IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Design and Development of a ZigBee-Based Domestic Energy Control System

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Abstract: Rising energy consumption, especially with the ever-increasing growth and development of urban systems, has become a major concern in most countries. In this article, the authors propose a cost-effective home energy control system based on ZigBee, consisting of a gateway, a base station, and a sensor. Specifically, a new hardware platform has been developed for power sensor nodes to measure local and remote power parameters and perform power on / off switching for electronic devices. Experimental results show that ZBDECS can easily monitor energy usage with a high level of accuracy. Two common ZBDECS applications such as sub-entry metering and domestic metering are offered. The former includes lighting socket power, HVAC power, electrical power and special power. The latter includes the central function zone of the campus and home metering according to each college or department. Therefore, the system can be used for energy consumption monitoring, long-term energy conservation planning, and development of automated energy conservation for building applications.

Keywords: ZigBee, BLUETOOTH, Environmental consumption, Energy consumption

1. Introduction

With the advent of new and advanced technology, quality of life has reached an all-time high. An important part of the modern lifestyle is connected with the use of electrical and electronic devices. However, an increase in the use of electronics and electrical appliances has resulted in a dramatic increase in energy consumption. Thereafter, due to the gap between demand and supply, the price paid by the end user continues to increase annually. As a result, there is an urgent need to improve energy consumption and develop more energy-efficient technologies and electronic systems. This need has led to the development of new basic and applied research areas in the field of energy conservation. In these research areas, resulting in potential development in energy consumption, resulting in potential development, power consumption is the design of advanced monitoring and control mechanisms with the ability to monitor and control, so that users easily electronic devices can measure power consumption. And improve their use to enhance their energy consumption efficiency [1].

With the development of wireless technologies and distributed sensor network operations, the housing energy consumption system starts to reduce energy consumption and increase energy efficiency to benefit from these systems. After eliminating the need to manage wires at the current facility, wireless technologies can help reduce the cost of construction in a 'smart' building. Due to small foot marks, wireless nodes can be easily installed without interrupts and can be easily mounted without maintenance and change without construction workers. There is another advantage of a wireless technologies that make them suitable for use, there are fewer energy consumption, because they can be strong by the batteries with long service lives 2

Table 1 describes the key features of some common wireless mechanisms [3]. From an application perspective, Bluetooth is designed for hands-free mice, keyboards, and headsets. As an enhanced version of Bluetooth, BLE (BLUETOOTH LOW ENERGY) is intended to provide greatly reduced power consumption and cost while maintaining a similar communication range. Ultrawide Band (UWB) is targeted at high-bandwidth multimedia links. Wireless Universal Serial Bus (Wireless USB) is the personal interconnection technology used to meet the needs of multimedia consumer electronics, PC peripherals, and mobile devices. Wi-Fi is targeted at computer-to-computer connections as an extension or replacement for wired networks [4, 5]. Infrared (IR) wireless approaches are used for short and medium range communications and control. Unlike radio frequency (RF) wireless links, IR wireless links cannot penetrate walls or other obstructions [6].

In contrast to other wireless protocols listed in Table 1, ZigBee is designed for reliable network control and control networks. Example comparison between Zigbee and BLE, popular technologies for wireless measurement applications, indicates why the previous one is favorable for our application. The BLE is more concerned with user movements, while ZigBee goes for remote automation and control. Bluetooth admits 8 nodes for each network, while ZigBee supports up to 255 nodes per network. In addition, the ZigBee function allows network network capabilities to be very easy to install without having any private installation service. Hay - close-up, zigbee more suitable for monitoring and remote energy control.

Due to the previous reason, in this document, the local energy control system is sent to ZigBee (ZBDEC), which provides a promising solution to the above objectives. For monitoring, the hardware depends on the current circles and stress, the microcontroller (MCU), the console, the ZigBee unit. Heat the current measuring circuit / voltage and current effort and send information to MCU. MCU is achieved from energy distortions and sends information to the construction server, where a database is maintained through ZigBee. To control, the relay is added to the energy monitoring devices. In case of emergency found by MCU, the relay power supply for electrical construction devices after receiving the control command. The software program (GUI) is used as an interface between user devices and finished. After that, the user can control all electrical appliances through a mobile phone or desktop computer or laptop.

2.RelatedWork

The control of energy is essential to understand consumption sources within the building and take appropriate measures to save energy. In general, energy monitoring and control efforts can be divided into two broad categories: devices and software headquarters. The applicable approach focuses on involving material equipment, such as smart plugs and intelligent connectivity strips to control ICT (ICT). The studies carried out in [7-9] indicate a perspective of great savings. In addition, the substitution of the efficiency equipment may be a more effective energy, as observed in [10, 11], with credits of approximately 40-60%. Kamilaris et al. [12] The contribution of hardware-based methods in savings must be determined. In this way, companies and organizations will be aware of the return on investment when considering any of these methods. The techniques based on the program are mainly energy management (PM) and virtual simulation. Somniloquy [13] and Sleep-Server [14] are main efforts with respect to PM, claiming GIS savings, exceeding 60%. Lite Green [15] and VMware programs [16] dominate the predetermined simulation. Current business products for PM and virtual simulation are advanced and reliable and reliable features and great savings potential.

A comparison between hardware and software-based techniques [11] that the hardware-based approach is more effective, for example, when replacing desktop computers with laptops. The other approach emphasizes the role of commercial buildings in the scenarios of intelligent networks [17 and 18] and the importance of combining detection with joint operations [19].

At the same time, efforts are recognized by the impact of large trucks, which affect 20-50% of total energy use in the field of 10 and 20, and focus on stimulating its occupants towards energy saving to Through proposals, timely advice and comments. Timely echo techniques [21-23].

While hardware-based methods and software can significantly affect electricity consumption, savings is fundamental for conservation.The decisions presented during the early design phase can affect around 60% of the total energy use cycle, leaving the effect of the user's behavior and the actual control to the rest of 40%. However, small savings can have significant effects on the total costs of companies and in the environment [12].

Apparently, in order to achieve ecological standards and unified objectives for business buildings and various electricity charges, policies and international energy regulations should be identified by stakeholders and key actors, involving legislative measures, economic tools, voluntary agreements and specifications of innovation.

Finally, it is expected that ICT embedded, although the energy consumption in world energy around the world, plays a crucial role in energy efficiency throughout the economy, helping office teams to work more intelligently and Effective

Compared to the relevant work mentioned above, the contributions of our proposed system combine existing hardware and software techniques. First, our system accommodates traditional energy counters, environmental sensors, wireless data management and administration within an integrated framework, which allows the colonel and monitor different types of measurements that reflect the energy consumption and the environmental state of the buildings. Second, the system extends more web-based management programs, which provide an enriched analysis and advanced reports functions to monitor energy and environmental consumption.

Table 1: Key Characteristics of common wireless standards

Wireless standard	Data Rate	Range	Network Topology	Operating Frequency	Power Consumption	Security	Applications
ZigBee	24,40 and 250kb/s	10 – 100 m	Peer to Peer, Star, or Mesh	868 MHz (Europe) 900-928 MHz(NA) 2.4 GHz(Worls wide)	Very Low	128 AES plus Application Layer Security	Industrial control And monitoring, sensor networks, and building automation.
Wi Fi	11 and 54 Mb/s	50 – 100 meters	Point to Hub	2.4 and 5 GHz	High	--	Wireless Local area network (LAN)c onnectivity, broad bandI nter net access
Bluetooth	1 Mbps	10 meters	Adhoc very small networks	2.4 GHz	Medium	64 and 128-b Encryption	Wireless connectivity between devices, such as phones and Personal digital assistants, laptops and headsets.
BLE	1 Mbps	>100 meters	Adhoc very small networks	2.4 GHz	Low	128-bit AES with counter mode CBC - MAC	Mobile Phones, gaming watches, health care and home electronics.

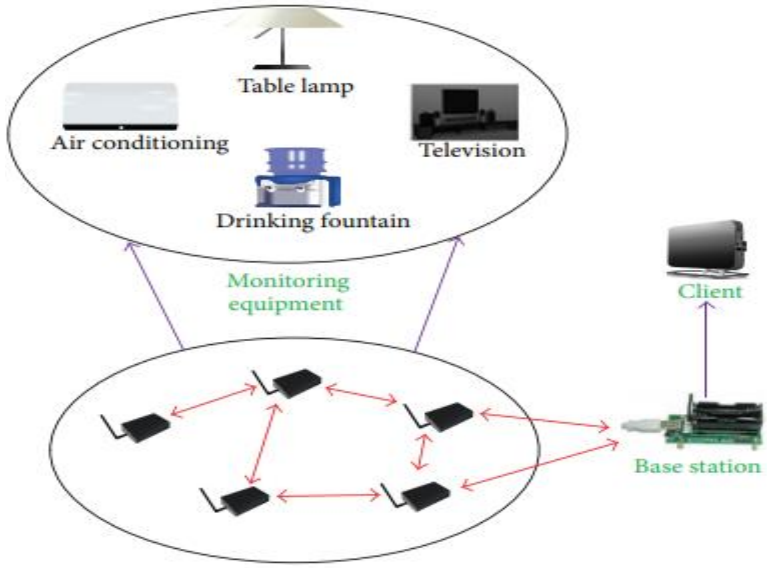

Figure 1: Architecture of the ZBDECS

3.System Architecture: ZBDECS consists of a Gateway, a basic station and sensors, as shown in Figure 1. The gateway is also established, and the purpose is to connect the sensor contract to an existing Ethernet network. The base station provides a connection between the sensor and the door. Monitoring sensors and control energy control for electrical equipment and data transfer to the base station.

3.1 Gateway. For this execution, the portal is established in the SQ120 ("Client" in Figure 1) and is based on the XServer processor of Intel IXP420 operates at 266 MHz, which has an Ethernet port with Cable and USB 2.0 ports. The device is equipped with 8 MB of the Flash program, 32 MB of RAM, USB 2.0 2 GB 2.0 Deb. Xserve and Mote Explorer system. After these programs started automatically at the SQ120 boot time. To configure a sensor network portal setting, you must connect a base station into a SQ120 secondary USB port. The SQ120 contains a built-in web server (Mote Explorer) and the Xserve Network Manager (Xserve). The latter can specify the types of sensor panels that are automatically connected to the retention of the wireless sensor network and the help of directed Mote Explorer to show the data accordingly [24].

3.2. Base Station. The base station is the monitoring and control center of all circuits, the external communication gateway and the user interface; Its main functions are the following [25]: (1) Implement control instructions over the Internet; (2) monitoring energy consumption for the sensor contract; (3) calculate the remaining power of each branch circuit; (4) Refers to all energy consumption information. As shown in Figure 2, the base station is consistent, a complete function (FFD), of the processor / radius (XM2110) platforms and the door response (MIB520CB) through the 51-pin connector. Therefore, the base station is configured with respect to the Zigbee (ZC) coordinator of WSNS. The Statute receives the statements sent through all the nodes in the network and send it to a message through the USB connection to the computer. The base station runs the Linux Debian Linux charger with software management software packages in data transfer and data visualization programs, including ECOVIEW and XSERVE [26]. Figure 3 illustrates the software flow scheme for the base station.

3.3. Sensor Nodes. The sensor node, which is the measured node and control, in Figure 4. The sensor of the current power unit (DC) is purchased directly, the MCU console, the current feed controller (AC), the unit of Zigbee of the unit and after the MCU Module connected with the power module by terminating a representative front (AFE) and with the ZigBee unit through the Universal Transmitter interfaces of ASENCHRONOUS / UART. Communication is achieved between the ZigBee console through pulse screen modification technology (PWM).

The main tasks of the sensor are the following [25]:

(1) Measurement power parameters, such as voltage, current and output.

(2) Control on the Exit of the Director.

(3) Safety protection of overload.

(4) Transfer all the node information to the base station through ZigBee.

3.3.1. DC Power Module. The main function of the DC power module is to convert 220V AC power to 5V and 3.3V DC power to provide operating power to all units in the sensor node. The circuit structure of the drive is shown in Fig. 5. The 220V AC is converted by converting the power drive to 5V DC and 3.3V by linear regulator.

3.3.2. Power Measurement Module. The energy metering module consists of a 71M6541D energy metering integrated circuit (IC), which is a fourth-generation Teridian single-phase metering system on a chip (SoC), with a 0.1% margin of error that complies with with all ANSI and IEC electrical measurement standards. This IC is an integrated power meter that combines a 22-bit class II delta sigma analog-to-digital converter (ADC), four analog inputs,

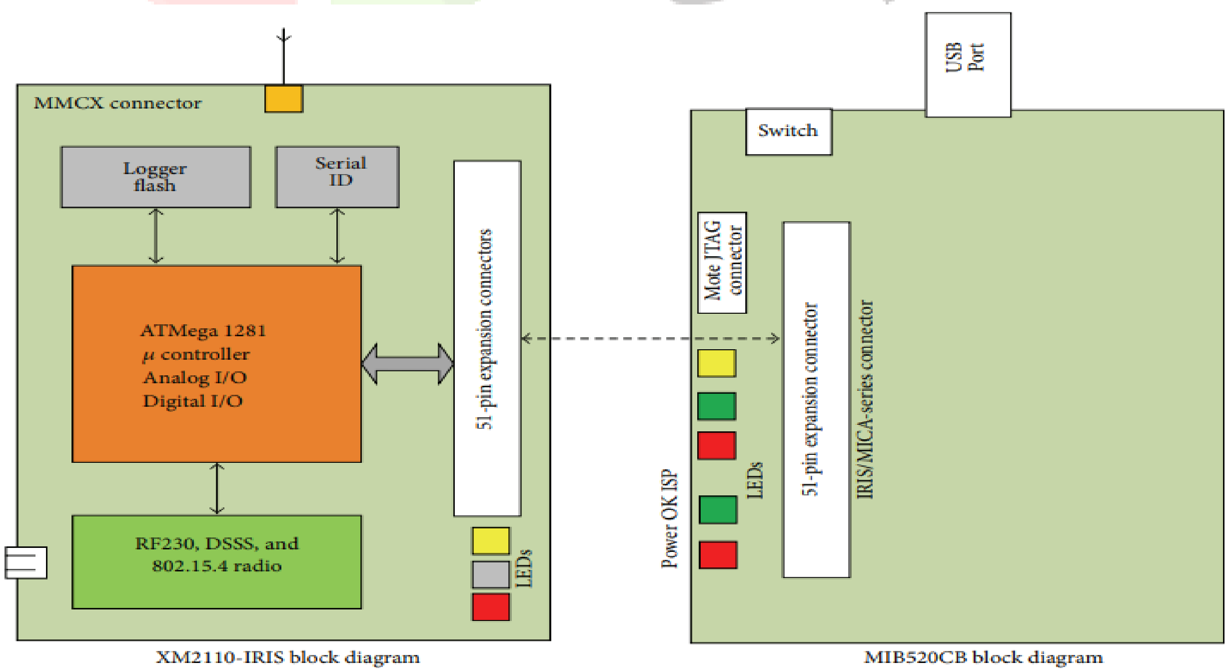

Figure 2: Structure of the base station

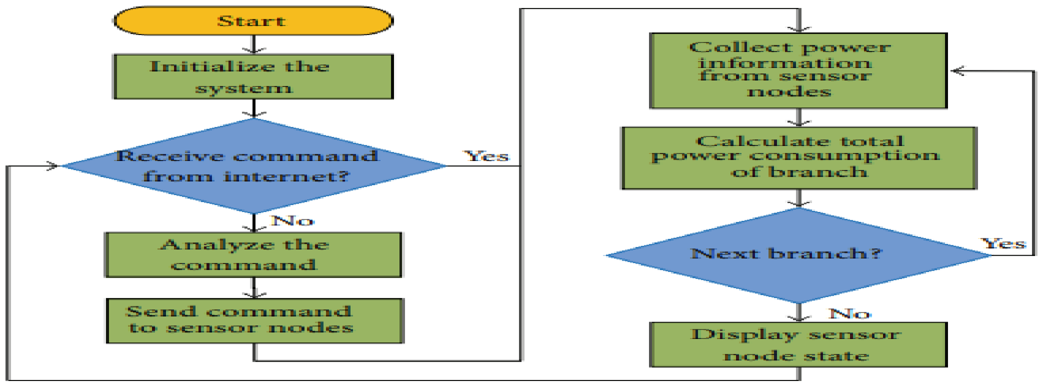

Figure 3: Software flow chart for the base station.

Digital temperature compensation, precise voltage reference, 32-bit independent computation engine (CE), and serial interface (SPI) on a single chip. Additional features include AC and DC calibration and phase compensation. Designed for residential single-phase or three-phase industrial power meter applications, the IC accurately measures instantaneous current and voltage while calculating rms voltage *U*rms, rms current *I*rms, reactive power, active power *P*, apparent power *S*, power factor PF, voltage total harmonic distortion THD, current total harmonic distortion THD, etc. [27]. The circuit of this unit is shown in Fig. 6. The flowchart for calculating RMS voltage and current can be divided into two parts: AD conversion and digital signal processing [25]

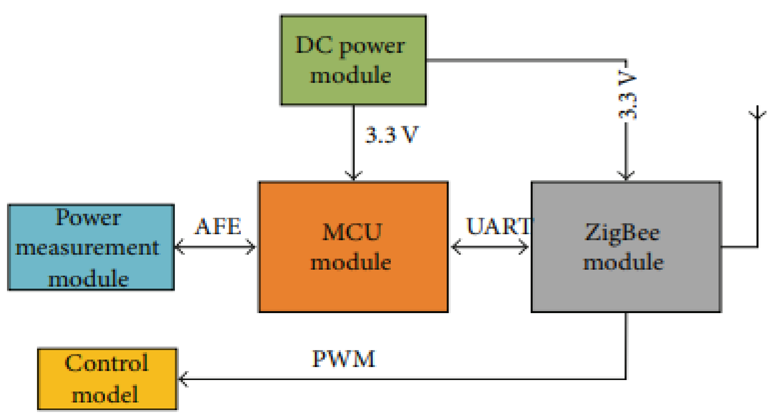

Figure 4: Block diagram of the sensor node.

Part 1 (Analog-to-Digital Conversion).ADC is used to convert analog signal to digital signal. The measurement IC has a 22-bit second-order sigma delta ADC, which was used to convert the current signal and voltage signal.The ADC output is destroyed by the finite impulse response (FIR) filter and stored in CE's random-access memory (RAM), where CE can access and process it.

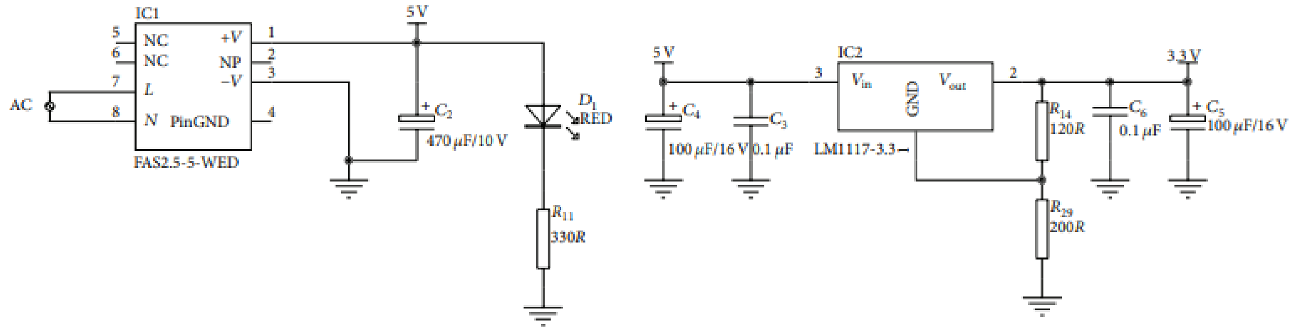

Figure 5: Circuit structure of the DC power module

The maximum signal input into the measurement IC is ±0.25V, therefore a heavy-duty voltage divider with properly designed impedance is used, which can convert a current of 250V AC to ±0. 25 V. In addition, the current sampler can use a current transformer to measure the current signal with a suitable impedance, and can convert the 30 A AC current to ±0.25 V. The transformed voltage and current are input into Measurement CI to proceed to the next calculation, as shown in Figure 6.

Part 2 (digital signal processing). The various power parameters can be calculated in real time, including root-mean square voltage Urms, root-mean-square current Irms, reactive power$Q$, active power P, apparent powr S, power factor PF, total voltage harmonic distortion UTHD, and total current harmonic distortion ITHD.. Compatible facilities are described to calculate power parameters below [28]. Although (FFT) is effective, it has compiled strict data; The number of data points collected must be exactly the power 2 ($2n$) [29]. If we use FFF to process data, it is likely to emerge the problem of spectrum leakage effect reduced or obstacle, which does not meet our goals. Therefore, in this system, we use the conversion algorithm discrete Fourier transform (DFT) separately, which requires only 100 samples / data points during the period and has a set of acceptable time, instead of using FFT to process data collected [30].

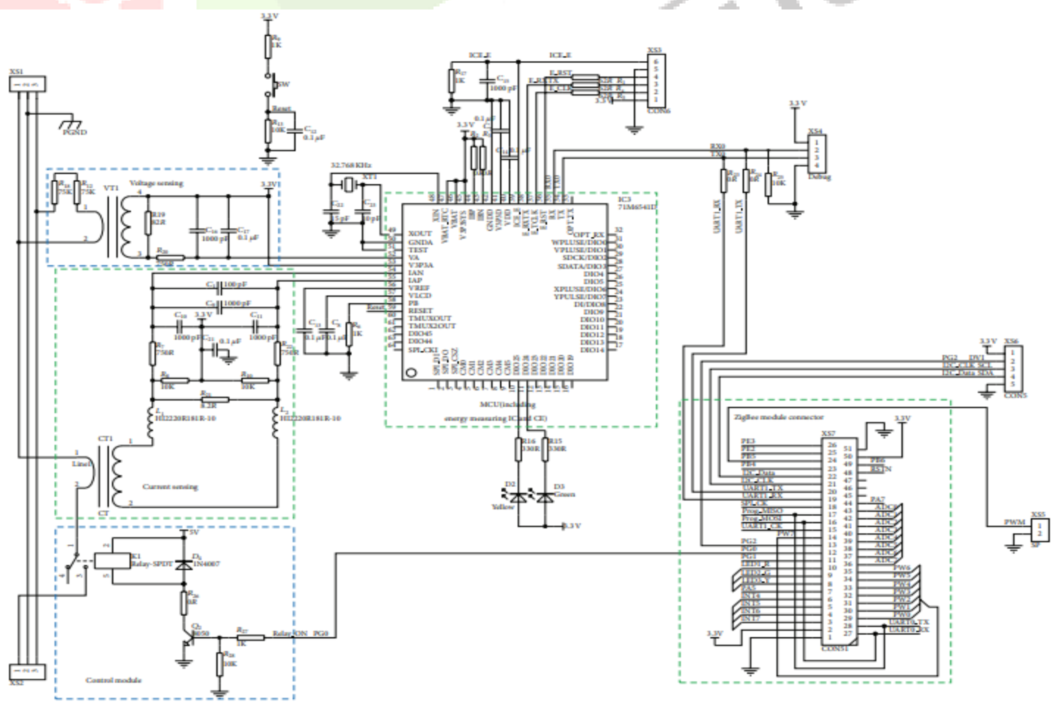

Figure 6: Circuit diagram of the sensor node

Voltage or current signal x(t) can be assumed to be having sampled sequence x(n) at a regular time interval T, that is, $\{x(0), x(T), \ldots, x((N-1)T)\}$. The DFT of $x(n)$ is $X(k)$, which are defined as the sequence of complex values $\{X(0), X(\omega_0), \ldots, X((N-1)\omega_0)\}$ in the frequency domain, where ω_0 is the fundamental frequency given by $\omega_0 = 2\pi/NT$. According to the decimation FFT algorithm [31], the DFT values $X(k)$ at frequency $kw0$ are computed as follows:

$$X(k) = \sum_{n=0}^{N-1} x(n) W_N^{nK}, \qquad k = 0,1, \ldots \ldots N-1, \tag{1}$$

$$X(k) = \sum_{n=0}^{N-1} x(n) W_N^{nk}, k = 0,1, \ldots \ldots, N-1, (1)$$

where $W_N^{nk} = e^{-j(2\pi/N)kn}$ *is the twiddle factor*.

Given the DFT values $U(k)$ and $I(k)$, the root-meansquare values U_{rms} and I_{rms} of the sampled voltage and the current values $u(n)$ and $i(n)$ can be computed as follows:

$$U_{rms}^2 = \frac{2}{N^2}\left\{\sum_{k=0}^{\frac{N}{2}-1}((Re[U(k)])^2 + (Im[U(k)])^2)\right\}$$

$$I_{rms}^2 = \frac{2}{N^2}\left\{\sum_{k=0}^{\frac{N}{2}-1}((Re[I(k)])^2 + (Im[I(k)])^2)\right\}, \tag{2}$$

where Re[·] and Im[·] represent the real and imaginary parts, respectively.

The reactive power Q and the active power P can be computed as follows:

$$P = \frac{2}{N^2}\left\{\sum_{k=0}^{\frac{n}{2}-1}\left(\left(Re[U(k)]Re\left[I[k]\right]\right) + (Im[U(k)]Im[I(k)])\right)\right\},$$

$$Q = \frac{2}{N^2}\left\{\sum_{k=0}^{\frac{n}{2}-1}\left(\left(Re[I(k)]Im\left[U[k]\right]\right) - (Re[U(k)]Im[I(k)])\right)\right\}, \tag{3}$$

The apparent power S and the power factor PF are calculated as follows:

$S = U_{\text{rms}} I_{\text{rms}}$, PF = P/S . (4)

ThetotalvoltageharmonicFinally,distortionU_{THD}andtotalcurrentharmonicdistortionI_{THD}computedas given below:

$$U_{THD} = \frac{\sqrt{\sum_{k=2}^{N/2} U^2(k)}}{U(1)} \times 100\%,$$

$$I_{THD} = \frac{\sqrt{\sum_{k=2}^{N/2} I^2(k)}}{I(1)} \times 100\%, \tag{5}$$

3.3.3Control Module:

The relay and its drive circuit are embedded in the control module. as shown in Figure6. This module mainly receives control instructions from the ZigBee module to obtain the relay status and then to control the outlet output power. The controlling signal from the ZigBee module is amplified by the transistor and then transmitted to the driving relay. Freewheeling diodes mounted on either side of the relay are used to provide a diode discharge method to generate a reverse voltage, instantaneously switching the relay from ON to OFF and preventing transistor damage [25]. Figure 7 shows the software flow diagram of the sensor node. Figure 8 shows the function of the control module.

3.3.4 ZigBee Module. The ZigBee module consists of a more processor/radio platform (XM2110), which uses Atmel RF230, complies with IEEE 802.15.4. The ZigBee-ready radio frequency transceiver is integrated with the Atmega1281 MCU. This upgrade provides up to three times the radio range and twice the program memory of the previous generation MICA motes [32]. The XM2110 block diagram is shown in Figure2. At the sensor node, the XM2110 is connected to the sensor board via the a51-pin expansion connector, the structure of which is shown in Figure 6.

ZigBee is a wireless networking protocol and adapted IEEE 802.15.4 standard owned by the ZigBee Alliance, which defines the media layer and destination layer. ZigBee exhibits low transmission speed with low cost and low energy consumption, with high security, and supports a large number of web node operations. Therefore, ZigBee is very suitable to be used in building monitoring and control systems.

In a ZigBee module, the effective transmission distance between nodes is determined by the transmission energy designed for the module. At present, the transmission distance of commercial modules can reach about 100m under barrier-free conditions. Although the building partition block can reduce the communication distance, the use of ZigBee can support the network structure with a tree or mesh, and setting certain nodes in the network to router functions can effectively solve the problem of transmitting on the same horizontal floor. and on different vertical floors over long distances. Conceptually, ZigBee communication can be applied to buildings without limitation of transmission distance [25,33].

For resolving the noise interference problem, ZigBee utilizes the direct sequence spread spectrum to decrease the environmental interference and utilizes CSMA/CA protocol.

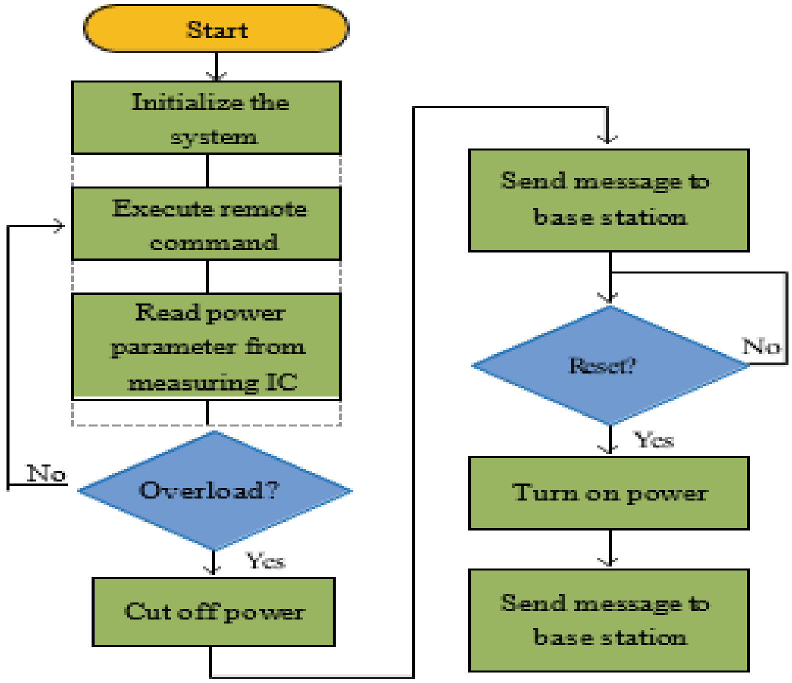

Figure 7: Flowchart of the sensor node.

Figure 8 : Control module in action.

mechanism, dynamic frequency selection, and transmission power control for avoiding channel collisions [4,34,35].

4. Experimental Results
4.1. Accuracy Verification.

To check the accuracy of the ZBDECS, a practical demo system has been introduced; the design methods and practical work have been shown in Figure 9. This demo system is supported with one base station which manages 2 branch circuits, each one include one sensor node. Each node consist of a ZigBee mocule, a MCU, A voltage and current measuring circuits with relays.The operating screen is clearly shown in Fig 11.

First, we use the ZBDECS and the standard clamp meter to measure the use of current and voltage for the lamp, the hair dryer, and an electric heater simultaneously, as shown in the 12 and 13 forms. Table2 shows experimental results. From Table2, we can find that the average deviation of the size between the ZBDECS and the standard clamp scale is 0.051A, and that the average deviation of voltage was 2.0 volts; Standard deviation corresponding to the current is 0.017A, which is the voltage is 0.545 volts.

Table 2: Current and voltage at a comparison between the ZBDECS and a standard clamp meter.

	A:ZBDECS		B: Standard Clamp Meter		A →B	
	Current (A)	Voltage(V)	Current (A)	Voltage(V)	Current(A)	Voltage(V)
Lamp	0.27	235.2	0.25	238	0.02	−2.8
	0.26	235.5	0.24	238.2	0.02	−2.7
	0.25	235.5	0.22	237.2	0.03	−1.7
	0.24	235.3	0.19	236.4	0.05	−1.1
	0.23	235	0.18	236.5	0.05	−1.5
	0.22	235	0.16	236.5	0.06	−1.5
	0.21	233.9	0.15	236.6	0.06	−2.7
	0.20	234	0.14	236.7	0.06	−2.7
Hairdryer	0.77	235.4	0.72	237.4	0.05	−2.0
	3.53	233.8	3.46	236.1	0.07	−2.3
	4.49	233.8	4.42	235.5	0.07	−1.7
Electricheater	2.82	234.5	2.75	236.3	0.07	−1.8
	4.71	233.2	4.65	235	0.06	−1.8
	7.5	231.7	7.45	233.4	0.05	−1.7
				Averagedeviation	0.051	−2.0
				Standarddeviation	0.017	0.545

Figure 9: Proto type system.

Figure 10: Circuits of the sensor node.

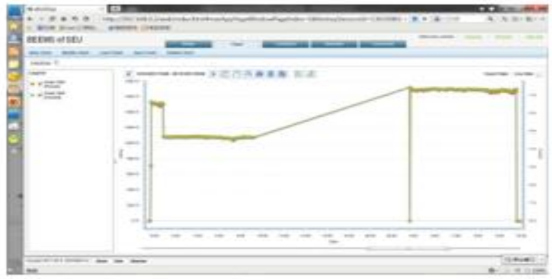

Figure 11: GUI showing the local and remote monitoring and control screen.

Figure 12: ZBDECS,standardwattmeter,andclampmeter.

Next, we use ZBDECS, a standard and standard scale to measure energy consumption in two electric heaters. The experimental results appear in Table 3. of this schedule, we find that the ZBDEC values and the standard of the implications are greater than the nominal power values, the average normative deviation and the deviation between them are minimal. The average deviation for branch 1 is 0.058 kWh ·H, the branch of branch 2 is 0.060kw·H and therukis0.118 kWh; The standard deviation of branch 1 is 0.035 kWh per hour, and branch 2 is 0.035 kWh, and the self is 0.071 kWh per hour.

Table 3: Power consumption data for two electric heaters (KWH).

Time(h)		1.00	8.17	9.35		
C:ZBDECS	Branch1	0.609	8.838	15.779		
	Branch2	1.508	18.633	7.278		
	Trunk	2.117	27.471	23.057		
D:standardwattmeter	Branch1	0.7	8.9	15.8		
	Branch2	1.6	18.7	7.3		
	Trunk	2.3	27.6	23.1		
Poweronnameplate(kW)	Branch1	0.6	1.0	1.6		
	Branch2	1.5	2.2	0.7		
	Trunk	2.1	3.2	2.3		
E:nominalpower	Branch1	0.6	8.170	14.960		
	Branch2	1.5	17.974	6.545		
	Trunk	2.1	26.144	21.505	Averagedeviation	Standarddeviation
C−D	Branch1	−0.091	−0.062	−0.021	−0.058	0.035
	Branch2	−0.092	−0.067	−0.022	−0.060	0.035
	Trunk	−0.183	−0.129	−0.043	−0.118	0.071
C−E	Branch1	0.009	0.668	0.819	0.499	0.431
	Branch2	0.008	0.659	0.733	0.467	0.399
	Trunk	0.017	1.327	1.552	0.965	0.829
D−E	Branch1	0.100	0.730	0.840	0.557	0.399
	Branch2	0.100	0.726	0.755	0.527	0.370
	Trunk	0.200	1.456	1.595	1.084	0.768

Figure13: The tested appliances included a lamp, a hair dryer, and two electric heaters.

Therefore, you can trust the accuracy of the ZBDECS measurement, and we can use ZBDEC to monitor the construction parameters of electrical devices.

4.2. Case study. The Architectural Building of Run Run Run Shaw (RRSAB) is an office building located at the University of Southern South East, Nanjing, China. We use ZBDEC to monitor the energy consumed by appliances in the rooms 701,705,707, 708 and 709 of the seventh floor of Rrsab. Figure 14 shows the plant plane on the seventh floor of RRSAB.TABLE4 List of facilities in the test rooms. Figure 15 shows the consumption of the electrical power of the test rooms. In Figure 15, the energy consumption per hour of the facilities is easily available in the test rooms.

FIGURE14:FloorplanoftheseventhflooroftheRRSAB.

Table4: The facilities in the testing rooms

705 Teaching Room	11 Computers, 4 Fans, 1 Refrigerator, Air Conditioner and an Electric Kettle.
707 Reading Room	1 Computer,1aircondition,4fans,and1water dispenser
708 Library	2 Computers,1airconditionerand1fan
709 Lab	4computers,1aircondition,1electrickettle,1waterdispenser,and3robots

5. ApplicationofZBDECS

ZBDECSprovidesbothlocal/remotepowerparametermeasurementandpoweron/offswitchingforelectricappliances.

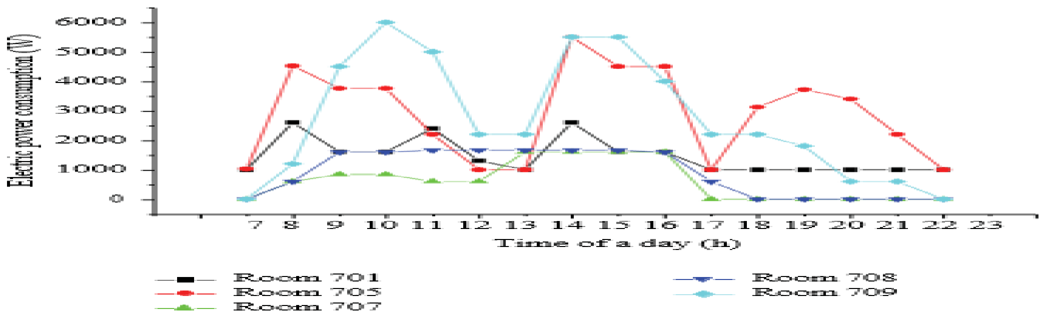

FIGURE15:Electricpowerconsumptionofthetestingrooms.

Therefore, this system can be used to monitor energy consumption, long -term energy conservation planning and the development of automatic energy conservation of construction applications. One of the typical ZBDECS applications is the sub conjunction of energy of building.. For example, for most campus buildings that its energy consumes mainly in the hot and humid climate, , ZBDECS collects data according to the electrical system, which can be divided into the following four separate elements, as shown in the figure 16:

(1) Lighting socket electricity mainly includes the lighting and power sockets and socket electricity. The out door landscape lighting, corridor and emergency light electricity.

(2) HVAC electricity, which is mainly the electricity of theheating and cooling source equipment (refrigeratingelectricity, fan electricity of the cooling tower, andelectricity of the electric boiler), air terminal socketelectricity,andelectricityofthetransportationequipments

(3) Electricity, which mainly includes the total elevator, water pump, fans and private electricity (where private electricity indicates a private energy consumption that does not belong to the natural function of electrical equipment). The special characteristic of private electricity is a high energy density. Use more important energy and electricity equipment. According to the characteristics of the construction of the campus, private electrical installations generally include laboratories, clean rooms, information centers, dining rooms, washing rooms, swimming pools and other private facilities;

(4) Special electricity for large special teams for scientific research or other auxiliary teams. Another typical application for ZBDEC is the family measurement of energy construction. For example, a housing measurement method is implemented according to the main function area of the campus, as shown in Figure 17. It is considered a university campus as a subenenergy management compound and each building is divided into the Campus in four components: administrative area, office area, area and life study. Then, find the total energy consumption for each building. We take passage statistics by step from the room to the building, which is the center of classroom, floors, construction and energy management. The other home measurement method is implemented

according to each university or department, as shown in Figure 18, which is to monitor energy consumption on campus. The specified measurement method is similar to the first method. It applies to the campus that needs a separate measurement for each university. In particular, this method is divided into a campus into a different university campus and the adoption of a subgroup of the buildings consumption control system so that each small university campus can independently monitor energy consumption. Each small campus can build a university energy consumption system. In addition, each university campus can also be divided into an administrative area, a teaching area, a library, a living room, an office area and other different areas. Next, the division of a subgroup of the power control system is created. To improve the comfort of management, office and laboratory area, they can be assigned to the university management system and monitor and perform each university. We also make passage statistics by step from the rooms to the buildings using the same statistical method as in the first method.

6.Conclusions

In this article, the authors have suggested that ZBDECS suggested expensive, which consists of a basic door and sensors. Specifically, a new device platform for the energy sensor contract has been developed to perform both the local energy teacher who measures/remotely and switching/off for appliances. Experimental results show that ZBDEC can easily monitor energy use with a high level of precision. Two ZBDEC model applications are presented as subsets and household measurement construction energy. The first includes electricity in the HVAC lighting and electricity plug, electricity and private electricity. The latter includes domestic measurement according to the area of main functions in the campus and each university or department. Therefore, this system can be used to monitor energy consumption, long -term energy conservation planning and the development of automatic energy compatibility of construction applications.

Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

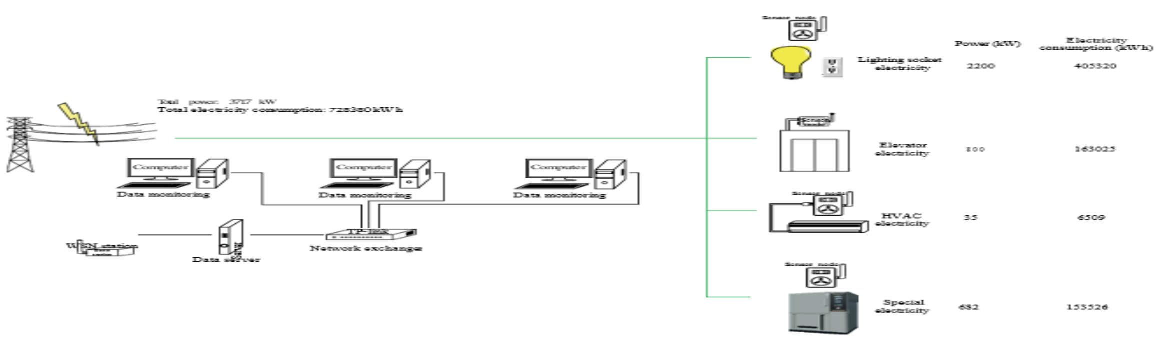

Figure 16: Subentry metering of building energy by ZBDECS.

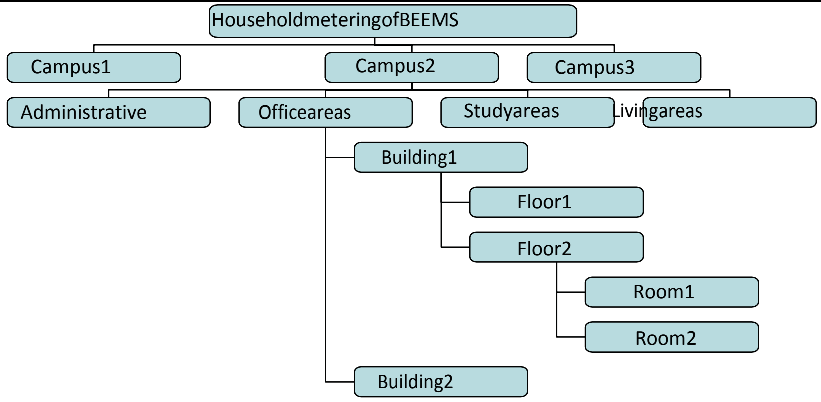

FIGURE17:HouseholdmeteringmethodoftheZBDECSaccordingtothecampusmainfunction.

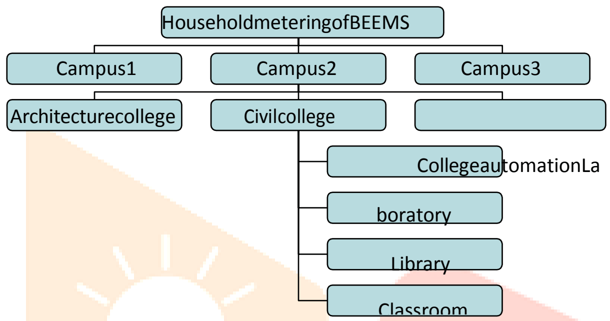

Figure 18: Household metering method of the ZBDECS according to each college.

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