Retraction

Retraction: Advanced smart energy meter for energy conservation (*J. Phys.: Conf. Ser.* **1916** 012136)

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This article (and all articles in the proceedings volume relating to the same conference) has been retracted by IOP Publishing following an extensive investigation in line with the COPE guidelines. This investigation has uncovered evidence of systematic manipulation of the publication process and considerable citation manipulation.

IOP Publishing respectfully requests that readers consider all work within this volume potentially unreliable, as the volume has not been through a credible peer review process.

IOP Publishing regrets that our usual quality checks did not identify these issues before publication, and have since put additional measures in place to try to prevent these issues from reoccurring. IOP Publishing wishes to credit anonymous whistleblowers and the Problematic Paper Screener [1] for bringing some of the above issues to our attention, prompting us to investigate further.

[1] Cabanac G, Labbé C and Magazinov A 2021 arXiv:2107.06751v1

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Advanced smart energy meter for energy conservation

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Abstract. The recent trends in Advanced Metering Infrastructure (AMI) have paved the way for incremental needs within the consumers such as real time billing transparency, data exchanges without errors, high precision, individual load consumption, and remote-control features. In advanced metering infrastructure, the smart energy meter acts as the primary equipment for household metering appliances. Such energy meters come with different design topologies that have proven itself for remote billing, post paid and prepaid packages for electrical consumers, high accuracy, anti-tampering design and remote control over household mains. However, there are few studies that interpret energy meters can be used for energy conservation purposes. The energy conservation suggestions by modern energy meters are not observed effective as they do not assess the individual load characteristics. Moreover, the billing transparency is not based on real time and accurate in the modern energy meters. This paper focuses on advanced billing methodology and consumption of individual load without the need of additional sensors and the meter alerts the user by forecasting the energy consumption continuously.

Keywords. Energy meter, Advanced Metering Infrastructure (AMI), Energy Conservation, Individual load assessment, Billing transparency

1. Introduction

The world of power generation combating the needs of consumer demands has substantially increased as the trends grow in household appliances. Besides the trend, the consumption rate has also increased due to the societal culture. The government policies are meanwhile causing the directional shift towards the enforcement renewable energy sources to confront the spike in energy consumption. The directional shift also encourages the functional participation of energy audits and consumers together sustaining the conservatory insights on power consumption to reinforce the art of sustainable development in power sector and to achieve the network efficiency. The inevitable need for the metering infrastructure thus come in and plays a vital role in measuring the consumption as well as to predict the demand characteristics. In AMIs the most fundamental component of metering the consumption is the common household energy meters and industrial meters. The energy consumption of household and industries are nevertheless calibrated using the energy meter installed by the electricity board of the government. Regardless of digitalization of the energy
meter, it lags some features mainly the real-time billing transparency, network latencies in communication and equipment-level power consumption portfolio [1]. The real-time smart billing is however present in the existing smart meters, the cost of individual load bills is not displayed on the meter. Moreover, the unused energy is not calibrated by the energy meter. The need of calibrating and displaying equipment-level power consumption and the cost of unused power is to impart the awareness about energy conservation and promote the use of low power consuming qualitative products [2]. Some energy meters can measure the equipment-level and unused energy consumption with the use of auxiliary sensors installed in the switching modules, but it is not cost effective and reliable as the sensors might cease to operate under certain environmental conditions and it is not durable. Therefore, this paper proposes the incremental innovative concept of equipment-level load consumption, real time billing transparency, equipment level consumption forecast and most effective energy conservation tips [3]. The proposed system is cost effective as no additional sensors are used for the equipment-level consumption assessment. As the energy meter can be used for conserving energy and making consumers aware about the equipment they utilize, the advanced energy metering concept is most reliable for the future power sector [4].

2. Research background
The recent proposal [5] “An internet of things based smart energy meter for monitoring device-level consumption of energy” proposes a IoT model in which the current sensor is integrated with the AC mains to monitor the device level consumption. The paper proposes the microcontroller-based energy meter and utilizes the ThingSpeak for implementing the IoT technology. As the paper proposes the design-based device level consumption monitoring, it increases the cost for the consumer. It also uses the ESP8266 which operates only if the Wi-fi is available. The paper [6] “Artificial Neural Network-Based Smart Energy Meter Monitoring and Control Using Global System for Mobile Communication Module” proposes an optimized way of utility power allocation using the global system for mobile communications. It is done with the help of Artificial intelligence using back propagation methodology which in turn reduces the cost of energy. But the paper fails to provide energy conservative aspects using metering infrastructure. The paper [7] “SMART HOME: Energy Measurement and Analysis” provides the measurement and analysis of consumer load pattern and interprets the data with the use of integrating IoT enabled switching module that powers the equipment. Their system can measure and interpret the consumption pattern of the consumer therefore detects the unnecessary usage of electrical power leading to energy wastage. It also helps to make the consumer aware about the output of utilisation of energy as well as the cost of energy utilized. However, the device level consumption with the use of switching module increases the cost and the billing transparency and accuracy is less in this system. The paper “An IoT based Intelligent Smart Energy Management System with Accurate forecasting and Load Strategy for Renewable Generation”, introduces ISEMS (Intelligent Smart Energy Management System) in order to forecast the load for utilizing the renewable energy sources without hindering the power demand characteristics . In this PSO based SVM regression model is implemented for forecasting the load characteristics as the model is superior to other models. The model however lags in equipment level consumption forecasting for individual households.
3. Proposed system

![Figure 1. Block Diagram of Advanced Smart Energy Meter employing Thingspeak IoT platform](image)

The figure 1 consists of the block diagram of advanced smart energy meter that consists of microcontroller, LDR sensor, RTC timer, GPS & GSM module and energy meter IC as its primary components. The things speak is an IoT platform which is used for posting the data received from the GSM. The microcontroller is used for processing the control signals whereas, the microcontroller MSP430 series can also be used to measure the power consumption for every second, LDR sensor is used to necessitate the required signals needed to process the data by the microcontroller, RTC sensor plays a vital role in relating the power consumed every second to the time at the geographical location. The GPS sensor is used to request the latitudinal and longitudinal information. The determination of cost of energy consumption is processed by the microcontroller. A Probabilistic distributed arithmetic progression (PDAP) algorithm has been introduced to measure the equipment level power consumption without using additional sensors. After assessing all the cost of individual power consumption, the data is displayed in the LCD. The PDAP algorithm is defined as below,

**PDAP Algorithm [Probabilistic distributed Arithmetic Progression]**

In this paper, PDAP algorithm is introduced for cost effective device level power consumption calibration.

**Step 1:** Initialization of energy meter with acquiring predefined data of power ratings of each electrical or electronic household appliances.

The energy meter is defined with the preset values, which are fed in either ways through smart app initialization or manual method.

**Smart App initialization** - The power ratings of all household equipment is noted and fed through the app which is then sent through the internet to the GSM of energy meter or instead of noting down the power rating a database of all electrical equipment in the geographical boundary can be created and the consumers shall be provided with choices or with the help of image processing and electrical appliances database the power ratings can be fetched effortlessly from the consumers.

**Manual method** - The manual initialization is done by switching on each equipment separately for 30 seconds. So, that the energy meter fetches the predefined value.

**Step 2:** The next step is to assess the reference power consumption of each component in terms of W/S (watts/second) For example,
E.g., If the power rating of an equipment is 10 W/hr. The Power per second (PPS) is 10/3600 = 2.7 mW.

**Step 3:** The probability of combinations of switched equipment is estimated. The possible combinations of different equipment switched at different time is defined as $2^n$, where $n$ is the total numbers of equipment.

**Step 4:** The PPS of all the combinations is calculated, this acts as the pre-defined set of values along with the individual PPS of all equipment.

**Step 5:** Once the values are defined, the microcontroller recognizes the received consumption data from energy meter IC and allocates it to the respective combinations.

**Step 6:** The combinational consumption is disintegrated to equipment level by the microcontroller itself.

![Flowchart of PDAP algorithm](image)

Figure 2. Flowchart of PDAP algorithm

For better accuracy, the unused energy is calculated by assessing the power consumption in standby mode of every equipment and the plug points. Moreover, the proposed system also alerts the consumer about the threshold of unit consumption rates. The energy meter can be controlled remotely through smart app or GSM module. The proposed system is integrated with prepaid and post-paid payment options for consumer. The real time unit consumption rates can be taken from government owned data hubs such as Vidyut Pravah in India. So that, as the GPS verifies the location, the unit data from the Vidyut Pravah site is fed to the energy meter through the GSM module and the bill is estimated and displayed spontaneously. This avoids confusion in billing and increases the billing accuracy Figure 2.

**Limitations of PDAP Algorithm:**

If one or more PPS is similar, the disintegration is done approximately and displays the consumption in either or ways.
4. Design and implementation

The Advanced Smart Energy Meter consists of the following, such as special function (energy metering) microcontroller for measurement of electrical parameters such as voltage, current, frequency and power, RTC timer which for relating the consumption data with the time variable, LDR sensor for necessitating the required signal for the micro-processor, GPS sensor for initialization of the RTC timer and the unit consumption cost information at the specific location, GSM module is used for enabling the GPRS connectivity as well as to send or receive text messages, LCD display which is used to show the meter parameters to the consumers and the microcontroller is also used to facilitate the control signals transmitted to the auxiliary components. Besides the smart App is built using the API provided by the ThingSpeak for IoT purposes. The following is the detailed hardware description for advanced smart energy meter,

4.1 Microcontroller

The microcontroller used is the special purpose which is used for energy metering applications Figure 3. The microcontroller MSP430F67641A is a low-cost polyphase metering microcontroller which has 10 bit SAR ADC, 128 KB flash and 8KB RAM which is far enough to process the PDAP algorithm and store it too. It has 1 I2C port, 4 SPI ports and 3 UART ports and 72 GPIO pins. And it has the accuracy <5% over 2000:1 dynamic range of phase current. It has ultra-Low Power Consumption During Energy Measurement – 3.0 mW at 10-MHz Operation (3.0 V)

![Figure 3. Architecture of MSP430F67641A SoC](image)

4.2 GPS Module

The neo-6M is a low cost and good GPS module which is integrated with the antenna, and it has a built-in EEPROM in order to store the configuration parameter data and also has built-in ceramic active antenna of size 25 x 25 x 4mm that renders strong satellite search ability. The neo 6M module is equipped
with power and signal indicator lights and data backup battery. The Power supply of the module is 3-5V and its default baud rate is 9600bps. The module can be interfaced with RS232 TTL.

4.3 GSM Module
The GSM SIM 900 A is adopted. It supports Quad-band such as GSM850, EGSM900, DCS1800 and PCS1900. The SIM 900 A is compatible onto any global GSM network with any 2G SIM. It can also make and receive voice calls. Through the SIM 900 A, it is able to send and receive SMS text messages and also able to send and receive GPRS data (TCP/IP, HTTP, etc.). The transmit Power of SIM 900 A is Class 4 (2W) for GSM850Class 1 (1W) for DCS1800Serial-based AT Command Set U.FL and SMA connectors for cell antenna. Another good feature is it accepts Full-size SIM Card.

4.4 Smart application
The smart mobile application is built using the android studio using java and implemented with the ThingSpeak API. The IoT enabled API gets the consumption data processed by the microcontroller through the GPRS established by the GSM. The major network. The application is integrated with Open CV for image processing for recognizing the power rating of the appliances for initializing the smart meter with the values. The energy consumption by the consumer is clearly evaluated and displayed through the application. Most importantly, the data from the Vidyut Pravah website is requested and posted to the energy meter through the smart application Figure 4.

5. Future enhancement
In future, the convolutional neural networks can be integrated with the application for studying the consumer pattern at equipment level consumption. This can be used to forecast the demand at large scale and it can also be used for selling the modern low consumption appliances and can be promoted to conserve electrical energy at large scale.
6. Conclusion
The development of PDAP (Probabilistic Distributed Arithmetic progression) algorithm has proved that without the use of additional sensors and equipment the individual household load can be estimated. Along with this the real time billing transparency provides the consumers the credibility and reliability over the cost effective advanced smart meter. As the threshold of unit rate consumption is alerted to the consumer, the household power consumption can be minimized effectively. The robustness and simplicity of the system makes it most reliable and efficient against the modern smart meters which is best suited for advanced metering infrastructure (AMI).

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