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RESEARCH ON DESIGN OF IOT DEVICES FOR COMPUTER ROOM SAFETY MONITORING

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Abstract:

The use of IoT devices to monitor temperature and humidity, as well as detect fire explosions within the computer, is critical for experiment safety and efficiency. IoT devices can identify fire explosions and dangers early on, allowing them to safeguard costly equipment and assets, keep the environment steady, and improve experiment accuracy. Furthermore, it enables continuous remote monitoring, saving both time and effort. When an event occurs, IoT quickly transmits alerts, allowing for rapid response, reducing losses, and preserving costs. Based on these requirements, the research proposes options for designing IoT devices, including temperature-humidity and smoke sensors incorporated on a web server platform to monitor computer room safety.

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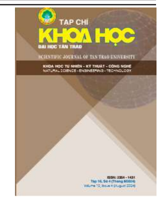

NGHIÊN CỨU THIẾT KẾ THIẾT BỊ IOT GIÁM SÁT AN TOÀN PHÒNG MÁY TÍNH

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Tóm tắt

Việc ứng dụng thiết bị IoT để giám sát nhiệt độ, độ ẩm và phát hiện cháy nổ trong phòng máy tính là cần thiết để đảm bảo an toàn và hiệu quả trong nghiên cứu. Hệ thống IoT có khả năng phát hiện sớm các nguy cơ cháy nổ, bảo vệ các thiết bị và tài sản có giá trị cao, đồng thời duy trì môi trường ổn định, tăng độ chính xác của thí nghiệm. Ngoài ra, nó cho phép giám sát liên tục từ xa, tiết kiệm thời gian và công sức. Khi phát sinh sự cố, thiết bị IoT tự động gửi cảnh báo, giúp phản ứng kịp thời, giảm thiểu tổn thất và chi phí bảo trì. Dựa trên nhu cầu này, bài báo trình bày giải pháp thiết kế thiết bị IoT tích hợp cảm biến nhiệt-ẩm và cảm biến khói, được nhúng trên nền tảng webserver để giám sát an toàn phòng máy tính..

1. Introduction

Nowadays, socioeconomic life is evolving, allowing individuals to quickly access new means, enhance their quality of life, and save time. However, this convenience is associated with several risks, including fire, electrical mishaps, and loss of security. These dangers might result from manufacturer mistakes or human negligence when operating the device. As a result, there is a rising requirement for safety monitoring in workplaces and buildings, particularly computer rooms with a high concentration of information technology equipment.

IoT devices to monitor temperature, humidity, and fire alarms in computer rooms are critical to ensuring safety and research productivity. IoT technologies identify fire and explosion hazards early on, safeguarding expensive equipment and property. It contributes to the stability of environmental conditions, improves experiment accuracy, and allows for continuous remote monitoring, saving labor and time. Furthermore, this system complies with safety and environmental laws, provides continuous reporting and data storage, and assists in reviewing and enhancing workflows. IoT also enhances management and operational efficiency by centralizing management and data analysis, allowing for better process prediction and optimization. IoT has several practical benefits, including increased safety and performance in computer rooms.

2. System model

Based on the survey of the Wifi when monitoring buildings, we realize that some of the common monitoring requests include: temperature and humidity tracking, fire alarm, smoke alarm, and intrusion warning. To address these requirements, the team suggested an early concept for a computer room monitoring system based on WiFi technology. This model not only increases the safety and security of the building, it also helps to control, and facilitate operations thanks to remote monitoring and quick response. In addition, using Wifi technology can reduce the setup and maintenance costs compared to the traditional style with wires. This is a critical first step toward developing a comprehensive, efficient, and cost-effective monitoring system for modern structures.

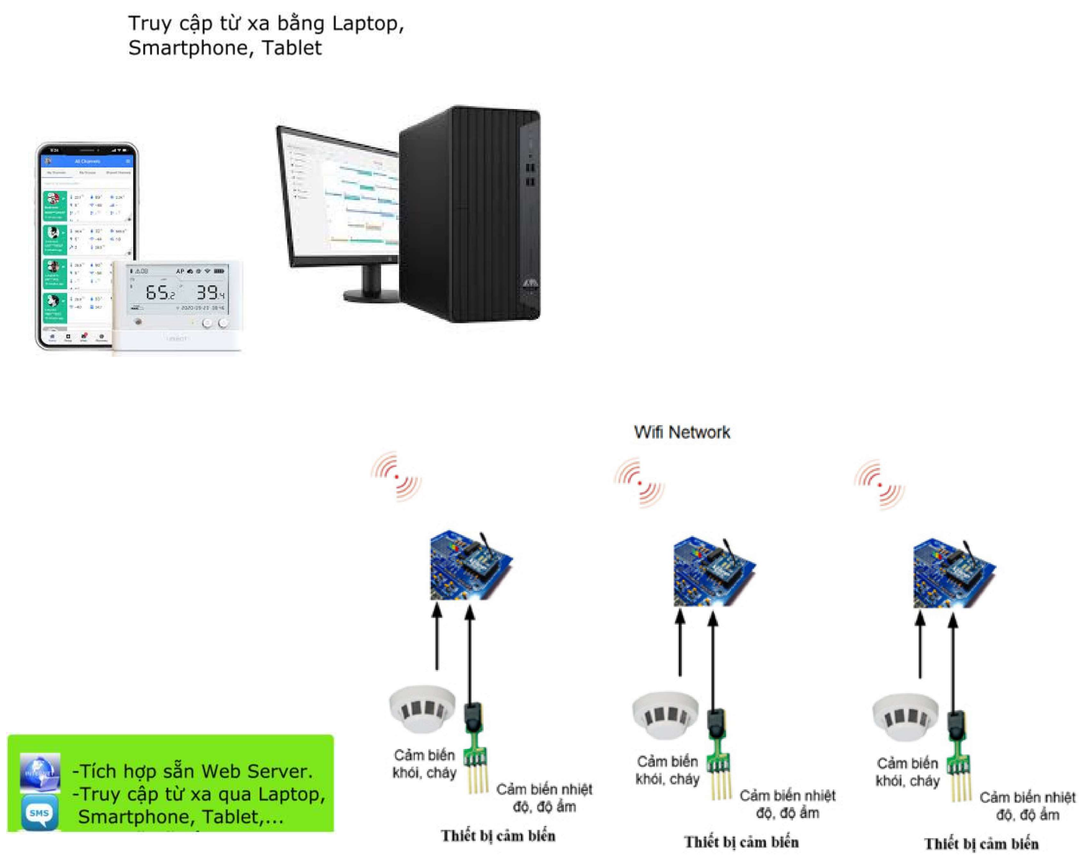


Figure 1. Model of computer room security monitoring system via wifi network

3. IoT Device Hardware Design

The system is composed of wireless sensors installed in the building to continuously monitor environmental factors and security. This sensor will transfer data through Wifi to a control center where data will be analyzed and processed. When detecting unusual indexes such as high temperature, unstable humidity, smoke, or trespassing, the system will activate immediate alarms through multiple channels like mobile phone, email, or whistle.

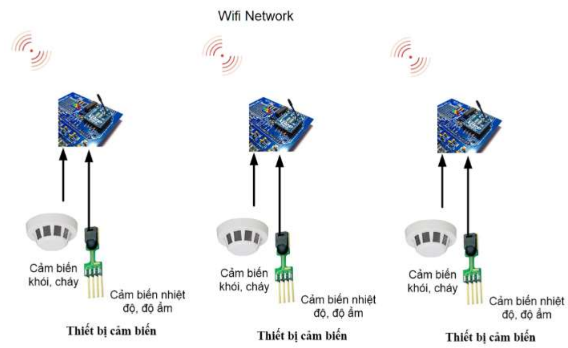


Figure 2. IoT device model for monitoring computer room safety

3.1. Temperature and humidity measuring module

The role of collecting devices is to obtain an index from heat sensors, humidity, and smoke detectors. The output of the heat sensor, humidity is voltage solution from 0-5V. Thus, heat and humidity measuring devices require at least 2 inputs similar to AI to connect with heat and humidity sensors. The devices that collect environmental indices will transport collected data through wireless Wifi heading to the main server. Therefore, the wireless information transferring module will be incorporated into the mainboard.

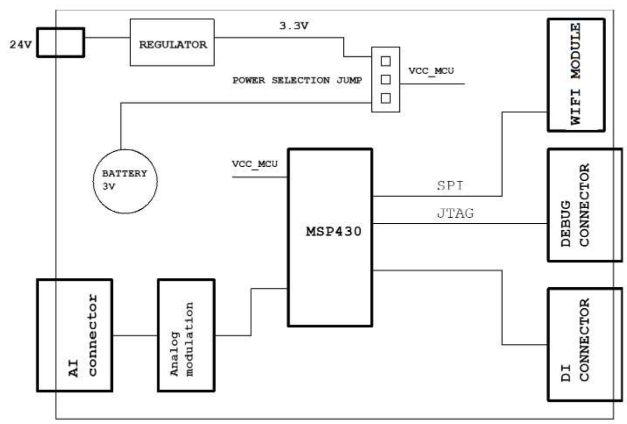


Figure 3. Block diagram of temperature and humidity measuring module

The center of this module will be the Processor MSP430F2618 from Texas Instrument. This processor is responsible for collecting AI and DI parameters and then transferring these parameters to the Wifi module to transfer to the server. AI signals with a range of 0-5V will be passed through a signal modulation system to enhance stability, anti-interference and form a suitable signal before being sent to the processor.

The mainboard will have a Debug port to load programs to the on-board Processor and debug programs written to the processor.

The processor will control the operation of the Wifi IC, transmitting the collected data to it to transmit to the server via wireless network.

Other than that, the power supply for the entire board will be flexibly selected to commondate actual needs. There are 2 options for power supplies:

+ Power supply from 3.3V battery: This power supply is suitable for designs that require little energy and are difficult to supply power.

+ Power supply for over 24V: This power supply is suitable for designs that require a lot of energy, need to operate continuously for a long time and are convenient for supplying 24V power. The 24V power supply will be modulated into a 3.3V power supply to supply the entire board.

These two power sources can be flexibly selected by Jumper.

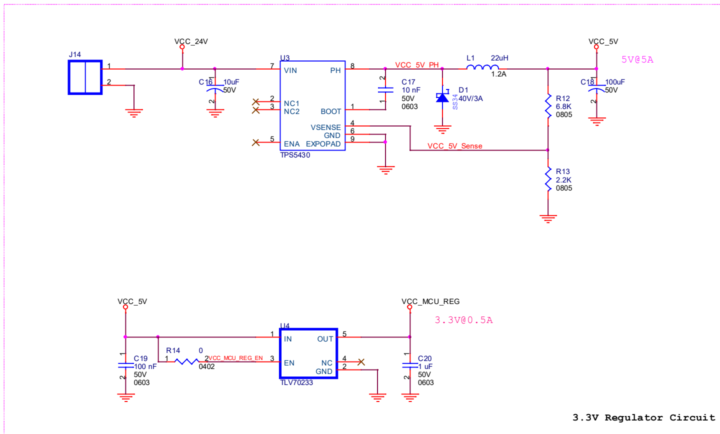


Figure 4. 3.3V power modulation circuit from 24V power source

To increase the stability and heat resistance, the power circuit is designed into 2 layers. The first layer modulates from 24V to 5V, the second layer reduces the voltage to 3.3V.

3.2. Embedded software design

As analyzed above, the temperature and humidity measuring device is designed on the MSP430 chip technology platform and Wifi communication chip. The Wifi chip is integrated on a separate module, specialized in performing network connection to increase system flexibility and convenience for research. The MSP430 processor is responsible for controlling the Wifi network input IC, transmitting and receiving information with the network via the Wifi wireless protocol. At the same time, this processor is also responsible for receiving information from the temperature and humidity sensor and sending this data to the central monitoring device via the Wifi protocol. With such features, the firmware written for the MSP430 processor is designed according to the following algorithm flowchart:

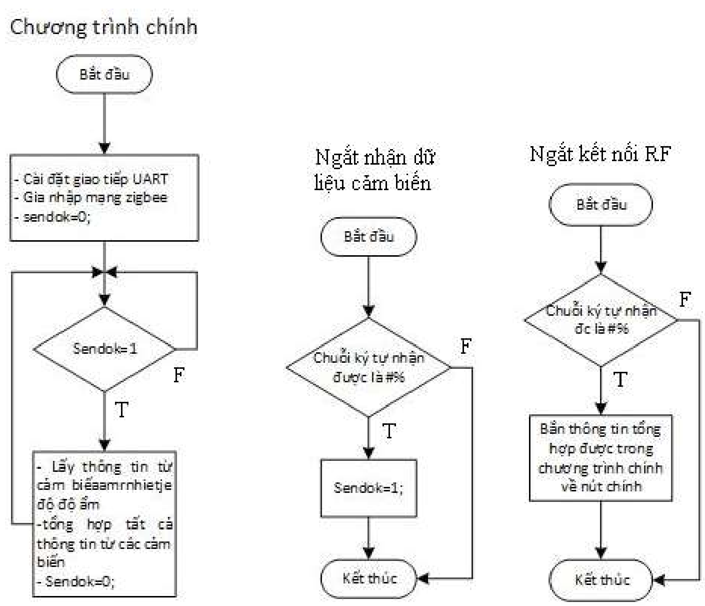


Figure 5. Embedded software algorithm flowchart

This program will perform the following process: When powered on, it will initialize the modes for the device, interrupts, UART ports, I/O … Then it will control the IC Wifi to find and connect to the Wifi network system. After that, it will wait until the server sends a data request command. Meanwhile, the temperature and humidity information from the sensor is continuously sent to the device and stored. When there is a data request command from the user server, this data will then be sent to the user server via Wifi.

Some executable code of the software:

Interrupt program receives UART from temperature and humidity module

```
#pragma vector=USCIAB0RX_VECTOR
__interrupt void USCI0RX_ISR(void)
{
      xx=UCA0RXBUF;
      if (xx=='%') ii=0;
      if (xx=='#')
      {
sendok=1;
      }
      rec[ii]=xx;ii++;
}
```

Interrupt program receives uart from RF transmitter module

```
unsigned char ss;
#pragma vector=USCIAB1RX_VECTOR
__interrupt void USCI1RX_ISR(void)
{
  yy=UCA1RXBUF;
 if((yy=='#')&(ss=='%'))senddata(0x0000,st);
  else ss=yy;
}
```

Main Program

```
while (1)
{
   sendok=0;
st[0]='(';st[1]='0';st[2]='0';st[3]='0';
st[14]=')';
 if (P2IN & BIT1) {st[4]='0';}
else st[4]='1';
if ((P2IN & BIT0)) {st[5]='0';}
else st[5]='1';
unsigned char j=6;
while (!(sendok)){}
for (i=1;i<9;i++) {st[j]=rec[i];j++;}
}
```

3.3. Smoke alarm device module

The device that gathers measurement parameters is in charge of gathering information from temperature, humidity, and smoke alarm sensors. The output of fire and smoke alarms is digital. Thus, the smoke alarm module needs a digital input (DI) to connect to the fire and smoke alarm sensor.

The environmental parameter collection device will transfer the collected data via Wifi wireless network to the server. Therefore, the wireless communication module will be integrated into the circuit board.

The fire alarm and smoke sensor is a digital sensor. When the smoke concentration (CO_2) exceeds a certain level, this sensor will generate a digital signal by closing a contact point. This contact will be connected to the fire alarm and smoke alarm processing module via a DI port with a suitable mechanism to generate a digital signal for the module.

The center of this sensor circuit will be the Texas Instrument MSP430F2618 processor. This processor is responsible for collecting DI parameters and then transferring these parameters to the Wifi module to transfer to the server.

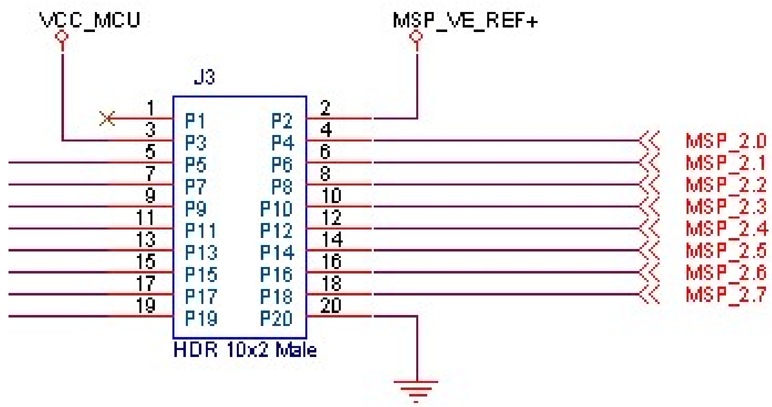


Figure 6. Connect the smoke detector to the DI

This module is basically designed similar to the temperature and humidity sensor module, including the MSP430F2618 processor as the center and communicating via Wifi network. However, this module uses a digital signal output sensor, so it is necessary to design a digital connector to connect to the sensors.

4. Integrating and testing IoT devices to monitor machine room safety

4.1. Install IoT devices to monitor machine room safety

- Install the app on your smartphone (Android recommended)

Android:

https://play.google.com/store/apps/details?id=de.kai_morich.serial_bluetooth_terminal&hl=vi&gl=US

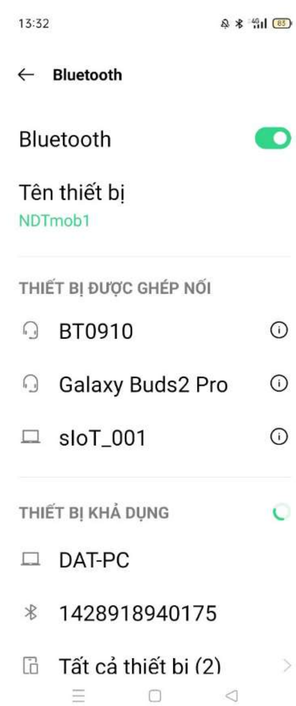
IoS:

https://apps.apple.com/us/app/bluetooth-terminal/id1058693037

- Device setup steps:

Step 1: Turn on the device

Step 2: Go to the Bluetooth configuration of the smartphone:



Step 3: Select the device (default is sIoT_001) to pair with the smartphone

Step 4: Open the Bluetooth Serial Terminal app on the smartphone

Step 6: Turn off the device, then turn it back on

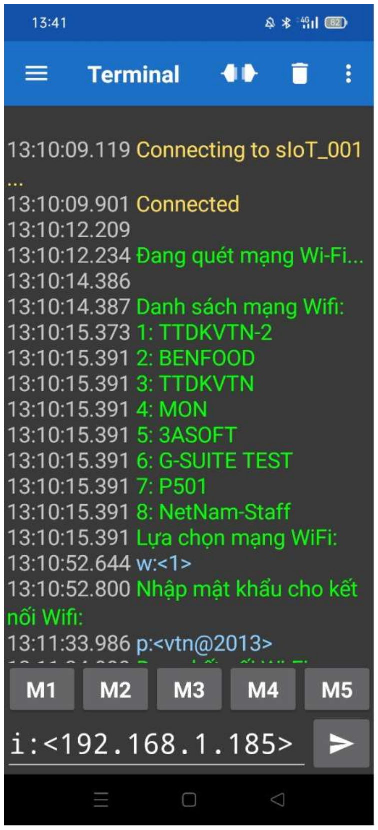
Step 7: Immediately after turning the device back on, go to the app and follow the steps to connect to the device. Select the device (default is sIoT_001)

Step 8: Configure the device:

Immediately after connecting to the device, the app displays the connection status (Connected).

Press the Enter button to continue.

The app will scan all enabled Wifi networks:



Select the network and set the password according to the instructions displayed on the app screen:

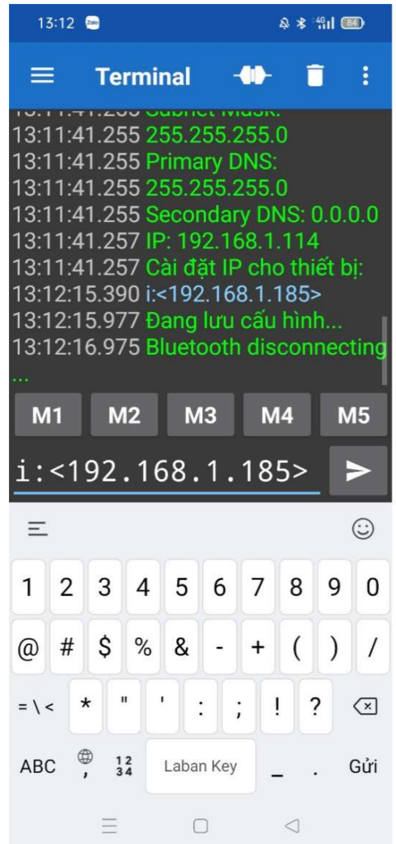
Select the network by typing the command: w:<id> in which id is the serial number of the Wifi network currently displayed

For example, to select network number 1, type the command: w:<1> then Enter

(Note: the commands are typed together, without spaces)

Set the password for the network: p:<password> in which password is the password of the network.

After installing Wifi, the device will automatically connect to the Wifi network. If the connection is successful, go to the step of setting a fixed IP for the device:



Set IP using command: i:<xxx.xxx.xxx.xxx>

For example, set IP 192.168.1.185 for the device, use command i:<192.168.1.185>

After installation is complete, wait for Save configuration and the device to run automatically (you can reset the device to check).

Note: Bluetooth connection for setting is only performed immediately after turning on the device, and must be connected within 5 seconds after turning on the device. If there is no Bluetooth connection, the device operates with the previously installed configuration.

4.2 Test results

The building monitoring system using IoT technology has been initially completed. The measuring devices, central monitoring devices and monitoring software have been completed by the research team and tested in the computer room of Tan Trao University. The devices have been connected to each other, collecting parameters from sensors and displaying on the monitoring software located on the web base.

Here are some images of the test run

Figure 7. IoT devices monitor computer room security

Figure 8. Webbase temperature-humidity and smoke alarm monitoring software interface

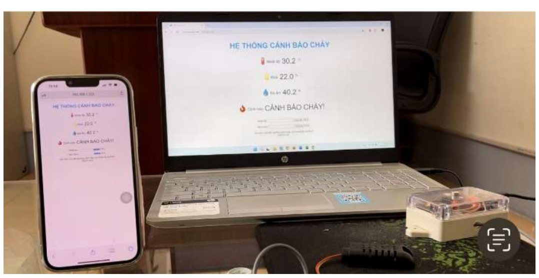


Figure 9. Fire alarm test results

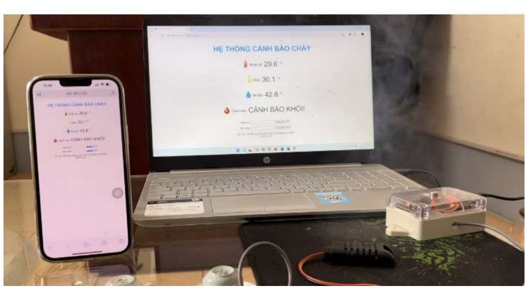


Figure 10. Smoke alarm test results

5. Conclusion

The computer room security monitoring system connecting to communication based on Wifi technology has been tested in the computer room at Tan Trao University and has shown very positive results. The system runs stably, consumes low energy; information exchange is very smooth (with a sampling frequency of 5s/time); the system can easily configure wifi network connection via Bluetooth; parameters are sent to the webserver and displayed accurately on the software.

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