# *Energy Monitoring Prototype for Internet of Things with Smart Metering*

[1]Nikhil B. Bhoknal, [2]Yash M. Kothari, [3]Pooja S. Anande, [4]Gauri M. Bendre, [5]Prof. T H.Gurav
*Department of Computer engineering, smt.. Kashibai Navale College of Engineering,Pune. Maharashtra, India*

***Abstract:*** *- Energy monitoring is one of the important applications arising from research in Internet of Things (IoT). Smart meters allow us to obtain periodic updates of energy consumption data that can be analyzed to provide important insights into energy usage. However, design limitations in smart meters only allow the monitoring of the aggregated consumption data instead of real-time consumption data. In order to increase the value of energy monitoring data, the system should be able to monitor and collect data up to appliance level, and with larger sensing frequency. We develop a prototype device for sensing in smart homes using Wi-Fi enabled communication. Wi-Fi was selected as the technology of choice due to high availability in homes, and issues about energy consumption were ignored due to availability of a permanent power source. The prototype device, henceforth termed as ELIVE device, was named after the goal to record live energy measurements. In order to achieve this, we employed ATMEGA328 microcontroller to interface with an ESP8266 Wi-Fi system on chip (SoC) module, an AC transformer, as well as current transducers. The ESP8266 allows the microprocessor to connect to the Internet very easily through an established WiFi connection, based on serial interfacing requirements. Arduino integrated development environment (IDE) was used to program the microcontroller to obtain energy measurements using an analog to digital converter (ADC) to interface with the sensors.*

***Keywords: Artificial intelligence, automated meter infrastructure, big data, cloud computing, data analytics, Internet of Things (IoT), machine learning, privacy, smart grids (SGs), smart meters..***

## I. INTRODUCTION

Smart Energy has been an important conceptual paradigm for future energy use. Because of limited non-renewable energy resources available on Earth and also high costs of acquiring renewable energies (REs), how to make energy use more efficient and effective is critical for future social and economic developments.

A lot of systems have been designed and developed to reduce the energy consumption in the industrial environment as well as in the private households. These traditional energy management systems can be divided into two types. These are referred to as intrusive and non-intrusive systems. For intrusive systems, sensors are installed at every appliance, and a communication network is required to control, monitor and communicate with the sensors. Intrusive energy monitoring systems are costly to deploy since a multiple number of sensor devices are required to be attached to each appliances. Otherwise, only expensive appliances such as smart washing machines or refrigerators equipped with network interfaces can be utilized. Upgrading each non-compatible device with an additional network interface in a private household can be too expensive. Smart meters allow us to obtain periodic updates of energy consumption data. Design limitations in smart meters only allow the monitoring of the aggregated consumption data instead of real-time consumption.

## II. RELATED WORK

1. Energy Monitoring Prototype for Internet of Things: Preliminary Results

Energy monitoring is one of the important applications arising from research in Internet of Things (IoT). Smart meters allow us to obtain periodic updates of energy consumption data that can be analyzed to provide important insights into energy usage. However, design limitations in smart meters only allow the monitoring of the aggregated consumption data instead of real-time consumption data. We develop a prototype device for sensing in smart homes using Wi-Fi enabled communication. Wi-Fi was selected as the technology of choice due to high availability in homes, and issues about energy consumption were ignored due to availability of a permanent power source. Preliminary results from comparing the energy measurement from the prototype device with an off-the-shelf device using statistical techniques are presented in this paper.

Currently, many solutions are available in the market for energy monitoring purposes. OpenEnergyMonitor.com introduces a system that has the capability to monitor various parameters of an electrical system such as alternating current (AC) power, temperature and humidity with hopes of extending the measurements to include other air measurements like moisture. Few Taiwanese companies such as Billion and Energy have product lines for energy monitoring as well. In our research, we compare the measurement accuracy of our prototype with Billion sensor devices on a Smart Energy Gateway

There is a growing demand for non-intrusive monitoring of energy consumption at multiple scales and also for autonomous energy saving opportunities for both individuals and communities. A service framework, named E-SAVE that aims to monitor activities by a user or community and configure the environment of devices for a smarter energy usage has been proposed [12]. E-SAVE is an intelligent service framework that provides smart services for identifying relationships between devices based upon activities in which they are used, energy consumption levels, changes in environmental conditions, and the number of members involved.

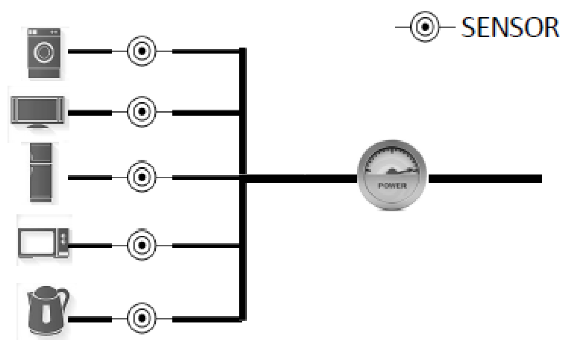


Fig.1. Intrusive energy monitoring. The energy sensors are attached to each appliance under observation. This allows for obtaining detailed measurements regarding the pattern of electricity usage for individual appliances.

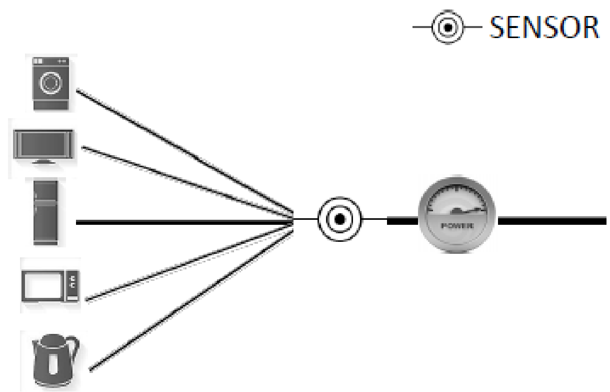


Fig. 2. Non- Intrusive energy monitoring. The energy sensor is attached next to the electric meter, and can only sense the total/aggregate energy consumption.

2. Smart Electricity Meter Data Intelligence for Future Energy Systems: A Survey

Smart meters have been deployed in many countries across the world since early 2000s. The smart meter as a key element for the smart grid is expected to provide economic, social, and environmental benefits for multiple stakeholders. There has been much debate over the real values of smart meters. One of the key factors that will determine the success of smart meters is smart meter data analytics, which deals with data acquisition, transmission, processing, and interpretation that bring benefits to all stakeholders. This paper presents a comprehensive survey of smart electricity meters and their utilization focusing on key aspects of the metering process, different stakeholder interests, and the technologies used to satisfy stakeholder interests. Furthermore, the paper highlights challenges as well as opportunities arising due to the advent of big data and the increasing popularity of cloud environments.

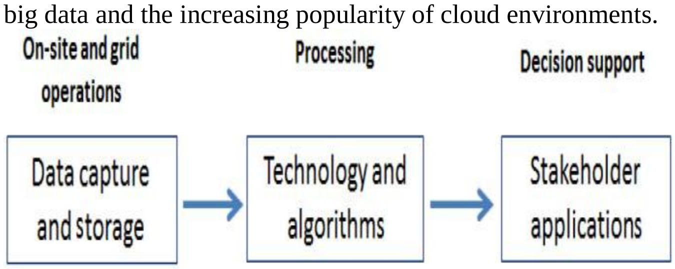


Fig: 1. Key components of electricity meter data intelligence.

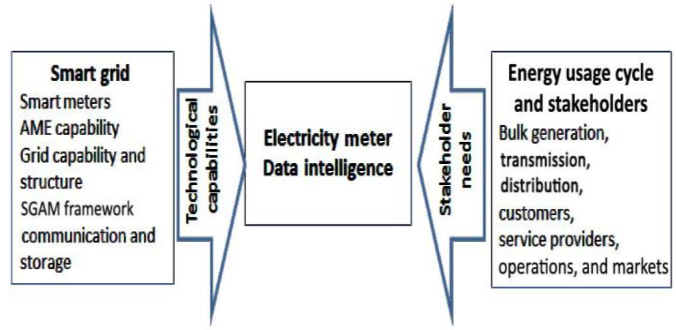


Fig: 2. Environment for smart meter data intelligence.

3. An Experimental Evaluation of a Cooperative Communication-based Smart Metering Data Acquisition System

Smart meters are being deployed globally on a trial basis and are expected to enable remote reading and demand response among other advanced functions, by setting up a two-way communication network. However, it remains to be determined as to how these meters will transmit their data to an aggregation point. An elegant solution to this problem is the use of cooperative communication in a neighbourhood area network. This work experimentally compares cooperative networks, deployed in disparate environments, in terms of range extension and energy consumption of the overall network. Data transmissions take place through the universal software radio peripheral (USRP) platforms. The method has been implemented in both indoor and outdoor environments, with cooperative transmission (CT) taking place over a multi-hop network, employing the binary phase shift keying (BPSK) scheme. The results indicate that CT can be used to effectively and reliably relay data in a network such as that in a smart grid.

4. Smart Metering Load Data Compression Based on Load Feature Identification

In recent years, smart meters have been widely installed in households across the world, which has led to problems with big data. The huge amount of household load data requires highly efficient data compression techniques to reduce the great burden on data transmittance, storage, processing, application, etc. This paper proposes the generalized extreme value distribution characteristic for household load data and then utilizes it to identify load features including load states and load events. Finally, a highly efficient lossy data compression format is designed to store key information of load features. The proposed feature-based load data compression method can support highly efficient load data compression with little reconstruction error and simultaneously provide load feature information directly for application. A case study based on the Irish Smart Metering Trial Data validates the high performance of this new approach, including in-depth comparisons with the state-of-art load data compression methods.

5. A survey on smart metering and smart grid communication

The smart metering and communication methods used in smart grid are being extensively studied owing to widespread applications of smart grid. Although the monitoring and control processes are widely used in industrial systems, the energy management requirements at both service supplier and consumer side for individuals promoted the evolution of smart grid. In this paper, it is aimed to disclose in a clear and clean way that what smart grid is and what kind of communication methods are used. All components of a smart grid are introduced in a logical way to facilitate the understanding, and communication methods are presented regarding to their improvements, advantages, and lacking feature. The developing generation, transmission, distribution and customer appliances are surveyed in terms of smart grid integration. The communication technologies are introduced as wireline and wireless classification where the key features are also tabulated. The security requirements of hardware and software in a smart grid are presented according to their cyber and physical structures

## IV. CONCLUSION

We the support of technology and will develop the above discuss system to energy monitoring with smart meter in Real-Time. Due to this, consumer can know exactly how much power is being utilized by each device. This device is developed with less labour cost and remote access of the meter reading. This device is developed such that less human resource and capital is used in future. The sensors attached to the electrical appliances will generate a bill and will also calculate energy consumed by appliance individually

Presently the officials visit every house and click photograph of meters and submit it to higher authorities and further valuate the bill. By this developed app the bill will be generated automatically and will be sending directly to the officials of the company. Hence efficient system is developed and less time will be consumed.

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