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PORTABLE WEATHER STATION ON A MICROCONTROLLER

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Abstract. *In the modern world, a very relevant topic is modern developments that are used in technologies: "smart home". One of these developments is the development of a portable weather station using the Arduino-Uno microcontroller system. The portable weather station allows you to measure: temperature, humidity, atmospheric pressure. The results of these measurements are displayed on the liquid crystal display. The temperature and humidity sensor can be removed from the microcontroller unit by several meters, which allows you to place the microcontroller unit with a liquid crystal indicator in a convenient place in the room.*

The weather station is powered from a DC source with a voltage of 7 to 24 volts and the supply current does not exceed 100 milliamps.

A standard AC/DC 220V ~ /9V= adapter (converter) can be used as a power source, which makes the use of the weather station safe. Programming of the weather station is carried out using a standard computer via a cable via the USB 2.0 telecommunications port.

Keywords*: Arduino-Uno, smart home, humidity sensor, temperature sensor.*

I. INTRODUCTION

A smart home is a residential building organized for the convenience of people living using various high-tech devices.

The Smart Home understands specific situations occurring in the building and responds accordingly to them using pre-developed algorithms. At the same time, a person sets the desired environment with one command, and automation sets and monitors the operating modes of all engineering systems and electrical appliances in accordance with external and internal conditions.

The smart home itself adjusts the operation of all systems in accordance with the person's wishes, time of day, position in the House, weather, outdoor lighting to ensure a comfortable state inside the House. Creating a smart home involves having smart devices.

Smart home technology is an intelligent home management system that ensures automatic and coordinated operation of all life support and security systems. Such a system independently recognizes changes in the room and responds to them accordingly. The main feature of this technology is the integration of individual subsystems and devices into a single complex controlled by automation.

One of the main functions of a smart home is climate measurement, namely the use of temperature, pressure and humidity sensors. We will look at this function using the example of a portable weather station, the main component of which is the use of a DHT22 sensor that connects to the Arduino UNO microcontroller.

2. ARDUINO UNO MICROCONTROLLER

Arduino is a hardware computing platform for amateur design, the main components of which are a microcontroller board with I/O elements and a Processing/Wiring development environment in a programming language that is a simplified subset of C/C++. Arduino can be used both to create stand-alone interactive objects, and to connect to software that runs on a computer (for example: Processing, Adobe Flash, Max/MSP, Pure Data, Super Collider).

In this project, we used one of the varieties of Arduino microcontroller boards, namely the Arduino UNO board.

The Arduino Uno is a widely used Open Source microcontroller board based on the ATmega328P microcontroller. It includes everything you need for convenient operation with the microcontroller: 14 digital inputs/outputs (6 of them can be used as PWM outputs), 6 analog inputs, a 16 MHz Quartz resonator, a USB connector, a power connector, an internal programming connector (ICSP) and a reset button. To get started with the device, simply apply power from an AC/DC adapter or battery, or connect it to your computer using a USB cable.

Fig.1: Arduino UNO microcontroller.

Unlike all previous Arduino boards, the Uno uses an ATmega16U2 microcontroller instead of an FTDI chip as a USB-UART interface converter.

Table 1.

Basic value	Criteria
Analog inputs	6
Maximum output current 3.3 V	50mA
Maximum current of one output	40mA
Microcontroller	ATmega328
Supply voltage (limit)	6-20 V
Supply voltage (recommended)	7-12 V
Operating voltage	5 V
Clock speed	16 MHz
inputs / outputs	14 (6 of them can be used as PWM outputs) EEPROM 1 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Flash memoty	2 KB (ATmega328) of which 0.5 KB is used by the bootloader
SRAM	2 KB (ATmega328)

The Arduino Uno can be powered by USB or an external power source — the source type is selected automatically.

An AC/DC network adapter or battery/battery can be used as an external power source (not USB). The adapter plug (diameter — 2.1 mm, Center contact — positive) must be inserted into the appropriate power connector on the board. If the battery is powered, the wires must be connected to the Gnd and Vin pins of the POWER connector.

The voltage of the external power supply can be in the range from 6 to 20 V. However, reducing the supply voltage below 7 v leads to a decrease in the output voltage of 5V, which can cause unstable operation of the device. Using a voltage greater than 12 V may cause the voltage stabilizer to overheat and the board to fail. With this in mind, it is recommended to use a power supply with a voltage in the range from 7 to 12 V.

The ATmega328 flash memory capacity is 32 KB (of which 0.5 KB is used by the bootloader). The microcontroller also has 2 KB of SRAM memory and 1 KB of EEPROM.

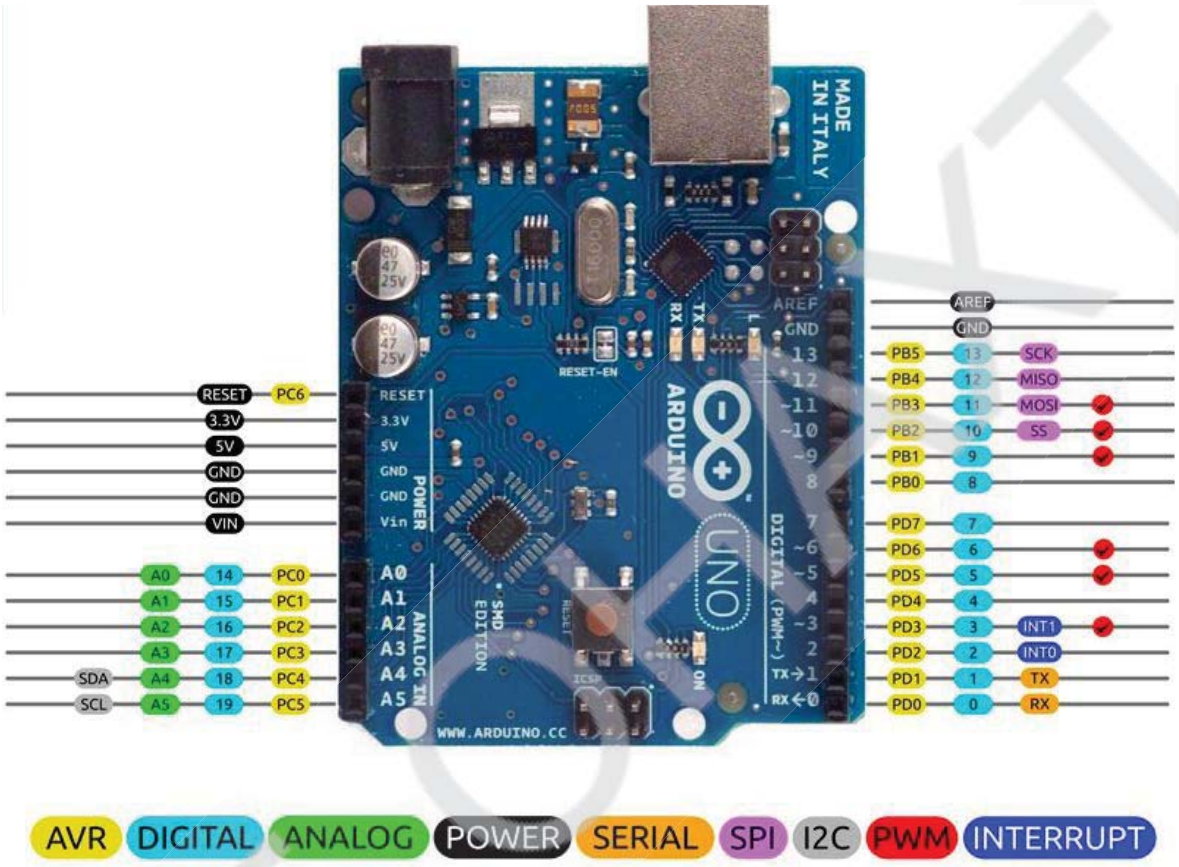

Fig. 2: Arduino Uno pin placement diagram.

The ATmega328 has a UART receiver that allows serial communication via digital outputs 0 (RX) and 1 (TX). The ATmega16U2 microcontroller on the board connects this receiver to the computer's USB port, and when connected to a PC, it allows the Arduino to be detected as a virtual COM port. On the Windows platform, only the appropriate one is required .inf file. The Arduino software package includes a special program that allows you to read and send simple text data to Arduino. When transmitting data via a USB-UART converter chip during a USB connection to a computer, the RX and TX LEDs will flash on the board. (When transmitting data in series using outputs 0 and 1, without using a USB converter, these LEDs are activated).

3. WEATHER STATION AND ITS COMPONENTS

A portable weather station is a small digital climate control device that allows you to accurately determine the ambient temperature and changes in atmospheric pressure.

The weather station I developed for this project consists of the following set of components:

1. DHT22 temperature and humidity sensor;
2. BMP180 Atmospheric Pressure Sensor;
3. 1602 LCD liquid crystal display;
4. Breadboard;

5. Connecting wires;
6. 100 Ohm resistor.

Fig. 3: components that are required for a portable weather station.

3.1. DHT22 sensor

The DHT22 sensor consists of a capacitive humidity sensor and a thermistor. In addition, the sensor contains a chip that converts an analog signal to a digital one. During the manufacturing process, the components included in the DHT module can receive various parameters, and in order for the sensor readings to be correct, the manufacturer calibrates each DHT sensor in the calibration chamber, and the correction factor is stored in memory and called when reading data.

General characteristics:

- low cost;
- power supply and I / O: 3-5V;

- determination of humidity 0 - 100% with an accuracy of 5%;
- temperature detection of 0 - 50 ° C with an accuracy of 2%;
- sensor polling frequency no more than 0.5 Hz (no more than once every 2 seconds);
- dimensions: 17 x 13 x 5 mm;

The advantages of this sensor are small size, low power consumption, high transmission range (up to 20 m), the disadvantages include relatively low measurement accuracy.

The sensor has 4 contacts:

1. VCC power supply;
2. SDA contact for data exchange between the sensor and the microcontroller;
3. NC-not used;
4. GND-ground.

To start receiving data from the sensor, the microcontroller must send a request to the sensor and wait for it to respond that the sensor is ready to transmit information. This happens as follows. When the microcontroller is going to receive data, it should pull the data line to zero for 18 Ms, then release it back to 1. at the same time, the microcontroller goes into standby mode and monitors what happens to the data line. After 20-40 microseconds, if everything is in order, the sensor responds by drawing the data line from its side to zero at 80 microseconds and releases it at 80 microseconds. In this way, the sensor lets the microcontroller know that everything is fine with it, and it starts transmitting data. Data is transmitted Bitwise. Depending on how many microseconds the sensor releases the line to 1, the microcontroller recognizes which bit was transmitted: if the duration of the time interval until the next attraction to zero is 26-28 microseconds, then 0 is transmitted, if 70 microseconds is transmitted 1.

The amount of transmitted information is 40 bits (5 bytes). The first and second bytes contain integer and fractional parts of humidity information, the third and fourth bytes contain integer and fractional parts of temperature information, and the fifth byte is a checksum that represents the last 8 bits from adding up the previous 4 bytes.

After transmitting a data packet, the sensor goes into sleep mode until the next request from the microcontroller.

To read DHT22 sensor data using Arduino, there is a ready-made DHT library that you need to import into the Arduino IDE.

3.2. BMP180 Atmospheric Pressure Sensor

The BMP180 sensor is a cheap and easy-to-use touch sensor that measures atmospheric pressure and temperature. It is usually used to determine the altitude and in weather stations. The device consists of a piezo-resistive sensor, a thermal sensor, an ADC, non-volatile memory, RAM, and a microcontroller.

General characteristics of the BMP180 sensor:

- Pressure measurement limits are 225-825 mm.

- Power supply voltage 3.3-5V;
- Current 0.5 ma;
- I2C interface support;
- 4.5 ms response time;
- Dimensions 15 x 14 mm.

3.3. Arduino LCD 1602 LCD display

LCD I2C display screen and adapter Arduino liquid Crystal Display (Liquid Crystal Display) LCD 1602 is a good choice for displaying strings of characters in various projects. It is inexpensive, there are various modifications with different lighting colors, you can easily download ready-made libraries for Arduino sketches. But the biggest drawback of this screen is the fact that the display has 16 digital pins, of which a minimum of 6 are required. therefore, using this LCD screen without I2C adds serious limitations to Arduino Uno or Nano boards. If there are not enough contacts, then you will have to buy an Arduino Mega board or save contacts, including by connecting the display via I2C.

Display specifications:

- Character display type, it is possible to load characters;
- LED backlight;
- HD44780 controller;
- Power supply voltage 5V;
- 16x2 character format;
- Operating temperature range-20c to + 70C, storage temperature range - 30c to +80c;
- 180-degree viewing angle.

ASSEMBLY AND PROGRAMMING

Next, we will take a closer look at connecting all the available elements and programming a portable weather station on the Arduino Uno microcontroller.

The DHT22 sensor, which will be used to receive data on ambient temperature and humidity, is connected as follows:

Table. 2.

VCC	5V
NC	Does not connect
SDA	Through a 10kohm K 5V resistor
GND	GND

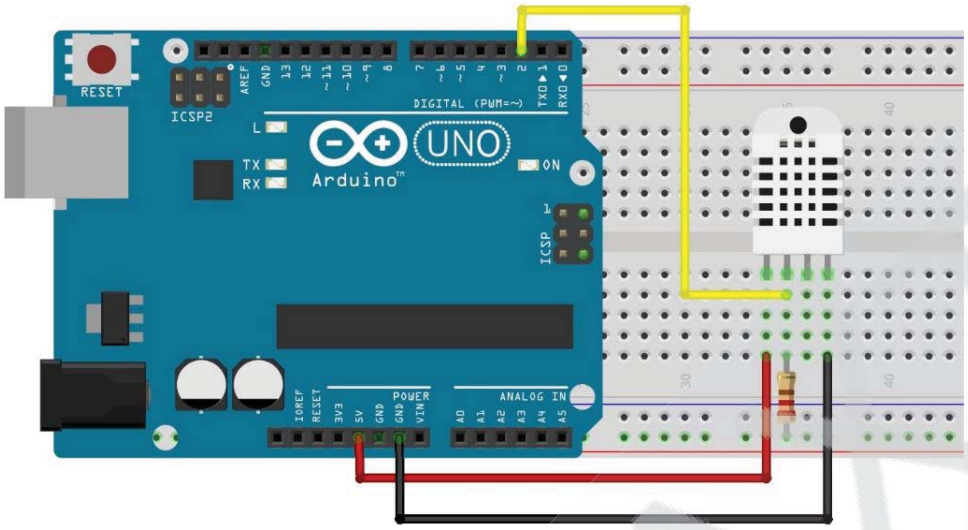

Fig. 4: connection diagram of the DHT22 humidity sensor.

Connecting the BMP180 sensor to the Arduino. To connect, you will need the BMP180 sensor itself, an Arduino UNO board, and connecting wires. The connection diagram is shown in the figure below.

Table. 2

VIN	5 B
GND	GND
SDA	A4
SCL	A5

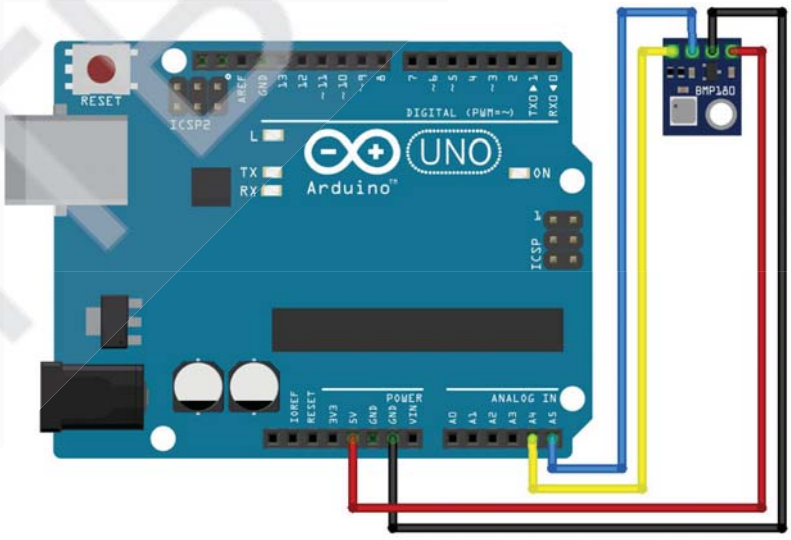

Fig. 5: Wiring diagram of the BMP180 sensor to the Arduino Uno.

Now we connect the LCD1602 IIC / I2C character display to the Arduino Uno, which will display information about temperature and humidity.

Table.3

Display 1602		Arduino Uno	Display 1602		Arduino Uno
1	GND	GND	9	DB2	Does not connect
2	VDD	5V	10	DB3	Does not connect
3	Contrast	To GND via resistor	11	DB4	Pin 2
4	RS	Пін 0	12	DB5	Pin 3
5	R/W	GND	13	DB6	Pin 4
6	Enable	Pin1	14	DB7	Pin 5
7	DB0	Does not connect	15	Back LED+	To 5V via resistor
8	DB1	Does not connect	16	Back LED-	GND

The wiring diagram for connecting the DHT22 pressure sensor and the LCD 1602 display is shown in Figure 6.

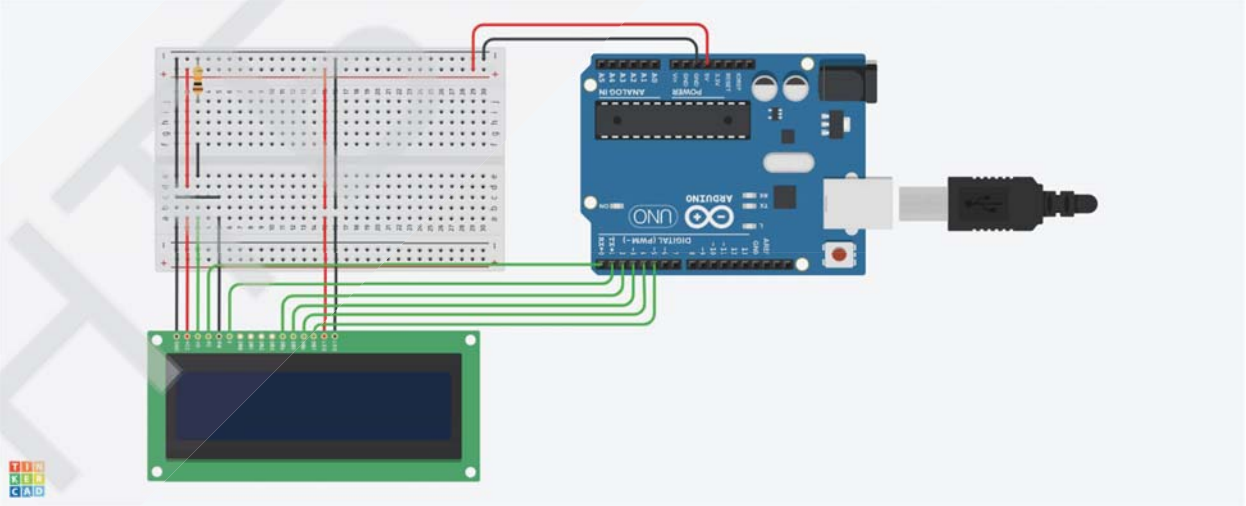

Fig. 6: connection diagram for the 1602 LCD display.

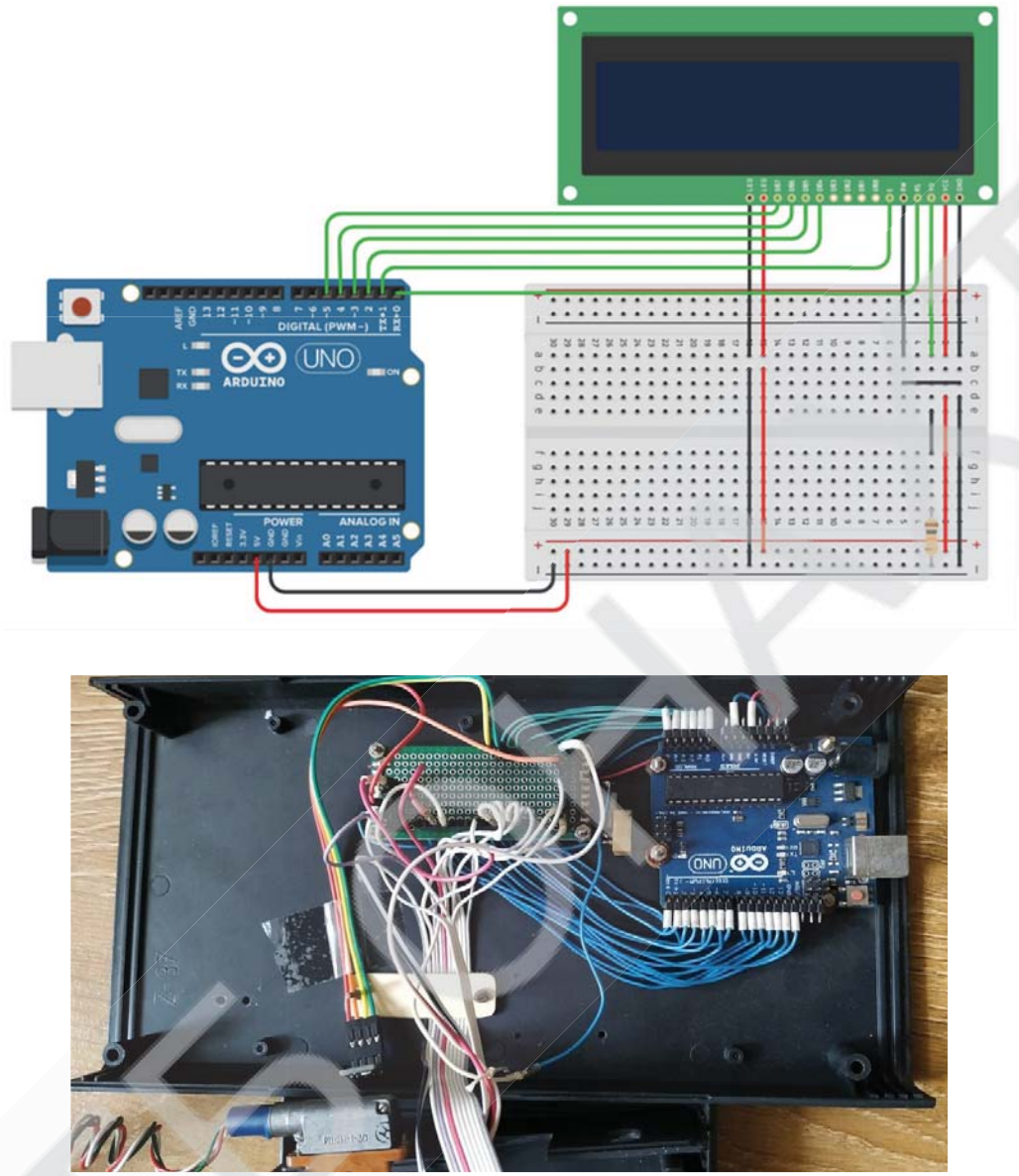

Fig. 7: connection diagram for DHT22 sensor and 1602 LCD display.

After we have assembled the connection diagram for all the necessary elements, you need to download a ready-made sketch or write it yourself using examples. A typical arduino sketch for working with the DHT22 temperature and humidity sensor and the LSD1602 display looks like this:

/*TEMPER_VLAGNOST_V2
CONNECTING THE TEMPERATURE AND HUMIDITY SENSOR TO THE LCD 1602. Connecting the LCD pins to ARDUINO_UNO/
LCD RS pin to digital pin 12

```
  LCD Enable pin to digital pin 11
  LCD D4 pin to digital pin 5
  LCD D5 pin to digital pin 4
  LCD D6 pin to digital pin 3
  LCD D7 pin to digital pin 2
  LCD R/W pin to ground
  10K resistor:
  ends to +5V and ground
  wiper to LSD VO pin (pin 3)
        */
// connecting libraries
#include <LiquidCristal1.h>
#include "DHT.h"
#define DHTPIN 7
// initials of the library to the controller contacts
LiquidCrystal LCD(12, 11, 5, 4, 3, 2);
#define DHTTYPE DHT22 // initializing the sensor
DHT dht(DHTPIN, DHTTYPE);// initializing the sensor
void setup()  {
 lcd.begin(16, 2);//initializing the 16X2 indicator
 lcd.setCursor(0, 0);//set the cursor to 0, 0
 lcd.print("TEMPERATURE-");//display the word "temperature-"
 lcd.setCursor(14, 0);//set the cursor to 14, 0
 lcd.print("*C");//display the words "*C"
 lcd.setCursor(0, 1);//set the cursor to 0, 1
 lcd.print("VLAGNO-");//display the word "wet-"
 lcd.setCursor(14, 1);//sets the cursor to 14, 1
 lcd.print("%");//display the word "%"
 Serial.begin(9600);//activate the COM port at speed. 9600
 Serial.print ("Test test!"); / / display the word " Dthxxx test!"
 dht.begin (); / / start the temperature and humidity sensor
}
void setup() {
float h = dht.readHumidity();//the variable h to assign the sensor reading
float t = dht.readTemperature();//assign the variable t to the sensor readings
 if (isnan(t) || isnan(h)) //conditional branch.....?

 {
    Serial.println("Failed to read from DHT");//display on the screen "error reading
from sensor"
  }
          else//
         {
         Serial.print("Humidity: ");//display the word "humidity"
```

```
        Serial.print("h");//display the humidity reading
        Serial.print("%/t");//display the word "%/t"
        Serial.print("Temperature: ");//display the word "temperature"
        Serial.print("t");//display the temperature reading
        Serial.print("*C");//display on the monitor screen, the word "*C"
          }
 //set the cursor to colum 0, line 1
 //(note: line 1 is the second row, since counting begins with 0)
         lcd. setCursor(8, 0);//set the cursor to 8, 0 / /
         lcd. setCursor(10, 1); / / print the number of second since reset
         lcd. print(t);/ / display the temperature reading lcd.setCursor (8, 1);//set the
cursor to 8, 1
        lcd. print(h);//display the humidity display delay (3000); / / pause for 3 seconds
         }
```

4. Conclusions

In modern homes, the use of smart home technology is increasingly common, which helps the owner of the house to monitor its condition. Namely, to control the lighting, security system, climate control system, allows you to monitor all electronic devices in the house (independently turn them on and off).

This technology makes life easier for the owner of a house (apartment) to a greater extent, and makes his place of residence cozy and safe.

The climate control system is one of the components of a smart home. It provides simultaneous management of the operation of devices that carry out the processes of heating, ventilation and air conditioning in the building. In addition, it allows you to set the temperature for each room and constantly maintain it at a given level.

In this article, we looked in more detail at the climate control system using the example of a portable weather station that works using an Arduino Uno microprocessor, and consists of: a DHT22 pressure and temperature sensor and an LCD 1602 liquid crystal display. You can also make a wireless weather station on an Arduino Uno, using Bluetooth or radio modules to transmit information over a distance.

5. Literature

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