

## TEMPERATURE AND HUMIDITY MONITOR AND CONTROL SYSTEM

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**Abstract:** *This paper presents how the environmental parameters can be controlled with a microcontroller circuit.. The software part of the application is performed in C++ and C# programming languages. For the hardware part implementation an Atmel ATmega328p microcontroller, a Bluetooth HC05 module, sensors (temperature, humidity, soil moisture) and DC fan have been used. The data is sent between master and slave devices using Bluetooth communication that is achieved through an UART interface .*

*The application is very useful because it allows the user to set the needed thresholds of the environmental parameters and control them. Also, the application incorporates a mechanism by which the user is notified when the thresholds are exceeded.*

**Keywords:** *Bluetooth, sensors, microcontroller, database*

### 1. INTRODUCTION

Data acquisition systems have seen an impressive development over the years and plays an important role in automation process. The data acquisition process is a branch of engineering dealing with collecting information from a number of numerical and/or analogue sources, the conversion of these data into a digital form, processing, storage and data transmission (e.g. for a computer/laptop through a graphical interface). [1]

Sensors have a significant role in real-time data acquisition process, without which the automation process would no longer exist. The sensors are devices that detects and responds to some type of input from the physical environment. They can measure different parameters : temperature, heat, pressure, humidity, etc. [2]

The content of the project is based on the system design and its characteristic functions, and on the design of the hardware part starting with the electrical scheme. The information captured by the sensors is stored in a database which is accomplished in MySql. Through a graphical interface achieved in C# programming language the data are displayed at certain time intervals. Based on values stored in the database during a day will be created graphs and determining the minimum and maximum values.

### 2. SYSTEM IMPLEMENTATION

This project can be structured in two major components, both in hardware and software point of view:

1. User interface
- ✓ Hardware components
- Laptop/PC

- ✓ Software components
  - C# programming language
  - MySQL database
- 2. Wireless temperature and humidity monitor and control system
  - ✓ Hardware components
    - ATmega328P microcontroller
    - Bluetooth HC-05 module
    - Temperature sensor
    - Humidity sensor
    - Soil moisture sensor
    - 5V DC fan
  - ✓ Software components
    - C programming language

The block diagram of the system consists of the modules shown in the Fig. 1 below.

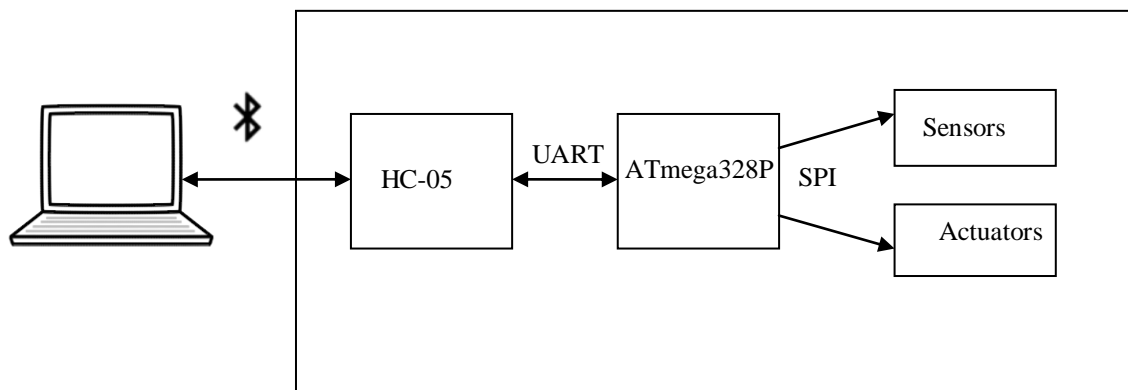


FIG. 1. The system block diagram

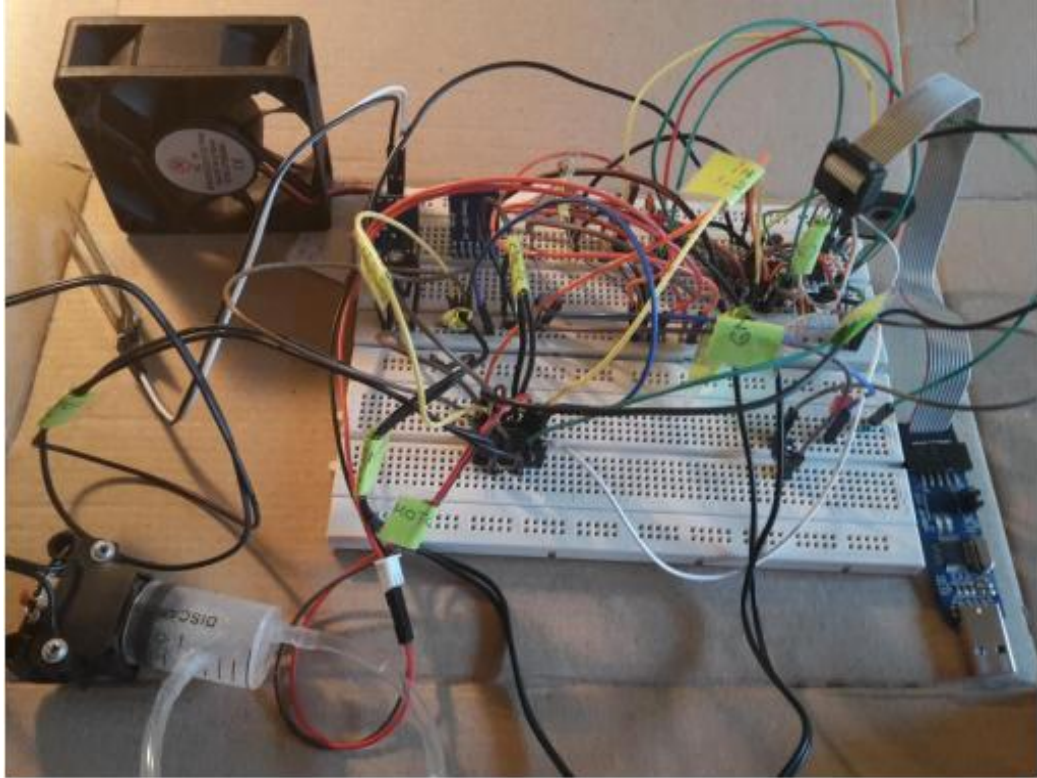
## 2.1 Hardware Implementation

ATMega328p is a chip created by Atmel belonging to mega AVR series. The microcontroller ATMega328p includes as main features: 32KB of Flash memory with reading and writing capabilities, 1KB of EEPROM memory, 2KB of SRAM, 23 pins I/O for general use, 32 registers for general use, 3 counters, intern and extern interrupts, USART (Universal Synchronous/Asynchronous Receiver/Transmitter), SPI (Serial Peripheral Interface), I2C (Inter-Integrated Circuit) and a watchdog with internal oscillator. The device has a maximum operating frequency of 20MHz and operates between 1.8V-5.5V [3].

HC-05 module is a Bluetooth SPP (Serial Port Protocol) module which is easy to use, designed for wireless serial communication. The Bluetooth module is qualified with Bluetooth v2.0+EDR (Enhanced Data Rate), 3Mbps baseband modulation and radio transceiver of 2.4GHZ. The module uses CSR (Cambridge Silicon Radio) 04-Bluecore and it has CMOS technology with AFH (Adaptive Frequency Hopping Feature) [4].

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. This sensor has as main features the calibration directly in ° Celsius, linearity + 10.0 mV/°C scale factor, 0.5°C accuracy guarantee able (at +25°C) , rated for full -55° to +150°C range, suitable for remote applications, low cost due to wafer-level trimming, operating from 4 to 30 volts, less than 60 µA current drain. [5]

The HIH-5030/5031 series low voltage humidity sensors operates down to 2.7 Vdc, often ideal in battery-powered systems where the supply is a nominal 3 Vdc. As features can be mentioned: the low power design, operation down to 2.7 Vdc, near linear voltage output vs %RH. [6]



**FIG. 2.** The hardware part of the system

## 2.2 Software Implementation

For the implementation of the software part, Atmel Studio v.6 (for designing the microcontroller application) and Visual Studio Express (for the user interface) tools were used.

The programming languages used for this application are C++ and C#. The connection between the Bluetooth module and the hardware circuit is established by the software application. After that, the user needs to set the thresholds of the environmental parameters in order to monitor the temperature and humidity. These parameters are controlled by using the heating and cooling systems.

As example, below are listed a few functions used for developing the microcontroller application:

- 1) ReadADC() function - the below function is used to read the data from the ADC channel of the microcontroller.

```

uint16_t ReadADC(uint8_t channel_adc)
{
    channel_adc &= 0b00000111;
    ADMUX = (ADMUX & 0xF8) | channel_adc;
    ADCSRA |= (1<<ADSC);
    while(ADCSRA & (1<<ADSC));
    uint8_t theLow = ADCL;
    uint16_t theTenBitResults = ADCH<<2 | theLow>>6;

    return theTenBitResults;
}

```

**FIG. 3.** The ReadADC() function

2) USARTTransmitt() and USARTReceive() functions - The below code snippets are used to transmit and receive data through UART interface. During the data transmission, the 8-bit data is loaded into the UDR0 (UART Data Register) to be transmitted. On the receive part, firstly the whole data should be received and after that the values are stored in UDR0 register.

```

void USARTTransmitt(unsigned char data)
{
    while(!(UCSR0A & (1<<UDRE0)))
    {
    }
    UDR0=data;
}

```

**FIG. 4.** The USARTTransmitt() function

```

char USARTReceive()
{
    while(!(UCSR0A & (1<<RXC0)))
    {
    }
    return UDR0;
}

```

**FIG. 5.** The USARTReceive() function

The user interface consists of two main components: the specific window for setting the needed parameters and selecting the COM port for transmission and the second window for displaying the graphic results.



FIG. 6. The user interface

The window shown above allows the user to connect to a COM port after completing the pairing procedure between the Bluetooth module related to the slave module and the Bluetooth adapter of the master (laptop/PC). The user must press the “Connect” button in order for the connection to be fully established. After that, the user must insert the required values for system operation (e.g. minimum/maximum temperature) and he can also enter the email address to be informed in case of the values are exceeded. When the “Automat” button is pressed the data is automatically transmitted in 2.4GHz wireless bandwidth. The data received from sensors is displayed in the user interface and stored in the database as can be seen in Fig.7.



FIG. 7. Data acquisition window

In the second window is presented how the user can view the data in graphics. He can select any date from past to visualize the graphics for that specific day, as well the minimum and the maximum values.

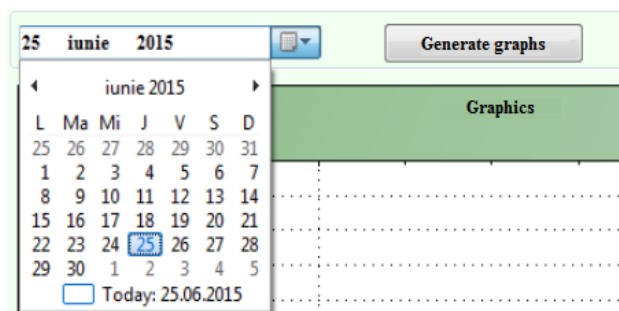


FIG.8 Date Time Picker

As an example, in the below image is presented the variation of the temperature during a specific day selected by the user.

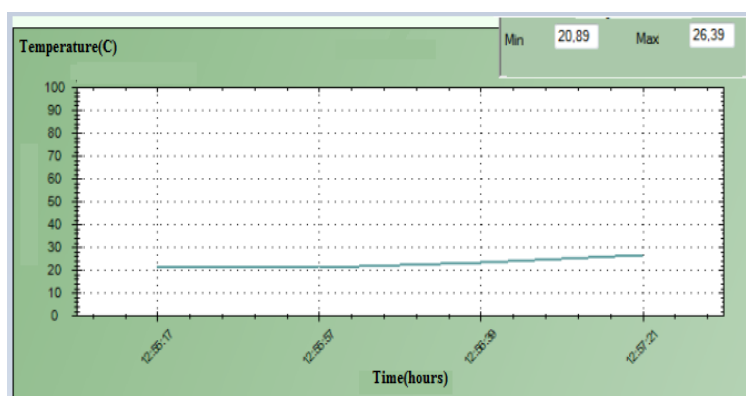


FIG.9 Temperature graph

### 3. CONCLUSIONS AND FUTURE WORK

The main advantage of the designed system is that it is controlled by wireless communication, so the user can read the values from distance. The devices do not need to be set every time to communicate between them, once they were connected the connection is kept.

Furthermore, a continuously monitoring and controlling of the environment and maintaining a real time updated database, represent as well an advantage.

The system can be improved by extending the software on other devices such as Smartphones, tablets and other gadgets. In order to extend this, an implementation of Android or iOS operating systems will be required.

Another future development is to improve the communication by monitoring the system from more than 10 meters distance via WiFi. ESP8266 module can be used in this purpose.

### REFERENCES

- [1] [www12.tuiasi.ro/users/112/L.Zaharia-SMCAD-curs.pdf](http://www12.tuiasi.ro/users/112/L.Zaharia-SMCAD-curs.pdf);
- [2] Borza, P., Gerigan, C., Ogruțan, P. și Toacșe, Gh. – Microcontrollere. Aplicații, Editura Tehnică, București, 2000;
- [3] ATM328p Datasheet, Available at [www.atmel.com/images/8161s.pdf](http://www.atmel.com/images/8161s.pdf);
- [4] \*\*\*, HC-05 Datasheet, Available at [www.electronica60norte.com/mwfls/pdf/newBluetooth.pdf](http://www.electronica60norte.com/mwfls/pdf/newBluetooth.pdf);
- [5] Datasheet, Available at [www2.ece.ohio-state.edu/~passino/LM35.pdf](http://www2.ece.ohio-state.edu/~passino/LM35.pdf);
- [6] Datasheet, Available at [www.sensing.honeywell.com/honeywell-sensing-hih5030-5031-series-product-sheet-009050-2-en.pdf](http://www.sensing.honeywell.com/honeywell-sensing-hih5030-5031-series-product-sheet-009050-2-en.pdf);