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Arm Based Intelligent Environment Monitoring And Control System Via Zigbee Network Using Gprs/Sms

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***Abstract* - This work builds arm based intelligent environmental monitoring and control system for industrial production and safety concerns. There are a number of smart monitoring systems developed for smart grids, bridges or machine system management, temperature/gas and light source monitoring and so on. As information technology advances at a continuous rapid pace, humans have become connected online and this connection has extended into the interactions between things and humans. Employing the FLAGPSoC-1605A development board as the platform, all sensor data are transmitted via a ZigBee wireless module, a TCP/IP network module and a long range wireless communication GPRS/SMS module for analysis to the environment and industrial production and have to control it. This constitutes a smart network for connections between humans and objects**.

I. Introduction

Currently facing an energy crisis caused by the green house effect, the relative humidity and temperature control in many precision environmental research facilities is critical to research success. Bridges in a city are important engineering lifelines for basic civil life, with safety a critical factor. This study establishes an intelligent environmental monitoring and control system that includes a smart grid, bridges, gas leakage in industries and mechanical tilt monitoring temperature and humidity monitoring.

The FLAG-PSoC-1605A development board platform is used in this work to transmit all sensor data through a ZigBee wireless module linked with a TCP/IP network module and remote wireless communication GPRS/SMS module to a remote computer for information analysis to the environment and industrial production and have to control it. . The Programmable System On Chip (PSoC) chip is a self-selecting digital pin or analogue input and output unit that can significantly reduce the number of required peripheral parts and quickly fulfill the design needs.

II. LITERATURE SURVEY

The issue of bridge inclination monitoring is addressed in this work using a three axis accelerometer mounted on the bridge structure. An administrator is alerted by a text in case of any earth quake or inclination event. A bridge structure safety monitoring system is demonstrated in using motion picture virtual reality technology, stimulating a futuristic research direction.

In addition to bridge monitoring, there are a great number of three axis accelerometer applications, one of which, as presented in provides a force and torque analysis suggestion

when reducing the ingredients. We can also employ the detection function in bridges for managing shock

(horizontal or vertical) and the signal amplitude to predict the possible outcomes and follow-up treatment.

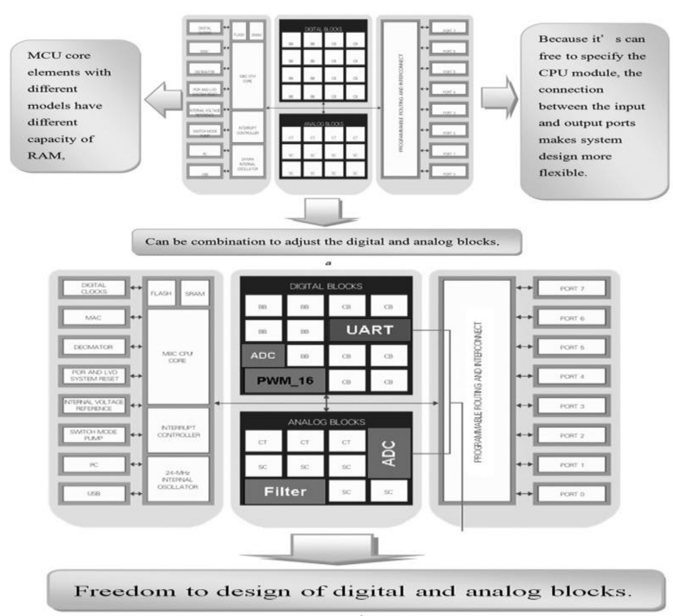

Fig. 1 PSoC configuration

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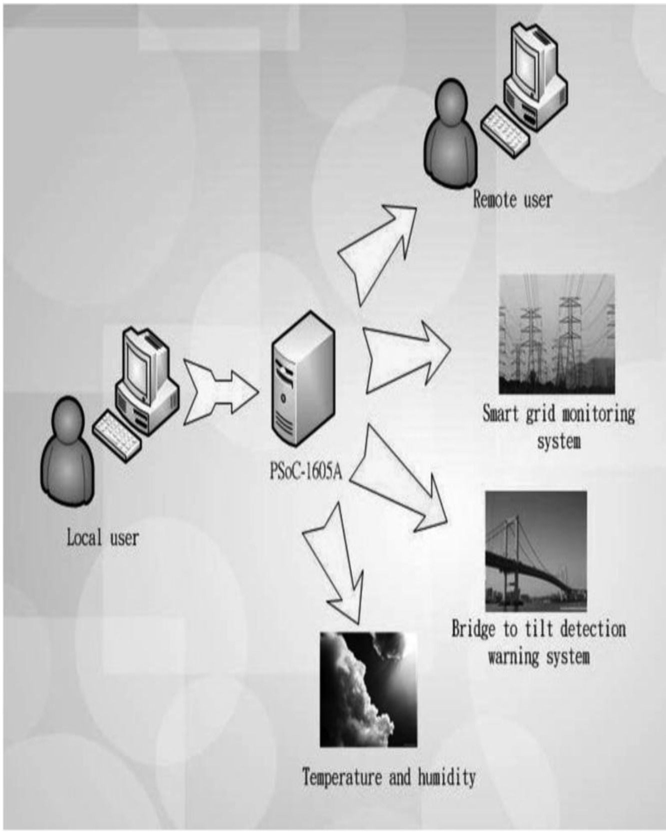


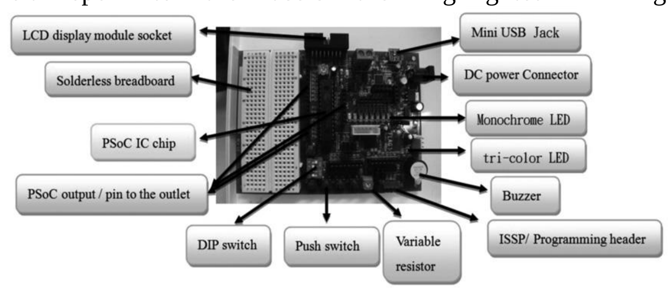
Fig. 2 System architecture

A complicated but reliable data transmission is ensured by a dynamic routing topology with multiple transmitting nodes. In an improved routing prototype version, dynamic multi path prototype is proposed to upgrade the ZigBee network and a novel safety health and environmental management system is presented for a smart home energy manager. Temperature and humidity are both factors that must be regulated for storage or during chemical processes. A temperature/humidity module is connected to a PC via a USB interface. The monitored data is then delivered to remote end users via a network. A dual mode USB interface provides a more reliable and higher speed data transmission. As presented in a humidity/temperature curve is plotted in a Visual Basic program and analyses in Microsoft Office Excel. In a GSM alarm system was presented in the event that the monitored temperature/humidity exceeds specified levels. Introduced by Microsoft, Visual Basic is a programming language featuring graphic user interface, database management and communication. Compared with this study design does not use the Visual Basic program. The proposed system uses the Access Port program which is free software to greatly reduce cost.

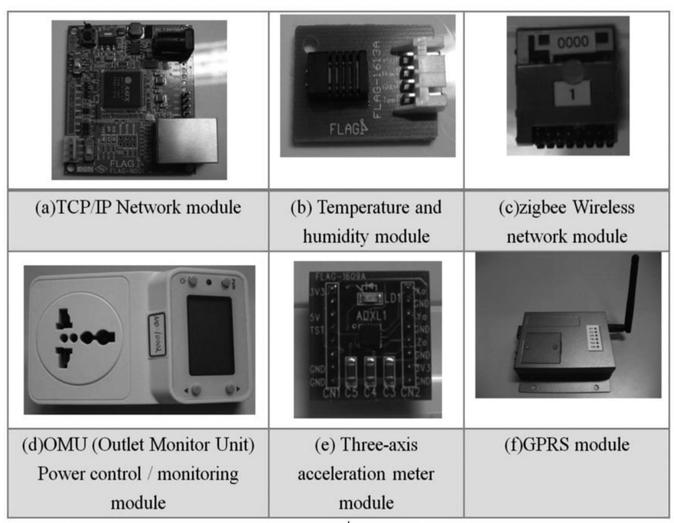
.III. SYSTEM ARCHITECTURE

Announced by Cypress Semiconductor, USA, the Programmable System On Chip (PSoC) is also known as the mixed signal array. Integrated together with a variety of electronic components it is able to serve as a regular microprocessor for configuring both digital and analogue blocks to meet the users' needs. A PSoC configuration is illustrated in Fig.

Different PSoC models are equipped with various sizes of RAM, EEPROM, Flash RAM and so on, just as various types of MCUs are equipped with various core components. shows a block highlighted in blue representing the area that is left open to the users. Respective registers can be set in each block employing pre designed firmware. This approach allows various features to be provided, for example, DAC, SPI, PWM, ADC, UART etc. The digital and analogue blocks left open to the users are highlighted in Fig.



a



b

Fig. 3 FLAG-1605A

A PSoC is made more versatile with the following features

1. Graphical user interface: the PSoC designer enables the users to design a graphic user interface and provide a development environment in two levels, that is, system and chip levels.

2. Mixed signal: by integrating digital and analogue blocks together a PSoC is enabled to deal with analogue and digital signals at the same time.
3. Programmable: a reduction in peripheral requirements is made by the user programmable analogue and digital blocks in the PSoC MCU.

In compliance with IEEE 802.15.4, ZigBee is a wireless network standard stipulated by the ZigBee alliance. A ZigBee module is a bidirectional short range wireless transmission device featuring low-energy consumption, low cost, small size, low delay and low-transmission rate. The physical layer and Medium Access Control Layer, as in IEEE 802.15.4, are arranged at the bottom, whereas the Network layer, application layer and security layer are at the top. A ZigBee device is operated at 2.4 GHz, 868 and 915 MHz bands, supporting 128 AES bit encryption.

In this work, a FLAG-PSoC-1605A development board is adopted as an experimental platform Taking advantage of an LCD display, ICP/IP network, temperature/humidity, ZigBee wireless, OMU, three axis accelerometer and GPRS/SMS modules, a number of monitoring systems are expected to be developed, including a bridge inclination alert system and a smart grid monitoring system. As shown in Fig. the reading is registered on the LCD display module, and then dispatched to a PC at the remote end through the PSoC via a TCP/IP network.

IV DEVELOPMENT PLATFORM

This work employs a FLAG-PSoC-1605A with built-in PSoC-CY8C29466 PDIP as a development platform, where an ISSP socket gets connected to a Cypress MiniProg burner and the built-in USBUART Bridge chip is connected to a PC via a USB interface. Up to 24 sockets are directly connected to the PSoC I/O pins and a variety of peripheral devices; including push buttons, DIP switches, single and triple colour LEDs, variable resistors, and buzzers and so on. Other than these, a number of components can be easily added to a USB or ISSP powered development board that can be powered at 7–9 V DC as well. The adopted FLAG-1605A development board is pictured in Fig.

.

The individual modules are described as follows

(a) TCP/IP network module: The development board is connected to a 10BaseT/100BaseT/1000BaseT network via a universal asynchronous receiver/transmitter (UART) module. It supports dual transmission modes, P2P AND TCP. In the TCP mode, the receiver can be dynamically specified by PSoC, meaning that there is no need to reboot the module. Although in the P2P mode an exclusive security channel is built for the specified IP address connection. This module is designed to handle the HTTP prototype and web preference can be altered by a web browser directly.

(b) Temperature/humidity module: there is a built-in sensing circuit composed of a humidity sensor chip and a thermistor, whereby a thermometer/humidistat can be built accordingly.

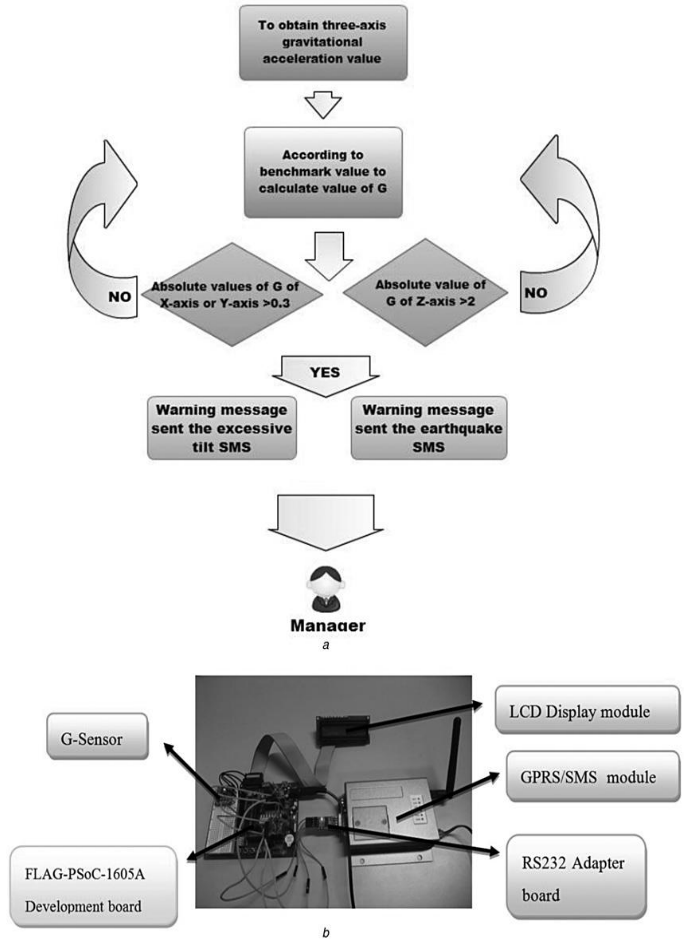


Fig. 4 Bridge inclination monitoring system

This module is powered at 5 V, providing an analogue output between 0.8 and 3.42 V for the humidity range of 0–10% RH, with an error of ± 5% RH over 20–95% RH, whereas a 10 kΩ NTC thermistor at 25°C is connected in series with a reference resistor of 39 kΩ, providing an output voltage between 0 and Vcc.

(c) ZigBee wireless network module: in compliance with IEEE 802.15.4, the ZigBee module is operated at 2.4 GHz band, with a UART/I2C interface for an easy connection to the MCU. Through an I2C to UART converter, the UART interfaced data can be acquired by the I2C interface. This ZigBee module allows the settings to be configured, acquiring the respective module dynamic status, data transmitted to other modules with auto network connection and jumper functions. A flexible network topology is also provided in the transparent mode for easy data exchange.

(d) OMU: this module is designed to monitor AC current, voltage, power factor and more. An electrical appliance is plugged in a built-in outlet in the OMU, following which all

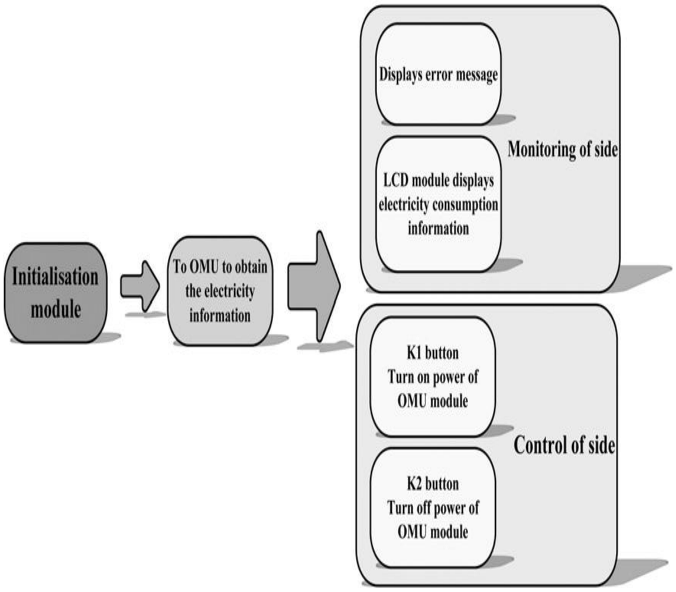


Fig. 5 OMU system configuration

the data from the sensors are sent through the built-in ZigBee module to a PC for analysis.
(e) Three axis accelerometer: this module is designed to sense the respective acceleration levels along the X-, Y and Z-directions, that is, it can be employed to detect whether the object is horizontally or vertically oriented or the vibration level and direction thereof. Powered at either 3.3 or 5 V DC, this module can detect acceleration up to ± 3 g in any of the X-, Y- and Z-directions. (f) GPRS/SMS module: compliant with the NMEA 0183 GPS protocol, a well known SiRF Star III chip is designed to reach a horizontal position accuracy of 10 m. A wide area augmentation system module provides improved accuracy of 5 m and is connected to a variety of MCUs via a UART interface.

V EXPERIMENTAL SIMULATION AND RESULT DISCUSSION

V.1 Bridge inclination monitoring system

Since Taiwan is a rainy, windy island subject to frequent earthquakes, plenty of bridges suffer many types of ageing Problems. Accordingly, a high precision, prompt bridge monitoring system is seen as more important than ever before these days. A bridge inclination alert system is made up of a FLAG-PSoC-1605A as the development board with a three axis G-sensor to monitor the bridge inclination level. An administrator is alerted by the monitoring system via a GPRS/SMS module in bridge over inclination or excessive vibration situations. A G-sensor provides an output voltage to indicate an acceleration level between ± 3 G. The output voltage goes up from 3.3 V/2 at 0 G at a rate of 3.3 V/10/G. The sensor in operation registers 1 G when it is outward vertically oriented, and − 1 G along the opposite direction, and indicates zero readings in the x- and y-directions. A reading of 0.3 G on the LCD is treated as over inclination by default, and a warning message is then sent to an administrator by way of the GPRS/SMS module Acceleration above 2 G is regarded as an earthquake event and a warning message is displayed as in the above case. A test shows that it takes on the order of 8 s to deliver an alert message to an administrator for taking any measures, for example, emergency evacuation, that is, a figure far less than 30 s, the time required to issue warnings by the Seismological Center, Central Weather Bureau, Taiwan. Energy saving has been turned into a hot issue these days because of ecological concerns. A smart monitoring system is designed for both household and enterprises to manage electricity consumption and promote energy efficiency.

```
[pseudo code]
Zigbee Start
Read OMU data
OMU data =1 second
While OMU data loss >=3 second
    Print To OMU to obtain the electricity information
        If obtaining information Then
            Displayed on the LCD
        Else Displays an error message
        Endif
Else
    If press K1 button Then
        Turn on power of OMU module
    Else
        If press K2 button Then
            Turn off power of OMU module
        Else OMU data loss >=3 second
        Endif
    Endif
End while
[pseudo code]
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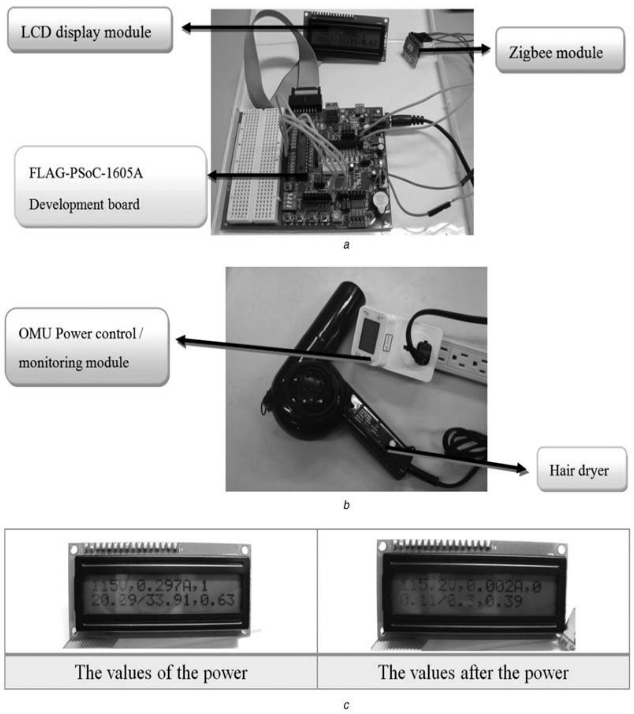
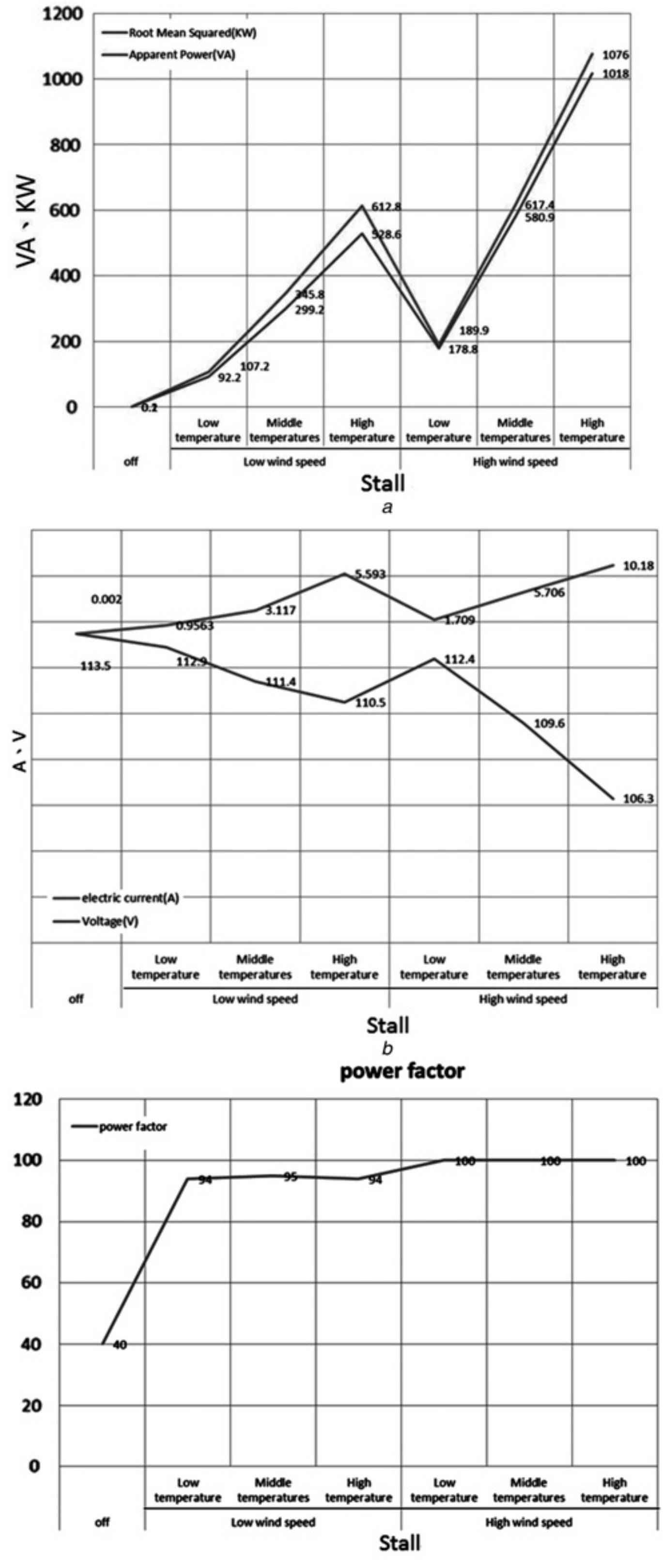


Fig. 6 Smart grid monitoring system

V.2 Smart grid monitoring system

With a FLAG-PSoC-1605A board employed as an experimental module, a number of quantities, for example, voltage, current, effective power, apparent power and power factor, are monitored and displayed on an LCD by an OMU module via a ZigBee transmission module. An OMU system configuration is presented in Fig. 6. The above configuration could be written in pseudocode as shown in Fig. 7. Pictured, respectively, in Figs. 8a and b are the proposed Smart and the OMU monitoring systems. It takes on the order of 6 s to initialise the ZigBee module, following which a number of quantities, that is, voltage, current, switch-status condition (1: open, 0: off), effective power, apparent power and power factor, are monitored by the OMU module and displayed on an LCD in order from left to right and top to bottom. A comparison is demonstrated in Fig. 8c between power on and power off. The aforementioned quantities, recorded by the OMU, are plotted in Fig. 9 with a Tashin TS-2000, 110VAC, 1200 W, 50/60 Hz hair dryer as a test object.

In Figs. 9a and b, we can see that the stall speed, temperature, voltage, current, active power and apparent power value changes because of the time change. At low speed and low temperature the power consumption is lowest. At low speed with high-temperature or high speed with medium temperature the power consumption is the same value. In high winds with high temperatures stall, the power consumption is highest and it's growth rate is close to low



Wind speed with high temperature. Discretion is advised in this condition. In Fig. 9c, the low speed Power factor is between 94 and 95%. The high-speed Power factor is 100%. By comparing Figs. 9a–c, we can Summaries the following arguments: the high stall speed with medium temperature is the maximum energy efficiency. Even in the non-used condition a hair dryer has 40% power factor loss, therefore if anybody is not using a hair dryer they can unplug it and avoid creating an unnecessary waste of energy. The OMU is designed not only to monitor the electricity consumption of devices at the remote end but also more importantly to provide safety protection. In the case of 10 A for a duration of 10 s, a warning indicator flashes red, whereas the indicator stops flashing and remains lit. The residence at specific humidity recommended for the residents' health.

V.3 Data transmission network system

Employees are believed to promote competition in a cozy workplace. An efficient way to regulate the ambient temperature/humidity levels for both enterprises and residences must therefore be found. With a FLAG-PSoC-1605A board as the experimental module, the humidity and temperature levels in a laboratory were regulated using a TCP/IP network module with DIP1 specified as the humidity/temperature module switch. Both the temperature and humidity are acquired, displayed on an LCD screen connected to a local PC via a USB interface. The data are sent to another computer at the remote end. The measured data are presented in graphic as well as tabular form. Figs. 10a and b illustrate the system design flow and laboratory configuration. The combination of the temperature/humidity and the TCP/IP network modules is pictured in Fig. 11a. Once the FLAG-PSoC-1605A board and the TCP/IP modules are powered on, DIP1 is specified as active and the temperature/humidity readings are accepted by the board and displayed on the LCD. The Accessport and WinTcp tools are started at the local and the remote ends, respectively. The local end computer displays the USB interfaced transmitted data, whereas the remote end displays data via the TCP/IP module. The accepted data presentation is made in either graphic or tabular form by EXCEL. Fig. 11b shows the LCD module, Access Port and the WinTcp tools.

VI NUMERICAL ANALYSIS

Relative humidity and temperature, measured in Celsius, are compared with. There are a total of 12 000 records during a time span of 10 h, that is, 1 record is taken per 3 s. As many as 60 records are made in total, namely one per 10 min, for statistical purposes. The standard deviation is given Suppose that there are a total of N records, that is, X1, X2, X3,…, Xn, from which n records are randomly selected, namely x1, x2,

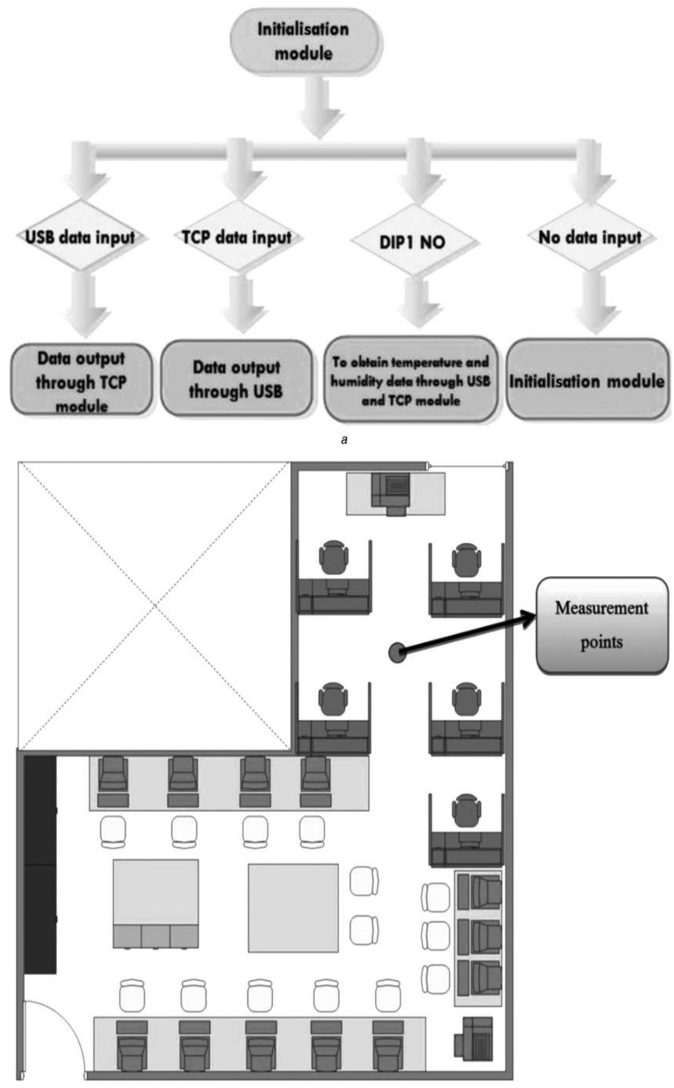


Fig. 8 Data transmission network

x3, …, xn. Thus, the mean value of the total data is evaluated as X = (1/N)_N i=1 Xi, and the variance thereof is s2 = (1/N) _Ni=1 Xi− X _ _2, whereas the mean of those selected, x1, x2, x3, … , xn, is given by x = (1/n) _n i=1 xi, and there are CN n possible combinations of n out of N records. A statistics on temperature and humidity is tabulated in Table 1 and the measured data against the sequential numbering of records are plotted in Figs. 12a and b. This experiment analysed the data and drew diagrams to indicate clear and rapid changes in the laboratory environment temperature/humidity condition. Figs. 12a and b show that the laboratory equipment sensed the temperature at about 28°C and humidity at about 55% in the morning. In the first 30 data (devices sensing the temperature reached 31°C), the system opened the air-conditioning system. The temperature and humidity decreased to the air-conditioning set temperature of 28°C. The humidity is lowered from the original 55% down to about

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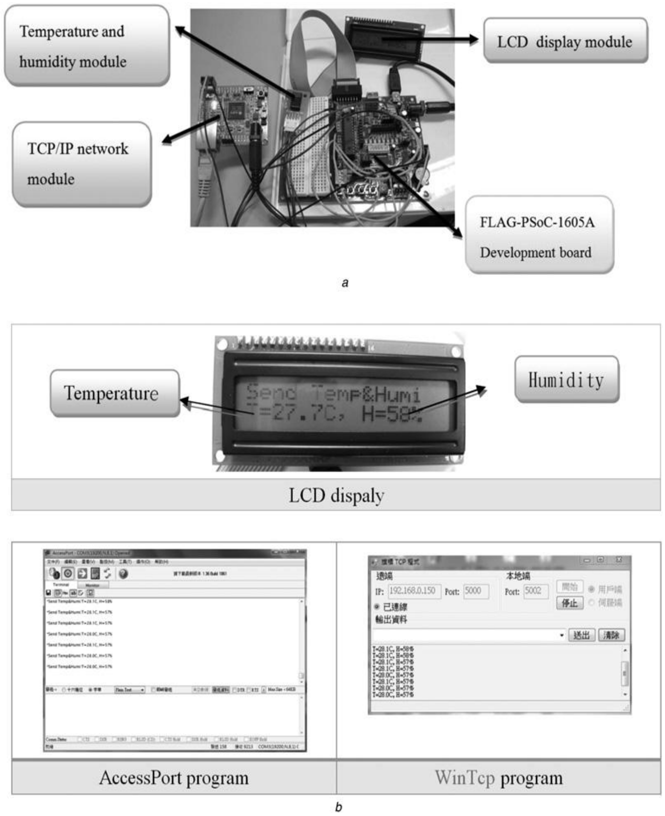

Fig. 9 Data transmission network

30%, about ten documents (s) to complete this record (about 1 h). When this system reaches the 40th data, the air temperature is adjusted to 26°C. Therefore the data is 40– 45 and the temperature and the humidity have been decreased significantly. By the statistical results and formula for analysis, temperature measurement and reference value error rate approach 0.69 which is quite accurate. The error rate of humidity measurement is high, the gap up to 7.53 is more commonly criticised, but also needs improving.

VII CONCLUSIONS

This study employed a FLAG-PSoC-1605A development board to establish an intelligent environmental monitoring and control system that consists of a smart grid, bridges or machine tilt and temperature/humidity, gas monitoring. The bridge tilt system issued a warning time of 8s, far less than the Seismological Center of Taiwan's Central Weather Bureau warning of 30s, can strive for more contingency time for managers. The error rate of temperature monitoring is only 0.69 which is quite accurate, the power monitoring system can help the users to enhance the level of electricity management. The produced chart data, allows the users to more clearly and quickly understand electricity. If any gas leakage occurred in the industries, have to monitor and control the industrial widows automatically. In the part of the data transmission module, this study uses small volume, low-cost and low-latency rate characteristics of the ZigBee module as a short-distance data transmission medium to achieve better security, intelligence, energy saving and efficient results.

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