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ENERGY MONITORING PROTOTYPE FOR INTERNET OF THINGS WITH SMART METERING

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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. LITERATURE SURVEY

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

They 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

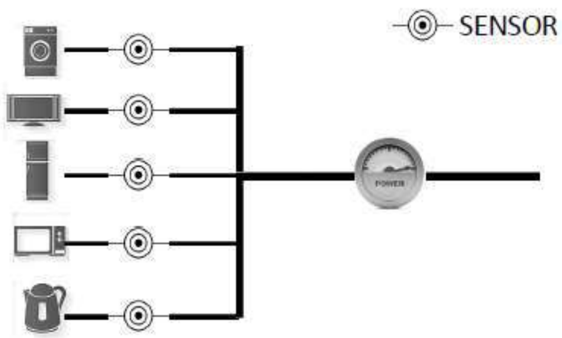

Fig. 1.Intrusive energy monitoring.

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.

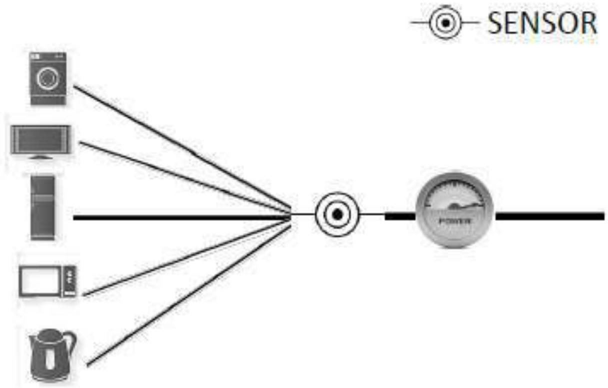

Fig. 2. Non- Intrusive energy monitoring. The energy sensor is attached next to the electric meter, and can only sense the total/aggregate energy consumption.

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

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.

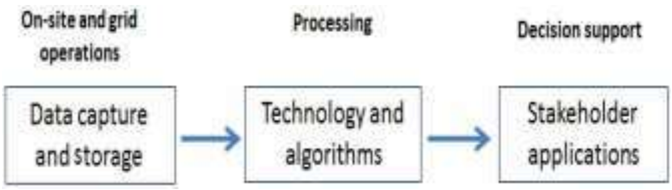

Fig. 1. Key components of electricity meter data intelligence.

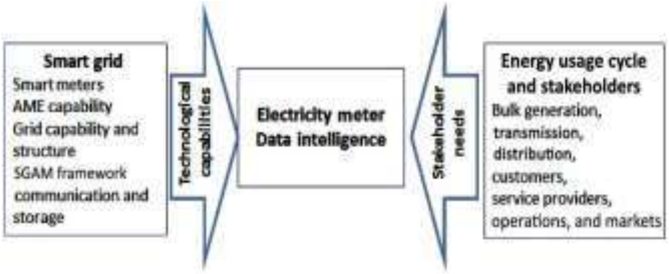

Fig. 2. Environment for smart meter data intelligence.

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.

III. PROPOSED SYSTEM

The increasing adoption of smart meters has led to more innovative solutions in the smart grid industry particularly in telemetric technology. 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 would develop a prototype device for sensing in smart homes using Wi-Fi enabled communication.

Scope of Project

- We like to propose Intrusive energy monitoring model where 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.
- User will be having access to view per appliance energy usage data via his/her smartphone application
- Use of Arduino as microcontroller & ESP8266 chip as WiFi connector help smart meter to report energy usage to server

The Whole system consists of Sensors Hardware, Cloud Server and Smart mobile. In this system there are two Users/Actors system Admin and user. Authorized system admin can create a user account on server. Sensor hardware can start the sensors. First of all hardware can initialize the sensors values. After initializing hardware can read the sensors values and send it to server. Server can fetch the sensors value and updated into database. Server can generate the energy meter bill. User should have application which is used for controlling and monitoring the energy meter. Authorized user can login to that application. User can view the energy readings. User will be able to view the reading per device. Server can send the generated bill to user using SMS notification. User can view the notification. Server can check the due date of bill. If it is over then server can send the power off command to hardware. Also server will send the notification to user.

IV. CONCLUSION AND FUTURE WORK

After Developing these system we will compare the energy measurement from the prototype device with an off-the-shelf device using statistical techniques.

Future work shall focus on removing the permanent power source, and switching the prototype to a battery source.

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