MONITORING TEMPERATURE AND HUMIDITY IN A GREENHOUSE

M., IONESCU, "Constantin Brâncuși" University from Tîrgu-Jiu, ROMANIA, e-mail: i_marian_19@yahoo.com, ROMANIA

Abstract: *This paper presents a method for monitoring temperature and humidity in a greenhouse using the Arduino Uno motherboard and the DHT 11 temperature and humidity sensor. Automatic temperature and humidity monitoring systems are based on applications dedicated to measuring degrees in a room and bringing them to a set temperature as well as calculating its humidity percentage. To measure and monitor environmental variables, temperature and humidity, a command and control system was proposed consisting of an enclosure equipped with a heating and ventilation device, the Arduino Uno development board and the DHT 11 temperature and humidity sensor. For the software design of the temperature and humidity monitoring station, the open-source Arduino development environment (IDE) was used, which facilitates writing code and loading it into the Arduino Uno motherboard microcontroller.*

Keywords Arduino Uno, DTH 11 temperature and humidity sensor, monitoring systems, Arduino development environment IDE

1. INTRODUCTION

Monitoring environmental variables such as temperature, pressure and humidity have been shown to have a significant impact on plant growth productivity, food industry quality and the efficiency of many temperature and humidity sensitive equipment. Monitoring temperature and humidity in laboratories, warehouses, halls, schools and hospitals is important in terms of health and hygiene. Reliable measurement and monitoring are crucial in this competitive era of technology [1]. Due to sudden changes in weather, unfavorable conditions arise for agricultural work. Heavy rains can destroy crops and low rainfall amounts can lead to drying out of crops. Also, a smaller amount of light can affect the proper growth of crops[2]. Monitoring temperature and humidity parameters is essential for optimizing productivity, reducing energy consumption, increasing operational efficiency, and minimizing losses related to production or storage processes. Maintaining optimal environmental conditions is crucial in spaces such as cold storage facilities, warehouses for fruits and vegetables, mushroom farms, greenhouses, and similar environments. Inadequate control over these variables can lead to significant financial losses and, depending on the nature and scale of the business, even bankruptcy. In this context, the implementation of a remote monitoring system becomes necessary, as it provides real-time data on the temperature and humidity levels within the enclosure. For instance, in a greenhouse where these two variables are critical for optimal plant growth, it is sufficient to connect the sensors to a transmission system, allowing the values to be accessed at any time via a computer or mobile device [3].

2.DESCRIPTION OF STUDIES

The IoT-based greenhouse monitoring and control system using an Arduino Uno motherboard aims to improve current agricultural practices by using modern technologies to achieve better yields. This paper presents a way to control a smart greenhouse, which helps farmers carry out agricultural work in an automated greenhouse [4].

Automatic temperature and humidity monitoring systems are based on dedicated applications for measuring the degrees in a room and bringing them to a set temperature as well as calculating the percentage of humidity inside it. The automation device measures the output values of the technological process (temperature and humidity in the room), compares them with the requirements imposed by the program prescribed to the system, and depending on the result of this comparison, it commands the input of the technological process so that it returns to the imposed state [5]. Minimum and maximum limits for temperature and humidity can be programmed so that when they are exceeded, an alarm signal is sent to the e-mail to know if the system is working correctly. The internet connection provides direct access to the monitoring system, allowing you to follow the variation in real time of the temperature and humidity values. Such an automatic regulation system eliminates human error, additional personnel costs and can present the production process that takes place inside the greenhouse with precision and objectivity [3].

3. DESCRIPTION OF THE EXPERIMENTAL PLATFORM FOR COMMAND AND CONTROL OF PARAMETERS INSIDE THE GREENHOUSE

Among the basic principles of automatic control systems are the feedback and control of the parameters that are to be monitored. The information provided by the sensors about the current state of the system is used to adjust and control the process in accordance with the references established for the parameters that are to be adjusted [6]. The automatic control system has the following components, namely: sensors for measuring the state of the system (temperature and humidity), a control processor (automatic controller) that interprets the data and makes decisions, actuators (execution elements) that act on the system to regulate it, and the technological process (greenhouse) that is subject to automation. The automatic control cycle of the technological process consists of measuring the state of the system (temperature and humidity), comparing them with the desired value (setpoint), calculating the error, and adjusting the system parameters to minimize this error [7].

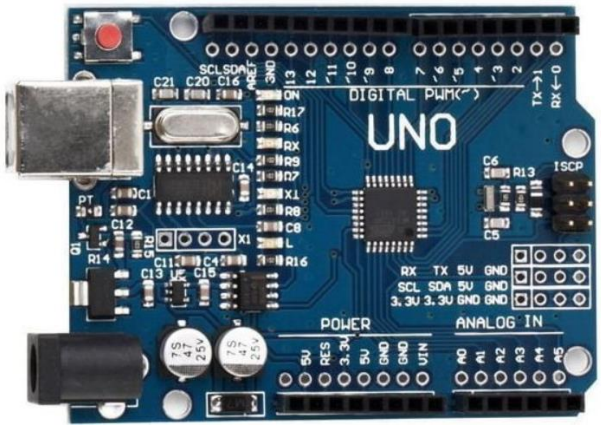

Fig.1. The Arduino Uno Board [8]

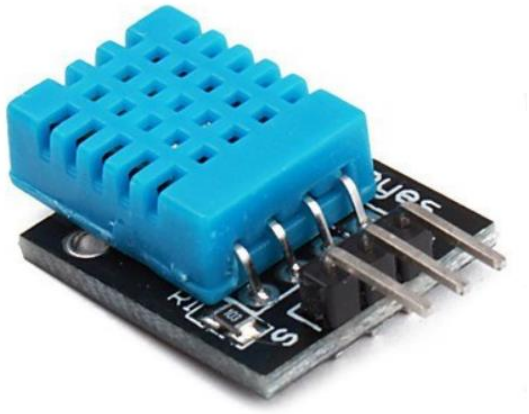

Fig.2. The temperature and humidity sensor [9]

Arduino Uno Board show in Fig.1 is a microcontroller-based development board where the creation and development of interactive objects is possible with the help of the necessary programming software. The Arduino software IDE (Integrated Development Environment) provides space for writing codes in the language (programming languages C, C++) that the

Arduino board uses. User-friendly design and flexibility for advanced modifications are some of the features of the Arduino hardware and software based on the microcontroller, which give it a wide range of uses. Both the Arduino hardware and software are open source. Arduino boards are designed so that any user without advanced knowledge or previous experience in programming can build their own interactive experimental platform that can detect different parameters of the environment and which can be controlled. The DHT 11 temperature and humidity sensor shown in Fig. 2 is a sensor integrated into the housing and has three pins for connection to various electronic motherboards. This type of sensor consists of two parts, a capacitive humidity sensor and a thermistor. There is also a very simple chip inside that does an analog-to-digital conversion and outputs a digital temperature and humidity signal. The digital signal is quite easy to read using any microcontroller.

In Fig. 3 below, the temperature and humidity control platform is shown. It consists of the greenhouse in which the temperature and humidity sensor is positioned, a bulb for the temperature variation in the greenhouse, a fan for cooling the greenhouse and the electronic platform for controlling the two parameters to be controlled.

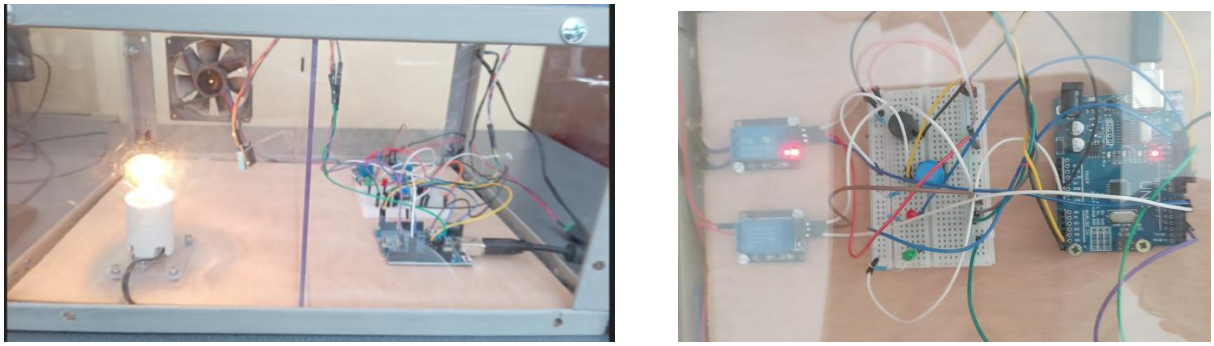

Fig.3. Experimental platform for temperature and humidity control

For a temperature increase slightly above the allowed limit "limit_temp1", the red LED will light up, and our fan will start running at a low speed, the buzzer signals will in this situation have an action interval of once every two seconds. If the temperature is, or has been restored, within normal limits, the LEDs remain off and the fan stops. The fan is controlled by a PWM signal on the “MOTOR_PIN_ENA” pin, and the direction of rotation is set by “MOTOR_PIN_IN1” and “MOTOR_PIN_IN2”. The buzzer is controlled to emit beeps at a frequency of 1000 Hz, with different time intervals depending on how much the temperature exceeds the set limit.

4. CONCLUSIONS

This station demonstrates the versatility of the Arduino platform, which allows the development of customized and adaptable solutions for various applications, from environmental control in greenhouses and storage spaces, to use in the home for comfort and safety. With the possibility of expanding and adjusting the functionalities by adding new components and sensors, the temperature and humidity control station proves to be an educational and practical project.A very important aspect of this temperature and humidity monitoring system is the accuracy of the measurements. The sensors used in this system must be calibrated and provide reliable data to ensure accurate monitoring.

The automatic control of a fan according to the detected temperature, along with the visual and auditory signals generated by LEDs and a buzzer, significantly improve the ability to react

to climatic variations. Thus, the system can maintain optimal conditions, preventing overheating or excessive cooling of the monitored environment.

In terms of connectivity and data management, temperature and humidity monitoring systems can be equipped with wireless communication technologies and programming interfaces that allow data transmission to recording devices or analysis platforms. This ensures the quality and reliability of the systems as well as good monitoring and data collection that helps to make immediate decisions for proper system operation.

5. REFERENCES

[18]. https://www.theseus.fi/bitstream/handle/10024/142235/Dangi_Nagendra.pdf?sequ

[19]. Raj Ranjan Kumar, Sahil Kumar, Sonu Kumar, Yugendra Chincholkar, *Greenhouse Monitoring System Using IOT*. Journal of University of Shanghai for Science and Technology.22(12) DOI:10.51201/jusst12371, December 2020.

[20]. https://www.romtech.ro/noutati/sistem_monitorizare.html

[21]. https://ijcrt.org/papers/IJCRT22A6142.pdf

[22]. https://ro.scribd.com/document/448931317/Sisteme-de-Reglare-Automată-a-Temperaturii

[23]. https://www.cds.caltech.edu/~murray/books/AM05/pdf/am08-complete_28Sep12.pdf

[24]. https://elmoukrie.com/wp-content/uploads/2022/06/process-dynamics-and-control-dale-e.-seborg-thomas-f.-edgar-etc.-z-lib.org_.pdf

[25]. https://www.circuito.io/blog/arduino-uno-pinout/

[26]. https://www.electronicwings.com/sensors-modules/dht11