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An Industrial DAQs and Internet Based Data Logging and Remote Monitoring System for Real-Time Multi-Parameters Measurements

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Abstract: In this paper, we proposed a design and implementation of a multi-parameters data logging and remote monitoring system for investigating both of electrical parameters and physical ones for indoor and outdoor environments. The task of logging and monitoring parameters are temperature, relativity light intensity and nineteen electrical parameters with storage and transmission of this information in the form cloud storage service to the user's computer over internet in real-time for in-situ or further analysis. Due to industrial data acquisition modules, this system is easy to build with an expandable capability and enduring stability. Also a large of logged data can be measured by using this system with high accuracy and they are able to observe in a large surveying area.

Keywords: DAQ-data acquisition, data logger, remote monitoring system.

1. Introduction

The electrical energy consumption and the indoor/outdoor environmental conditions are closely associated. The electrical energy consumption used for lighting and air-conditioning systems increases quickly in recent year because of the rapid global warming, the climate change and the urban expansion. Remotely monitoring of electrical and environmental parameters in a large area is important in the various applications and the industrial processes. Several researchers and commercial companies are trying to monitor the environmental parameters such as temperature, humidity, and electrical energy mere precisely in real-time [1-7]. However, these developed systems are not suitable for the real-time monitoring for both of indoor/outdoor environmental parameters and electrical energy ones in the large area of the surveying zones. Actually, precise monitoring for the long duration of these parameters and their time relations has a huge potential in terms of energy saving solutions.

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In this study, we developed a precise, expandable, remote monitoring and multi-parameters data logging system based on the industrial data acquisition modules in order to solve on the previous problem. We face to electrical energy and two environmental parameters as temperature and relative light intensity, because of their affection to the electrical energy consumption. Furthermore, these logged data can be sharing over the internet for further applications.

2. System Implementation

Main function of this system is automatically monitoring and logging the relativity light intensity, indoor/outdoor temperature, and consumed energy of a testing room.

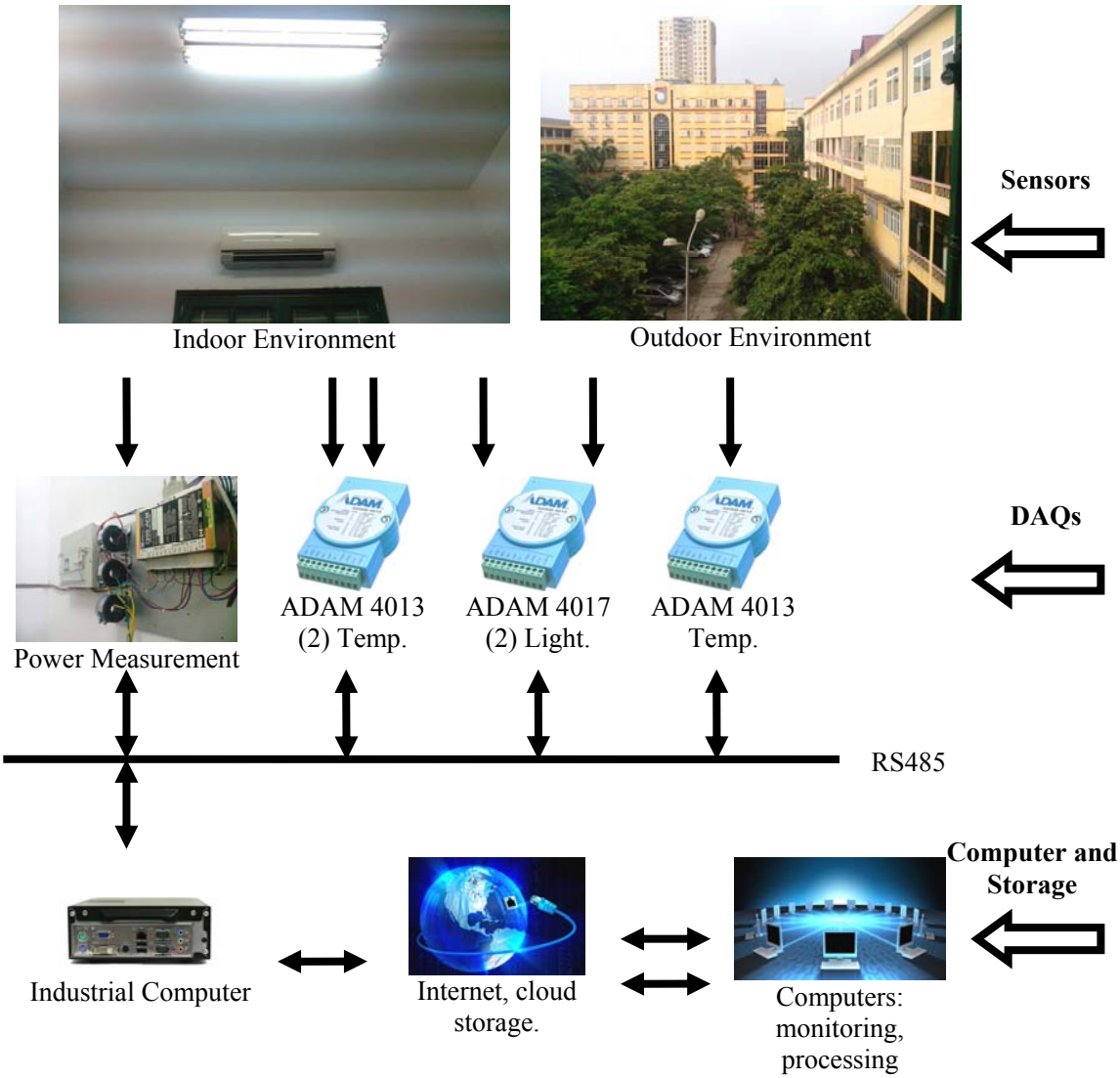


Figure 1. Data logging System block diagram.

The block diagram of the data logging system included three parts: sensors in order to measure environmental parameters, data acquisition modules, and host computer with the control program as shown in Figure 1. The host computer is a low power MINI-ITX computer with Windows XP operation system and pre-installed free Dropbox service. Functions of each part will be described in detail as following

2.1. Sensors

For temperature measurements, three RTDs (Resistance Temperature Detector) model S467PD from MINCO Corp. (USA) are used. This sensor is a Platinum RTD with resistance of 100Ω ± 0.1% at 0 °C (PT100), the Temperature Coefficient of Resistance – TCR is 0.00385 / °C, these sensors are high accuracy temperature sensors and used widely in many fields of the industrial applications[8]. Two RTDs were placed in two difference indoor zones for measuring the distribution of temperature on the energy consumption, while another was placed outdoor for ambient temperature monitoring.

For relativity light intensity measurements, two commercial solar cells model SS4114 with a lighting diffuser are used [9]. The first sensor was placed indoor for measuring the light intensity in working environment, while another was placed outdoor for sensing the natural daylight intensity and the night light one. The measured open voltage of these solar cells at the middle noon of a bright sunshiny day is not exceeded 3.0 V.

2.2. Data acquisition (DAQ) modules

Data acquisition for temperature and light intensity measurement are the addressable ADVANTECH's modules with ADAM4000 series. The main function of DAQ modules is to convert an analog signal to digital data and remotely communicate with the host computer through a simple set of commands issued in ASCII format and then transmitted in RS-485 protocol. An ADAM4013 RTD Input Module was used for temperature measurement with a high accuracy better than ± 0.1 %. And an ADAM-4017 module which is a 8-channel analog input module with programmable input range as ±150 mV, ±500 mV, ±1 V, ±5 V, and ±10 V was used for light intensity measurement. Because of ±0.1% accuracy, 16-bit resolution at sampling rate of 10 samples/ second, and an 20MΩ input impedance in voltage mode, the ADAM4017 is a proper choice for directly interfacing with the solar-cell [10]. Simultaneous, a Digital Power meter (Power Measurement Ltd., USA) model 3300ACM was used for electrical parameters measurement [11]. This 3300ACM module is a 16-bit microprocessor based device, microprocessor based 3-phase power meter, and using RS-485 protocol for communication; moreover it also operates in many voltage modes. In this work, this 3300ACM module is configured to fit in 4 WIRE WYE mode providing up to nineteen measurements as shown in Figure 2. In addition, a RS232 to RS485 conversion using the ADAM4520 module connects both of the DAQs and the 3300ACM module to a host computer.

2.3. Host computer

In this research, a host computer is an industrial standard computer with the low power Mini-ITX main board [12]. The communication port COM1 of this computer was connected to an ADAM4520

module in order to control all system. The Graphical User Interface (GUI) program written in Visual Basics (VB6) performs two simple tasks: acquiring measured results from all DAQs and save them to a simple ASCII file. A real-time system clock is used to synchronize all of measurements. This takes about 2 seconds for a full data collection and then these data will be saved as an ASCII file located in a Dropbox's shared folder. Specially, the Dropbox service is the free cloud storage and cloud sync service for all connected devices such as computers or smart phones; thus, this service provides the easiest way to acquire data, remote control and share the data file without internet configuration setup. Therefore, the shared data file can be used by any computer which is connected to the internet and has access permission provided by the administrator.

The data file is in simple ASCII file with a form of measured data separated by TAB ASCII character. The measured data include "time" in "yyyyddhhmmss" format, unit ID of each DAQ nodes, nineteen electrical parameters, indoor/outdoor temperature in Celsius degree and relativity light intensity in volts unit (Figure 2).

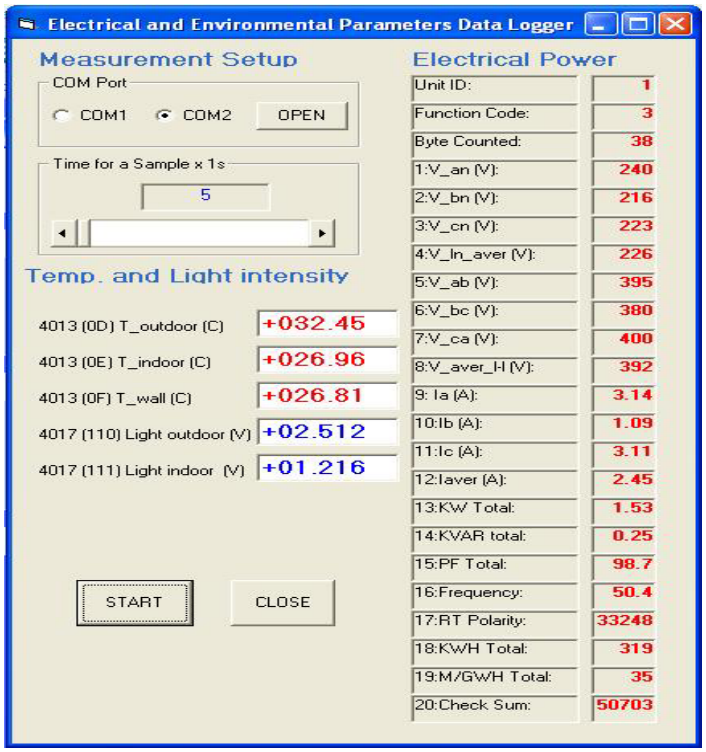
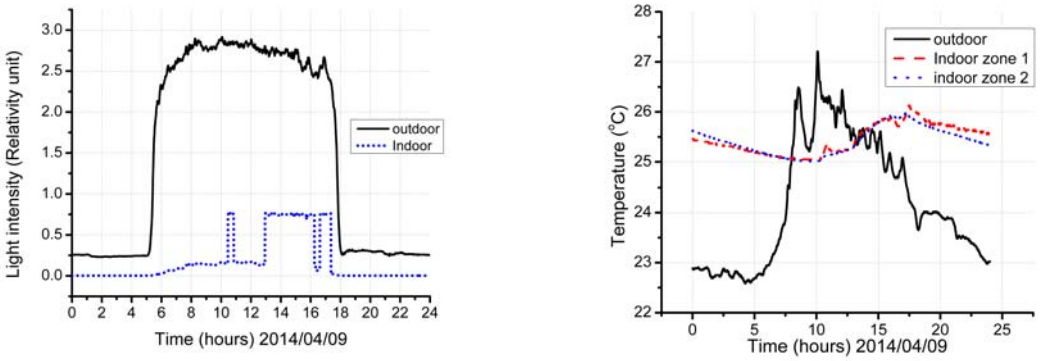


Figure 2. Graphical User Interface of data logging and monitoring system.

3. Results and Discussions

For evaluating technical parameters which will be used to determine the working conditions of this data logging system, temperature and light intensity of a testing laboratory at Thuong Dinh campus (HUS) have been measured from Apr. 08, 2014 to now with 60 s of time duration for each

measurement. Several electrical and environmental parameters have been measured and logged simultaneously, after that these parameters have been stored in the ASCII file named "data.txt" and then shared over the internet by using the Dropbox service. This file can be opened by a working computer, which connected to the internet with access permission. Furthermore, these parameters and their time relation could be analyzed as Figure 3which showed some example curves of logged parameters with their time relation during 24 hours of Apr 09, 2014.



a) Indoor and outdoor light intensity

b) Indoor and outdoor temperature

Figure 3. An example of the typical curves.

In figure 3a, solid curve indicated the outdoor relativity light intensity while dot curve showed the variation of the indoor light intensity lit by Neon lamp. Figure 3b shows the difference of temperature between indoor and outdoor environment. Because of good thermal isolation of building wall, the indoor temperature is stable with a small fluctuation about 1 ^{0}C although the outdoor temperature was varied about 4 ^{0}C for the whole day.

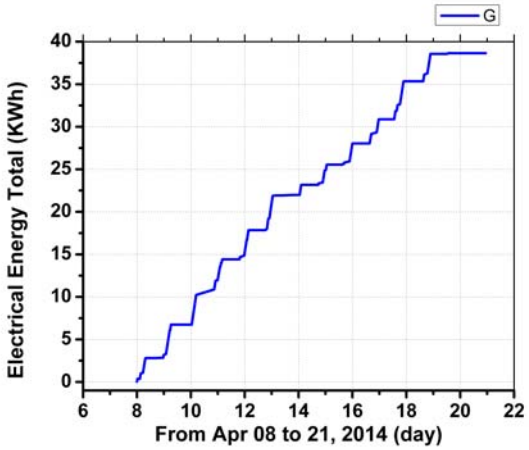


Figure 4. Electrical energy total of 3 phases suplied of the testing room from Apr 08 to Apr 21, 2014.

Notably, the indoor temperature increased from 8 am to 17 pm is due to self-heating of the electrical devices. The distribution of temperature in this testing room is stable with small difference between indoor zone 1 and indoor zone 2.

Furthermore, the electrical energy consumption of three phases supplied of the testing room was measured from Apr 08 to Apr 21, 2014 and shown in Figure 4. In this figure the horizontal segments indicates the non consumption of electrical energy with time correlation in during night and weekend, while the incremental segments indicates the electrical energy consumption in the working days. The obtained results shown in Figure 3 and Figure 4 illustrated that this system is working continuously with a high stabilization and precision. That is good agreement with the device's specifications provided by manufactures.

4. Conclusions

In this research, a simple, stable, precision, remotely multi-parameters data logging and monitoring system was successfully designed and developed. Based on five DAQ modules and a power meter module, this system was used to measure and to collect the both of electrical energy and environmental parameters such as temperature and relative light intensity of outdoor and indoor places with a high stabilization and precision. Because of using the RS-485 communication and the industrial computer supported up to 4 COM ports, this system could be expanded to 4x31 DAQ modules, therefore the multi-parameters environment and the consumed electrical energy were monitored easily and high confidence in a large surveying area. Especially, a large of measured parameters of environment and electrical energy consumption of three phases supplied of the testing room were successfully measured and shared over the internet through the Dropbox service, which are very useful for further applications such as research in physical environment, thermal distribution, close-loop control for electrical energy saving solution, smart buildings or investigate the dependence of efficient energy use on the architecture and construction of buildings, etc.... Thus, this system is a good candidate for real-time electrical measurements and it will be studied more in future.

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