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COMPUTERIZED SYSTEM FOR MONITORING THE TEMPERATURE AND HUMIDITY CONDITIONS OF COTTON STORAGE PILES

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АННОТАЦИЯ: В статье разработана компьютеризированная информационно-измерительная система на базе датчиков HIH3610, DS18B20 и микроконтроллера ATmega8 для непрерывного мониторинга температурно-влажностного состояния хлопка в бунтах. Система обеспечивает прием, обработку и визуализацию данных в режиме реального времени, позволяя оперативно контролировать условия хранения хлопка.
Ключевые слова: хлопковый бунт, температура, относительная влажность, датчик, информационно-измерительная система, мониторинг, микроконтроллер.

ABSTRACT: The article presents a computerized information and measurement system based on HIH3610 and DS18B20 sensors and an ATmega8 microcontroller for continuous monitoring of the temperature and humidity conditions of cotton stored in storage piles. The system provides real-time data acquisition, processing, and visualization, enabling effective monitoring of cotton storage conditions.Keywords: cotton storage pile, temperature, relative humidity, sensor, information and measurement system, monitoring, microcontroller.

INTRODUCTION

The preservation of raw cotton quality is directly dependent on the temperature and humidity conditions within the storage pile. Traditional periodic monitoring methods do not allow a comprehensive assessment of the dynamics of changes in these parameters.

Therefore, a computerized information and measurement system based on HIH3610 and DS18B20 sensors and an ATmega8 microcontroller has been developed for real-time measurement, processing, and visualization of temperature and humidity parameters.

The aim of the study is to develop a computerized information and measurement system for continuous monitoring of the temperature and relative humidity of cotton stored in piles, digital processing of sensor signals, and transmission of the acquired data to a computer.

For this purpose, a combined temperature-humidity measurement channel, a secondary conversion unit, a signal-processing algorithm, and software for real-time data acquisition, storage, and visualization were developed.

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The measurement process consists of converting physical parameters into electrical signals, digitally processing the signals, and presenting the results on a computer [1]. Based on this principle, a generalized structural and functional diagram of the information and measurement system was developed [2].

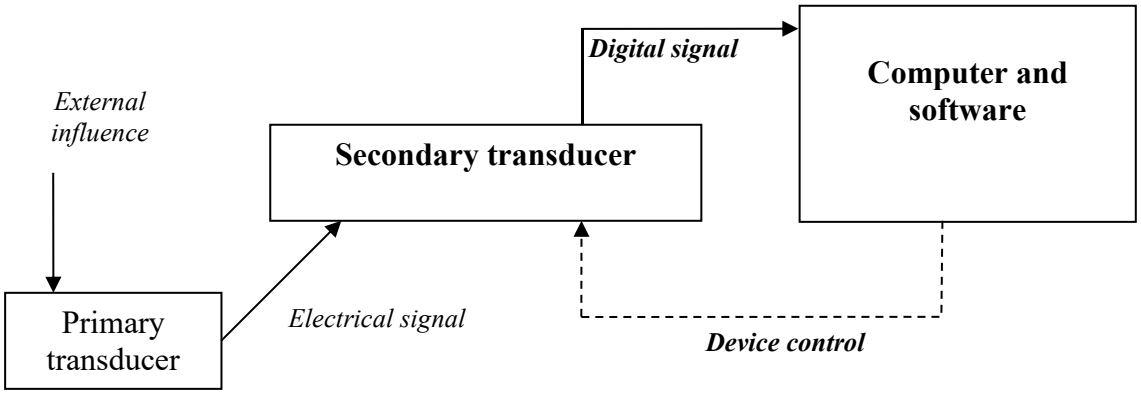


Fig. 1. Operational diagram of a computer-based measurement system

A computerized information and measurement system consists of three main components: a primary transducer, a secondary conversion unit, and a personal computer equipped with specialized software.

The main parameters measured to monitor the temperature and humidity conditions of cotton in the storage pile are temperature and relative humidity. According to the system operation algorithm (Fig. 2), the primary sensors continuously measure these parameters, and the acquired signals are transmitted to the secondary conversion unit.

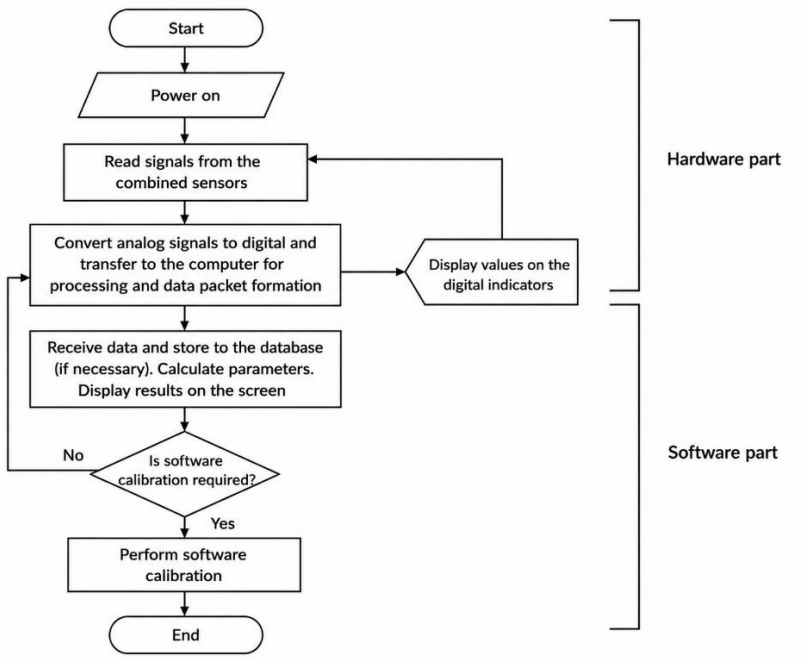


Fig. 2. General operating algorithm.

The analog signal corresponding to relative humidity is digitized using an analog-to-digital converter (ADC) and combined with the digital temperature data into a single data packet. The generated data packet is transmitted to a computer, while the current temperature and relative humidity values are displayed on a digital indicator. The data are processed and stored on the computer using specialized software, which also calculates additional physical parameters such as absolute humidity, air density, and saturated water vapor pressure.

The variations of the measured and calculated parameters over time are visualized graphically, enabling continuous monitoring and analysis of the temperature and humidity conditions of the cotton storage pile.

A combined semiconductor sensor consisting of the HIH3610 (Honeywell) relative humidity sensor and the DS18B20 (Maxim) temperature sensor is used as the primary transducer (Fig. 3).

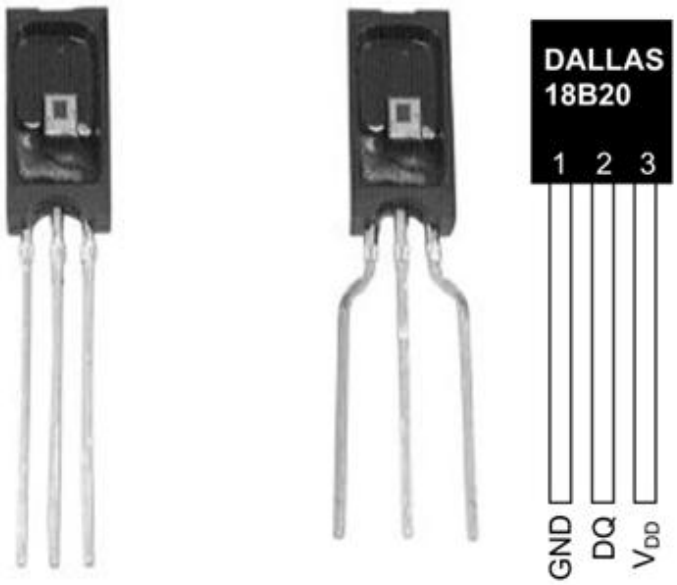


Fig. 3. Primary transducer sensors for measuring relative humidity (a) and temperature (b).

The HIH3610 relative humidity sensor incorporates a thermoset polymer-based sensing element protected by a multilayer structure against environmental effects. The sensor operates at a supply voltage of 5 V and provides an analog output signal ranging from 0.958 to 4 V over a relative humidity range of 0–100% [3].

The DS18B20 digital temperature sensor measures temperature over the range of −55 to +125 °C and operates at a supply voltage of 5 V [4]. These sensors are integrated into a single measurement system to form a combined temperature-humidity sensor.

The interface unit is based on an ATmega8 microcontroller, a MAX232 serial interface controller, and a digital display. The microcontroller digitizes the analog signal from the HIH3610 sensor, combines the temperature and humidity data into a single data packet, displays the current

values, and transmits the data to a computer. The device is powered by a 5 V supply. The schematic circuit diagram and general view of the secondary conversion unit are presented below.

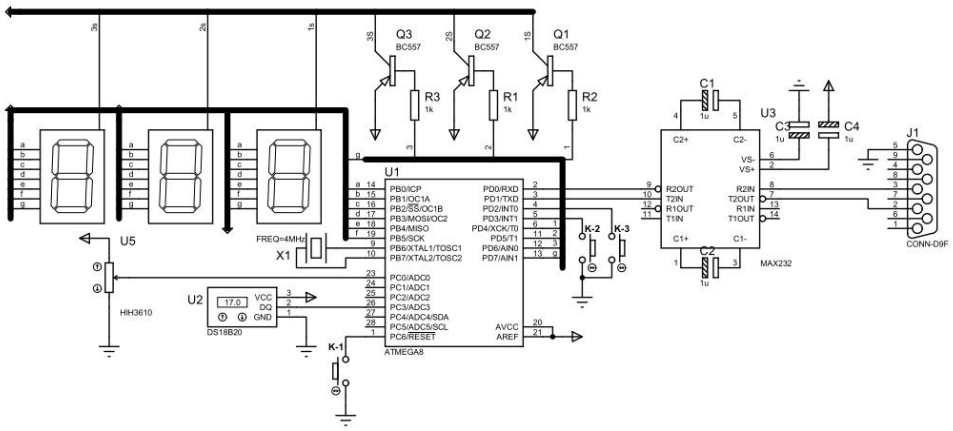


Fig. 4. Schematic circuit diagram of the device.



Fig. 5. General view of the hardware unit of the device.

The software was developed in Microsoft Visual Studio Express 2010 using the Visual Basic programming language. Reference data used to calculate additional physical parameters are stored in XML files. The software enables visualization of measurement results in tabular and graphical forms, configuration of communication parameters, data import and export, and storage of the obtained results (Fig. 6).

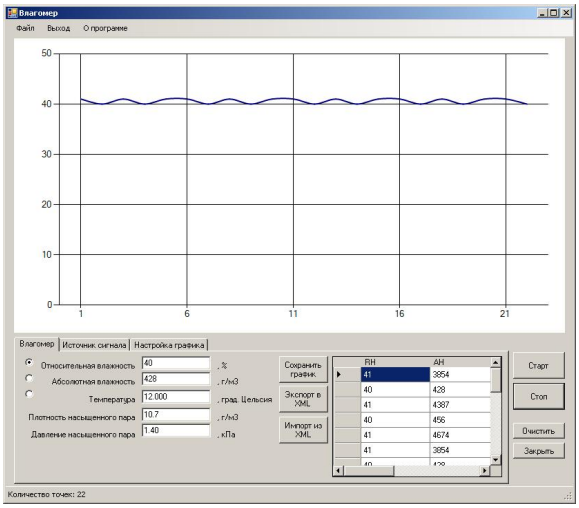


Fig. 6. General view of the software interface.

Specialized software has been developed to calculate additional parameters and visualize measurement results in real time. The software operation algorithm is presented in Fig. 7.

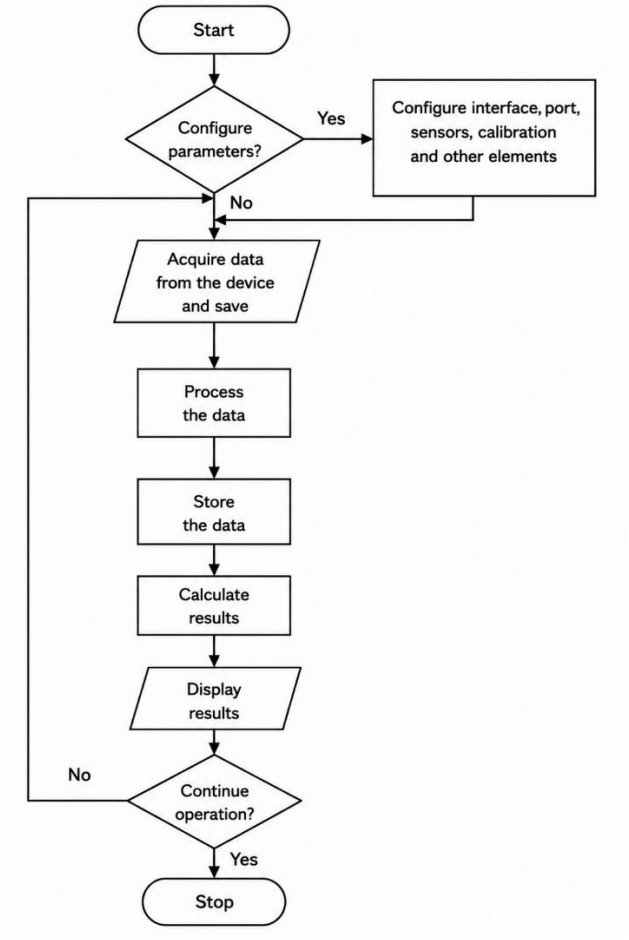


Fig. 7. Flowchart of the software operation algorithm.

RESULTS AND DISCUSSION

The developed computerized information and measurement system enables continuous monitoring of the temperature and humidity conditions of cotton stored in storage piles. Data obtained from the DS18B20 and HIH3610 sensors are processed by the ATmega8 microcontroller and transmitted to a computer as a single data packet.

The specialized software provides real-time recording, storage, and visualization of temperature and relative humidity data, as well as calculation of additional parameters, including absolute humidity, air density, and saturated water vapor parameters. Graphical analysis of these parameters over time enables the identification of temperature and humidity dynamics and deviations from the specified storage conditions.

The obtained results demonstrate that the proposed system is effective for automated monitoring of the temperature and humidity conditions of cotton storage piles and for rapid assessment of storage conditions.

CONCLUSION

A computerized information and measurement system has been developed for continuous monitoring of the temperature and relative humidity of cotton stored in storage piles. Based on the HIH3610 and DS18B20 sensors and the ATmega8 microcontroller, the system provides real-time acquisition, processing, storage, and visualization of measurement data. The proposed solution provides a technical basis for rapid assessment of the temperature and humidity conditions of stored cotton and timely detection of deviations from the specified storage conditions.

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