

Energy efficient Smart home based on Wireless Sensor Network using LabVIEW

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Abstract: - Smart home is a house that uses technology to monitor the environment with the help of various sensors, control the electrical appliances and communicate the outer world. Now-a-days the demand for home automation systems in homes and offices are invariably increasing. The home automation system is a key for energy conservation that can be equipped in normal buildings. As there are many benefits of wireless technology over wired, most of the home automation systems are based on the WSN technology.

In this paper we present the design and implementation of a smart home based on LabVIEW using wireless sensor network system. The system can monitor the temperature, light, fire & burglar alarm of the house and have infrared sensor to guarantees the family security. The monitored data is automatically stored into an excel file. The system can be connected to internet to monitor the security of home from anywhere in the world.

Keywords: - WSN (Wireless Sensor Network), Labview, Home automation system

I. INTRODUCTION

A smart home is a space or a room which is provided with the ability to get accustomed by itself to certain situations to make the occupants feel comfortable [1].

Today, the term 'smart home' is no longer alien to anybody as it was a few years ago. Smart homes can also refer as Intelligent Homes or Automated Homes. However, the term smart homes simply indicate the automation of daily chores with reference to the equipments in the house. Smart homes could be simple remote control of lights or more complex functionalities such as remote viewing of the house interiors for surveillance purposes. With the recent expansion of communication networks, smart home applications can be further enhanced with new dimension of capabilities that were not available before. In particular, wireless access technologies will soon enable exotic and economically feasible applications.

To this end, in this paper, we present the design and implementation of a smart home which aims to define framework for remote monitoring and control of smart home devices via the internet. The design is based on wireless sensor network system of National Instruments. The programming is done using LabVIEW. For the sensing part, occupancy (PIR- passive infrared) sensor, infrared (IR) sensors, photosensors and temperature sensors are used and for controlling part relays are used.

We present the design of the system and implementation of it with all the aspects. The design of the developed smart home is shown in figure 1.1. Similar type of system can be used for various application related to building automation field.

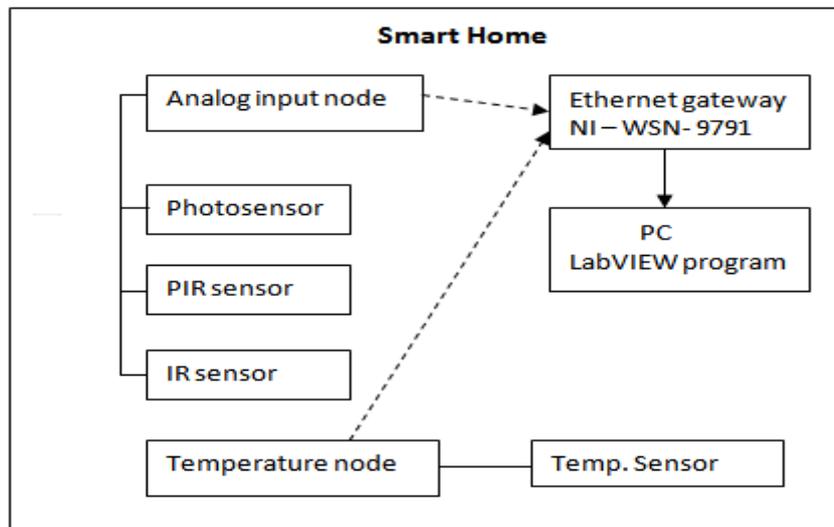


Fig 1 Design of Smart Home

The smart home using WSN starter kit is shown in figure 1. The PIR, IR and LDR (Light Dependent Resistor) are connected to programmable analog input node. The thermocouple is connected to programmable thermocouple node. Both these nodes are wirelessly connected to Ethernet gateway. The paper is organized as follows. In Section 2, a brief review of existing smart home application is given. Section 3 will cover the technical portion of this paper, where the proposed and implemented solution is described. Conclusions of the developed systems are covered in Section 4.

II. EXISTING SMART HOME APPLICATIONS

A smart home system mainly includes heating, ventilation, and air conditioning, Lighting control, or Audio and Video distribution to multiple sources around the house, security (involving presence simulations, alarm triggering and medical alerts).

Smart homes systems are grouped by their main functions such as

- i) Alert and sensors – heat/smoke sensors, temperature sensors
- ii) Monitoring – Regular feed of sensor data i.e. heat, CCTV monitoring
- iii) Control – switching on/off appliances i.e. sprinklers, lightings
- iv) Intelligence and Logic – Movement tracking i.e security appliances

The different technologies that could provide for smart home communication are X10, Insteon, Zigbee and Z-Wave. X10, developed in 1975 by Pico Electronics of Glenrothes, Scotland, allows compatible products to talk to each other remotely over the already existing electrical wires of a home. The first "home computer" was an experimental system in 1966. The Smart House Project was initiated in the early 1980's as a project of the National Research Centre of the National Association of Home Builders (NAHB) with the cooperation of a collection of major industrial partners [2].

By using wireless technology, today one can easily control home's mechanical systems and appliances over cellular phone or Internet. As the GSM technology provides ubiquitous access to the system for security and can automat appliance control, it is very popular technology now a days.

Home Security with Messaging System [3], Security & Control System, and Remote and Security Control via SMS [4] were the three alarm system that were designed using SMS application to securely monitor the home condition when the owner are away or at night. The system described in [5], is also based on GSM technology. The system is wireless and it provides security against intrusion as well as automates various home appliances using SMS. The system uses GSM technology thus providing ubiquitous access to the system for security and automated appliance control.

Intelligent home monitoring system based on LabVIEW is described in [5] and it can act as a security guard of the home. This system can monitor the temperature, humidity, lighting, fire & burglar alarm, gas density of the house and have infrared sensor to guarantees the family security. The paper [6] paper presents the hardware implementation of a multiplatform control system for house automation using LabVIEW. The system uses LabVIEW, PIC16F877A and Data Acquisition Card. The system also has internet connection to monitor and control the house equipment's from anywhere in the world.

III. PROPOSED SMART HOME AUTOMATION SYSTEM

The proposed smart home automation system is based on wireless sensor network system from National Instruments and programming is done in LabVIEW.

I. Hardware Support

National Instruments Wireless Starter Network includes NI-WSN-9791 Ethernet Gateway (Fig 2), NI-WSN-3202 programmable analog input node (Fig 3) and NI WSN-3212 programmable thermocouple node (Fig 4).



Figure 2 NI-WSN-9791 Ethernet Gateway



Figure 3 NI-WSN-3202 programmable analog input node.



Figure 4 NI-WSN-3212 Programmable thermocouple node.

The NI WSN Starter Kit requires a PC running Windows Vista/XP OS to act as the host controller in the system. NI WSN-3202 programmable analog input node has the range of ± 10 V. Any thermocouple can be connected to NI-WSN-3212 programmable node. The TTL outputs are also available on each node which is used to control the lights or fans or to give alarm indication for intruder entry in the home. The hardware requirements of the systems are: Intel Core Duo Processor, 1GB of RAM, Windows XP, Professional / Vista / 7, Ethernet NIC and LabVIEW 8.6 or higher installed on the PC.

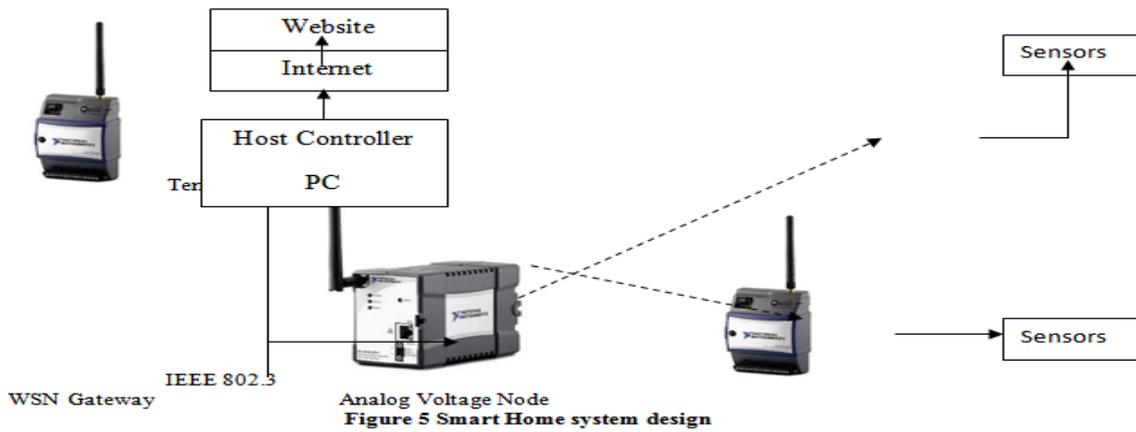
IV. SOFTWARE SUPPORT

NI LabVIEW software is used for a wide variety of applications and industries. LabVIEW is a highly productive development environment for creating custom applications that interact with real-world data or signals in fields such as science and engineering. LabVIEW Support for thousands of hardware devices, including: Scientific instruments, Data acquisition devices, Sensors, Cameras, Motors and actuators, Familiar programming model for all hardware devices, Portable code that supports several deployment targets. LabVIEW has freely available drivers for thousands of NI and third-party hardware [7].

The G programming language is often called “LabVIEW programming”, which can quickly tie together data acquisition, analysis, and logical operations and understand how data is being modified. LabVIEW contains a powerful optimizing compiler that examines your block diagram and directly generates efficient machine code, avoiding the performance penalty associated with interpreted or cross-compiled languages. The compiler can also identify segments of code with no data dependencies (that is, no wires connecting them) and automatically split your application into multiple threads that can run in parallel on multicore processors, yielding significantly faster analysis and more responsive control compared to a single-threaded, sequential application [7].

III. Smart Home system design

With technological advances, the control in smart home systems evolve and include new and sophisticated methods based on different control programs and systems. The developed system design is shown in figure 5.



In this paper we use LabVIEW program, and wireless control to control the different systems in the smart home model. Through LabVIEW software, system will control the lighting system, security system and fan control system.

1. Lighting system

The lighting system uses light dependent resistors (LDR) to sense the light and PIR motion sensor to detect the movement in the room. This system automatically turns on or off the lights depending upon the light and the movement inside the room. The motion sensor detects the person in the room and LDR senses the light intensity in the room and accordingly lights will be turns on or off. The LabVIEW software program user can monitor the light intensity and pulse of person detection on front panel.

2. Security system

The security system uses infrared sensor to detect the intruder which is fitted on the sides of the window. This system gives alarm when the person is detected at the window. A pulse is transmitted by the sensor to the node and finally to the Ethernet gateway when a person is entering from the window.

3. Fan Control system

The fan control system uses temperature sensor and PIR motion sensor. Whenever there is a movement in the room, temperature sensor senses the temperature and accordingly fan will be turn on or off. A “Low Node Power” alarm will occur when the node power level is ≤ 4 V, which is 0.4 V above the minimum required voltage [8]. An indicator LED on the front panel labeled “Low Node Power” will illuminate and give the indication. The quality of the wireless connection between the nodes and the Ethernet gateway is also critical to successful operation of the system. Poor signal quality could result in data loss or losing communication with a node completely. So a wireless “Link/Signal Quality” of each node is also checked and indication of poor link quality is given on the front panel. The stated maximum effective range of the nodes is 90 m indoors and 300 m outdoors [9].

V. SMART HOME SYSTEM IMPLEMENTATION

The front panel is designed using LabVIEW allows monitoring to all parts of smart home system that connected with LabVIEW via WSN kit of NI which is shown in figure 6



Figure 6 Front Panel of Smart Home

As shown in Figure 6, the sensors outputs are monitored on the front panel. Automatically this data is stored in an excel file. A poor link/signal quality and also poor battery indication is given on the front panel. With the built-in Web Server in LabVIEW, the front panels of the application without adding any development time can be publish to the project. LabVIEW generates front panel images that can access from any Web browser. Through Web Publishing Tool of LabVIEW one can create an HTML file in the application instance from which the VI is open. In the viewing mode clients can view and control the front panel remotely using a browser. The VI must be in memory on the server computer so clients can view and control the front panel.

VI. CONCLUSIONS

The main objective of this Paper is to design and implement a control and monitor system for smart home. Smart home system consists of many systems that can be controlled by LabVIEW software with the help of wireless sensor network starter kit. Wireless connectivity is the main advantage of the developed system. Similar type of systems can be designed for various applications. However, LabVIEW software run on host PC, so as long as the host PC is plugged in to a power source and the sensor nodes have adequate battery power, the software can be run.

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