International Journal of Research in Engineering, Science and Management
Volume 4, Issue 6, June 2021
https://www.ijresm.com | ISSN (Online): 2581-5792

Intelligent Control System for Energy Conservation

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***Abstract*: Smart Room technology is the future of residential related technology which is designed to deliver and distribute number of services inside and outside the house via networked devices in which all the different applications & the intelligence behind them are integrated and interconnected. These smart devices have the potential to share information with each other given the permanent availability to access the broadband internet connection. Hence, Smart Room Technology has become part of IoT (Internet of Things). A Smart Network that incorporates communication between three lights & five fans system inputs and outputs, using ultrasonic sensor, relay, contactor & ESP12-E. On and Off scheduled of fans and lights are automated by detecting the presence and absence of human in room and the details of in and out of humans can be viewed from anywhere using the mobile application.**

***Keywords*: Arduino Uno, IoT sensors, nRF module, MIT app inventor.**

1. Introduction

Energy conservation is the effort made to reduce the consumption of energy by using less of an energy service. This can be achieved either by using energy more efficiently (using less energy for a constant service) or by reducing the amount of service used (for example, by driving less). Energy conservation is a part of the concept of Eco-sufficiency. Energy conservation measures (ECMs) in buildings reduce the need for energy services and can result in increased environmental quality, national security, personal financial security and higher savings. It is at the top of the sustainable energy hierarchy. It also lowers energy costs by preventing future resource depletion.

Energy can be conserved by reducing wastage and losses, improving efficiency through technological upgrades and improved operation and maintenance. On a global level energy use can also be reduced by the stabilization of population growth.

Energy can only be transformed from one form to other, such as heat energy to motive power in cars, or kinetic energy of water flow to electricity in hydroelectric power plants. However, machines are required to transform energy from one form to other. The wear and friction of the components of these machine while running cause losses of very high amounts of energy and very high related costs. It is possible to minimize these losses by adopting green engineering practices to improve life cycle of the components.

Energy systems (ES) are a complex and constantly evolving research area. Because energy systems are multi-layered and distributed, there is a growing interest in integrating heterogeneous entities (energy sources, energy storage, micro-grids, grid networks, buildings, electrical vehicles, etc.) into distribution systems.

Intelligent control (IC) describes a class of control techniques that use various artificial intelligence techniques such as neural network control, Bayesian control, fuzzy logic control, neuro-fuzzy control, evolutionary computation, machine learning and intelligent agents. IC systems are very useful when no mathematical model is available a priori. IC is inspired by the intelligence and genetics of living beings.

IC, communications infrastructure and wireless networking play an important role in a smart grid network in achieving reliable, efficient, secure, distribution, cost-effective generation and consumption. IC on energy storage devices provide reliability and economic impacts on the energy systems.

Buildings consume a large portion of the world's energy and they are a source of greenhouse gas emissions. The concept of sustainable and zero energy buildings is emerging as an important area for the smart micro-grid initiative. In addition, effective energy management is becoming more feasible using the innovative smart micro-grid technologies and IC. These changes have resulted an environment of high complexity, uncertainty and imprecision. The IC can play a remarkable and vital role in handling a significant part of this high uncertainty and nonlinearity by providing new smart solutions for a more efficient and reliable operation of ESs.

A lighting control system is an intelligent network based lighting control solution that incorporates communication between various system inputs and outputs related to lighting control with the use of one or more central computing devices. Lighting control systems are widely used on both indoor and

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outdoor lighting of commercial, industrial, and residential spaces. Lighting control systems serve to provide the right amount of light where and when it is needed.

2. Literature Survey

Onur Ayan and Belgin Turkay propose a paper about "IoT-based Energy Efficiency in Smart Homes by Smart Lighting Solutions.

Biying fu, Naser damer, Florian kirchbuchner1, and Arjan kuijper proposed a paper about "Sensing Technology for Human Activity Recognition". Sensors are devices that quantify the physical aspects of the world around us. This ability is important to gain knowledge about human activities

T. M. Tatarnikova and A. Ivanova proposed a paper about "Access Control System for the Premises using the "Smart Home Technology". A comprehensive solution to the construction of a room access control system is proposed. Complexity is realized by choosing the platform of the technology of the internet of things.

Francis Jesmar P. Montalbo and Erwin L. Enriquez proposed a paper of about "An IoT Smart Lighting System for University Classrooms". This research is the development of an IoT based controller device with a cloud-based system to switch, manage, and monitor the lights of university classrooms period if there are occupants in the room.

Neelam verma, Anjali jain proposed a paper of about "Energy Efficient Building Automation System". Insightful Buildings have been built on three pillars of automation which are Building, Communication.

3. Modeling and Analysis

Innovativeness in proposed system:

Automatic light ON/OFF, based on presence and absence of humans in the room.

The basic need of any automation home environment is the detection of human being. The turning OFF and ON of the main switch is directly dependent on the presence of human being. If a person is detected than the main switch is turned ON using a relay circuit and in the absence of any person the whole system will be turned OFF. Due to advancement of technology there are various methods for detection of human being. There are various methods for identifying and tracking user position such as Cricket, Mote Track or GPS. GPS offers a scalable, efficient and cost effective location services that are available to the large public.

Real time monitoring of human count over IoT by using mobile application.

The Internet of Things is a paradigm where everyday objects can be equipped with identifying, sensing, networking and processing capabilities that will allow them to communicate between devices and services over the Internet to achieve some objective. People counting provides powerful data to improve site performance. Strategically placed PIR sensor with webcam and lighting system within a facility provide data on how many people are using the space, how often they are using it and at what times. Also it identifies wasted space and over-used space.

An architecture of IoT based real-time people counting System for smart buildings is shown in figure. In this system consists a PIR sensor along with webcam and a lighting system. PIR sensor detects the change in infrared radiation of moving object.

Hardware implementation:

It functions. using Arduino UNO, ESP-12E, Ultrasonic sensor, Relay.

Software implementation:

Arduino IDE with Embedded C.

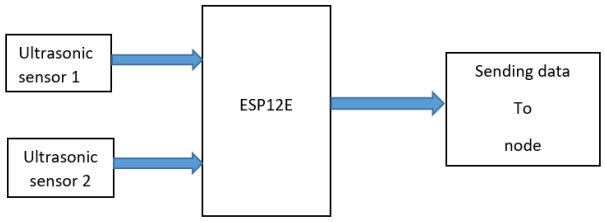

Fig. 1. Block diagram of access point block

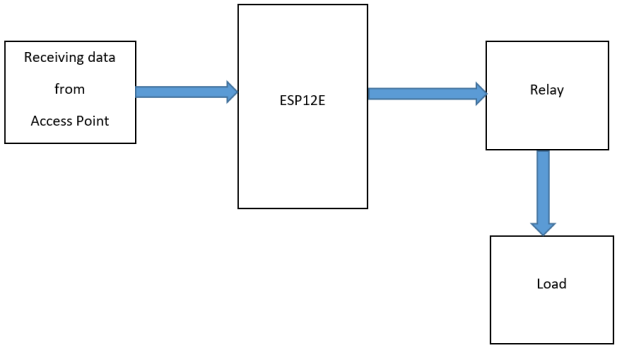

Fig. 2. Block diagram of node block

A. *Hardware Description*

1) *Arduino Uno*

The Arduino possess a huge support group and a lot of support libraries and hardware add-on "shields" (e.g. Arduino wireless can be made easily with Weixel shield), making it a great introductory platform for embedded electronics. They also offer a Spark Fun Inventor's Kit, consists of an Arduino Uno with an assortment of components such as breadboard, sensors, jumper wires, and LEDs that make it possible to create a number of modules.

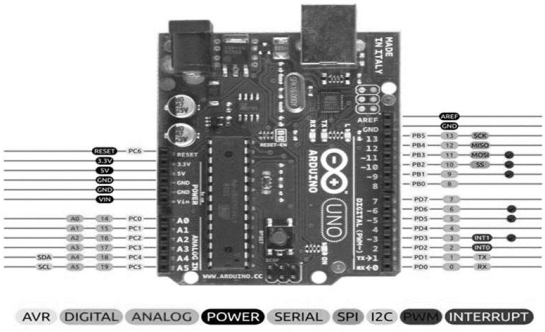

Fig. 3. Pin diagram of Arduino Uno

2) *Ultrasonic Sensor*

Working: HC-SR04 distance sensor is commonly used with both microcontroller and microprocessor platforms like

Arduino, ARM, PIC, Raspberry Pie etc. The following guide is universally since it has to be followed irrespective of the type of computational device used. Power the Sensor using a regulated +5V through the V_{cc} and Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo

Pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor. The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information, the distance is measured as explained in the above heading.

3) Relay

The relay is the device that open or closes the contacts to cause the operation of the other electric control. It detects the intolerable or undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area. Thus protects the system from damage.

- T Shape Relay with switching capacity 30 Amps in small size for various use.
- Simple magnetic circuit to meet mass production for low range.
- Dust cover and sealed cover available to meet various requirements.
- Applications - Inverters, Heating, Controllers, Domestic Appliances.
- Coil Voltage - 12VDC Ampere - 30A

4) ESP-12E – Wi-Fi module

ESP-12E is a miniature Wi-Fi module present in the market and is used for establishing a wireless network connection for microcontroller or processor. The core of ESP-12E is ESP8266EX, which is a high integration wireless SoC (System on Chip). It features ability to embed Wi-Fi capabilities to systems or to function as a standalone application. It is a low cost solution for developing IoT applications.

Overview of ESP-12E ESP-12E is a member of 'ESP-XX' series. Although all of them are based on ESP8266 SoC they differ in on output pins, flash memory and antenna type. These modules numbered from ESP-01 to ESP-15 and are best in performance and cost. Many engineers use these modules to setup a wireless communication between two applications. For data sharing and IoT you will find these modules Ideal.

- Connect positive +3.3V power to the module.
- Interface module to a microcontroller or ARDUINO using UART (Connect RXD of ESP to RXD of μC & TXD of ESP to TXD of μC).
- Download the libraries for the module from the internet. For ARDUINO, the IDE will have pre-installed libraries. If you do not have them just update the libraries from ARDUINO website.
- Write the program for setting up the baud rate and data exchange.
- Send data to the module for transmitting through Wi-Fi or Receive data from the module that was transmitted via Wi-Fi.
- There is another way for setting up the module which is to bypass microcontroller and directly connect the module to PC using FTDI. After interface you can use serial monitor to communicate with the module.

4. Results and Discussion

Access Point Block:

The Access point block consists of two ultrasonic sensors which is used to detect entry and exit of human. When the presence of human count within the room is one and more than one, the access point Triggers the alert signal to the node.

Node Block:

The Node block act as a switching control unit for the fans and light within the room .The fans and light switches on/off based on the alert signal received from the alert signal.

5. Conclusion

Energy consumption increases globally due to the ever increasing demand in the developed and developing countries. Energy consumption in the buildings is about one third of the total energy consumption in the world. During the work with this model it was possible to identify practical difficulties that encountered in implementation of the concept of using a smartphone as an identifier and transmitting a signal over a Wi-Fi network. In our opinion, the development of such systems will improve the quality of life of people with limited mobility and can be used as in medical and social institutions and in the workplace or in the organization of living space.

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