An Automated Energy Metering System Using Mobile Smartphone

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Abstract:-

Automated Energy Meter has become the technology of today. In many recent studies lots of researchers and organizations have been working on smart meter. In the smart grid, smart meters are considered the primary component which assists the customer and provider controlling the consumption or usages of power corresponding to the availability of capitals. Great losses have impacted the electricity market because of the increasing in cost. These losses of electric power have caused an economic issue, therefore in order to make an efficient use of energy, smart metering system was counted as a best solution. The planned power metering scheme composed of power meter, connection through WiFi, and web server. Single phase power indicator was deployed using ARDUINO microcontroller and connection segment was deployed through WiFi transmission. Server end and user end are executed in web server. Smart indicator has the ability of collecting the measured power and transmits that statistics to the electrical panel, which keeps the data and acknowledges the costumer throughout SMS messages.

Keywords:- Smart meter; Smartphone; ARDUINO; WiFi Communication; web server.

I. INTRODUCTION

We can define the electronic indicator or power meter as a tool which evaluates the quantity of electrical power brought to home or corporation. The most popular form is identified as a (kilo) watt-hour indicator or a joule indicator. After measuring the quantity by these meters, the utilities will record the measured value and invoice the electricity. They might document other variables such as the period when power was consumed. Time of usage (TOU) metering includes separating the day, month and year into charge slots with greater charges at load peak phases and little price rates at off-peak load phases.

Smart meters are the main elements in a smart network. Smart network is an electric power scheme where functions such as generating, conduction and allocation of electricity takes place. Smart indicator presents real time expenditure data to the clients helping

them reducing their inclusive electricity depletion. Smart indicators accouter outstanding benefits if deployed in smart networks as its two pathway transmission performs as an entrance linking the clients and merchants to control their electricity expenditure. In order to get an accurate meter evaluation, first, meter reader must reach to each and every single user to get and record the evaluation. Second, the authority should invoice the users. In conventional meter reading system, this will be both time and effort consuming. Thus the employment of an automated meter evaluation scheme is crucial in business plus in manufacturing discipline thru improving both networking scheme and data scheme. However, the electronic energy meter and the billing sector in Iraq, still consuming more time and labor. One of the main reasons is the inaccurate traditional billing system which lacking flexibility as well as reliability [8]. For that reason, smart meter will deliver an excellent solution in deploying efficient energy metering technologies which are more precise, accurate, error free.

II. BACKGROUND

AMR is the scheme that gathers information through one transmission path, whereas AMI system has the capability toward constrain and observe the energy indicator. By combining both systems the AMI and AMR, we get a smart system. The AMR system reduces the cost of the supplier's meter and invoices the users with accurate meter evaluation. However, in order to make the AMR system capable of communicating both the server and the customers, it would require special infrastructures to do so. The connection can be wired in many different ways, such as Ethernet or WiFi or PLC or wireless like GSM or Wimax. Bluetooth based energy meter has been employed to get back the meter evaluation with a reduction Of being involved [3]. The one disadvantage with that meter was the limited reach of the transmission.

GSM and ZigBee are another transmission technology which could be utilized to link to the nearby server [1]. This includes several functional complications whilst transporting messages from the household to the dominant server. Each consumer must pay message fee and if statistics amenities fail nevertheless it will be hard to direct metering evaluation when it is demanded by the electrical panel. Ethernet and WiFi transmission could be applied to avoid any system breakdown catches. In WiFi connection only initial installation cost will be required.

In addition, the transmission could be established through assigning a small bandwidth alongside with the household mobile grid. The status of real time

energy consumption for each customer will be recorded with less cost. The smart meter gathers any information related to the load flow of energy in order to manage them by distributors from the smart grid. Smart meters seem to give us the same characteristics as an intelligent system in order to maintain electricity amenities effectively. Smart indicators reduce charge, stores power and enlarge consistency of system [9,5].Smart indicators are in favor of the success of smart network.

III. SYSTEM OVERVIEW

The planned power metering system as **fig. 1** shows composed of an energy meter, WiFi transmission and web server. ARDUINO microcontroller has been deployed along with a single phase energy meter and a transmission segment was employed using WiFi transmission, server end and user end are connected together via web server. The connection joining the server end and user end could be established utilizing several various technologies such as Bluetooth technology, WiFi, Ethernet, GSM. In this paper the WiFi technology has been deployed to transfer information from the power meter point into the server point.

3.2 Connection part

For the connection part a WiFi communication technology was deployed hence the recorded

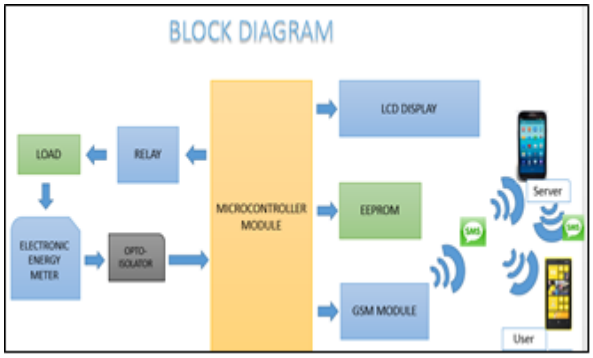

Fig. 1 Smart Meter Block Diagram.

3.1 Power meter part

The power meter section composed of voltage and current scheming component, altitude shifter and ARDUINO. On behalf of our experiment objective a luminous light of 60 Watt is employed. For safer values a current and voltage transducers are exploited in order to shorten the electrical energy. After shifting the level of the voltage and current signals, they will be consumed in the Arduino panel. The amount produced from the voltage altitude shifter is contributed to the analog input of an Arduino panel at bits A0 and earth. In the same way the amount produced from current altitude shifter is contributed to the analog input of an Arduino panel at bits A1 and earth. Finally, a regulator on the panel will estimate the power when inputs are given to the Arduino board information will get transferred toward the mesh page with a lesser amount of charge.

3.3 Server and management part

A remote server will receive the collected energy consumption data from the connection part and store it inside databank. The server administrative scheme will be responsible on monitoring and handling the expenditure of power usage of the users.

IV. SYSTEM HARDWARE

Arduino is an accessible resource program. Ardino uno is a microcontroller panel established on ATmega328. It composed from 14 numerical I/O bits (6 PWM outputs) and

6 Analog inputs. Clock rate is 16 MHz Arduino uno could be run thru utilizing a power jack, USB docks. A converter throughout pin VIN could also be worked as a power source for the clock speed. Shields could be operating in Arduino and Arduino panels. As an extension to the Arduino foundation shields will be attached to the system. Many types of buffers are around like Ethernet, WiFi, RF in which we employed WiFi buffer in our system. Because of the productivity of current transducer and possible voltage transducer are AC signals. It will be impossible to transmit the information straight to Arduino. First, we will clamp the signal by level shifter circuits, then directly send it to the Arduino for energy calculating purpose. After that the estimated power will transfer into the server via Wi-Fi buffer.

Fig. 2 Smart meter system.

In this paper two software has been used. They are Arduino and WAMP server. All the components of the system are programmed to communicate with each other through Arduino microcontroller. In which we consider the Arduino microcontroller the main part of the system because it responsible for calculating the energy meter readings and sending it to the remote server using Wi-Fi connection.

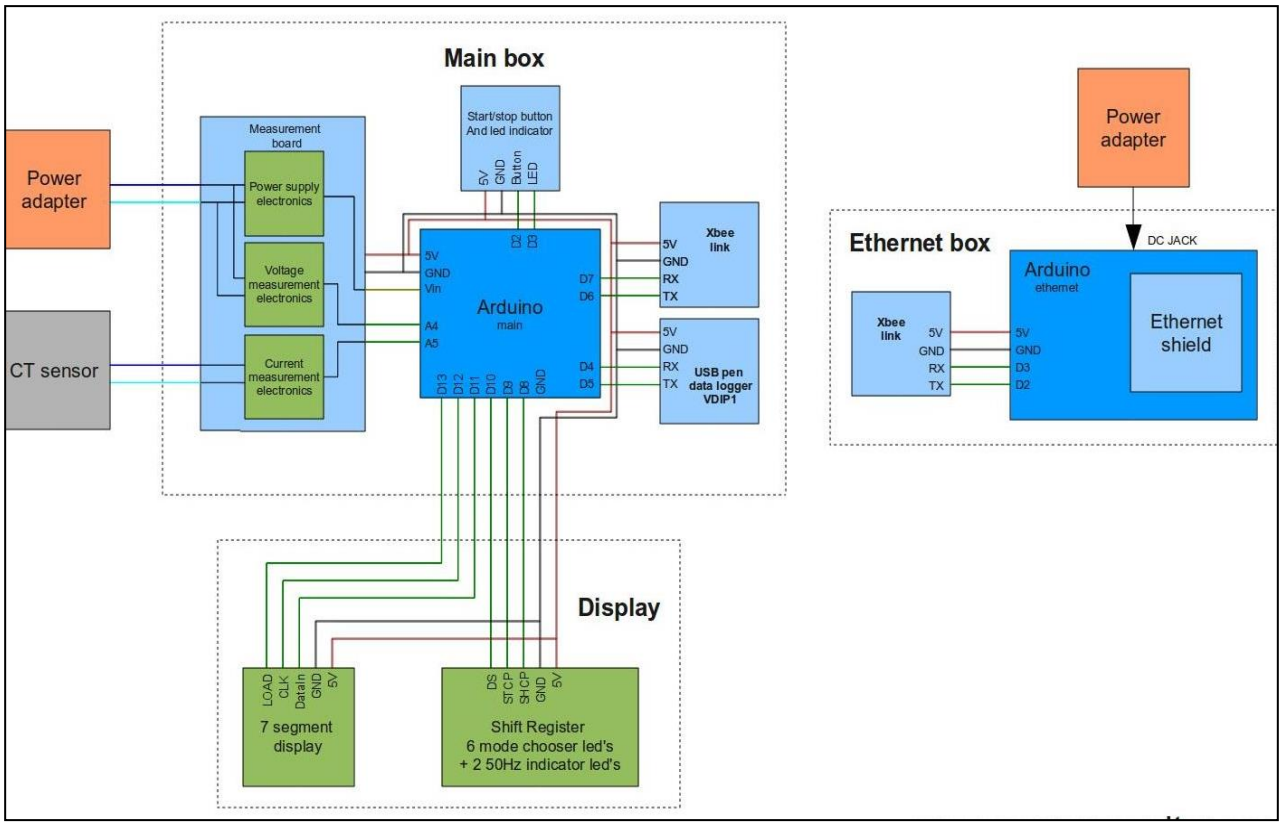

Fig. 3 Smart meter chart.

V. ACCURATE POWER MEASURMENT IN SMART METERS

Most smart meters use several various of a delta-sigma-type (ADC) to make their voltage and current evaluations. It is commonly supposed that devices using this structural design are the best cost-effective keys for offering the high-resolution digitization at the testing speeds needed for an accurate power and energy reading. However, it is a little hard to decide when it comes to choosing how many bits of resolution and the right sample rate to use. The level of accuracy entailed for a utility meter differs corresponding to the group of application they are planned for. Preferably, the conclusive accuracy of the calculations

must be defined only by the quality of the board layout, the accuracy of the current sensor, and the accuracy of the ADCs.

In general, power reading accuracy is estimated in terms of a percent error over a given dynamic range (DR) where:

$$DR = I_{max} / I_{min} \quad (1)$$

Using the example for a Class B meter in Table 1 as an example:

$$DR = 60/ 0.25 \text{ or } 240 : 1$$

TABLE I. POWER MEASURMENTS.

Letter Class	$I_{reference}$ (I_{ref})	$I_{maximum}$ (I_{Max})	$I_{transitional}$ (I_{tr}) $I_{tr} = I_{ref}/10$	$I_{minimum}$ (I_{min}) $I_{min} = 0.5*I_{tr}$	Accuracy <I_{min} to I_{tr}>	Accuracy <I_{tr} to I_{max}>
A	5 A	60 A	0.5 A	0.25 A	2.5%	2%
B	5 A	60 A	0.5 A	0.25 A	1.5%	1%
C	5 A	60 A	0.5 A	0.15 A	1%	0.5%

VI. SMART METERING CHALLENGES

The smart energy metering has upraised a few challenges which could utilize to future smart energy metering. Concerns have been stated considering health impacts, data access and cyber security.

1. Data access

Energy corporations are worried that too many clients will offer them authorization to access more specified data resulting in limiting the advantages of smart metering to providers. Clients may not decide on if they count the possible use of data is for industrial practices such as consumer profiling and directed marketing as excessively disturbing. Nevertheless, energy corporations which are already establishing smart meters have stated that 90% of early adopters have decided on to half-hourly data access.

2. Unauthorized access and cyber-attacks

Smart meters and their information might be used illegally. Smart metering tools can endanger to cyber-attacks, such as hacking, possibly guiding to energy interruptions. Energy usage information might possibly be utilized to determine a person's presence or behavior within a residence. Consumers can interfere with their personal smart meters to interrupt meter calculations and get reduced bills. The Smart Metering Equipment Technical Specifications prepared security procedures to avoid external access to smart metering equipment. These procedures contain the verification of consumers,

confirmation of messages, encryption of information and the interfere resistance of smart metering equipment.

3. Health impacts and smart meters

Smart meters use radio waves to transmit the calculations they gather. There are lots of everyday machines that use radio waves for telecommunications objectives such as radio/television receivers, cell phones and wireless computers.

The smart meter system built up of two key radio parts:

- Home Area Network (HAN), hat connects the smart meters with an in-house display, which permits consumers to observe their power usage in real time.
- The telecommunications unit which permits transmission between the meter and the utility corporation includes a SIM card similar to those used in cell phones.

The telecommunications are not continuous and simply happen through short discontinuous pulses when information is truly being transmitted.

VII. SYSTEM SOFTWARE

By using PHP and ASP.NET a website has been created in order to provide data regarding real power usage of consumers. It accumulates energy information from home arduino panel upon call. When the customer consumption is higher than the acceptable threshold an SMS has transmitted toward home owner's smartphone along with a warning buzzer which is offered by the arduino. Displays apache mysql php server is depleted to format the neighboring server where the webpage is held. For each house owner power expenditure could be demonstrated via neighboring server and if customer power consumption passes over the allowed threshold, an alert message is transmitted into consumer and electricity supply will be cut off.

VIII. RESULT

The power meter was experimented according a resistive load of 60W bulb. The prototype of the electrical meter circuit is illustrated in the figure below. The arduino had adjusted for gathering voltages and current data from the deployed system and to evaluate the power that is resulting from that data. The consumed energy will appears on the serial monitor window of arduino in the system and will be transmitted to the webserver through Wi Fi upon demand. In case of the power expenditure is larger than the acceptable level, a sms message is transmitted directly to consumer and a warning alarm will be powered on the smart indicator notifying the consumers to lower their expenditure. **Fig.4** presents the serial monitor window in arduino displaying real time power data, and **Fig.5** shows the power panels webpage designed using PHP and ASP.NET. **Fig.6** displays the sms transmitted to costumer smartphone when power consumption crosses the allowed threshold.

Fig. 4 The prototype of electrical meter circuit [2]

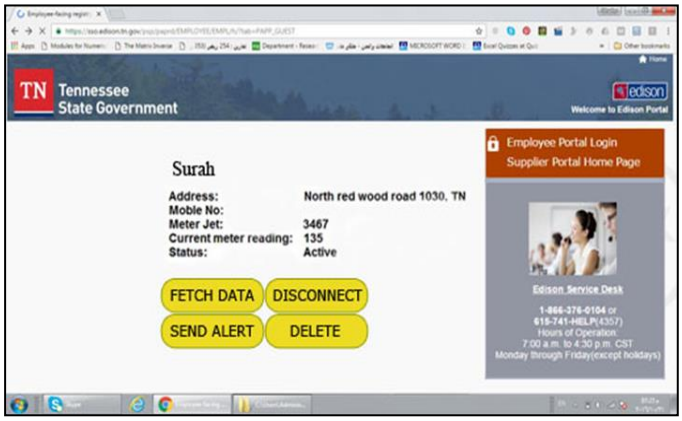

Fig. 5 User web page details.

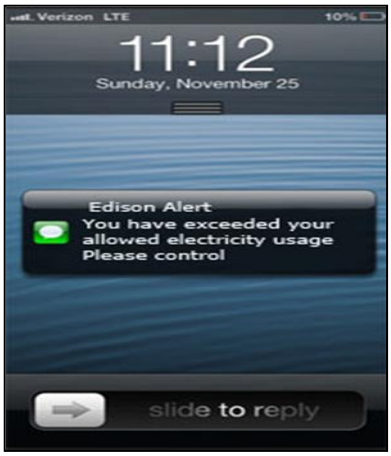

Fig. 6 SMS received on costumer smartphone.

CONCLUSION

The objective of this paper was to propose a scheme that collects and record power disbursed in a house in order to transmit the disbursed power into the remote server upon demand from the main power panel. After collecting the information, it will be analyzed whether the expenditure of power usage is higher than the proposed limits or not. A Wi Fi connection is depleted in this paper because information will be accessible with no suspends. Additional prospect work shall incorporate developing new models of such design in real scenarios like settling it in homes. This scheme permits customers to review and adjust their power consumptions.

In the present day if users want to know their energy usages so they could reduce their usage they must wait for power invoice. However, via smart meter, user will be capable to receive warning messages as soon as their power consumption surpasses the allowed amount. This will certainly benefit consumers in their energy consumption or usages resulting in saving together power and money.

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نظام قياس الطاقة الكهربائية الذكي باستخدام الهاتف المحمول الذكي

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أصبح عداد الطاقة الآلي من التكنولوجيا اليوم. في العديد من الدراسات الحديثة العديد من الباحثين والمنظمات تعمل على تطوير استخدام العدادات الذكية. وفي الشبكة الذكية، تعتبر العدادات الذكية المكون الرئيسي الذي يساعد المستخدم والمزود على التحكم في استهلاك أو استخدامات الطاقة المقابلة لتوفير الطاقة. وقد أثرت خسائر كبيرة على سوق الكهرباء بسبب الزيادة في التكلفة. وقد تسببت هذه الخسائر في الطاقة الكهربائية في قضية اقتصادية، وبالتالي من أجل استخدام الطاقة بكفاءة، تم حساب نظام القياس الذكي باعتباره أفضل حل. المخطط الاساسي للنظام الذكي يتألف من عداد الطاقة، اتصال من خلال واي فاي، وخادم الويب. تم نشر مؤشر الطاقة مرحلة واحدة باستخدام متحكم أردوينو وتم نشر قطعة اتصال من خلال انتقال واي فاي. يتم اتصال نهاية الخادم ونهاية المستخدم من خلال خادم الويب. مؤشر العدادات الذكية لديه القدرة على جمع الطاقة المقاسة وينقل تلك الإحصاءات إلى اللوحة الكهربائية، والتي تحافظ على البيانات و بعدها يتم اعلام المستخدم بتلك الحسابات و المصروفات من الطاقة عبر رسائل اس ام اس ترسل مباشرة الى موبايل المستخدم.

الكلمات الرئيسية : الهاتف الذكي، واي فاي ،الاتصالات؛ قاعدة بيانات للانترنت، اوردينو .