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DESIGN AND IMPLEMENTATION OF MONITORING AND CONTROL SYSTEM BASED ON WIRELESS SENSOR NETWORKS FOR AN ENERGY CONSERVATION IN BUILDING

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ABSTRACT

Wireless Sensor Network provides a potential technique for monitoring the indoor environment. This paper presents a Building Monitoring and control system based on Wireless Sensor Networks .The excess usage of energy in a building is controlled and conserved using LabVIEW. The usage of excess energy for electric appliances in human absence is detected and it is switched-off by using ARM controller, mbed NXP LPC1768 integrated with the LabVIEW, to continuous monitoring of appliance status. The fan and light are automatically controlled by monitoring the human activity in the indoor environment using PIR Sensor. The human activity information are tracked and sent to LabVIEW to control the electric appliances through feedback control system. The system modeled provides the efficient energy conservation strategy.

Keywords: WSN, energy, sensor, monitoring and control.6LoWPAN technology.

1. INTRODUCTION

Building control is essential within a building to optimize levels of service, comfort and safety in an energy efficient manner. These are the few important benefits of building control systems. To minimize the running costs, energy consumption, to improve comfort for building users, to prevent the unwanted operation of equipment in out of hours and to minimize maintenance, repair and replacement costs. Reduce the use of equipment such as lighting, fans and motors. Thomas Schmid [1] reported that the deployment of sensors, implementation and operation of Sensor, an indoor environmental monitoring network based on WSNs. In Literature [2] demonstrated an industrial-strength wireless sensor network application for indoor environment monitoring that is they represent how the application is integrated WSNs with a Building Management System. Won-Suk Jang [3] showed how advanced WSN technologies can be used to monitor conditions in and around buildings. In [4], W.S. Jang and W. M. Healy investigated WSN performance metric for building monitoring applications and also it indicate that WSN provides huge potential for building monitoring. Dinusha Rathnayaka [5] has proposed Wireless Home Automation strategy using wireless embedded sensors and actuators integrated with architectures. 6LoWPAN compresses IPv6 addresses by eliding the IPv6 prefix, the global prefix known by all nodes in the network gets converted to link-local prefix indicated by header compression format. Elided link-local communication is again compressed for multihop destination and source addresses.

An Energy monitoring system for energy conservation is an ongoing process for identifying, planning and implementing improvements in the way a building uses energy. According to UN Environment Program organized during 2007 [6], nearer to 40% of energy is used for heating, cooling, lighting and ventilation of buildings. Energy savings can be made by using these functions only when and where they are needed. Such control is only possible when indoor conditions such as temperature, relative humidity or light are measured. Transmitting sensing data wirelessly provides benefit for monitoring indoor environment. But, our traditional wireless systems suffered from their own drawbacks, like high running cost, and high energy consumption of monitoring devices. The data from the nodes are gathered to LabVIEW module using the serial communication running on LabVIEW based workstation through IPv6 eliding using 6LoWPAN Technology. The technology 6LoWPAN is used to transfer the IPv6 packets from each node over Ethernet. The main advantage of using this technology is that it compresses the header addresses. The 6LoWPAN works on the principle of flat address spaces with unique MAC addresses.

In this proposed system, an energy monitoring and control system is designed to identify the energy usage in a building and optimize the usage by an automatic control. The nodes to be monitored are connected to the Ethernet by assigning individual identity address and integrated with the mbed NXP LPC1768.The remainder of the paper is organized as follows. The system description is given in Section 2. Section 3 shows experimental results and discussions, Conclusion is given in Section 4.

2. SYSTEM DESCRIPTION

The proposed system consists of Monitoring and controlling mode. The monitoring modes involve the reading of energy consumption and the status of each node and display them in LabVIEW. The control mode involves the control of nodes from LabVIEW based on the output from the sensor and the status of the node. The nodes are linked through Ethernet and are given individual IP

address using which the individual node is identified and controlled automatically through LabVIEW. The block diagram for Energy conservation is shown Figure-1.

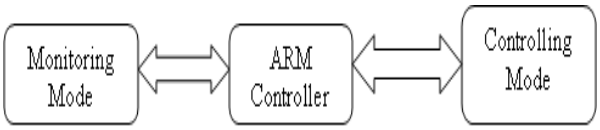

Figure-1. Block of energy conservation.

2.1 Monitoring mode

The status of the electrical appliance is monitored by power module (ACS712) and the measured data is given to the ARM controller and then to LabVIEW to display of result. The monitoring of nodes is done such that the nodes are connected to a relay board so that the AC-DC conversion can be done in that and power monitoring module is connected to the nodes in serial order is shows in Figure-2. The energy consumption of each node is monitored using ACS712; it is a fully integrated, Hall Effect-Based Linear Current Sensor IC with 2.1 kVRMS Isolation and a Low-Resistance Current Conductor. It is typically used for load detection and management in AC or DC current sensing. The energy consumption of each node read by ACS712 is displayed in LabVIEW simultaneously along with the PIR sensor reading for human intervention. The logic is designed such that in the absence of human intervention if the energy consumption is prompted then the device that is ON will be automatically switched OFF using LabVIEW. Bojan Mrazovac [7] has proposed a wireless smart outlet network and RSSI method for detecting human presence. The human intervention is detected using PIR SEN-08630 and is given to mbed NXP LPC1768 in the proposed system. Communication of nodes with LabVIEW is done by controlling the IP address of each node using Ethernet. In [8], Blerim Quela has proposed Observe Learn Adapt algorithm includes the integration of wireless sensors and AI. The priorities on working concept can also be done in conjunction with RTOS. The effective communications among the nodes were done possibly by using 6LoWPAN protocol and it visualized using the software Contiki. The monitoring and control mode systems involve the manipulation of data over LabVIEW.

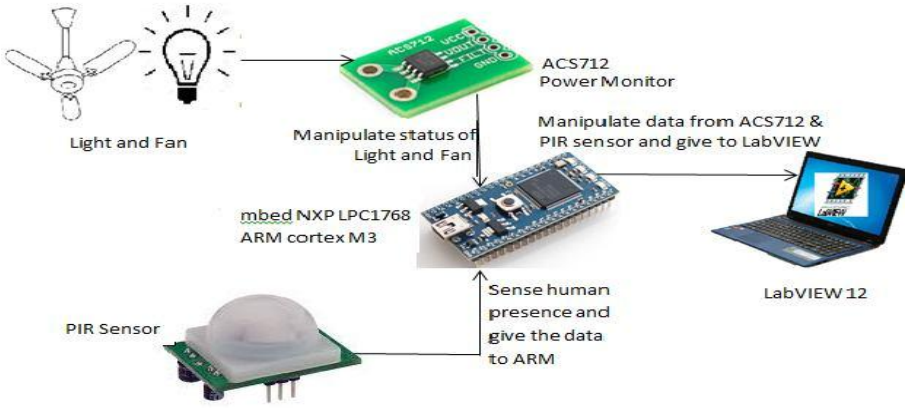

Figure-2. Block of Monitoring Mode.

2.2 Controlling mode

Each electrical appliance is controlled by using mbed and it is controlled by means of LabVIEW. The control mode over LabVIEW is done by connecting each node through Ethernet and then each mote is assigned by an unique addresses. The controlling system with nodes connected to LabVIEW is shown in Figure-3.

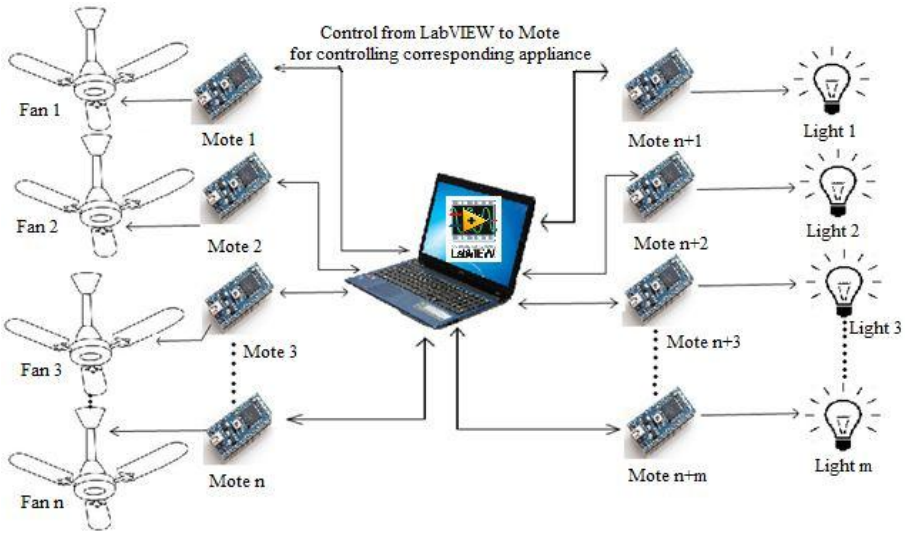

Figure-3. Block of Control mode.

The monitoring and control of flow process is described as shown in the Figure-4. The system overview is explained in the given below flowchart.

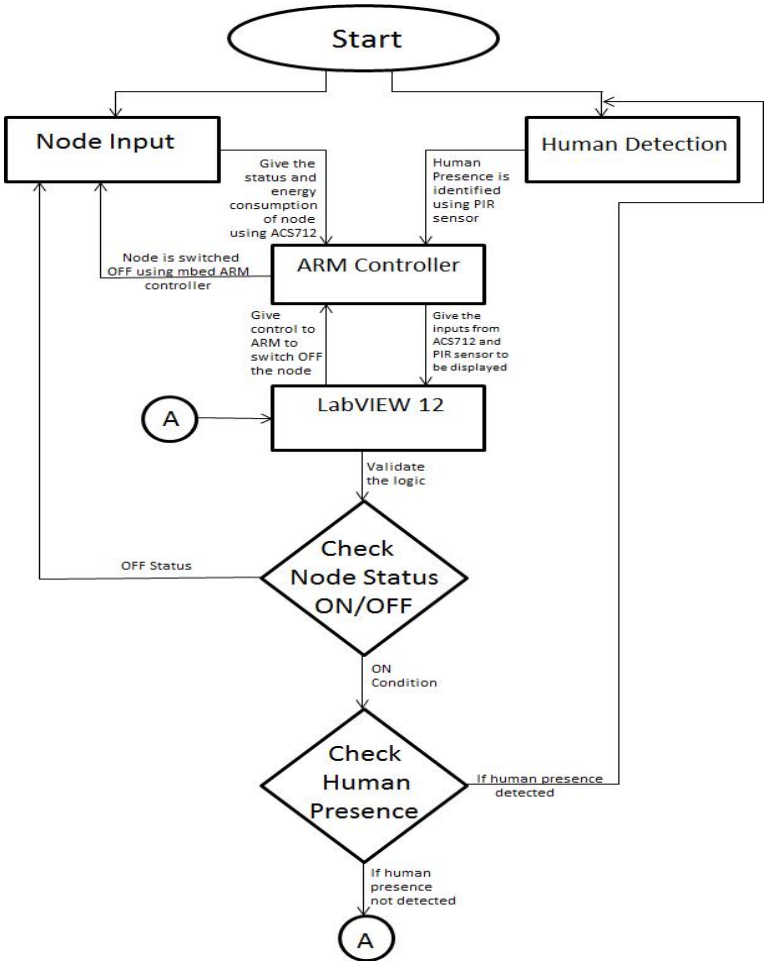

Figure-4. Process flow of monitoring and control mode.

2.3. Human detection

Each fan and light is connected with mbed controller and each controller is assigned an IP address and is connected to the PC using Ethernet. The logic is framed such that when the appliance status is ON and the data from the corresponding sensor shows human absence then the appliance gets control from LabVIEW to be switched OFF. The priorities are given for the node control can be achieved using RTOS and it can be enhanced with other applications. Human activity is monitored using the PIR sensor and the data is given for the validation of logic to LabVIEW through ARM. The PIR sensor circuit is shown in Figure-5.

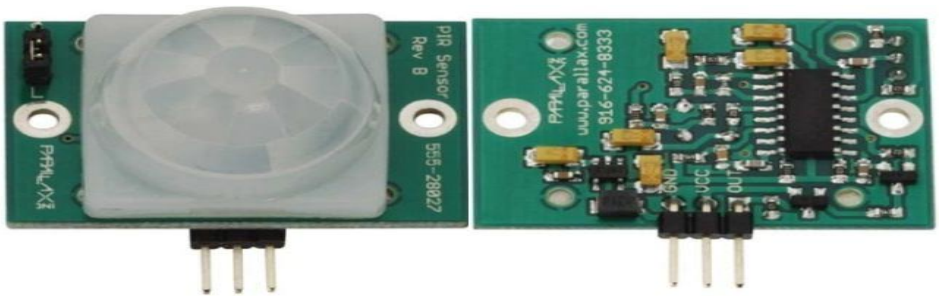

Figure-5. PIR sensor for human detection.

The PIR sensor detects the human activity and then through ARM the status result is sent to LabVIEW. The ACS712 power monitoring module measures the energy consumption and also it specifies the data in LabVIEW through mbed controller. Based on the logic fed in LabVIEW, the node is controlled with the results from sensor and measured power. The sample output for monitoring of one node in LabVIEW is as shown in the Figure-6. In this, status of the appliance is indicated in green colour for running condition and the energy of the fan is measured and displayed.

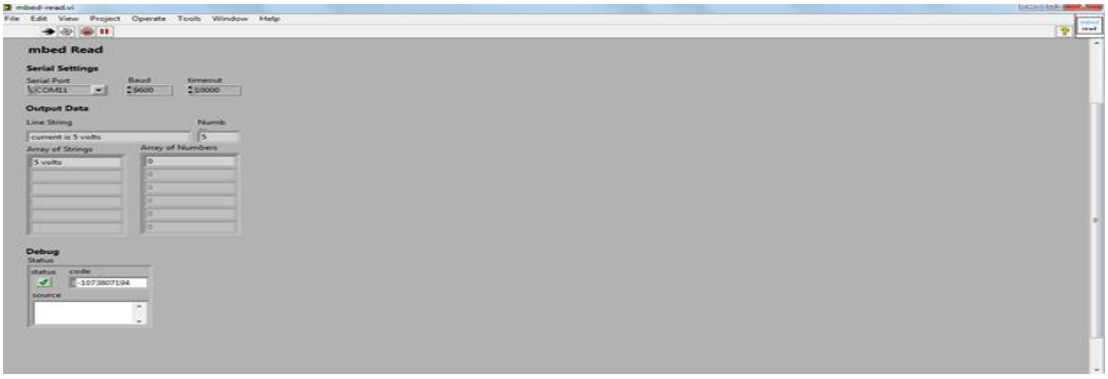

Figure-6. Sample result for monitoring one node using LabVIEW.

3. RESULTS AND DISCUSSIONS

The data transfer among nodes and the data compression using 6LoWPAN can be visualized using the software Contiki. It provides powerful low-power internet communication. Contiki supports fully standard IPv6 and IPv4, along with the recent low-power wireless standards: 6LoWPAN, and CoAP. Contiki is an open source operating system for networked, memory-constrained systems with a particular focus on low-power wireless Internet devices. Contiki networks can be emulated before burned into hardware and it provides an entire development environment in a single download. In proposed system the 6LoWPAN compression of data is visualized using Contiki software. The Passive Infra-Red sensor is a pyro electric device that detects motion by sensing changes in infrared (radiant heat) levels emitted by surrounding objects. This motion can be detected by checking for a sudden change in the surrounding IR pattern. When motion is detected the PIR sensor outputs a high signal on its output pin. This signal can be read by ARM controller and is given to the LabVIEW for manipulation and the control phase is initiated based on the input.

In CoAP function the timeline of the mote will send data to time (ms) and radio transmit time on the timeline window. The total bytes are used to send data by CoAP function in radio message is shown in Figure-7. Here the size of the packet data transferred is 64 bytes using CoAP function. The range of output bytes varies from 64 to 62 bytes sent by using CoAP function are

compressed by 6LowPAN function to 2 bytes and is shown in the Figure-8.

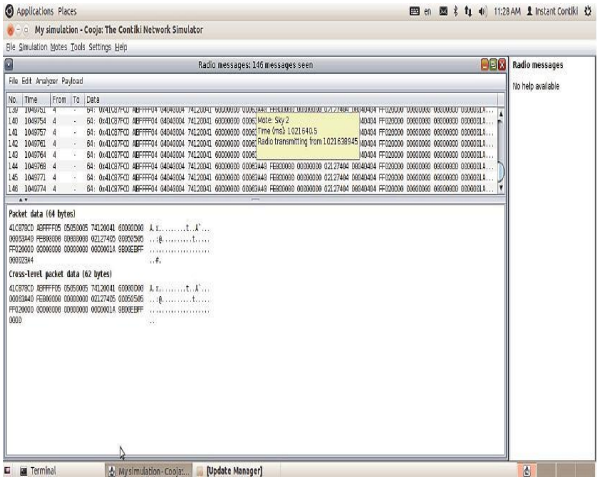

Figure-7. Uncompressed CoAP function.

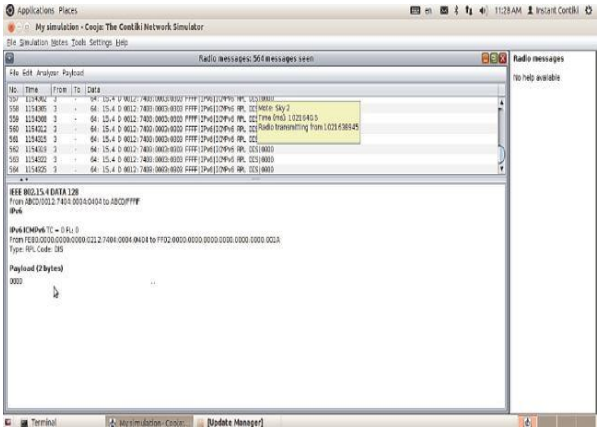

Figure-8. Compressed CoAP function.

In IPv6 output the uncompressed bytes ranges from 70 to 68 bytes to send data by using 6LoWPAN, the compressed bytes range to 12 bytes and it is as shown in the Figuere-9 and Figure-10.

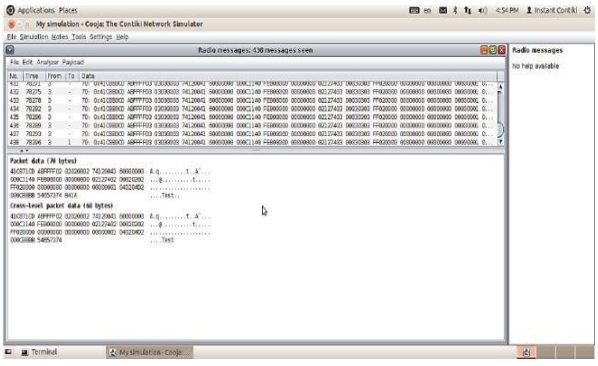

Figure-9. Uncompressed data in IPv6 protocol.

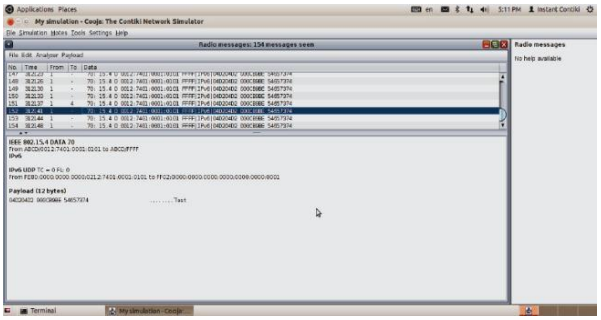

Figure-10. Compressed data in IPv6 protocol.

4. CONCLUSIONS

The system description is presented and an overview of system features is given. This paper focuses on the two key methodologies which are used to implement energy conservation in building is achieved by monitoring and control mode. However, there exist shortages inevitably as a result of exploratory research on applying WSNs to building monitoring and controlling. We will perform further tests to find problems, and then to improve the performance from both hardware and software. In Future, it include nodes are able to store normal data locally in order to save communication energy consumption, but the user queries data depending on their need. So, the deployment of nodes in the building environment to be distributed storage and query database. In order to solve this problem, it is necessary to explore a mechanism for switching automatically. The automatic control of fan and light connected through Ethernet has been achieved based on the input from sensors and power monitoring module for efficient energy management. The compression of appliance data from ARM enables the communication faster without data congestion. This can be further enhanced for various other appliances also.

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