REMOTE CONTROL AND MONITORING OF IRRIGATION PROCESS OPERATION

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Abstract: This paper reflects the development results of the irrigation processes automating platform for the plantations, which can be very user-friendly to optimize these processes and minimize irrigation costs and therefore serves as a means to become more competitive on the market. It have been carried out the automation of plantation's irrigation process: three irrigation scheduling and control modalities have been proposed and software testing has been carried out to ensure the high reliability of the information and command system and its efficiency with a series of applications for the irrigation monitoring system, which allows the final user to make the necessary totals and decisions.

Introduction

The Strategy for the Development of Agriculture in Rep. of Moldova provides for the achievement of the nominated goal and the analysis of the agro-food sector, 2 priorities and a series of measures. The first priority provides increasing of the agriculture-food sector competitively form Republic of Moldova (RM), by restructuration and modernization.

The second priority provides ensuring the sustainable management of natural resources. Although the Republic of Moldova has fertile soils and a favorable climate for agricultural production, it faces the many environmental challenges.

Therefore, a priority for the Republic of Moldova is adapting to climate change at national level and capacity building. Such an approach should include improving farmers' access to new varieties, technologies and information through farmer training; Improving the diffusion of weather forecasts for manufacturers, especially for extreme events; investigate crop reform options to reduce administrative costs and improve accessibility and encourage private sector involvement in climate change adaptation efforts. Improvement of institutional capacities should focus on the identification of drought-resistant varieties and temperatures, more tolerant animal breeds in the current international market for adoption in the Republic of Moldova, as well as the training of agricultural producers in more efficient use of water using advanced irrigation systems and to make use of new weather forecast information. The strategy proposes three measures in this respect:

- investments in irrigation services are also of great importance, along with better access to irrigation infrastructure and modern equipment.

- supporting production technologies and organic products, in order to increase biodiversity and reduce soil erosion while contributing to the conservation of water resources.

- assessments of agricultural producers in promoting and adopting relevant technologies that will help adapt to climate change and supporting a farm insurance fund against natural disasters would increase farmers' confidence and attract investment in new technologies.

Therefore, taking into account the provisions of the strategy, the development of automation tools in the agro-food sector is an activity meant to facilitate these provisions. In the following compartments it will present the automation facilities for irrigation installations, realized within the UNDP project "Autonomous integrated irrigation systems based on wind turbines, small hydro and photovoltaic installations" supported by RoAid the development of the RM, alleviate poverty, improve living conditions and support the transition to democracy [1].
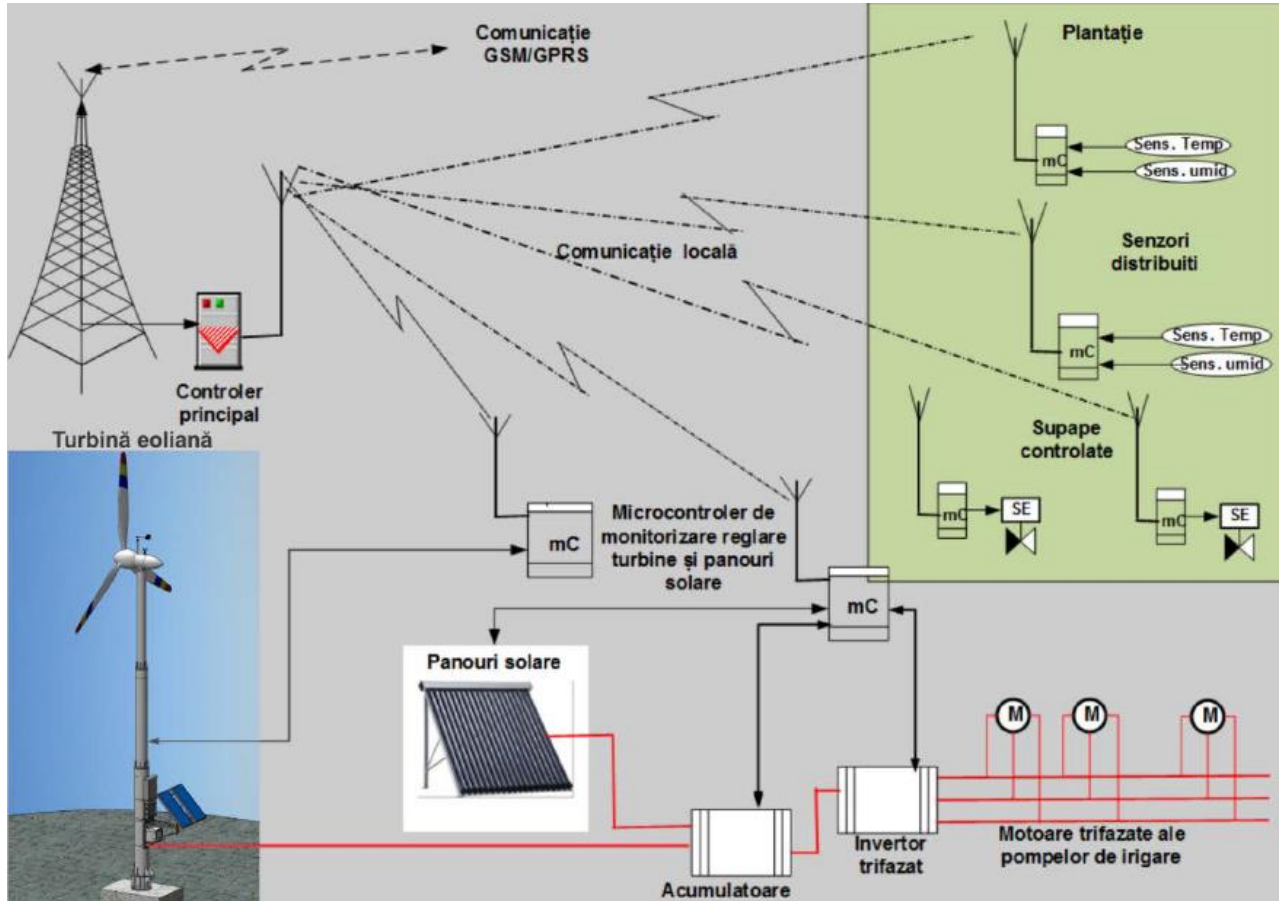
The concept of autonomous drip and sprinkler irrigation systems integrated with wind turbine and photovoltaic panels

At the current stage, although there are very advanced and sophisticated informational technologies and communications, the design of the monitoring and control system is not a trivial problem. The design of the automated control system for monitoring and optimization to ensure the irrigation processes will be carried out taking into account the following factors: acquisition of climatic data from plantations, application of nutrients and pesticides, herbicides, information processing and automatic control of the irrigation system, such as the monitoring of renewable energy sources. On the other hand, the design of the automated system must take into account the location of renewable plants and resources. In other words, the system has to be territorially distributed and it is reasonable to be hierarchized, considering the various issues that need to be solved.

Taking into account the experience of the most advanced companies in this field as well as their own experience, a three layer hierarchical system has been proposed (fig. 1). The bottom layer is the most sophisticated, nonhomogeneous and dependent and specific of agricultural enterprises. At this level are placed the means of acquiring the climatic data on the plantation field, the means of controlling the valves and pumps with remote control, the means of accelerating the fertilization equipment, as well as the means of monitoring and control of the renewable resources.

The second layer of the system has preponderant communication functions with minimal computing capabilities, decision-making, in other words, a kind of gateway between the lower level

and the upper level. The mission of this level is to provide communication coverage with all subsystems at the bottom level and to provide communications to the top level server (server).

Figure 1. The concept of autonomous drip and sprinkler irrigation integrated with wind turbine and photovoltaic panels.

Finally, the superior layer of the automation, monitoring and control system for irrigation systems is seen as a typical Internet solution, which will store all information on irrigated plantations as well as the state of the equipment and auxiliary subsystems. On the other hand, it must provide authorized access to users of this system. At the third level (server) will be first remote monitoring of several irrigation systems, groups of stations, including homing. If server monitoring and control node is connected to the Internet, then monitoring stations can be done from any point on the earth

Low layer of irrigation control system

The control units of the low layer are the core of irrigation stations and wind turbines or solar panels. The architecture of the control units is strictly dependent on the mission of the station should be able to solve a number of operational problems, including:

- Ensuring communication between the turbine and the local station monitoring system;
- Telemetry parameters of turbine control station;
- Control and regulation of power supply station subsystems.
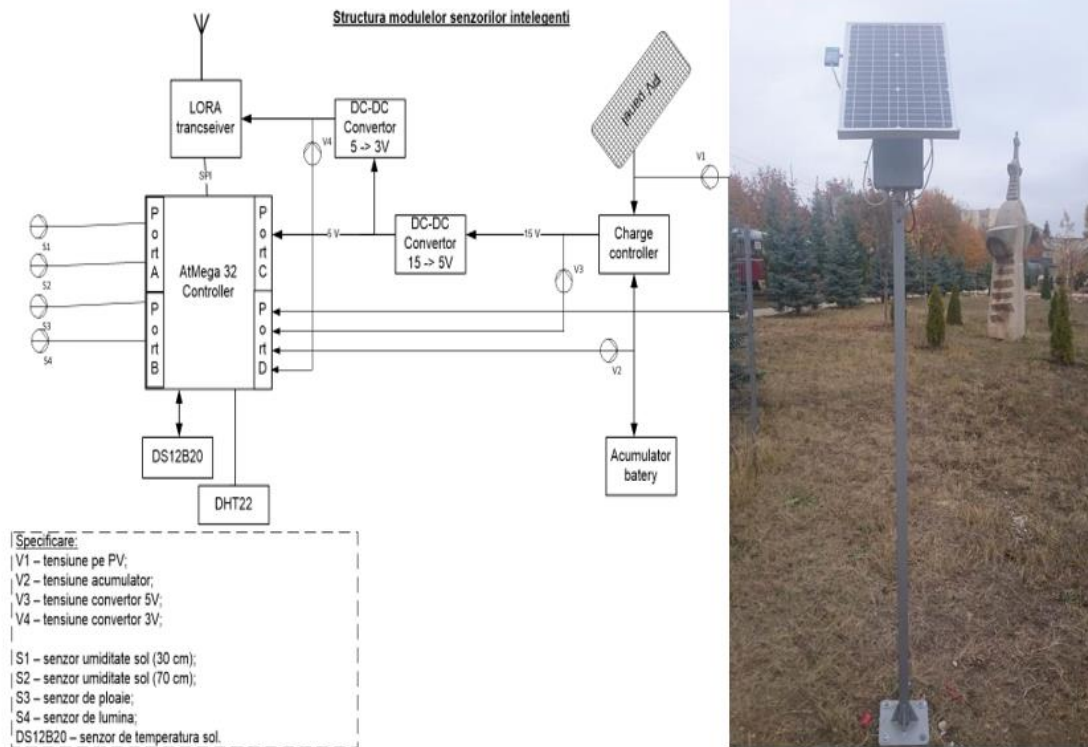
Figure 2. Functional schema and real view of integrated sensors module for irrigation system.

For any control and monitoring system, including for irrigation installations, data acquisition plays a primary role. For these reasons, it has been decided to build an acquisition subsystem based on an integrated sensor network. It was decided, taking into account the relief and climatic conditions of Rep. Moldova, that the control must be performed by an average performance microcontroller, which will operate autonomously and is monitored and guided by the two more powerful controllers by radio communication at short distances (up to 4-5 km). It was designed and realized the functional diagram and real equipment of integrated sensors and valve control modules for irrigation system. The most important sides of this modules are the autonomous electrical power subsystem with 20W photovoltaic panel, accumulator, remote data acquisition and control by of radio communication. The integrated sensor includes a set of sensors: air humidity and temperature, soil humidity and temperature at 2 levels; rain sensor, luminosity; photovoltaic panel and accumulator voltage (fig. 2).

Medium and high level of irrigation control system

It is proposed a farm plantation **medium layer control module** for irrigation system to coordinate all the processes for irrigation installation and for communication with high level (servers). For this case it was proposed the Raspberry controller with a higher computing performance and low cost and was developed the software for this controller, which include more components for the coordinating the communication between low level modules and the servers.

Interaction between the turbine station controllers, integrated sensors and the monitoring system was proposed to be performed according to a model, for example, as shown in fig. 4, which implies the access of the users of the stations practically from an unlimited distance, which is reasonable by the use of communications and computers, including the Internet.

The problem is simplified if the station controller connects to the network through units with a range greater than the previous one, sufficient to intercept the communications network. For such a case, high-speed and medium-to-high-speed radio communications, there is at the moment a whole range of possibilities and means.

For the communication between the medium and the upper level, we have proposed to use a way, called the GPRS interconnection. In GPRS operations instead, the connection is made directly to the internet as if the GPRS modem was an IP socket network interface. There is no data channel reserved for data sharing between two subscribers, instead the resources are dynamically allocated on demand and the data exchanged is usually packed in TCP/IP, in addition, the maximum transfer speed can be much faster than in GSM CSD mode. This approach has the immediate advantages of designing the GPRS control application Modem directly on the internet, ready to be accessed virtually anywhere in the world at the same productivity on GPRS, in fact, the "billing" of the GPRS connection is based on the amount of data exchanged (number of transferred packets) independently from the moment the connection is active or if these packets need to be delivered. Therefore, it is possible to leave the control application always logged in and ready to receive / send data on demand, while payment is made only for the really changed data. The disadvantage of the GPRS connection is that the request for control must have its own TCP/IP protocol stack embedded to decode the packets that arrive from GPRS and encode those to be sent over the Internet. This possibility can be seen as a way to get a "virtual" serial connection between the Application Software on the Internet Server computer and the lower level controllers with the GPRS module, regardless of all the software stacks.

The high level layer of irrigation control system. Taking in account the specifics of irrigation systems, it was proposed the architecture of the high level of control and information system based on 2 servers with different destination. First server, named "background" is organized on "IOT-technology" (Internet of Things) and have a destination for intensive communication with all local controllers of the irrigation installations. Its advantage is to operate with a lot of row data, without special formatting. But this server is accessible only for the administrator, not for the end-users. The second server, named public server have the destination to store the data about farm plantation, irrigation system and assure a friendly interface for the end-users. The developed database structure of the monitoring system reflects all the necessary components: plantations, plots, irrigation rules, composition and condition of facilities, etc. for the both servers. Conceptually, the structure of data bases on the servers is similar, but logical and physical structure a very different. It was developed a set of applications for data management for public server data base and some applications for graphical viewing of the current data from irrigation system.

Conclusions

Current information and communications technologies serve as a platform for automating of the irrigation processes for the plantations, which can be very user-friendly to optimize these processes and minimize irrigation costs and therefore serves as a means to become more competitive on the market . The developed the hardware of acquisition, processing and communication for the remote control and management of irrigation installation and the realized software of the low and medium layers provides the remote control.

The proposed architecture, software structure for the background and public servers can store all the data about irrigation processes. It have been carried out on the automation of plantation's irrigation process: three irrigation scheduling and control modalities have been proposed and software testing has been carried out to ensure the high reliability of the information and command system and efficiency with a series of applications for the irrigation monitoring system, which allows the final user to make the necessary totals and conclusions.

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