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2. Medeshova A.B., Mukhambetova G.G Object-Oriented Programming [Text] : stud. book / - Almaty : "Bastau", 2016.
3. Pavlovskaya T.A. C/C++. High level programming languages. -Almaty: "Daur", 2012.
4. Boribayev B. Algorithm, data stucture and programming languages: Textbook. – Almaty: Qazaq university, 2012..
5. Boribayev B. C/C++ programming (examples and tasks): Educational and methodical manual. –Almaty: Qazaq university, 2013.
6. Straustup B. Programming. Principles and practice of using C++: 1-2- Volume. Textbook. - Almaty: 2013-2014.
7. Boribayev B. Programming technologies: Textbook. – Almaty: LLP RPBK «Daur», 2011..
8. Shekerbekova Sh.T., Salgozha I.T. Programming [Text] : Educational manual / - Almaty: Almanah, 2016.
9. Pavlovskaya T. A. Shchupak Yu.A. C/C++. Structural and Object-Oriented programming: Workshop.-SPb.: Piter, 2011.

MONITORING AND MANAGING SYSTEM OF MICROCLIMATE INDICATORS IN EDUCATIONAL FACILITIES

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The algorithm and structure of an automated system for monitoring microclimate indicators in educational facilities are exposed. A model of for monitoring and managing microclimate system based on Phoenix Contact hardware and software has been developed. A user-defined web-interface for remote monitoring and management of the current layout from mobile devices has been developed.

INTRODUCTION

Nowadays, the microclimatic conditions in which the staff of a particular enterprise, institution, or educational institution works are of great importance.

Measuring devices that are offered on the market today have a high cost and will not show the dynamics of changes in microclimate parameters over a long period of time. The process of measuring with separate measuring devices requires personnel who will take the indicators of measuring devices, keep a report in manual mode.

In the modern world, the trend of using alternative energy sources and improving the efficiency of power systems and their automation has long been spreading. One of the most energy-efficient structures is the urban infrastructure of electrical communications for heating educational premises, the modernization of

which cannot be ignored, because it is an integral part of modern technological progress.

Goals and objectives. The aim of the work is to automate the microclimate monitoring system of educational premises with the function of monitoring and managing microclimate indicators.

Relevance. Nowadays, the microclimatic conditions in which the staff of a particular enterprise, institution, or educational institution works are of great importance. The introduction of systems for monitoring the microclimate of Educational Premises is a necessary component for organizing comfortable conditions for all subjects of the educational process and rational use of energy resources.

Problem statement: this system should be easy to use and provide comfort. Be cost-effective compared to other systems.

1. Modern approach to monitoring and managing microclimate indicators and energy efficiency issues in ukraine

Microclimate is the conditions of the internal environment of premises that affect the heat exchange of employees. Microclimatic conditions in the workplace and industrial premises are the most important sanitary and hygienic factor that determines health and working capacity of a person. Microclimatic conditions are divided into optimal and acceptable.

Optimal conditions are a combination of microclimate parameters that, with prolonged and systematic exposure to humans, ensure the preservation of the normal thermal state of the body, without activating the mechanisms of thermoregulation. They provide a sense of thermal comfort and create prerequisites for a high level of performance.

Acceptable microclimatic conditions-a combination of microclimate parameters that, with prolonged and systematic exposure to a person, can cause changes in the thermal state of the body, which quickly pass and normalize and are accompanied by tension in the mechanisms of thermoregulation within the framework of physiological adaptation.

Due to the unstable supply of energy carriers to power plants in the country, an energy deficit is likely to occur, when the amount of electricity generated will not meet the needs of consumers.. Today, the daily load schedule of the United energy system of Ukraine has significant inequality. It is characterized by peak load during the evening maximum hours, failure at night, and almost uniform power consumption in the morning and afternoon.

The fact is that the demand for electricity is always different and varies greatly by time of day. There are two peaks of consumption in a day (the time when the most energy is needed) - in the morning - when the greatest amount of electricity is consumed, because most training sessions are held in the first half of the day. And there is a failure of consumption – evening and night - when a minimum of energy is consumed. In the Ukrainian energy system, the difference between peak and failure is

almost 25%, that is, at the minimum of demand, almost a quarter less energy is consumed than at the maximum.

Having considered the existing problem, the scientific paper proposes an intelligent system for monitoring the microclimate of Educational Premises. This system includes several floor sections, a ventilation system, each of which consists of a heating panel connected to a corresponding relay. As a result, intelligent underfloor heating does not heat the entire area of the classroom, but only the part of it where classes are held. Regardless of the type of heating panels used, even with low power, the total energy consumption is very significant, and such a technical solution provides significant energy savings [1].

2. Software and hardware implementation of the laboratory stand

The proposed automated system for monitoring and managing the microclimate parameters of educational laboratories must meet the following requirements:

- 1) respond in time to individual elements of the system to influence the microclimate indicators such as temperature, humidity, carbon dioxide levels and maintain them during the specified time interval;
- 2) protects the system from overloading and overheating of the equipment;
- 3) organizes a clear sequence of switching on and off installations, receiving and processing data, and clear operation of the web server;
- 4) reports System emergencies and deviations of indicators from the specified operating intervals using mobile and fixed communication channels.

After developing the algorithm of the automated monitoring and management system, it is necessary to develop a software implementation for the training layout .

The entire system consists of the following components:

- 1) Esp8266 Nodemcu V3 controller;
- 2) temperature and humidity sensor;
- 3) CO2 carbon dioxide level sensor;
- 4) high-level relay modules;
- 5) power supply unit;
- 6) underfloor heating modules;
- 7)Phoenix Contact ILC 130 ETH controller [3,4];
- 8) battery for backup power.

The Figure below shows a general Arduino circuit using the components we selected.

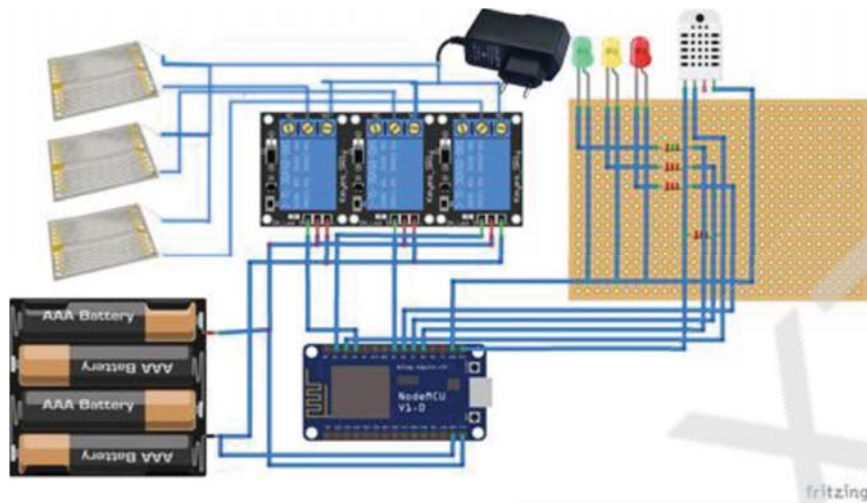


Fig. 2.1 – Arduino scheme

Connecting the Phoenix Contact ILC 130 controller
The ILC 130 controller receives an input signal from NodeMcu and generates a digital signal to control the relay States.

The input signal generation scheme is shown in the figure 2.2



Fig. 2.2 – Input generation scheme

After pointing all the components, we begin to assemble the training stand, first we will mount the NodeMcu ESP8266 controller in a standard model 3s

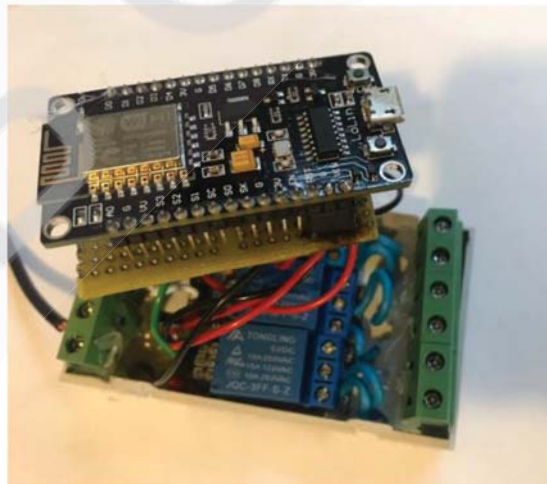


Fig. 2.3 – Assembling contoller

After connecting all the components, we mount them in a standard 3s enclosure.



Fig. 2.4 – 3s enclosure

Next we connect the controllers



Fig. 2.5 – Connecting controllers

After connecting the controllers, we connect temperature sensors, carbon dioxide sensors, underfloor heating plates, and a cooler. The result of developing model is on the Figure 2.6



Fig. 2.6 – Laboratory model

The main goals of creating our system are to achieve optimal microclimate parameters and energy efficiency. To do this, you need to develop a program that will solve these problems.

To solve the problem of energy efficiency, an algorithm for segmented floor heating in educational premises is proposed. This heating model reduces the necessary resources due to the fact that not the entire area of the room will be heated, but only that part of it where people are located. To do this, you need to use several relay modules and underfloor heating modules per audience. There are also several modes of operation of the system – standard and economical. The standard mode will be used when classes are held in classrooms. Economy mode will be used when classes are already over or during weekends and holidays. In Economy mode, the system will not operate at full capacity and will maintain a lower required temperature. This model allows you to save resources when the audience is idle and not heat up when it is not necessary.

The system will also have manual and automatic operating modes. In manual operation mode, the user controls the floor heating devices and segments themselves. In automatic mode, the user sets only the necessary temperature parameters for standard and economical operation. Dali the system controls the states of devices using relays by comparing the current microclimate parameters. The greater the difference in these parameters, the more powerful the system is. Below is a general flowchart of the program's algorithm.

For our project, developing a web server is one of the main tasks. The web server allows you to monitor and manage the system remotely and use a user-friendly web interface.

First, you need to implement the device's access to the internet. This can be done using the <ESP8266WiFi library.h>. To connect to the internet, you must specify the username and password from the Wifi hotspot and initialize the internet connection functions.

```
#include <ESP8266WiFi.h>
const char* ssid = "niz";
const char* password = "02121967";

void setup(void) {
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
  }
  Serial.println("");
  Serial.print("Connected to ");
  Serial.println(ssid);
  Serial.print("IP address: ");
  Serial.println(WiFi.localIP());
}
```

Fig. 2.7 – Connecting to the Internet

The next step is to start the web server. The ESP8266 module will independently perform the function of a web server and draw an html page. To do this, use the previously created sketch and add 2 <WiFiClient libraries.h > and <ESP8266WebServer.h>. These libraries allow you to send an html page at the user's request.

```
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <ESP8266WebServer.h>
const char* ssid = "niz";
const char* password = "02121967";
void setup(void) {
  WiFi.begin(ssid, password);
  while (WiFi.status() != WL_CONNECTED) {
    delay(500);
  }
  server.on("/", [](){
    server.send(200, "text/html", webPage());
  });
}
void loop() {
  server.handleClient();
}
String webPage()
{
  String web = "<div>Привет!</div>";
  return web;
}
```

Fig. 2.8 – Creating a web-server

The next step is to connect the Openweathermap web Weather Service and the time web service pool.ntp.org from the internet to our web server.

To connect Openweathermap, you need to register on the site to get the API

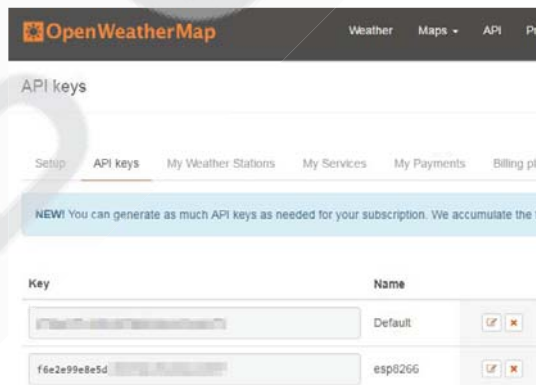


Fig. 2.9 – Receiving API key

These state data obtained allow us to view the temperature outside, use the weather forecast to turn on the heating in advance, since the heating system is inertial, it takes time to set the required temperature.

To get the date and time from the internet, use the <NTPClient library.h> which allows you to use the NTP protocol[8].After initializing a variable that receives time data from the web server pool.ntp.org this time is formatted using the

microcontroller's internal clock.

```
#include <NTPClient.h>
WiFiUDP ntpUDP;
NTPClient timeClient(ntpUDP, "pool.ntp.org", 10800, 3600123);
String date_time;
unsigned long times;
void setup() {
  timeClient.begin();
}
void loop() {
  if (millis() - times >= 1000) {
    times = millis();
    while (!timeClient.update()) {
      timeClient.forceUpdate();
    }
    int hh = timeClient.getHours();
    int mm = timeClient.getMinutes();
    int ss = timeClient.getSeconds();
    int dd = timeClient.getDay();
    datxml = String(weekd);
```

Fig. 2.10 – Receiving time data

This obtained data on the time state allows us to set the system's operating schedule based on the current time.

The created web interface is uploaded to the web server. Data from sensors is entered in the required fields. Hypertext transitions are implemented for buttons to access the server by the user.

After that, the server responds to the user's requests and sets the necessary system values.

```
server.on("/rele3Off", [] () {
  r3 = false;
  server.send(200, "text/html", WebsiteContent());
  delay(100);
});
server.on("/fanOn", [] () {
  f = true;
  server.send(200, "text/html", WebsiteContent());
  delay(100);
});
server.on("/fanOff", [] () {
  f = false;
  server.send(200, "text/html", WebsiteContent());
  delay(100);
});
server.on("/modeR", [] () {
  devmode = 2;
  server.send(200, "text/html", WebsiteContent());
  delay(100);
});
```

Fig. 2.11 – Server response

XML queries and Ajax technology are implemented to dynamically restore data from sensors and web services on the web server without updating the page. The

first step was to create XML to select and generate the necessary data, such as temperature, humidity, time, weather, and CO2 level.

```
void XMLcontent() {
    XML = "<?xml version='1.0'?>";
    XML += "<Donnees>";
    XML += "<temp>";
    XML += ttemp;
    XML += "</temp>";
    XML += "<time>";
    XML += alltime;
    XML += "</time>";
    XML += "<data>";
    XML += datxml ;
    XML += date;
    XML += "</data>";
    XML += "<hum>";
    XML += hhum;
    XML += "</hum>";
    XML += "<weath>";
    XML += weath;
    XML += "</weath>";
    XML += "</Donnees>";
    server.send(200, "text/xml", XML);
}
```

Fig. 2.12 – XML page

When the user or server accesses an XML page [9], its data is passed to a javascript file. This file selects the fields to which data will be sent and the frequency of data recovery.

```
Javascript += "function response() {\n";
Javascript += "xmlResponse=xmlHttp.responseXML;\n";

Javascript += "xmldoc = xmlResponse.getElementsByTagName('temp');\n";
Javascript += "message = xmldoc[0].firstChild.nodeValue;\n";
Javascript += "document.getElementById('div1').innerHTML=message;\n";

Javascript += "xmldoc = xmlResponse.getElementsByTagName('time');\n";

Javascript += "function process() {\n";
Javascript += "xmlHttp.open('PUT', 'xml', true);\n";
Javascript += "xmlHttp.onreadystatechange=response;\n";
Javascript += "xmlHttp.send(null);\n";
Javascript += "setTimeout('process()', 200);\n";
Javascript += "}\n";
Javascript += "</SCRIPT>\n";
```

Fig. 2.13 –Dynamic updating

To be able to get optimal temperature parameters in automatic operation mode, 2 input fields and a set Send button were created.

```
Javascript += "function set_alert(){\n";  
Javascript += "h = document.getElementById('standart').value;\n";  
Javascript += "m = document.getElementById('eco').value;\n";  
Javascript += "server = \"/modeA?h="+h+"\&m="+m+"\&Set=Set";\n";  
Javascript += "request = new XMLHttpRequest();\n";  
Javascript += "request.open(\"GET\", server, true);\n";  
Javascript += "request.send();\n";  
Javascript += "alert('Параметры изменены')\n";  
Javascript += "};\n";
```

Fig. 2.14 – Receiving input data

JavaScript reads data from the required fields and passes the value to the controller.

Reliability and fault tolerance are important system criteria. Any sudden malfunction can cause the entire system to fail.

After the development of the software and hardware complex, the entire system was tested for operability and fault tolerance.

Initially, the Esp8266 was programmed with a ready-made sketch of the program. All necessary debugging information is displayed in the port monitor. After downloading the program and enabling the module open the port monitor and see all the necessary information.

```
.....  
Connected to niz  
IP address: 192.168.1.107  
HTTP server started  
0 0 0 0 1 21.50 54 656 23 15  
0 0 0 0 1 21.50 54 656 23 15  
0 0 0 0 1 21.50 54 656 23 15  
0 0 0 0 1 21.50 54 656 23 15  
0 0 0 0 1 21.50 54 656 23 15
```

Fig. 2.15 – Port monitor information

In the figure, you can see data about:

- 1) relay States;
- 2) operating mode of the systems;
- 3) state of the economic regime;
- 4) data from the temperature sensor;
- 5) data from the humidity sensor;
- 6) data from the carbon dioxide sensor;
- 7) optimal temperature parameters in standard mode;
- 8) optimal temperature parameters in standard mode.

Data is read every 100ms.

After starting the system and checking the controller's connection to the internet, go to the site 192.168.1.107 in the browser.

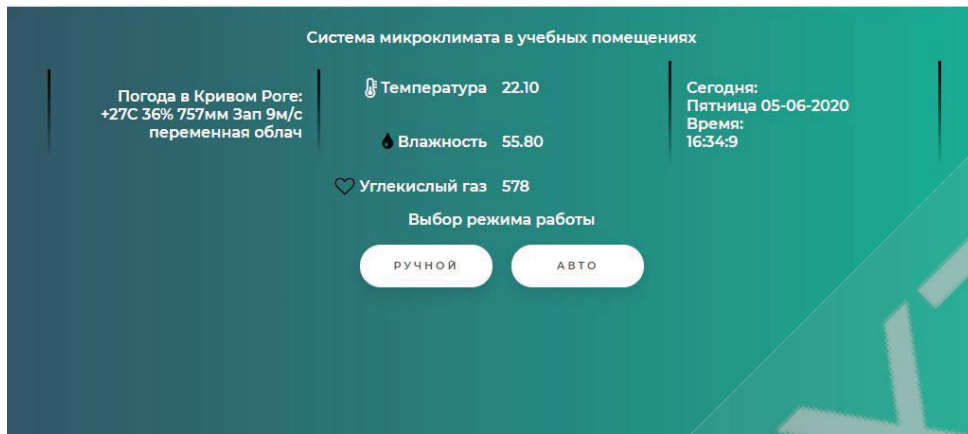


Fig. 2.17 – User web-interface

When switching the robot mode to "Auto", a stand is displayed that is economical to the robot mode, the fields for adjusting the necessary temperature parameters in the new modes, as well as the optimal parameters of the volumetric value and the level of carbon dioxide in the context of the standard norms of the parameters.

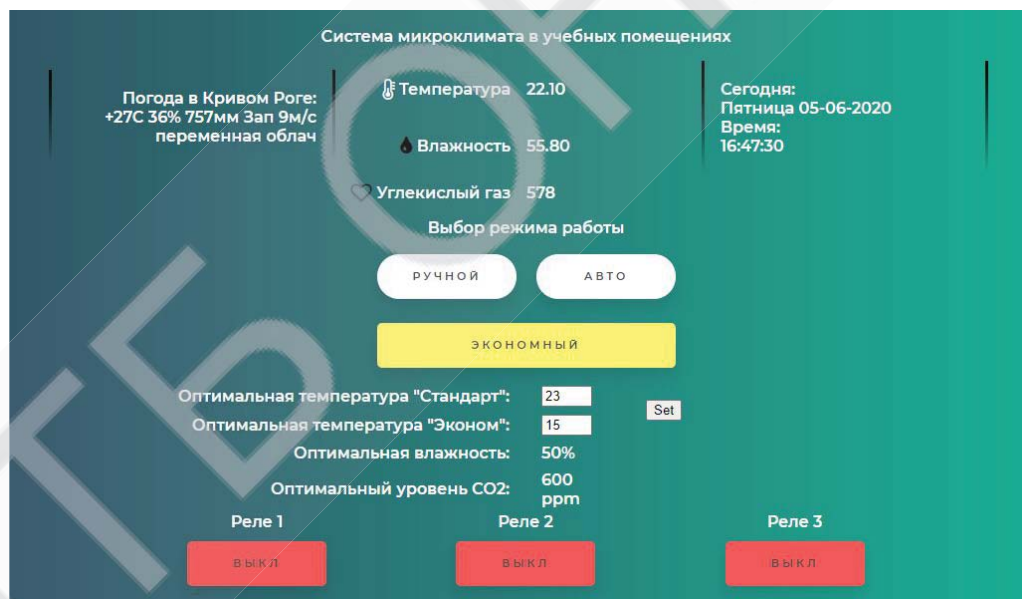


Fig. 2.18 – Economy mode

CONCLUSION

In the course of scientific work, an automated system for monitoring the microclimate in educational premises was introduced. The current state and relevance of the problem were studied, as well as a review of the modern approach to monitoring and managing microclimate indicators in educational premises was conducted. A functional scheme and algorithm of the system operation were developed.

After the developed scheme, the training stand "automated system for monitoring and managing microclimate indicators" was implemented.

After the implementation of the stand, an algorithm for the program was developed, all sensors and libraries were connected and configured. A web interface has been developed and a web server has been implemented. The program was also tested for operability and fault tolerance.

So, let's conclude that all the tasks set by us were successfully implemented and as a result, we have a working system for monitoring and controlling the microclimate in educational premises.

Testing of scientific results is presented at the following scientific and practical conferences: Computer intelligent systems and networks. Materials of the XI all – Ukrainian scientific and practical WEB conference of postgraduates, students and young scientists–Kryvyi Rih: state higher educational institution "Kryvyi Rih National University"2019 and 2020, information technologies and automation-2020:sat. additional information XIII International Conference, Odessa, 22-23 Oct. 2020

REFERENCES

1. Viesielovsky D. Monitoring and managing system of microclimate indicators in educational facilities / D. Viesielovsky, O. Ivaschenko, M. Ishchenko // information technologies and automation–2020 : sat. additional information XIII International Conference. Nauk. - prakt. conf., Odessa, 22-23 Oct. 2020 / Odessa. Nats. ACAD. food. P. M. Platonov Institute of computer systems and technologies "Industry 4.0"; org. com.: B. V. Yegorov (chairman) et al. - Odessa, 2020. - P. 99–101 : fig. – Ref.: 7 tit
2. Viesielovsky D. V., Ivashchenko A. R., Ishchenko M. A. MONITORING and MANAGING SYSTEM of MICROCLIMATE INDICATORS in EDUCATIONAL FACILITIES. Materials of the XI all-Ukrainian scientific and practical WEB conference of postgraduates, students and young scientists (March 22-24, 2020). Kryvyi Rih: Kryvyi Rih National University, 2019, pp. 230-232.
3. ILC 130 ETH-inline controller with Ethernet interface [electronic resource]-access mode: <http://www.denol.ru/phoenix/ilc130eth.php>
4. Phoenix Contact company catalog [electronic resource] - access mode: <http://catalog.phoenixcontact.net/phoenix>
5. DSTU EN 12599:2006 ventilation and air conditioning systems. Test procedures and measurement methods for commissioning ventilation and air conditioning systems. - [Valid from 259 01.07.2006]. - 48 s
6. Viesielovsky D. V., Ivashchenko A. R., Ishchenko M. A. automated energy– efficient heating system for residential premises// materials of the XI all – Ukrainian scientific and practical WEB conference of postgraduates, students and young scientists (March 21-23, 2019) - Kryvyi Rih: state higher educational institution "Kryvyi Rih National University", 2019. - pp. 150-151.
7. Open weather map [electronic resource] // access mode to information: <https://openweathermap.org/>
8. time synchronization NTP protocol [electronic resource] // access mode to information: <http://time.in.ua/ntp.html>
9. XML introduction [electronic resource] // mode of access to information: https://developer.mozilla.org/ru/docs/Web/XML/XML_introduction
10. HTTP requests. Methods of GET and POST [electronic resource] // mode of access to information: <https://guruweba.com/html/metody-get-i-post-ispolzovanie-i-otlichiya/>

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