A REAL-TIME MONITORING APPLICATION OF ENVIRONMENTAL CONDITIONS IN PROTECTED AREAS

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Keywords: protected spaces, crops, microclimate.

ABSTRACT

With the development of technology, the greenhouse sector is constantly expanding, which is advantageous in terms of material economy, cost reduction, improved lighting efficiency and cultivation, but at the same time requires the implementation of a large number of sensor nodes to ensure coverage of environmental monitoring. The paper presents a real-time monitoring application of environmental conditions in a greenhouse, which includes sensors for monitoring temperature, relative humidity; CO_2 concentration; soil temperature (at 3 depths: ground level, 10, 20 cm).

INTRODUCTION

The design of control systems for microclimate monitoring in protected areas is a complex process due to the interaction of several environmental variables that affect plant growth and production. (Ameur et al., 2001; Dumitraşcu et al., 2017).

The need to adapt food production to the needs of the current population requires an accurate knowledge of the factors that limit agricultural production (Brătucu et al., 2011).

The fluctuations of the natural environment on the behavior of the plants can be staged in a protected area of plant growth with partial or complete control of the environment, called greenhouse with controlled environment or automated greenhouse (Marin et al, 2014).

Among the advantages of smart greenhouses can be listed (Bang et al., 2015; Liang et al., 2018; Nicolescu et al., 2008):

 computer data will be obtained on the operation of each individual system and thus the whole system can be coordinated to provide an optimal environment for the development of future plants;

the computer can record environmental data that can be displayed, stored, processed;

several greenhouses can be controlled via a high-speed computer;

through a weather station, the computer will be able to anticipate weather changes and make adjustments in the programming of heating and ventilation systems, thus saving energy;

the computer can be programmed to trigger an alarm in case the weather conditions become unacceptable, as well as being able to provide information related to sensor and equipment failures.

Advanced digital systems allow the implementation of complex laws for digital controllers in a short period of time. One of the best options for implementing controllers is to use real-time systems based on a real-time operating system. A real-time operating system is able to reliably run programs with specific time requirements (Fang et al., 2006).

The modernization of greenhouses, the so-called "smart" greenhouses has seen a very important progress lately, automations have led to the very easy operation of production in a greenhouse (Gates et al., 1999).

In addition to the classic greenhouses, where water, temperature, air are regulated remotely with the help of modern technologies, new variants of plant growth system have appeared. (Lijun et al., 2018).

The state of the art in the field of greenhouse automation must be largely similar to the automation commonly encountered in industry: machines based mainly on mechanical solutions capable of performing exactly the same task several times (eg sowing, transplanting, spacing, grafting machines, automated spraying, sorting and sealing).

Obtaining a controlled microclimate in a greenhouse, has the role of maintaining optimal conditions for plants, so that they can grow in terms of quality, robustness, health and size. In addition, crop productivity will increase if all the conditions for the development of future plants are ensured (Maher et al., 2016).

The paper presents a real-time monitoring application of environmental conditions in a greenhouse, which includes sensors for monitoring temperature, relative humidity; CO_2 concentration and soil temperature.

MATERIAL AND METHOD

By managing the microclimate factors in greenhouses it can achieve the simultaneous maintenance of the main set of microclimate factors, namely temperature, relative humidity and CO_2 concentration close to the predetermined reference values. The real-time monitoring application allows the display of measured values in real time, directly on the touch screen type GS2107-WTBD used as a graphical interface.

The application was developed in the Melsoft GTDesigner3 programming environment (GOT2000) after which it was loaded in the GS2107-WTBD type operating terminal.

A Real-type data register has been assigned to each sensor, which allows the display of measurements to 1 decimal place. These registers have also been linked to the data saving function (logging) so that their evolution over time can be displayed. These registers correspond to the registers allocated in the PLC for saving the data of each sensor and are transmitted to the GS2107-WTBD operating terminal on the dedicated RS422 communication bus.

Figure 1 shows the Melsoft GTDesigner3 programming environment (GOT2000).

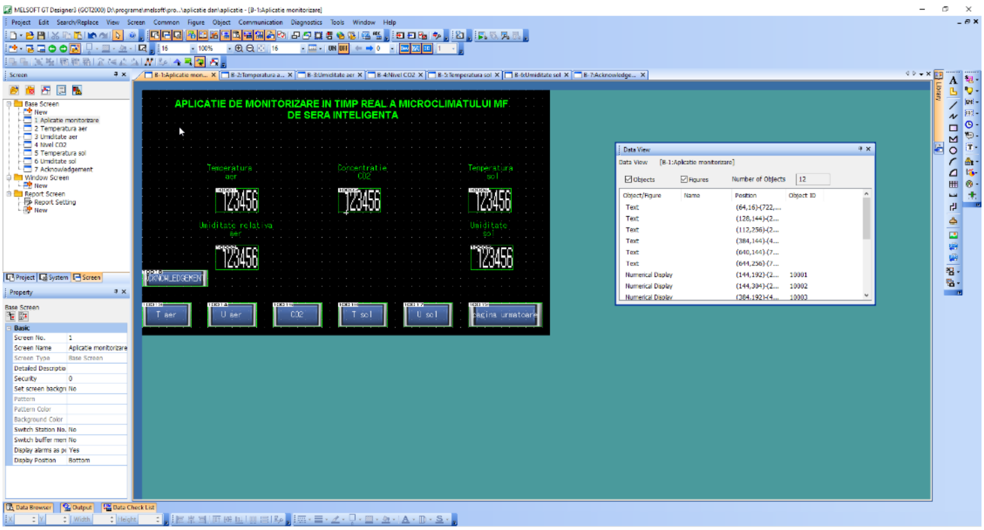

Fig. 1. Melsoft GTDesigner3 programming environment (GOT2000)

Figure 2 shows the logic diagram of the monitoring system of environmental conditions in the greenhouse.

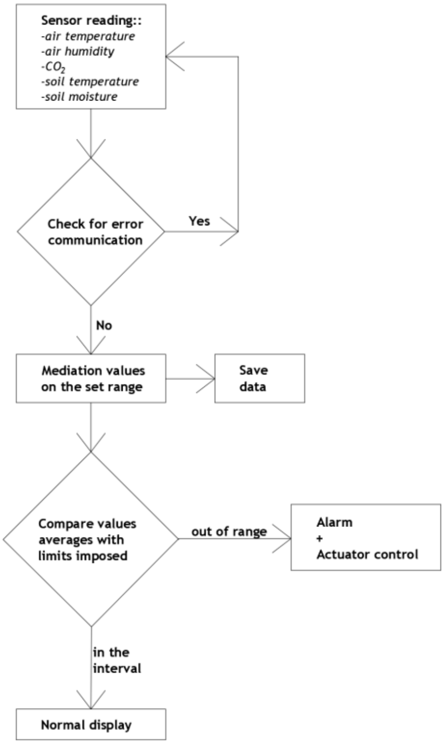

Fig. 2. Logical scheme of the monitoring system of the environmental conditions of the smart greenhouse

The real-time monitoring application consists of 6 program pages:

1. The first page where the current values measured by the sensors can be monitored (Fig. 3).

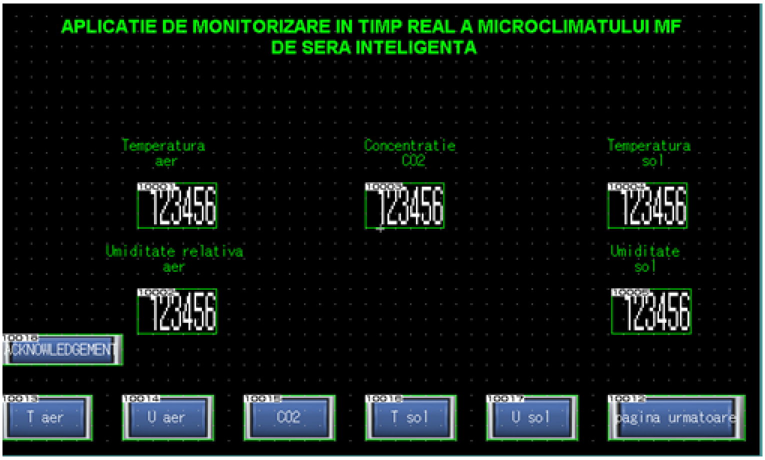

Fig. 3. The first page of the monitoring application

2. Monitoring page of the air temperature inside the greenhouse (where you can monitor the current temperatures measured by temperature sensors and their evolution over time in a graph - Fig.4).

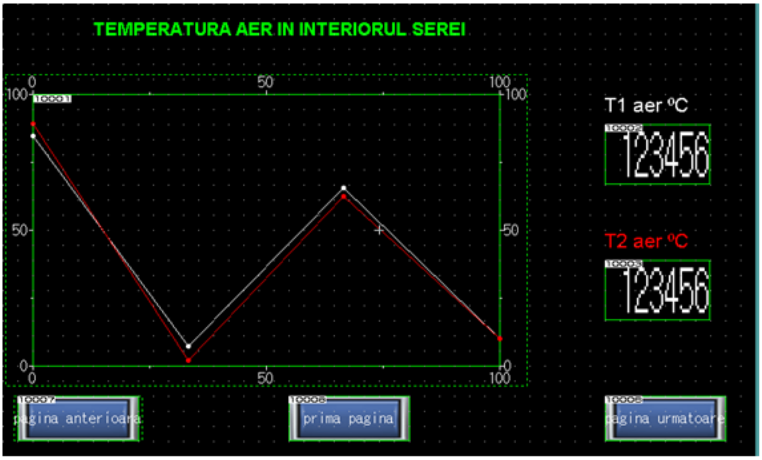

Fig. 4. Air temperature monitoring page

3. Monitoring page of the relative humidity of the air inside the greenhouse (where you can monitor the current relative humidity measured by the sensor and its evolution over time in a graph - Fig. 5).

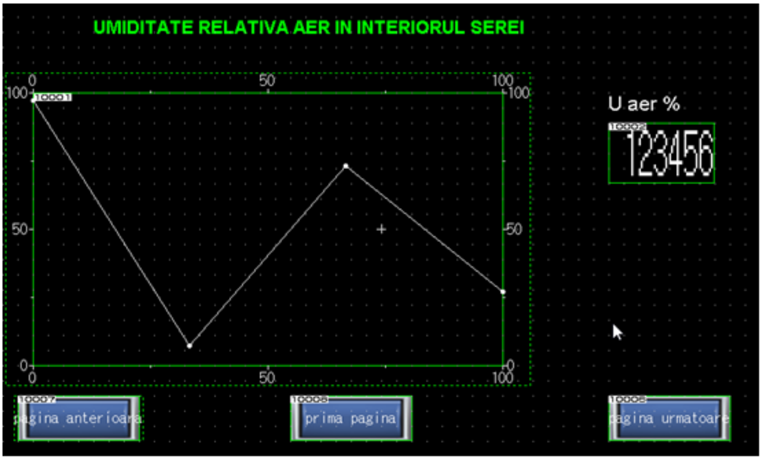

Fig. 5. Relative air humidity monitoring page

4. Greenhouse CO_2 monitoring page (where you can monitor the CO_2 level measured by the sensor and its evolution over time in a graph - Fig. 6).

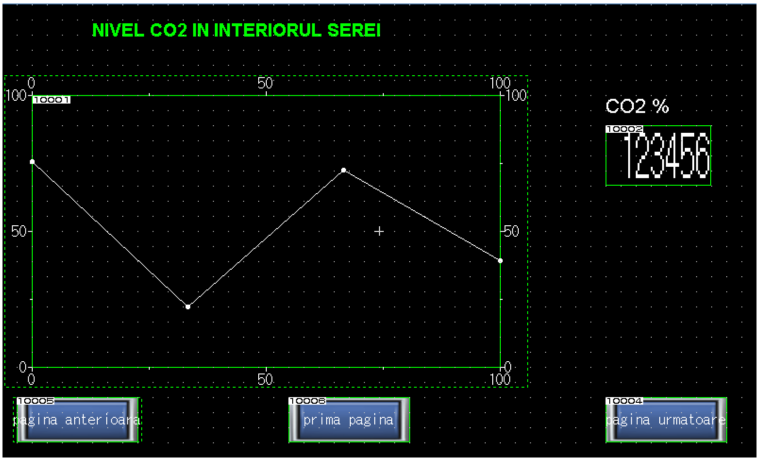

Fig. 6. CO_2 concentration monitoring page

5. Soil temperature monitoring page inside the greenhouse (where can be monitorized the current temperatures measured by the three temperature sensors in depth and their evolution over time in a graph - Fig. 7).

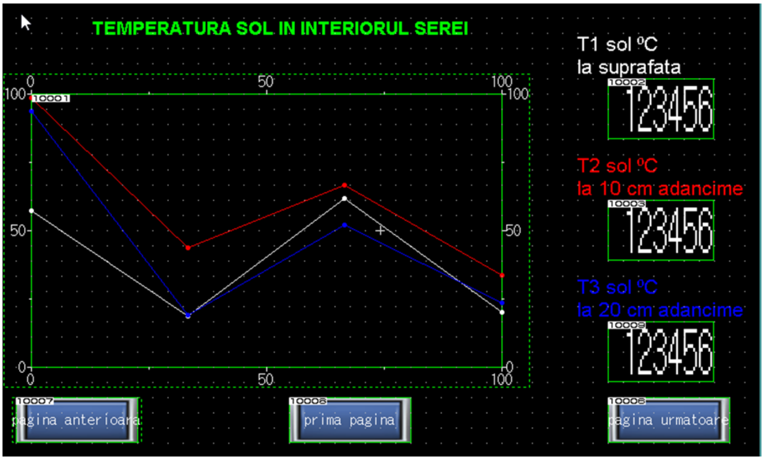

Fig. 7. Soil temperature monitoring page

6. Soil moisture monitoring page inside the greenhouse (where can be monitorized the current soil moisture measured by sensors and its evolution over time in a graph - Fig. 8).

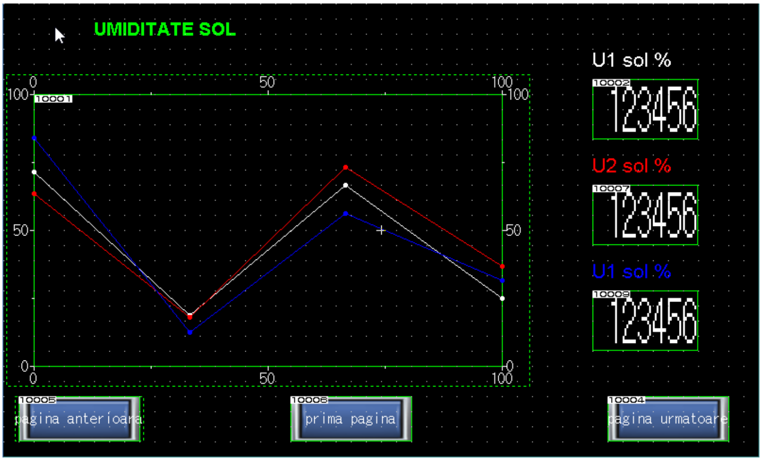

Fig. 8. Soil moisture monitoring page

Each page has designated switch buttons that allow you to switch from one page to another and return to the home page.

RESULTS AND DISCUSSIONS

By managing the microclimate factors in greenhouses it can achieve the simultaneous maintenance of the main set of microclimate factors, namely temperature, relative humidity and CO_2 concentration close to the predetermined reference values.

In computerized microclimate management systems in protected areas, several levels of its management can be distinguished:

• Level 1: (basic level) in which the time scale is very short (approximately 1 min); this level excludes information processing; most climate control computers use this level of management today.

• Level 2: where the time scale is of the order of an hour or a whole day; here the objective is to manage the physiological functions involved in the growth and development of plants in the short term (photosynthesis, transpiration) in addition to the simple monitoring of microclimate factors; this involves the use of numerical simulation models.

• Level 3: where the time scale is longer than 1 day; this level is characterized by bioeconomic optimization and strategic decision support; thus it is possible to obtain solutions that are close to the economic optimum, for each case.

Changes in temperature, humidity, light and other microclimate conditions can have a profound effect on plant productivity and production quality. By continuously monitoring many environmental variables simultaneously, a farmer is able to better understand how growing conditions fluctuate and respond to those changes to maximize efficiency and minimize adverse effects.

CONCLUSIONS

Remote monitoring systems of the greenhouse microclimate provide vital protection for them.

Thus, critical conditions such as temperature, leakage, humidity, damage, equipment failures are monitored, this information being vital during the growing period and outside the plant development season.

Temperature and humidity monitoring is essential for increasing productivity, decreasing energy consumption, increasing efficiency and reducing production or storage losses. In cold stores, vegetable fruit stores, mushrooms, greenhouses, etc., it is necessary to maintain a certain optimum temperature and humidity.

The multitude of factors that can produce changes in the microclimate of the greenhouse, threatening the health, yield and productivity of future plants, requires ensuring the optimal conditions for growth and development of cultivated plants.

ACKNOWLEDGEMENT

This work was supported by the Ministry of Agriculture and Rural Development, through the project entitled “Technologies and intelligent equipment for increasing productivity in protected spaces” – ADER 25.2.1 – Ctr. 25.2.1/27.09.2019

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