IOT Based Data Processing For Home And Industrial Monitoring Using Raspberry Pi

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Abstract

In this paper, a smart home electric energy saving system is implemented by combining smart meter, smart plug, smart mobile devices, and database server. The smart meter consists of a power metering app, a data storage unit, a meter interface AWS IOT and a RPi wifi module. We see the IoT as billions of smart, connected "things" (a sort of "universal global neural network" in the cloud) that will encompass every aspect of our lives, and its foundation is the intelligence that embedded processing provides The IoT is comprised of smart machines interacting and communicating with other machines, objects, environments and infrastructures . Internet of things (IOT) grant to people and things to be connected anytime, anyplace, with anyone, ideally using any network and any service. The smart plug is composed of a core control unit and a remote monitoring module. User can use smart phone to check and control the operation of appliance, and the power consuming information can be remotely monitored by connecting smart plug to the internet via Wi-Fi media. Besides, the load characteristics in the database server can be employed to identify appliance operation mode by Support Vector Machines (SVM) method, which provides effective message for home electric energy saving application. Finally, a prototype was built up and tested; the test results validate the feasibility of the proposed smart home electricity saving system.

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Keywords— IOT ,Smart Meter, Smart Plug, Support Vector Machines, Remote Monitoring, Home Electric Power Saving.

I. INTRODUCTION

For global energy shortage and price rising, energy-saving has become a serious issue that brings smart grid concept and development in recent years. Regarding as smart meter would base of the smart grid architecture, most of nations started to develop home electric energy management system with Advanced Metering Infrastructure (AMI). It measured and transmitted electric parameters to data center automatically, also provided remote control function to users, so that they could change their energy usage behavior based on energy information [1].

There are many different approaches among classification algorithms, machine learning and support vector machine (SVM) has recently achieved effectively methods for data recognition [2-3]. However, considering the uncertainty of user's energy consumption behavior, it is not yet completely clear for applying SVM method to identify appliance operation mode and home electric energy saving application.

Besides, the handheld mobile devices are becoming increasingly popular in recent years, APPs can provide convenient interface for remote real-time monitoring and Operation, allowing users to communicate with the controlled device. This is the effectively way for users to realize home Electric energy saving system, smart plug information, energy consumption history and power management [4-5].

This thesis proposed a home energy saving network frame that applied SVM with historical data to identify appliance operation mode. The smart home electric energy saving system would be shown and demonstrated. Block Diagram

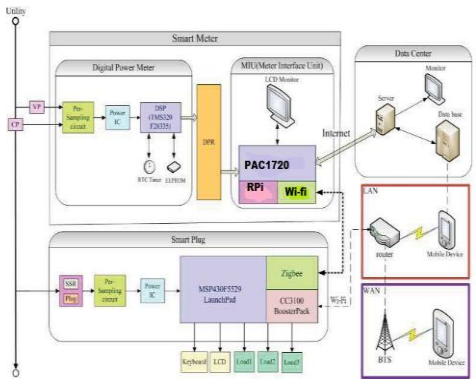

Fig.1 Simplified structure of the proposed home energy saving system

Fig.1 shows the home energy-saving system, it can be seen that there are three major units, smart meter, smart plug, and smart phone [1]. For the smart meter, the digital power meter is used to capture raw voltage and current signals separately, and the electric power energy consumption can be computed from the sampled discrete signals. Then, the real-time accumulative electric energy information is stored into MCU module and delivered to Meter Interface Unit (MIU) through the Dual Port RAM (DPR) modules. By smart plug, we can measure and analyze the power data for different loads, which is displaying on WEB PAGE and transferred to MIU by WI-FI . The power
Both of the electric energy consumption and power information can be passed to a remote Data Center with a client-server platform.

A. Smart Meter Unit

2. Block Diagram

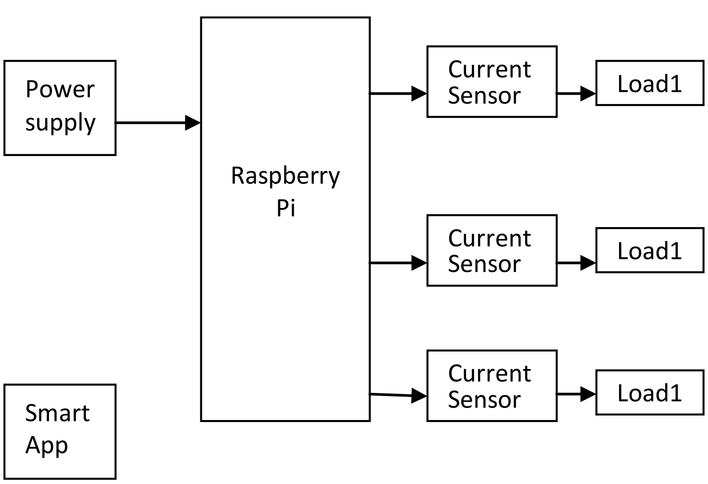

Fig. 2. Block Diagram of energy saving system

Gives the block diagram of the proposed architecture of the overall operation of the device. All the elements are illustrated in this block diagram. Here we use a simple Current sensor to sense the current of meter, and this will be fed to Raspberry Pi.
and the algorithm will calculate the units. This data will be saved on the server, which can be easily accessed by the user. The meter will also send an alert message when the consumption of units increases above the limit. The limit can also be set by the user as per his requirement.
Current sensor will send the smart meter current and voltage to the raspberry pi this will send the current to AWS IOT, using AWS IOT connecting with smart app using mqtt server.

3. Working smart meter

There are various techniques available for measuring the energy use of electronic devices and report this data over the network. The techniques are plug load monitoring system, non-intrusive load monitoring system, device-level load monitoring system.

Communicating power supply (CPS) includes electricity metering which measures the power consumption of device, computation, and interaction between the electronic devices. Smart meter connected to the internet, increases energy awareness amongst devices and users [4]. This paper [5], aims at improving accuracy of disaggregation algorithm by using ON/OFF events with smart meter data to calculate energy consumption of individual devices. Clamp-on current transformer is used in non-intrusive load monitoring system (NILM) system, for measuring the current consumption. NILM system has no direct contact with main supply. So it is safer method [6]. Non- invasive inductive current sensing technique [7], is used for current measurement of plug load devices, without breaking circuit of plug load devices. Maximum energy is consumed by plug loads in enterprises

To monitor and control electrical energy of plug loads like HVAC, there are multiple solutions available such as Building management system but there is no solution to analyze and trigger automatic action of plug loads in real time.

4. Remote Control by LAN/WAN

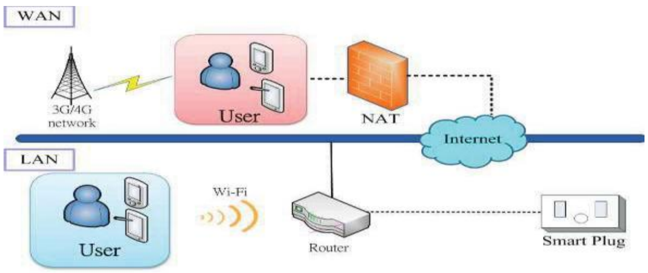

Fig:4. Overview of LAN and WAN communication route between mobile device and smart plug

Fig. 3 shows two communication medium of LAN and WAN between mobile device and smart plug. For LAN, user control and access from router to smart plug via Wi-Fi. In WAN which using 3G or 4G mobile communication, for its protective restriction of wireless to local network, therefore, introduced Network Address Translation (NAT) technology to convert and simplify the IP address between internal and external network. This paper used the restricted cone NAT for configuring the IP address definition, checking the transmission information and ensuring the security of data transmission.

Measurements on all three phases and even the neutral conductor.
The SmartPi 2.0 and the Raspberry Pi can be powered by the voltage. Input. An external power supply is not required.
The mobile device application is implemented by Android
Platform with software suit which are ADT, Android SDK. The procedure to develop home energy management
by application programming interface (API)

Implementation

The smart meter can record and measure the power consumption in small amount of time. By recording energy at these intervals, this allows the utility to bill customers using time of use pricing, Simply put the cost of energy meter through the day, therefore users will able pay bill at different price instead of flat rate.

Smart metering will have an AMI system where all the data are stored onto a web server . User can check his unit consumption at any time and can also pay the bill online. 3. The user will be able to set the limits for consumption. Beyond the limit of user will generate a warning message to the user. 4. Bill can be paid at any time online. There is no need for a person to come home and generate bills. All this work will be done by the system and it will be very reliable. 5. More accurate bills will be generated . 6. With the information on mobile , user can see immediately and adjust according to his need. 7. By making your energy usage more easily understood, you can make smarter decision to save energy and money, including feeling more comfortable switching energy supplier

5. DESIGN OF SYSTEM

The system has mainly three modules. The first module will be the smart meter. The second module will be android application. And the third will be it server(AWS IOT) were first two modules will be connected. The first module will be a unit calculating meter. The meter will be interfaced with the Raspberry Pi board, this will be in turn connected to third Module.i.e. Server AWS IOT. The server is created to handle MQTT request. The Android app will send request to the Raspberry Pi which will be connected to smart energy meter.

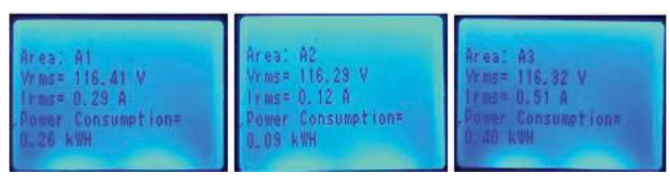

Fig:5 Energy power consumption and power parameters of different areas (a) A1, (b) A2, (c) A3

TABLE I. EXAMPLE OF IDENTIFICATION FEATURE SELECTION

Area	Schedule arrangement of Standby Mode		
	Appliances	Operation period	Standby period
A1	printer, monitor, computer, sound	7 hours (17:00-24:00)	17 hours (7:00-17:00 and 24:00~7:00)
A2	air conditioner	9 hours (7:00-9:00 and 17:00~24:00)	15 hours (9:00-17:00 and 24:00~7:00)
A3	home theater, LCD TV, TV box, DVD player	9 hours (7:00-9:00 and 17:00~24:00)	15 hours (9:00-17:00 and 24:00~7:00)

Home Energy Management of Mobile Device

Users can use mobile device to remote monitor the state and power energy consumption of appliances in house when smart plug connected to Wi-Fi successfully. In Fig.8, shows the power state and parameters of the personal computer on user mobile screen including in use (green), standby (yellow) and cut off (red).

Fig:6 Displaying the different power state and parameters on user mobile device (a) in use (green light), (b) standby (yellow light), (c) cut off (red light)

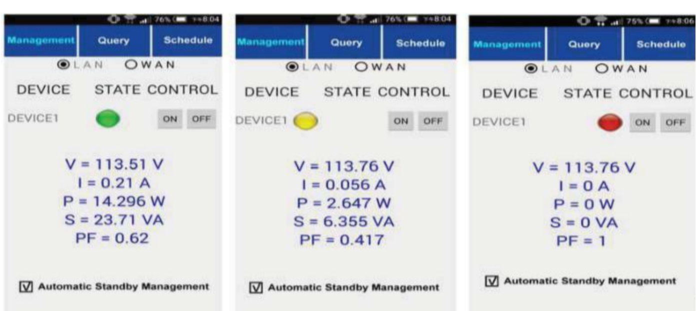

Fig:6 Displaying the different power state and parameters

7. ACS712S Current Sensor

Sensing and controlling current flow is a fundamental requirement in a wide variety of applications including, over-current protection circuits, battery chargers, switching mode power supplies, digital watt meters, programmable current sources, etc. One of the simplest techniques of sensing current is to place a small value resistance (also known as Shunt resistor) in between the load and the ground and measure the voltage drop across it, which in fact, is proportional to the current flowing through it. Whereas this technique is easy and straightforward to implement, it may not be very precise because the value of the shunt resistor slightly varies with its temperature, which in fact is not constant because of the Joule heating. Besides, this simple technique does not provide an isolation between the load and current sensing unit, which is desirable in applications involving high voltage loads. Today, we will talk about Allegro ACS712 device which provides an economical and precise way of sensing AC and DC currents based on Hall-effect. This discussion is divided into two parts. The first part will provide a brief overview of the ACS712 sensor and its characteristics used in the ADC operation. In most microcontroller circuits, the reference voltage for A/D conversion is the supply voltage itself. So, if the supply voltage is not stable, the ADC measurements may not be precise and accurate. However, if the reference voltage of ADC is same as the supply voltage of ACS712, then the ratio metric output of ACS712 will compensate for any error in the A/D conversion due to the fluctuation in the reference voltage.

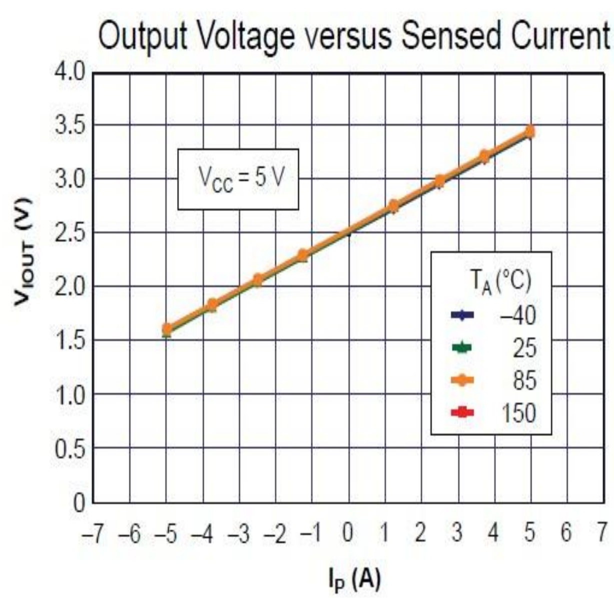

Fig :7. Output Voltage vs Sensed Current

The curve below shows the nominal sensitivity and transfer characteristics of the ACS712-05B sensor powered with a 5.0V supply. The drift in the output is minimum for a varying operating temperature, which is attributed to an innovative chopper stabilization technique implemented on the chip (read ACS712 datasheet for detail).

8. AWS IOT

AWS IOT enables Internet-connected things to connect to the AWS cloud and lets applications in the cloud interact with Internet-connected things. Common IOT applications either collect and process telemetry from devices or enable users to controlling the appliances remotely.

Things report their state by publishing messages, in JSON format, on MQTT topics. Each MQTT topic has a hierarchical name that identifies the thing whose state is being updated. When a message is published on an MQTT topic, the message is sent to the AWS IOT MQTT message broker, which is responsible for sending all messages published on an MQTT topic to all clients subscribed to that topic.

Communication between a thing and AWS IOT is protected through the use of X.509 certificates.

AWS IOT can generate a certificate we can use these certificate for our own. In either case, the Certificate must be registered and activated with AWS IOT, and then copied onto our thing. When our thing communicates with AWS IOT, it presents the certificate to AWS IOT as a credential. We recommend all things that connect to AWS IOT have an entry in the thing registry. The thing registry stores information about a thing and the certificates that are used by the thing to secure communication with AWS IOT. We can create rules that define one or more actions to perform based on the data in a message. For example, we can insert, update, or query a Dynamo DB table or invoke a Lambda function. Rules use. Expressions to filter messages. When a rule matches a message, the rules engine invokes the action using the selected properties. Rules also contain an IAM role that grants AWS IOT permission to the AWS resources used to perform the action

9 .Result

Date Time	Sampling Scale					State (1:ON/ 0:OFF)
	10 minutes before	an hour before	yesterday before	last week before	last month before	
4/19 19:00	18:50	18:00	4/18 18:00	4/12 19:00	3/19 19:00	1
4/12 19:00	18:50	18:00	4/11 19:00	4/01 19:00	3/12 19:00	1

Fig.9 Electric Power Parameters measurement

Fig. 9.1 shows the test results on the MIU LCD display real time information for a low voltage user's load, including rms voltage and current (Vrms and Irms), apparent power (S), real power (P), reactive power (Q), power factor (PF), electric energy and billing.

Fig 9.1 Results on the MIU LCD Display

10.CONCLUSIONS

Due to the growing number of household electrical appliances, and its power consumption. The energy power management, such as standby power control, must be effectively implemented. In this paper, the proposed structure is built using multiple low-cost microprocessors to increase its feasibility that contains smart meter, smart plug, and smart home energy-saving System. A single phase prototype meter system was built, and the desired functions were tested in the laboratory.

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