Design and Implementation of Energy Management System for Buildings

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ABSTRACT

Collecting data and monitoring from the related remote sensing activates perform a significant role for records the variants of environmental as a function of time by using Raspberry PI in green buildings. The main goal of this project is to develop a data acquisition system (DAQ) for monitoring the measurements of temperature and the humidity in order to extend this functionality for developing multipurpose DAQ and controlling system. In this work we have utilizes the digital sensors which have been connecting to I2C (Inter-Integrated Circuit) bus circuits with programs. The controlling units or analog to digital circuits translate the relative the analog data of temperature and humidity that sensed by the sensors to be a digital signal, after that, the client transmits these data to the server and then the data are going to be processing by the computers. The programmed interface system has been implemented by used Raspberry PI rather than PC that make it possible for users to manage all parameters of operation at high speed and low cost. The DAQ system can be operates either as standalone system or to work with PC. The monitoring and the recording system should be pre-loaded with online software such as Linux to be able to get the appropriate measurements.

KEYWORDS

Smart Buildings, Environment sensor, temperature monitoring, humidity monitoring, Raspberry PI.

1 INTRODUCTION

Due to an increase in the affordability and availability of wireless networks for home automation and buildings, there is an increase of interest for the environmental impact of the of buildings in both commercial and residential requirement. Thus, Building the energy management system can provide a central platform for controlling the energy usage of the buildings, which can be detecting and eliminating the waste and permit the efficient use of electricity resources. These systems should have a control unit along with sensors that can be used to enable the monitoring of room occupancy, lighting, ambient temperature, and other inputs in order to achieve useful management of lighting systems, climate control (ventilation, heating and air conditioning), and security [1, 2].

However, according to the drawbacks of the typical greenhouse control system, for example, higher cost and traditional bus mode network problem, this study focused on employed the low-cost component that can be achieved the task. Last years, the microcontroller units (MCU) and tiny computer has been improved and large number of MCU has been available for everyone because of its low cost and simple programming such as Arduino families, Raspberry PI, etc. In this work we have used Raspberry PI which is a low-cost, single-board, high-performance computer [3].

In this work we have designed a Raspberry PI communication module in order to offer a low power consumption and high radio frequency and we have built the user interface based on Client/Server webserver. The web server has been designed based on utilizing the S3C2440 microprocessor and Linux operation system. The proposed system has the voice prompt, remote control greenhouse device and remote monitor. The test of system shows that it is stable, and it can be developing to use as an authorized devise to be maintains that is appropriate for DAQ and as device control for several kinds of agricultural sites.

2 LITERATURE SURVEY

This section discussed the in short the several literatures presented related to Smart Home and Energy Management System

Sankaranarayanana et al .(2014) [4], developed a smart home monitoring prototype by utilizing the wireless sensor systems and android mobile handset. This prposed system has the ability to monitors the usage features of electrical power for the socket outlet in realtime. It can measures the current, voltage and temperature of the socket outlet frequently from every room and the monitoring data has been sent from the system to computing.

Lavanya et al. (2016) [5], developed an Automated Humidity and Temperature Control and Monitoring system by using raspberry pi. The raspberry pi has received the humidity and temperature values from sensors and then sent to the internet. However, this project has leaded to development of prototype of automated humidity and temperature control with good feasibility.

Kshirsagar and Upasani (2016) [6], developed the energy control system for smart home in order to manage energy at the ranges of appliances. Thus, towards this they developed the architecture of smart home energy management system . In this system, the sensors have controled the energy consumption of home devices. Furthermore, the solar energy has been used as an alternative source where it can be dependent on switched based o the weather conditions. The energy data via various home servers are aggregated by the PC server and appropriately compare them for making statistical analysis info.

Suresh et al. (2016) [7], developed an automatic control system for lighting in order to got an effective use of energy. They also have presented mobility and remote command performance to system by using Android mobile App through Bluetooth to control the lighting based upon the voice command

3 PROPOSED SYSTEM STRUCTURES

The proposed system is aimed to repeatedly monitoring the realtime humidity and temperature in a cost effective way via polling sensor at fixed time interval. The system requires designing of hardware, embedded software and application programs.

A. Hardware design:

The hardware component of proposed system is including: sensors, controls unit, actuators, analog to digital converts, busses cards and other components.

1. **Controls Unit:** The Minicomputer type Raspberry pi (Rev 2 model B) has been used as control card and gateway for remotely access. Raspberry pi has a 1.2 GHz, 64bit quad-core ARM V8 CPU, a 802.11n Wireless LAN, Bluetooth Low Energy version 4.1, the ports includes: Display port (HDMI), Display interface (DSI), composite video Camera interface (CSI) four USB ports, Full Ethernet port (LAN), 3.5mm audio jack, 40 GPIO pins, and Micro SD card slot. The video Core is IV 3D graphics core. Figure 1 shows the Raspberry pi board and its component figure 2 illustrated the PIN out from it [4].

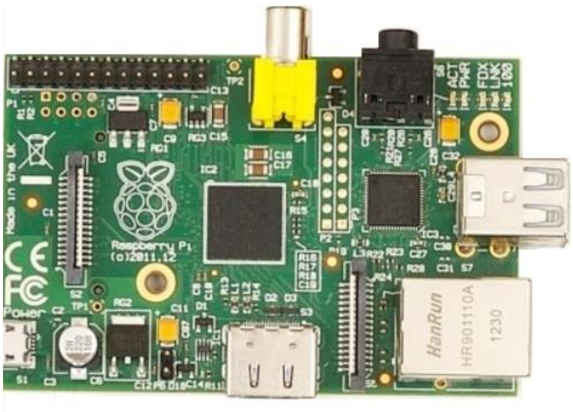

Fig.1. Raspberry pi board [5]

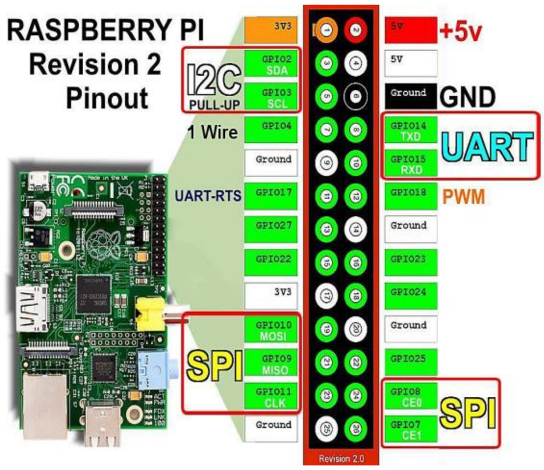

Fig.2. PIN out of Raspberry

2. **Temperature/Humidity Sensors:** The KEYES SHT10 Digital Temperature Humidity Sensor has been used to gathering the environment temperature degree and humidity percent.

3. **Other component:** Breadboard, resistors, jumper wires, green and red LED.

A. Software design:

The software has been designed to manage the overall operation, which includes: sending measured temperature and humidity data from sensors to user, getting user requests for turn off/on lamps or other electrical appliances.

1- **Raspberry Pi programing:** The main system software is the Raspbian [6], which is a free-license Linux operating system “Debian” which optimized for its usage with Raspberry Pi hardware. It is obtainable directly from the Raspberry Pi site as an SD Card image which requires to be copy to an SD card. Rasbian has been loaded into the SD card to be used in Raspberry Pi. RPi executes the Python script to communicate with the node and the web interface.

2- **Server programing:** Linux has a web server available named Apache, it is the most traditional web server software in the world. It also requires PHP complements for web-page creation and PostgreSQL for database management.

In this work we have used a server has windows operating system then we have converted the windows platform to linux distribution Ubuntu14.04 based on the instruction ofered by ubuntu.com site [7]. Figure 3 shows the prposed system expremental setup.

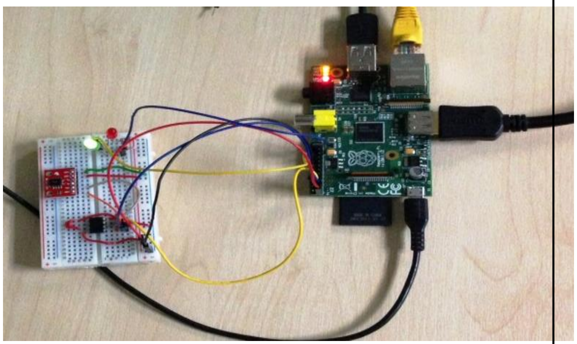

Fig.3. Raspberry pi connection with sensors

As shown from figure 3, the sensor has been connected to the raspberry pi by used jumper wire and the computer (server) has been connected to Raspberry pi via ethernet.

The raspberry pi is gathering information from sensors then store and display it the real time temperature and relative humidity.The raspberry pi has been programmed by used python language. Figure 4 shown the block diagram of the proposed method.The temperature is displayed in degree celsius or Fahrenheit as required. The user is able to know the current temperature and relative humidity at remote location by sign in the web browser by putting login name and password by the client.Web application starts after sucsess authintification and then the output graphical representation can be obtained. The processed data will be updated repeatedly on cloud server and the user can get stored data on on an hourly basis and daily basis.

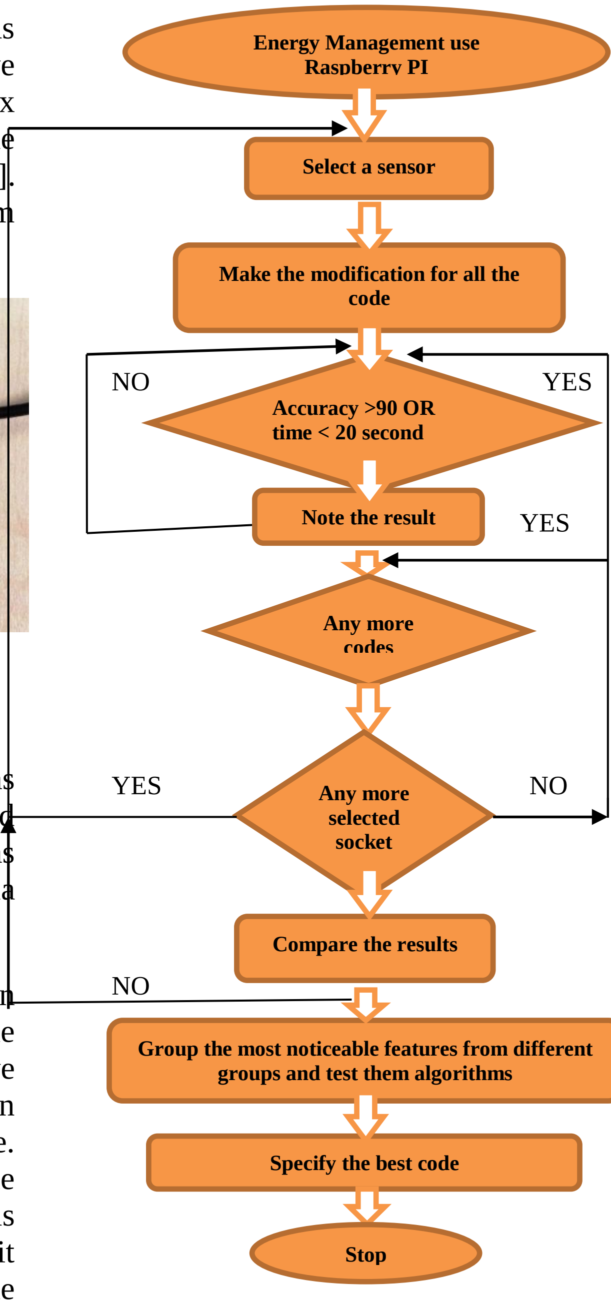

Fig.5. raspberry pi program Flow Chart

4 RESULTS

This program opens in UBUNTU terminal to configure the code of the parameters with shown GUNPLOT interface results. The steps of connecting with Raspberry pi is as following steps:

1. Open the Ubuntu terminal
2. Enter the code “cd /sys/bus/w1/devices” then enter “ls”

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and the terminal will showing the w1 bus master.

3. Enter the w1 bus master “28-xxxx”,
4. Enter cat w1_slave

After doing this steps the server and Raspberry pi, figure 5 shows the opration steps in terminal.

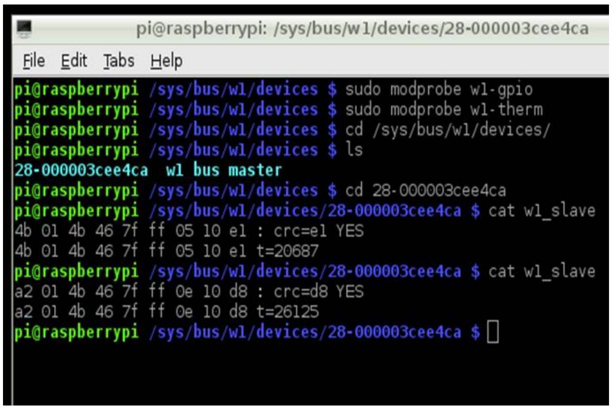

Fig 4. Ubuntu terminal

In this paper the time taken to get the results is not long because it tests some sensors at a time but if there are many ligands it may take more than one hour depending on the number of the processor, to monitor the processors usage install one of Linux system monitoring tools, this thesis uses htop which is a much advanced interactive and real time Linux process monitoring tool to install it enter on the terminal.

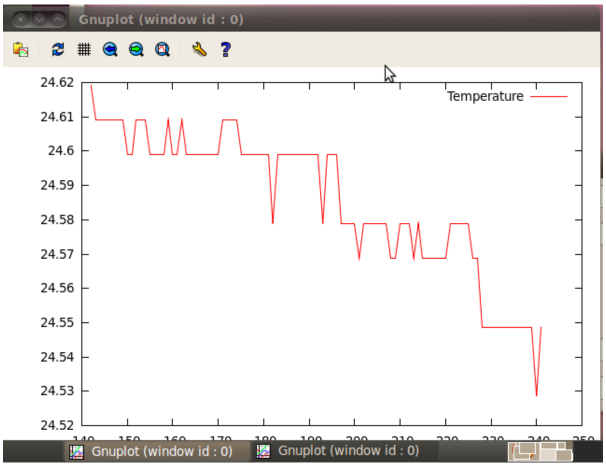

Fig.5. diagram for the temperature sensing records

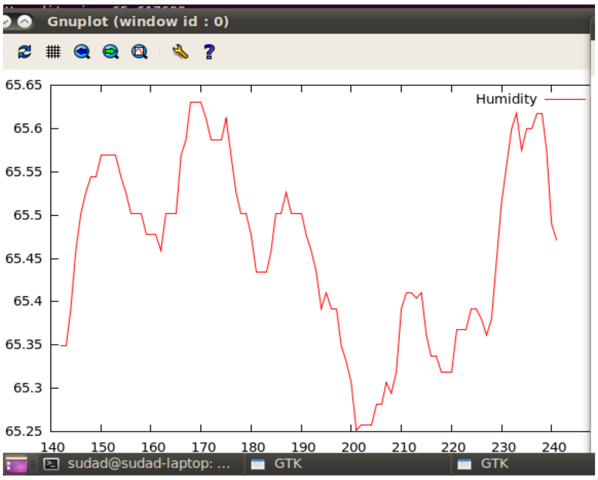

Fig.6. Diagram for the humidity sensing records.

5 CONCLUSION

Recent advances in the LAN technology enabled developing sensor networks, which enable implementing robust, flexible and reliable infrastructure by deploying high number of sensors within the environment. According to sensor networks can have very high number of sensors, densely deployed, regular change (addition, removing, or substituting), with limited requirements (power consumption and computational capabilities. In this work we have designed a monitoring management control system that is based on employed network and Raspberry transmission technology, and quickly presents the fundamental, system design and experimental results. The proposed system is used TCP/IP mode in network, the embedded development platform carrying out the remote monitoring, and have the ability to analyse and dispose the factors of the environmental such as: CO2 concentration, temperature, light, humidity, etc) automatically via the display of the field environmental data. The test provide that the proposed system has high reliability and applicability, the remote monitoring operation is simple, and in agriculture area have got a good prospect. In summary, we can conclude a main point in this project:

1- The proposed system can process, display, and store the data in both way (as DAQ system or dedicate system).
2- The benefit of utilizing a Raspberry PI for DAQ is that a Raspberry PI has the flexibility to adjust the changing requirements and its low cost.
3- The design and constricted of this model can be done in highest accuracy with time that consumed.

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