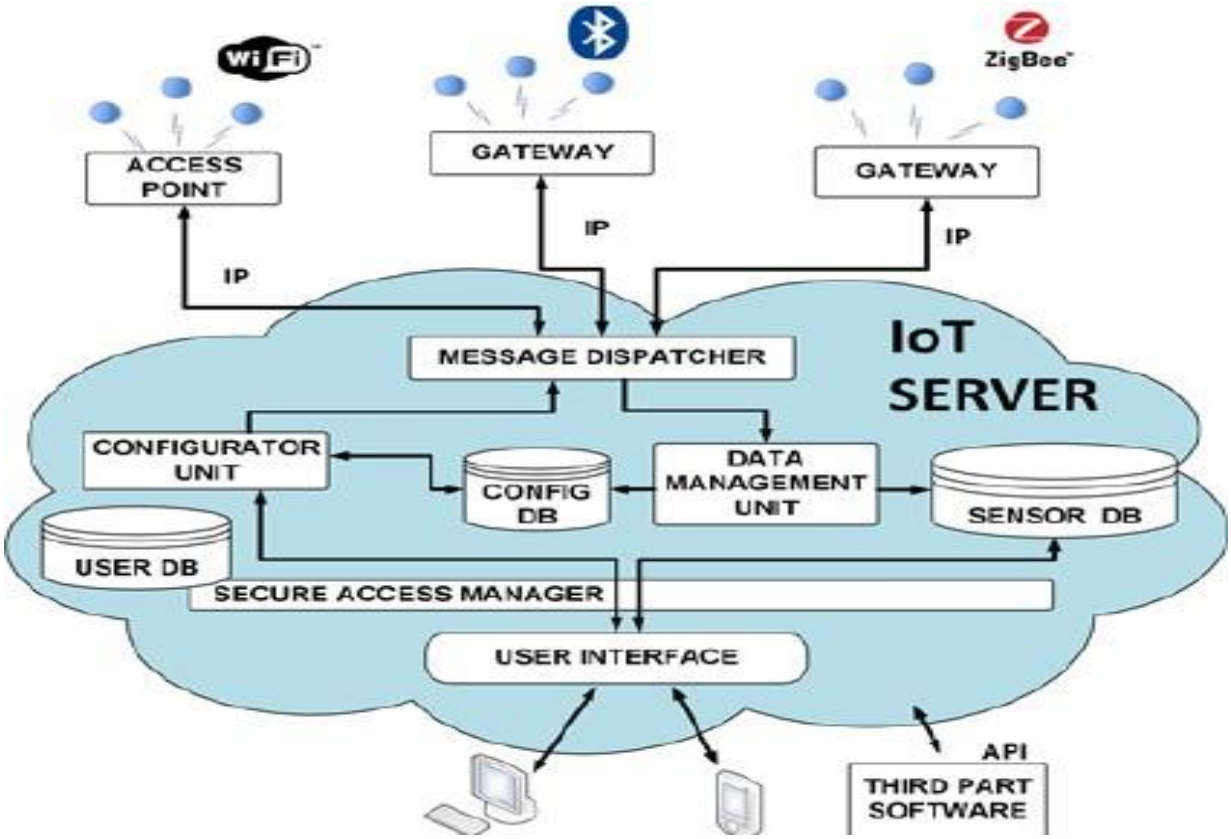

Fig 1: IOT Architecture

II. PROBLEM STATEMENT

The per capita consumption in any country is an index of the standard of living of the people in that country. Energy demand has been rapidly increasing with raising standard of living of people. Nowadays, we are overusing the natural resources of the planet. Being aware of exhausting resources people are unable to utilize the resources efficiently because there is no measure to track it. The problem is also getting worse as population and consumption keep growing faster than technology.

The focus of our project is to track daily usage of power, water and LPG and alerting the user about his usage. The sensors used track the consumption and alert the user. All that the consumer require is a smartphone application that provides him the notification. Data of the resource consumption of a locality is also available to the administrator who can view the

requirement and consumption of a locality. The higher authority or municipal procures the usage information of the locality which helps to obtain the statistical data.

The consumer who obtains his usage information can plan his usage according to his budget. Only the resources that are required will be used which to an extent reduces wastage [4] of resources.

III. EXISTING SYSTEM

The resources we obtain are being used without any proper planning which is leading to a huge wastage. In fact, the world's demand for power is rising faster than the demand can be met. Consequently, industries, homes, and businesses are already taking power saving measures to save money and to become more environmentally friendly. Power saving techniques seems to have a small impact to each individual, but as the price and demand for resources [5] rises, the collective power saving actions of everyone will make a significant difference. The three basic and obligatory resources that we are considering in this project are Electricity, Water and Liquid Petroleum Gas.

Existing meter reading techniques in India are analyzed and extensive study is conducted on energy meter or an electro-mechanical meter is fixed in the premise for measuring the usage. The recorded data need to be processed by a meter reading company. For processing the meter reading, company needs to firstly link each recorded power usage datum to an account holder and then determine the amount owed by means of the specific tariff in use different energy measuring instruments available now.

Water is an essential resource for all life on the planet. Due to the small percentage of water remaining, optimizing the fresh water we have left from natural resources has been a continuous difficulty in several locations worldwide. In the existing situation, in some parts of the country there is no system to measure water consumption. In contrast, in the metropolitan cities the water usage is billed on a monthly basis. In other cities of the country water bill is not based on the consumption rate instead it is to be paid on a yearly basis.

The next mostly used resource is LPG. Cylinders are supplied on a monthly basis and are refilled every month. The consumers are unable to track consumption which many times lead to shortage of cylinders. In all above scenarios there is no way to determine the per day usage of the resources. And there is no proper method to determine the actual requirement of the resources for a single person.

This per day usage data that will be provided by implementation of this project provides the consumer and the administrator of a locality knowledge about the resources being consumed. It also provides us the responsibility to utilize only the amount of resources we actually require and reduce unnecessary wastage.

IV. SENSORS USED

G 1/2 Water Flow sensor is used to sense the flow of water. Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse Signal and it is possible to get the flow speed via detecting the pulse.

Wiring up the Water Flow Sensor is pretty simple. There are 3 wires: Black, Red, and Yellow. Black to the Seeeduino's ground pin Red to Seeeduino's 5v pin. The yellow wire will need to be connected to a 10k pull up resistor. And then to pin 2 on the Seeeduino. The specifications are as follows:

Working voltage 5v-24v

Maximum current 15mA (DC 5v)

Weight 43g

External diameter 20mm

Liquid temperature <120 ℃

Storage temperature 25℃〜+80℃

Fig 2: G 1/2 Water Flow sensor

DIP Air Pressure Sensor (DIP-6, 0-40KPa) is used to sense the **LPG** pressure from which its consumption can be calculated. The specifications are as follows:

Measuring medium Air

Measuring range 0-40kPa

Operating temperature -40 ℃~ + 125 ℃

Storage temperature -40 ℃~ + 150 ℃

The figure is as shown below:

Fig 3: DIP Air Pressure Sensor (DIP-6, 0-40KPa)

ENERGY METER

An electricity meter or energy meter is a device that measures the amount of electric energy consumed by a residence, business or an electrically powered device. It is as shown below:

Fig 4: Energy Meter

Electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) to give energy used (in joules, kilowatt-hours etc.). Meters for smaller services (such as small residential customers) can be connected directly in-line between source and customer.

V. IMPLEMENTATION

INTERFACE

Wireless Sensor Network (WSN)

Wireless Sensor Networks (WSNs) can be defined as a self-configured and infrastructure less wireless networks to monitor physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants and to cooperatively pass their data through the network to a main location or sink where the data can be observed and analysed. A sink or base station acts like an interface between users and the network. One can retrieve required information from the network by injecting queries and gathering results from the sink. Typically, a wireless sensor network contains hundreds of thousands of sensor nodes [2]. The sensor nodes can communicate among themselves using radio signals. A wireless sensor node is equipped with sensing and computing devices, radio transceivers and power components.

The individual nodes in a wireless sensor network (WSN) are inherently resource constrained: they have limited processing speed, storage capacity, and communication bandwidth. After the sensor nodes are deployed, they are responsible for self-organizing an appropriate network infrastructure often with multi-hop communication with them. Then the onboard sensors start collecting information of interest .Wireless sensor devices also respond to queries sent from a “control site” to perform specific instructions or provide sensing samples.

A WSN node contains several technical components. These include the radio, battery, microcontroller, analog circuit, and sensor interface. When using WSN radio technology, you must make important trade-offs. In battery-powered systems, higher radio data rates and more frequent radio use consume more power. Often three years of battery life is a requirement, so many of the WSN systems today are based on ZigBee due to its low-power consumption. Because battery life and power management technology are constantly evolving and because of the available IEEE 802.11 bandwidth, Wi-Fi is an interesting technology.

The second technology consideration for WSN systems is the battery. In addition to long life requirements, you must consider the size and weight of batteries as well as international standards for shipping batteries and battery availability. The low cost and wide availability of carbon zinc and alkaline batteries make them a common choice.

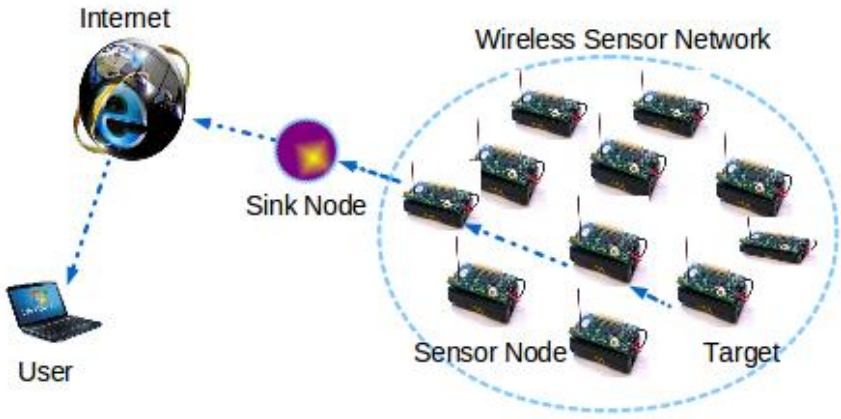

Fig 5: Schematic representation of WSN

SOFTWARE

The Integrated Development Environment (IDE), Cube Suite is used to generate the embedded code for the hardware mentioned. It offers the ultimate in simplicity, usability, and security for the repetitive editing, building and debugging of codes. It is also easy to install and operate which provides a highly user-friendly development. The robust line-up of expanded functions and user support functions ensures a dependable environment for all users.

CubeSuite+ bundles all the basic software necessary for Renesas MCU software development in one convenient package, ready to use immediately after initial installation. CubeSuite+ is also compatible with Renesas hardware tools, such as on-chip debugging emulator E1, facilitating advanced debugging.

HARDWARE

RENESAS MICROCONTROLLER BOARD

Renesas microcontroller surpasses its predecessor i.e. 8051 family of microcontrollers, with various in-built features as mentioned below:

- Renesas is a 16-bit microcontroller.
- Minimum instruction time can be changed from ultra-low speed (30.5us) to high speed (0.03125us).
- 16 to 512KB of ROM and 2 to 32KB of RAM are available depending upon the series and number of pins.
- On-chip high-speed (32 MHz to 1 MHz) as well a low-speed (15 KHz) oscillator is present.

• 10-bit resolution A/D converter (6 to 26 channels depending upon the series) is present.

• Totally 3 UART for Serial Interface is available.

• Totally 0-7 channels for timer is available.

• Most of the pins of Renesas have multi-task features.

• Cost of Renesas microcontroller is comparatively less.

• Rigid body of microcontroller hence less prone to damages due to electrostatic charge.

• Operates with 5v power supply.

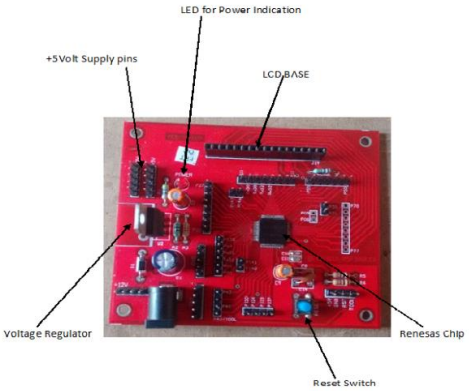

Fig 6: 64 pin Renesas Microcontroller board

GENERAL PACKET RADIO SERVICES (GPRS)

General Packet Radio Services (GPRS) is a packet-based wireless communication service that promises data rates from 56 up to 114 Kbps and continuous connection to the Internet for mobile phone and computer users.

DATA GPRS:

1 GPRS data downlink transfer: max. 85.6 kbps

2 GPRS data uplink transfer: max. 42.8 kbps

3 Coding schemes CS-1, CS-2, CS-3 and CS-4

4 Supports the protocols PAP (Password Authentication Protocol)

A GPRS connection is established by reference to its access point name (APN). The APN defines the services such as wireless application protocol (WAP) access, short message service (SMS), multimedia messaging service (MMS), and for Internet communication services such as email and world wide web access

In order to set up a GPRS connection for wireless modem, a user must specify an APN, optionally a user name and password, and very rarely an IP address provided by the network operator.

GLOBAL SYSTEM FOR MOBILE COMMUNICATION (GSM)

SIM900 is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS 1900 MHz SIM900 features GPRS multi-slot class 10/ class 8 (optional) and supports the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. You can use AT Command to get information in SIM card.

The SIM interface supports the functionality of the GSM Phase 1 specification and also supports the functionality of the new GSM Phase 2+ specification for FAST 64 kbps SIM (intended for use with a SIM application Tool-kit). Both 1.8V and 3.0V SIM Cards are supported. The SIM interface is powered from an internal regulator in the module having nominal voltage 2.8V. All pins reset as outputs driving low.

The "AT" or "at" prefix must be set at the beginning of each command line. To terminate a command line, enter. Commands are usually followed by a response that includes,"". Throughout this document, only the responses are presented, are omitted intentionally.

GSM networks operate in a number of different carrier frequency ranges (separated into GSM frequency ranges for 2G and UMTS frequency bands for 3G), with most 2G GSM networks operating in the 900 MHz or 1800 MHz bands. Where these bands were already allocated, the 850 MHz and 1900 MHz bands were used instead (for example in Canada and the United States). In rare cases the 400 and 450 MHz frequency bands are assigned in some countries because they were previously used for first-generation systems. For comparison most 3G networks in Europe operate in the 2100 MHz frequency band. For more information on worldwide GSM frequency usage, see GSM frequency brands.

LIQUID CRYSTAL DISPLAY

The liquid-crystal display has the distinct advantage of having a low power consumption than the LED. It is typically of the order of microwatts for the display in comparison to some order of milliwatts for LEDs. Low power consumption requirement has made it compatible with MOS integrated logic circuit. Its other advantages are its low cost, and good contrast.

The main drawbacks of LCDs are additional requirement of light source, a limited temperature range of operation (between 0 and 60° C), low reliability, short operating life, poor visibility in low ambient lighting, slow speed and the need for an ac drive. Basic structure of an LCD A liquid crystal cell consists of a thin layer (about 10 u m) of a liquid crystal sandwiched between two glass sheets with transparent electrodes deposited on their inside faces. With both glass sheets transparent, the cell is known as transmittive type cell.

When one glass is transparent and the other has a reflective coating, the cell is called reflective type. The LCD does not produce any illumination of its own. It, in fact, depends entirely on illumination falling on it from an external source for its visual effect

The LCD panel is powered by LCD drivers that are carefully matched up with the edge of the LCD panel at the factory level. These same principles apply also for smart phone screens that are so much smaller than TV screens. LCD panels typically use thinly-coated metallic conductive pathways on a glass substrate to form the cell circuitry to operate the panel. It is usually not possible to use soldering techniques to directly connect the panel to a separate copper-etched circuit board. Instead, interfacing is accomplished using either adhesive plastic ribbon with conductive traces glued to the edges of the LCD panel, or with an elastomeric connector, which is a strip of rubber or silicone with alternating layers of conductive and insulating pathways, pressed between contact pads on the LCD and mating contact pads on a circuit board.

METERING AND ALERTING SYSTEM FOR RESOURCE CONSUMPTION

This project aims at monitoring one's energy consumption and warns consumer if he/she is expected to increase beyond him/her pre-fixed energy units. This monitoring is done on a regular basis, so that if consumer is at the brink of exceeding his/her specified consumption limits, they will be warned. This is implemented using WSN technology, In WSN sensors are equipped with wireless interfaces with which they can communicate with one another to form a network. It has sensor nodes working together to monitor a region to obtain data about the environment. According to David Culler, Estrin and Mani Srivastava WSNs offer an alternative approach: performing Local processing at each device and transporting the data continuously to master node [2].

By fixing one's consumption below a fixed slab rate category and continuously checking that the consumption has not exceeded this limit for a time lapse, we can cut down the consumer's bill as well as the load on the system, if we succeed in limiting the consumption below the slab rate. This project constantly alerts consumer if their consumption has reached beyond the preplanned units on a regular basis [6], so that the consumer is aware of his consumption and voluntarily controls his consumption.

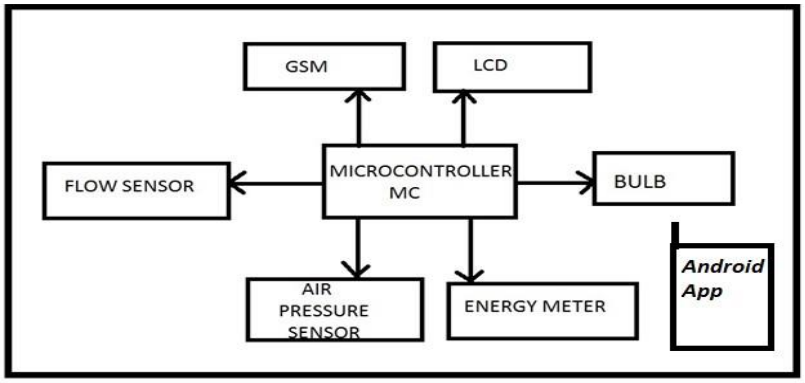

Fig 7: Representation of metering system

In this project we use respective sensors to measure the amount of usage of water, electricity and LPG in home. Electric meter can be configured to measure electricity consumption of a load [7]. The android application enables users to know the amount of energy they consume. This information is stored in the database [3]. Whenever the consumption will exceed the threshold, the user will be notified the amount of usage in that time span. This application is not only for common people but also for the higher authorities. The user and admin have their respective accounts. The user can only view his/her usage and the admin can view usage on locality basis.

VI. CONCLUSION

The implementation of this project provides awareness of daily usage by which we can use the resources effectively. The penalty is imposed for aggrandize usage of resources. By this people will be conscious about the resource usage.

Energy conservation is the only route that can get better mileage out of the available resources. These problems can be tackled with the implementation of this project by measuring and alerting the users. Since the usage of the resources is kept track of and monitored to ensure the safety of the future generation.

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