International Journal of Multidisciplinary Research and Growth Evaluation

International Journal of Multidisciplinary Research and Growth Evaluation
ISSN: 2582-7138
Received: 07-08-2021; Accepted: 25-08-2021
www.allmultidisciplinaryjournal.com
Volume 2; Issue 5; September-October 2021; Page No. 212-215

Wireless environment monitoring using a wifi data logger

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Abstract
In this paper, we would like to present a multiple sensors system that used wireless sensing was designed and implemented for monitoring many parameters of the environment on the greenhouse. The proposed system could be used to monitor multiple agricultural data on the greenhouse with highly exacting results. In the agricultural sector, sensors are used to collect air temperature and air humidity, soil moisture, and the intensity of sunlight inside the greenhouse. The measurement results were sent to a Raspberry Pi which works as a coordinator in a wireless sensor network. A website interface application was designed for experiments and shown the measurement results on the greenhouse.

Keywords: Wireless sensor network, Monitoring agricultural data, Chemical sensor, Climate sensor, Monitoring environment

1. Introduction

Nowadays, many environmental sensors are widely used in data loggers and it is an important factor for logging needed data. Many wireless technologies and wired connections for monitoring systems were developed in supermarkets, automation, and transportation. These systems used RFID technology to provide information about food quality, to avoid food poisoning, and compact size with novel battery-less sensor tags [1-3]. In particular, the advent of Radio Frequency Identification (RFID) technology has opened a variety in food applications. Spoilage of food does not only affect the economy but is also harmful to consumers when people consumed a small amount of food spoilage. In [1], the authors have been designed a novel RF sensor tag that it can be collect data through RF signal [4, 5]. The customized tag is consists of a loop antenna that operates at a frequency of 13.56 MHz, RF front-end, a passive RFID chip, an energy harvesting circuit, a microcontroller, and an electrochemical sensor. The energy harvester unit is used to extract power that power on the interface circuit of the gas sensor.

Depending on application scenarios have different standards for wireless communication range and working data rates. The IEEE 802.11g standard family with a high data rate and reading range up to several meters long is widely used at a frequency of 2.4GHz [6] while in [6] can communicate at a larger distance and operate at ultra-high frequency band such as the frequency of global system for mobile communications (GSM) 900MHz to 915MHz. However, the distance of RFID technology is not enough for applications of the greenhouse and the GSM can solve all problems with a big cell area, but it is so long for the greenhouse. With the abovementioned features, the WiFi protocol operating at 2.4GHz would be the best choice for monitoring the factors of the environment of the greenhouse.

2. System Design

The system structure contains three main parts. The sensor interface is responsible for the connections of the sensors. The microcontroller with a local database presents for communication of the web interface and the storage data connection. The website interface allows the user to use the system and monitor all of the measurement results. System's structure is shown in Fig. 1.

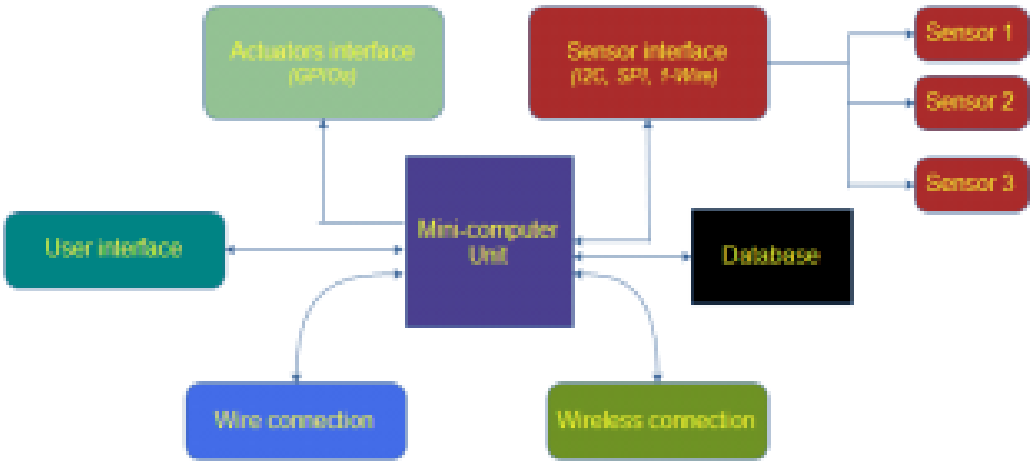

Fig 1: The Proposed System

The main component of a data collector device is the mini-computer unit with function as a micro-controller because it determines decisively the device's performance, expandability communicates with sensors, controls all actuators, and also sets the limits at the complexity of the program. Recently, a dual-core and high-performance micro-controller unit ESP32-WROOM-32 (32 bits mirco-controller, from Espressif Systems located in Shanghai, China) that low-cost SoC with built-in antenna Wi-Fi (WLAN network) is also a good choice for the proposed system. It can be operated at 240MHz [7], the authors have already detailed and some components of their system for wireless control and collect data in the agricultural sector.

Next, a wireless connection block uses to connect to a router WiFi network. The user interface is a portal web interface, presents measured results from sensors. The actuators interface block was developed to connect and control high-power machines. Lastly, the sensors connected to the proposed printed circuit board (PCB) and will be more detailed in the following part. To be more detailed about the software function and hardware will show in section II and section III and sensor components will be presented in the part A.

Sensor Components

There are three different types of sensors that is used to experiment consist of a DS18B20 sensor and an AM2315 sensor. A sensor board interface was designed to connect all sensors to MCU. The basic requirements are modularity, corresponding expandability, and minimizing the need for user interaction to be done with an operation.

To achieve this, the sensors or sensor board must be identified to the system in some way. This method covers more options. Assume that there is the sensor panel, which contains more sensors inside of a printed circuit board. The panel has a specific structure and connects to the motherboard based on a pre-designed interface with several cables and wired connect standards like I2C and analog to digital (ADC) conversion. With only one panel it would be easy because we only have to write one program to make it function, but with more panels, we have to achieve the identification as mentioned above. Information about few possible sensors can be seen in Table 1 as below.

Table 1: Characteristics of AM2315 sensor and DS18B20 sensor

Description	Characteristics of environmental sensors	
	AM2315 sensor [a.]	***DS18B20 sensor***
Measuring range	0^0C -100^0C, 10%-90%	-55^0C to 125^0C
Accuracy	± 2%, ± 1^0C	± 0.5 ^{0}C over range (-10^0C to 85^0C)
Operating range	0^0C - 80^0C, 0% - 90%	-55^0C -125^0C
Supply voltage	3.3-5.0VDC	3.0-5.5VDC
Response time	≤ 100ms	≤ 750ms
Sensor type	I2C	1-Wire interface
Dimension/pins	16mm x 98mm	3 pins

Connecting the sensors can be done with a simple digital, analog method, or with using I2C, and a 1-wire bus system. Another concept describes the sensor board as a blank printed circuit, with sensor-specific interfaces, which act as a separated system, and the sensors can be replaced by the user (see Table 2).

Table 2: The comparison of wireless communication technology

Name	Parameters of wireless technologies			
	Frequency band	***Data rate***	***Modulation***	***Application***
Zigbee	2.4GHz	<250kbps	DSSS, CSMA/ CA	Agriculture, Smart Home
GSM	GSM850MHz GSM900MHz DCS1800MHz Or PCS1900MHz	<85.6kpbs	TCP/ UDP, HTTP	Internet, Voice, Text, Agriculture
Bluetooth	2.4GHz	<1Mbps	FHSS	Automation, Home
WiFi	2.4GHz	<100Mbps	DSSS/ CCK, OFDN	Video, mart city, Green house
Lora	433MHz 868MHz or 915 MHz	<19.7kbps	OOK/ FSK	Agriculture, Smart city, Smart home

Software

A website was designed for interaction with users that it can be used to show result measurement and control actuators such as pump, motor through a simple locally database. When the software starts, it declares the global variables, imports libraries of GPIO ports, and checks all tables of a database, to the variables that contain the settings, which determines the system functions. The microcontroller can access the database via the services of the Apache 2.4 server control unit, and the values contained by it are defined by a custom database map. After the value assignment, the software initializes the connected devices, sensors, actuators, in addition, a basic debugging starts, which gives the user feedback, when a sensor is malfunctioning during the launch. The microcontroller is responsible for the sensor data read, the data are stored in the database after checking and processing, so we can be easily reached anywhere the measured data result from any kind of sensors.

3. Experimental Result

Fig. 2 shows the proposed WiFi data logger that was developed to monitor the environment with sensors. DS18B20 and AM2315 sensors are low power consumption environmental sensors and have a good sense of the environment inside the greenhouse (membrane house). DS18B20 with high accuracy was used to measure water temperature and AM2315 was used to measure air –humidity and –temperature in the greenhouse. The technical characteristics of sensors have been presented in Table 1. A commonly high accuracy commercial thermostat meter [8] that used to measure temperature and humidity in the air and it is also used to evaluate of the accuracy of the measured sensor data as well as calibration of the resolution of sensors.

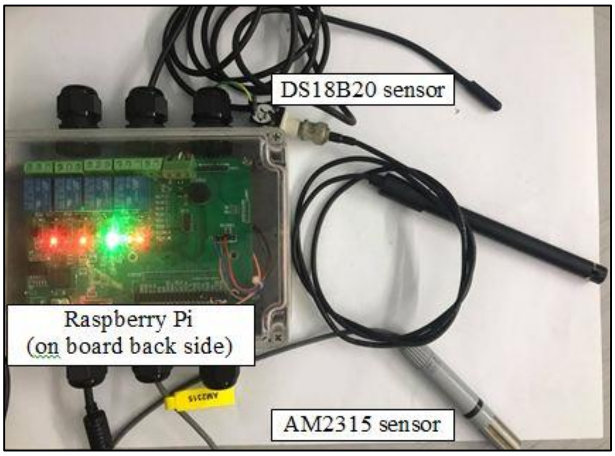

Fig 2: The proposed WiFi data logger and environmental sensors

In addition, we performed an experiment with the proposed system for one week and recorded measured data for 24 hours with an interval time equal to 30 seconds in laboratory room ambient temperature conditions, the water temperature is also experiment with a small fish tank in our laboratory and the proposed interface as illustrated in Fig. 3 and Fig. 4. The measured result of sensors inside the greenhouse has developed signs rapidly in the environmental conditions as shown in Fig. 4.

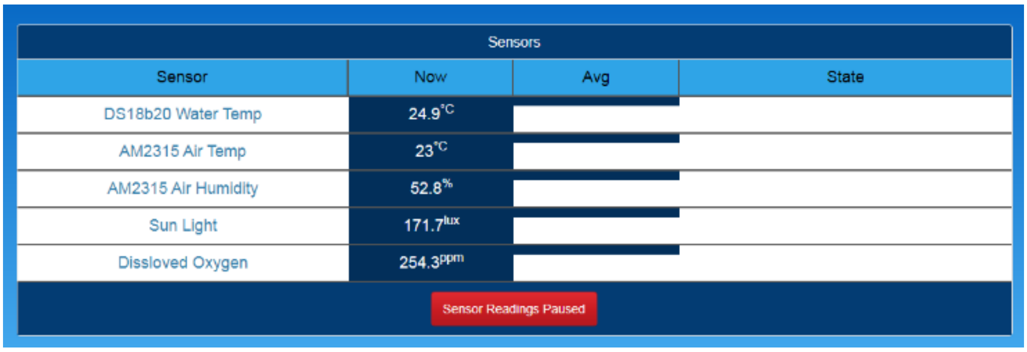

Fig 3: A screenshot of the main interface of the proposed website interface with sensor panel and measured results

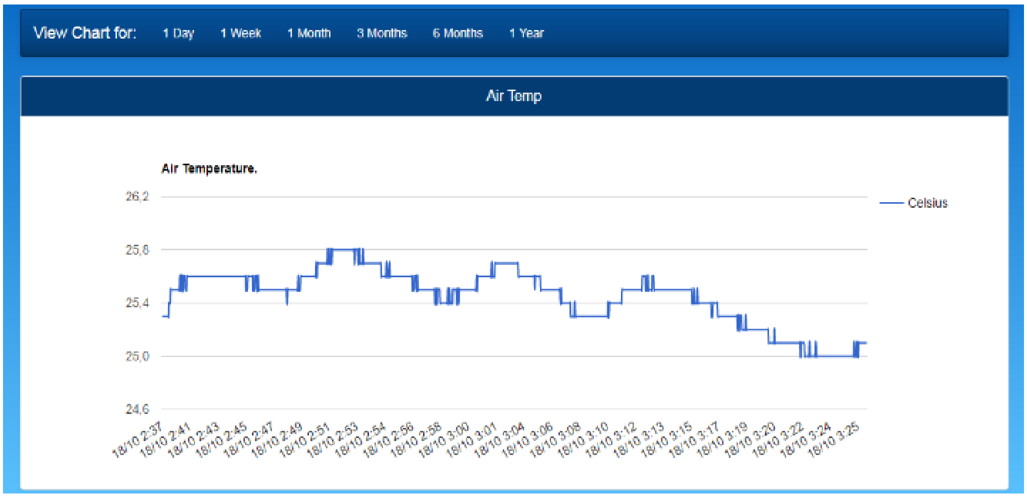

Fig 4: Screenshot of the proposed WiFi monitoring system with plotted measurement results of air–temperature by using AM2315 sensor.

4. Conclusion

In this paper, a multiple sensors data logger was designed using Raspberry Pi for monitoring some parameters of the environment in the greenhouse presented. The proposed system consists of a sensor node, an AM2315 sensor, a DS18B20 sensor, a prototype of an electronic mechanic, and a local server. The proposed system can be used to collect the water temperature, temperature, and humidity in the air inside the greenhouse, as well as analysis of the environment in advance from data collected in the database of Raspberry Pi. Through the router WiFi, the user can check remotely the environmental conditions inside the greenhouse through the logging system. Furthermore, the control actuators function will be developed.

5. Acknowledgement

This work was supported by FPT University, Hanoi. Vietnam.

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