International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 (www.ijsrcseit.com)
doi : https://doi.org/10.32628/CSEIT228643

Creative Solutions in Tackling the Power Challenges and Energy Savings in Smart Power Monitoring Devices

Oyinkanola Lateef. Adewale, Fajemiroye Joseph Ademola, Aremu Olaosebikan
Physics Department, The Polytechnic, Ibadan, Ibadan, Oyo state, Nigeria

Article Info

Publication Issue :
Volume 9, Issue 1
January-February-2023

Page Number : 176-184

Article History
Accepted: 10 Jan 2023
Published: 30 Jan 2023

ABSTRACT

Power Management System and Smart Technology are as well as the importance of the eye to the human physical structure. Smart Technology is designed in such a manner that they hold the capacity to control the appliances used by the great unwashed in their homes depending on the need and the ability of the designed system for its functions. The more home appliances, the higher the amount of energy needed and needed to make it function efficiently and efficaciously. Advance in technology has made every household to enjoy internet technologies and wireless system network. This has enabled home environment benefit of digital technology that provides novel possibilities for users to enjoy their economic consumption of household appliances. It has also made for automation with high speed connectivity to the world-wide universe. The primary aim of this report is to consistently evaluate the technical innovations that deliver improved energy use and how these conveniences have been deployed in places. This will enable the researcher to interpret the present situation, bottlenecks and necessary recommendations improve the use of technology in our household's applications.

Keywords : Appliances, Automated, Energy Smart, Technology.

I. INTRODUCTION

Technology advancement in internet applications has extremely transformed the contemporary world in such a way that there is tremendous transformation as exemplified by the wireless global connectivity and internet applications. The implication of this technological advancement is manifested in the various and diverse applications. The applications cover numerous instruments used in homes, offices, industries amongst others. Technological advancement has also being observed in another areas such as agriculture,industries, health etc. for the enormous benefits of human folk.

In our modern world, electricity (electric power) has become the major driving force for socio, economic and political development and progress of a nation or society. The advancement in technology implies increases in the energy needs of the population; hence the demand for it increases. The energy demands occur in homes and in the manufacturing sector. The purchase and usage of more home appliances and energy driven electronics is implying greater energy consumption. The total home appliances used to

determine the energy usage by households. The improvement in usage and technological improvement of internet technologies and WSN in the 21st century has been observed as the driving force for higher demand for energy consumption. Several homes have witnessed a swift overview of internet network that give rise to digital technology that provides improvement on the networking of equipment in homes for reason of home digitization.

The 21st century has proved that wireless sensor networks (WSNs) employed for environmental, health and industrial monitoring, has been extensively suggested as a way of decreasing the energy consumption and greenhouse gas emissions [1]. WSNs are also extremely elastic to use. WSN technology has proved to be an important instrument for industrial, commercial, and home applications. Specifically, in management control and collecting data such as pressure, humidity, temperature, flow level, electrical parameter etc. can be collected through detecting components and transmitted wirelessly to a switch system for maneuver and administration. Accepting WSNs for energy controlling, offers an unlimited benefit over the customary wired system. Nevertheless, WSN expertise is not developed sufficiently to be extensively employed in energy controlling usage.

Finally, this paper, will appraise available literature on smart home systems built on the wireless communication technology. And it will reveal the painful circumstances such as peak hour energy load shedding in industrial and domestic zones by providing an explanation at the energy needs and power utilization by looking at the landlords' well-being and state of the back –up from renewable energy to reschedule the loads.

2. Wireless Communication in Home Energy Management and Application Review

Wireless Sensor Networks popularly known as WSN have developed progressively significantly because of its power to celebrate and cope with information on numerous intelligent facilities. Liu et al., (2012) opined that some of the latest academic growth and applications of this engineering science are gaining prominence. Mechatronic systems have at present turned out to be increasingly universal in our house presently and in enforceable future and will importantly be beneficial in helping medical science principally for the aged and physically challenged people. Wireless Mechatronic devices, services, and organizations consisting of spatially distributed autonomous sensors are applied to monitor globally or locally physical or environmental conditions, such as temperature, vibration, force per unit area, movement etc. [2].

Circulated unattended ground sensor networks will be used in battlefield observation and surveillance operations have tried out to be significant in giving strategic information necessary for instruction and regulation, intelligence, surveillance, and reconnaissance planning. Darminders et al. of University College London and George et al of Galileo Ltd show a cross-layer method and lists the procedures that can permit NCC procedures inside a mission-oriented UGS monitoring situation [3].

Ramlee et al. and Sriskanthan et al. [4,5]suggested an application of Bluetooth technology in home computerization and networking setting. They suggested a network that comprises a remote, mobile host controller and numerous point user parts that function as home appliances. The user segments connect the host controller through Bluetooth devices, which in turn show the actual time revealing controls position. The instrument is designed in a manner that has comparatively reduced expenditure on energy used, accessible interface, and very easy to install.

Cheong et al. [6] point out that a pocket-friendly and low energy consumption Zig-bee based WSN node for the UV recognition of spark, will add to the flame security guard factory. Based on this background, this paper considers a WSN node for protection and branded the emission continuum from fires employing a spectroscopic method. Radiations

commencing from a shared petroleum product fire are appraised and employed as an inferno position for this research. The obtainable flame recognition can effortlessly be incorporated into structure or facilitate a management system at pocket-friendly cost.

WSN as a device has also been used in the medical environment. ICT has allowed online medical care observing possible using miniature sensing devices inserted in sick person's body. Information obtained in this way is conveyed in real time through single or multiple wireless to the hospital network. Music and Music [7] showed the result of their findings in a published research article about the design substitutions for the wireless quota of an online mediccare observing system and shows the outcomes of two-tier network that employs IEEE 802.15.4 low data rate Wireless Personal Area Networking (WPAN) for the sick person's body area network and IEEE 802.11b for the connection among the body area network coordinators and the wired portion of healthcare system.

The WSNs are progressively being employed at home for power usage monitoring facilities. Erol-Kantarci and Mouftah [8] showed a methodology that controls household appliances are censored and administered by WSNs connected to people's houses. Advance infotech for WSN comprises innovative progressions in information technology, sensors, metering, transmission, distribution, and electricity storage technology, in addition to providing new information and elasticity to both clients and manufacturers of electricity.

To produce smart homes which always ensure efficient energy utilization and efficiency, [6,9] the ZigBee Alliance, wireless communication platform is currently investigating Japan's new smart home wireless system insinuation by having a new invention with Japanese Government that will appraise the usage of the impending ZigBee, Internet Protocol (IP) description and the address Zig-Bee module IEEE 802.15.4.

In United States (US) some metropolitan area like California and Texas employed smart meters for their homes. It was found out that since June 2011, about 20 million households use smart technologies. This implies that about 50 percent of all households have been equipped with smart meters and expectation is that the number of homes with smart meters will rise to nearly 65 million by 2015. It is an accurate approximation of the size of the home energy management market [9].

A smart grid which is an enhancement of 20th century Power grid is a chance to employ novel information and communication technology to transform the Electrical Power system. At the moment several nations have laid down their specific "Smart grid" strategies and the intelligence of consumers is part of this research. As the background to the smart grid in consumer and grid intelligent management, AMR (Automatic meter reading) system performs an essential function. Li, Xiaoguang, Jian, and Ketai [10] opined that Wi-Fi-based innovative kind of network design for novel generations AMR system and studies show its procedures and topology optimization of cluster formation.

Andrey and Morelli [11] indicated that by 2010 Ontario ministry in Canada would have instructed consumers on the use of smart energy meter for dwellings. To employ smart meters in homes, a techno-economic model consisting of many purposeful planes of meters has been planned. They had established three different purposeful smart meters for this type of research: Minimum Functionality Smart Meters, Smart Meters with In-Home- Display, and Smart Meters with a Demand Control Unit. Making references to these three meters, it was detected that employing smart meters with a minimum functionality level was most effective. However, it was also observed that the greatest reduction in energy usage during peak demand periods occurred when demand control units were incorporated into the system

Dae-Man Han and Jae-Hyun Lim Member [12]contributes to the development of ubiquitous home networks, energy savings and thus user happiness to consumer are two major design considerations for modern lighting systems. This paper introduces smart home interfaces and device definitions to allow interoperability among ZigBee devices produced by various manufacturers of electrical equipment, meters, and smart energy enabling products. They introduced the proposed home energy control systems design that provides intelligent services for users and also demonstrates its implementation using real test bed.

Kamat, V.N [13]demonstrate the use of smart LT apparent energy meters for effective reduction in ATC losses. The technical component is reduced through the implementation of a fair apparent energy based tariff. An elegant single parameter (unit KVAh) based tariff that incorporates an embedded power factor based discount mechanism to offer a Win-Win solution, where consumers can avail discounts in their electricity bills while the utilities minimize their line losses through a reduction in harmonics and inductive loads.

In order to fulfill the energy saving targets and also for optimal power utilization, F.Benzi, N.Anglani al et [14] have proposed different information and communication technologies which is integrated with smart meter devices that have advanced value-added services so that home inhabitant can take advantages of their meter information, like optimal heating, air conditioning or lighting based on actual energy tariff and also tested at different flats in residential areas.

I.Kunold at al [15] describes a system concept of energy information system in flats using wireless technologies and smart metering devices. Smart meters offer a lot of new features, for example, handling of different dynamic tariffs and in addition to their carrier interface, a data access capability for in-house applications. Using these capabilities an embedded in-house energy information system with a smart energy controller (SEC) will be proposed, which allows displaying real-time data information and analysis of power consumption.

J. Han, C.S.Choi, and I.Lee. [16] proposed a Home Energy Management System (HEMS) using the ZigBee technology to reduce the standby power. This system consists of a ZigBee hub, a server, and automatic standby power cutoff outlet. The central hub collects information from the power channels and controls these power channels through the ZigBee module. The central hub sends the present state information to a server and then a user can monitor or control the present energy usage using the HEMS user interface. The power outlet with a ZigBee module cuts off the AC power when the energy consumption of the device connected to the power outlet is below a fixed value. Some type of uneasiness may also be created by this system like if the users may want the low intensity of light, for some situation but the system will cut the power off leading to darkness.

K.Gill, S.H.Yan, F.Yao [17]presented a ZigBee-based home automation system in which less importance is given to the home automation. However, because the adoption of home automation system has been slow so that this paper identifies the reason behind slow adoption and also evaluates the potential of ZigBee for addressing these problems with the help of design and implementation of flexible home automation architecture.

M.S.Pan, et al [18] presented A WSN based intelligent light control system considering user activities and profiles, in which wireless sensors are responsible for measuring current illuminations and the lights are controlled by applying the model of user's actions and profiles for indoor environments, such as a home for a reduction in energy consumption.

Song et al [19] presented the design and implementation of a home monitoring system based on hybrid sensor networks. The system follows a three-layer architecture which combines hybrid-node networking with web access. An enhanced sensor node has been designed and fabricated to add

controlled mobility to wireless sensor networks. Network repair and event tracking capabilities of the mobile sensor node were tested. Stability of the proposed system in a long time home monitoring tasks was also verified.

Suh and Ko [20] proposed an intelligent home control system based on a wireless sensor/actuator network with a link quality indicator based routing protocol to enhance network reliability. It can integrate diversified physical sensing information and control various consumer home devices, with the support of active sensor networks having both sensor and actuator components.

Nguyen et al. [21]have proposed building a smart home system with WSN and service robot. In which they have presented the design of an optical linear encoder(OLE) based system for the function of capturing human arm motion and arm function evaluation for home-based monitoring and this system would also find wide range application in the field of rehabilitation.

N.K.Suryaveda and S.C.Mukhopadhyay with M. Kay et al [22], [23] reported the design and development of smart monitoring and controlling system for household electrical appliances in real time, in which it emphasizes the realization of monitoring and controlling of electrical appliances in many ways. They determined the areas of daily peak hours of electricity usage levels and come with a solution by which we can lower the consumption and enhance better utilization of already limited resources during peak hours.

N.K Suryadevara and S.C.Mukhopadhyay [23] reported a mechanism for estimation of the wellbeing of the elderly based on usage of household appliances connected through various sensing units. This paper defines two new wellness functions to determine the status of the elderly on performing essential daily activities. The developed system for monitoring and evaluation of essential daily activities was tested at the homes of four different elderly persons living alone and the results are encouraging in determining the wellbeing of the elderly. In this research, wellness is about the well-being of elderly in performing their daily activities effectively at their home. This will facilitate the care providers in assessing the performance of the elderly activities doing independently. The developed home monitoring system using WSN is low cost, robust, flexible, and can efficiently monitor and assess the elderly activities at home in real time.

Rosslin and Tai-hoon tried to let us know that, we can apply context-awareness to smart home technology design [24]. What mean by context – awareness is the use of are environmental information such as location, existence, social interaction and the rest to improve the quality of interaction of the end user. But in their work, they didn't consider the state and the condition of the system to control. But in our proposed work we are use the condition of the system to control the power management of the off-grid system to increase the quality of power and retained the comfort of the owner.

In energy management approach to use based on energy required, the storage of the appliances, energy sources, communication protocols, and electrical home appliances to work on. This has leads into development of information and communication technology, such as power line communication, wireless sensors networks, that now made Wi-Fi communication to be more useful in power management in the house to monitor power consumption of different home appliances and remotely control multiple devices in order to minimize energy consumption. The comparison on the common wireless communication in most of home energy management shown in Table 1.

Table 1. Wireless Protocols Comparision in Home energy management

Parameters	**Bluetooth**	**Ultra wideband**	**Wi-Fi**	**ZigBee**
Standard	IEEE 802.15.1	IEEE 802.15.3	IEEE 802.11	IEEE 802.15.4
Network Topology	Small network, Ad-hoc	High-bandwidth Multimedia links	Point to point	Peer to peer, Star, or mesh
Data rate	1Mbps	(480Mbps- 1.6 Gbps)	11,54 Mbps	20,40,250 Kbps
Transmission rate	10m	Few meters	>100m	(10-100) m
Complexity	High	High	High	Low
Power Consumption	Low	Lows	Very-high	Very-low
Frequency band(s)	2.4 GHz	3.1-10.6 GHz	2.4 and 5 GHz	868/915MHz,2.4 GHz

From the above it was shown that ZigBee wireless sensors gain more attention in most of the home energy management and other applications for the rest like WI –Fi and Bluetooth. Referable to the facts of low power consumption, low data rate, low complexity and its financial support for most of the large number of nodes in the web which allow modification either by addition or removal of nodes without affecting the rest of the network in operation give ZigBee upper hands.

II. Limitations and Functions

Previously identified limitations which are mainly energy and power changing challenges and issues do strongly militate against the performance of smart power monitoring, and home automation. Thus, it is necessary and important to address the power and emerging saving challenges. Some of these power and energy saving challenges earlier found and mentioned in pre-existing literature, and reviews could vary based on 1) devices limitation like light levels or irradiance, 2) fixed threshold power consumption, and 3) consumer behavior, and not network characteristics and stability.

These limitations can be overcome by making some changes in the reviewed system, like in the first case if we use the sensing and load driver regarding power rating of appliances, then we can control the different devices other than household appliances. In the second case, we can change the value of threshold power consumption according to the requirement, of consumers which is technically done by making particular changes in programming. If we consider the third case, then it may have resolved by giving the flexibility to the power consumption and variable tariff of electricity.

Functions of the Smart home power monitoring and control systems:

- Collect real-time energy consumption from smart Meter and power consumption data from various in-house objects.
- Control activation/deactivation of appliances.
- Generate dashboard to provide feedback about power usage.
- Provide control menus to control appliances
- Provide a link to the utility and/or Internet.

Some smartphone manufacturers such as Oukitel and Yota are experimenting with the use of e-ink displays on the back of their devices. The e-.ink display can stay active at all time and give us convenient access to notifications, calendars, events or current time information without draining the phone's battery. It is unlikely that the use of e-ink displays will ever become a mainstream affair, but it's expected that we will see more smartphone manufactures take this approach in the future.

In another development, some manufacturers go the route of ultra-high capacity smartphones while others try to innovate the way we charge our phone and even the battery technology itself. A good example of the former approach is Oukitel with their 10,000 mAh battery capacity smartphone called Oukitel 10000. If your smartphone lasts about a day of regular usage, you can expect this backup to have enough battery power up to 3 days of continuous usage.

Another charging technology due to the media Tek Pump Express Plus and Qualcomm Quick Charge is a fast charging technological mechanism in which charging process is raised up to 75% to avoid very long charging time of such a large capacity described above.

Wireless charging technologies are vast constantly evolving and shaping how often we change our devices throughout the day. Wireless chargers based on the Qi technology have become fairly ubiquitous, and customers get used to the convenience of simply laying down their smartphone on a charging pad. The Watt Up wire charging system promises to bring wireless charging to the next level by delivering energy over the air in practically any space. Charging could finally become something that happens completely automatically as we go about our daily lives.

Despite the obvious huge advances and revolutionary improvements in many areas related to mobile batteries, one thing is clearly conspicuous: and it is that the Li-ion battery technology is simply not able to keep with advancements in mobile processing power. However, the emergence of the novel battery technologies with the advent of the Sodium-ion batteries has been far-fetched revolutionary improvements in recent trends.

Sodium-ion batteries are just one of several new, promising battery technologies that could potentially give our devices the long battery life we all wish for. These batteries use sodium ions as charge carriers, and their main advantage is the abundance of battery grade salts of sodium and the ability to discharge to 0% without damaging the active materials.

III. Conclusion and Future Work

With a persuasive at the future of electronics the wireless system network (WSN) has got a big batch of primer coat in several applications to gain advantage over the wired system of operation. WSN technology is considered mature enough to be widely implemented in bright homes. This report has cited novel and recent inventions for improving and enhancing the power saving mechanisms and improvements therein in smartphones, and control systems identified from the previous survey of existing works about a smart home system based on wireless communication technology in previous literature.

This overview of smart home system focuses on implementation, usability, and challenges. Smart power monitoring and control systems allow every level of the smart home to be connected and checked from a primal point, enabling power efficiency and

energy optimization. Leveraging the deployment of communications-enabled smart electricity meters, many applications can be drawn out to homeowners for optimizing overall energy management. And to utility companies as a means of managing the load of their grid and preventing power demand peaks. Smart power monitoring and control systems are the interfaces between the utility-controlled smart grid and energy consuming in-house objects.

Future research and development may continue to be focused on further improvements of the reliability, responsiveness and technology advancements on energy saving, power management, and fault tolerance, and focus should be on the power saving capacity of large capacity sized batteries this can be tremendously improved and well enhanced in order to encourage renewable energy.

IV. REFERENCES

[1]. H. Ramamurthy, B. S. Prabhu, and R. Gadh, "Wireless Industrial Monitoring and Control using a Smart Sensor Platform," no. Fall, 2007.

[2]. X. P. Liu, W. Gueaieb, S. C. Mukhopadhyay, K. Warwick, and Z. Yin, "Guest editorial introduction to the focused section on wireless mechatronics," IEEE/ASME Trans. Mechatronics, vol. 17, no. 3, pp. 397–403, 2012.

[3]. D. S. Ghataoura, J. E. Mitchell, and G. E. Matich, "Networking and application interface technology for wireless sensor network surveillance and monitoring," IEEE Commun. Mag., vol. 49, no. 10, 2011.

[4]. R. A. Ramlee et al., "Bluetooth remote home automation system using android application," 2013.

[5]. N. Sriskanthan, F. Tan, and A. Karande, "Bluetooth based home automation system," Microprocess. Microsyst., vol. 26, no. 6, pp. 281–289, 2002.

[6]. P. Cheong, K.-F. Chang, Y.-H. Lai, S.-K. Ho, I.-K. Sou, and K.-W. Tam, "A ZigBee-based wireless sensor network node for ultraviolet detection of flame," IEEE Trans. Ind. Electron., vol. 58, no. 11, pp. 5271–5277, 2011.

[7]. J. Misic and V. B. Misic, "Bridge performance in a multitier wireless network for healthcare monitoring," IEEE Wireless. Commun., vol. 17, no. 1, 2010.

[8]. M. Erol-Kantarci and H. T. Mouftah, "Wireless sensor networks for cost-efficient residential energy management in the smart grid," IEEE Trans. Smart Grid, vol. 2, no. 2, pp. 314–325, 2011.

[9]. A. Faruqui, D. Mitarotonda, L. Wood, A. Cooper, and J. Schwartz, "The costs and benefits of smart meters for residential customers," White Pap. July, 2011.

[10]. L. Li, H. Xiaoguang, H. Jian, and H. Ketai, "Design of new architecture of AMR system in Smart Grid," in Industrial Electronics and Applications (ICIEA), 2011 6th IEEE Conference on, 2011, pp. 2025–2029.

[11]. E. Andrey and J. Morelli, "Design of a smart meter techno-economic model for electric utilities in Ontario," in Electric Power and Energy Conference (EPEC), 2010 IEEE, 2010, pp. 1–7.

[12]. D.-M. Han and J.-H. Lim, "Smart home energy management system using IEEE 802.15. 4 and ZigBee," IEEE Trans. Consum. Electron., vol. 56, no. 3, 2010.

[13]. V. N. Kamat, "Enabling an electrical revolution using smart apparent energy meters & tariffs," in India Conference (INDICON), 2011 Annual IEEE, 2011, pp. 1–4.

[14]. F. Benzi, N. Anglani, E. Bassi, and L. Frosini, "Electricity smart meters interfacing the households," IEEE Trans. Ind. Electron., vol. 58, no. 10, pp. 4487–4494, 2011.

[15]. I. Kunold, M. Kuller, J. Bauer, and N. Karaoglan, "A system concept of an energy information

system in flats using wireless technologies and smart metering devices," in Intelligent Data Acquisition and Advanced Computing Systems (IDAACS), 2011 IEEE 6th International Conference on, 2011, vol. 2, pp. 812–816.

[16]. J. Han, C.-S. Choi, and I. Lee, "More efficient home energy management system based on ZigBee communication and infrared remote controls," IEEE Trans. Consum. Electron., vol. 57, no. 1, 2011.

[17]. K. Gill, S.-H. Yang, F. Yao, and X. Lu, "A ZigBee-based home automation system," IEEE Trans. Consum. Electron., vol. 55, no. 2, 2009.

[18]. M.-S. Pan, L.-W. Yeh, Y.-A. Chen, Y.-H. Lin, and Y.-C. Tseng, "A WSN-based intelligent light control system considering user activities and profiles," IEEE Sens. J., vol. 8, no. 10, pp. 1710–1721, 2008.

[19]. G. Song, Z. Wei, W. Zhang, and A. Song, "A hybrid sensor network system for home monitoring applications," IEEE Trans. Consum. Electron., vol. 53, no. 4, 2007.

[20]. C. Suh and Y.-B. Ko, "Design and implementation of intelligent home control systems based on active sensor networks," IEEE Trans. Consum. Electron., vol. 54, no. 3, 2008.

[21]. K. D. Nguyen, I.-M. Chen, Z. Luo, S. H. Yeo, and H. B.-L. Duh, "A wearable sensing system for tracking and monitoring of functional arm movement," IEEE/ASME Trans. Mechatronics, vol. 16, no. 2, pp. 213–220, 2011.

[22]. N. K. Suryadevara and S. C. Mukhopadhyay, "Wireless sensor network based home monitoring system for wellness determination of elderly," IEEE Sens. J., vol. 12, no. 6, pp. 1965–1972, 2012.

[23]. M. Kam, N. K. Suryadevara, S. C. Mukhopadhyay, and S. P. S. Gill, "WSN based utility System for effective monitoring and control of household power consumption," in Instrumentation and Measurement Technology Conference (I2MTC) Proceedings, 2014 IEEE International, 2014, pp. 1382–1387.

[24]. R. J. Robles and T. Kim, "Review: context-aware tools for smart home development," Int. J. Smart Home, vol. 4, no. 1, 2010.

Cite this article as :

Oyinkanola Lateef. Adewale, Fajemiroye Joseph Ademola, Aremu Olaosebikan , "Creative Solutions in Tackling the Power Challenges and Energy Savings in Smart Power Monitoring Devices", International Journal of Scientific Research in Computer Science, Engineering and Information Technology (IJSRCSEIT), ISSN : 2456-3307, Volume 8, Issue 6, pp.176-184, November-December-2022. Available at doi : https://doi.org/10.32628/CSEIT228643
Journal URL : https://ijsrcseit.com/CSEIT228643