Resource Management System for of the Utility Sector at The Base Wireless Sensor Networks

Andrii Sliusar[1], Sofiia Khrustalova[2]
1. Faculty ACT, Kharkiv National University of Radio Electronics, UKRAINE, Kharkiv, Nauki Ave. 14.
e-mail: andrii.sliusar@nure.ua
2. CITAM Department, Kharkiv National University of Radio Electronics, UKRAINE,
Kharkiv, Nauki Ave. 14., e-mail: sofiua.yakubovska@nure.ua

Abstract: this article is devoted to the problem of monitoring water consumption. This topic was analyzed and proved its relevance for all industries and economy. Currently, the problem of implementing automated information technology in the process of monitoring water consumption is relevant and very important.

Key words: water supply, pipeline, monitoring, flow meter.

I. INTRODUCTION

Despite the rapid development of technology, most of the countries still use manual methods for transferring data from a water flow meter to a water service provider. This approach takes a long time, and the data obtained may not be accurate enough. Therefore, to improve the quality of control and accounting for the use of water, including in industrial enterprises, it is necessary to develop a system that will have a low cost price and allow you to remotely, in real time, monitor the necessary parameters.

The main special devices for controlling water flow are flow meters. Flow meter (counter) - a device that measures the volume flow rate or mass flow rate of a substance, i.e. the amount of substance (volume, mass) that passes through a given flow cross-section, for example, the pipeline cross-section per unit time [1]. The current industrial water flow meters differ in installation method and operating principle. They have different working characteristics: maximum and minimum flow rate, temperature range, geometric dimensions of pipelines or channels, maximum excess pressure in the system, etc.

To control the water flow, different types of flow meters are used [5,6], based on different principles of action and having different designs.

Basically, all modern water flow control systems [2] are a complex of functionally integrated technical means and software and consist of a flow meter (counter) with pulse outputs that is installed directly to the water supply system, a control and data transmission unit that reads, processes and transmits the results of the measurements of the flow meter to the data collection server for further provision to external applications, including automated workstations of dispatch control.

II. THE MAIN ELEMENTS OF THE SYSTEM AND ITS PRINCIPLE OF OPERATION

The system of remote accounting and control of water consumption is designed to solve a variety of operational tasks aimed at monitoring the volume of water consumed and its parameters, calculations for the services provided for supplying water to consumers, monitoring of unauthorized consumption of water supply services and drainage and detecting hidden leaks.

The paper proposes a system of remote accounting and control of water consumption in industrial enterprises, the structural scheme of which is shown in Fig.1, has a wide functionality and performs a wide range of tasks: automated data collection and transmission from water-measuring units; analysis and processing of data for the selected period and in the context of any indicators, that is, data can be obtained at any required frequency. This is especially important in situations where it is necessary to track the dynamics of water consumption, identify the peak intervals of consumption; information visualization; providing access to system services for personnel; integration with other existing data collection and processing systems [3].

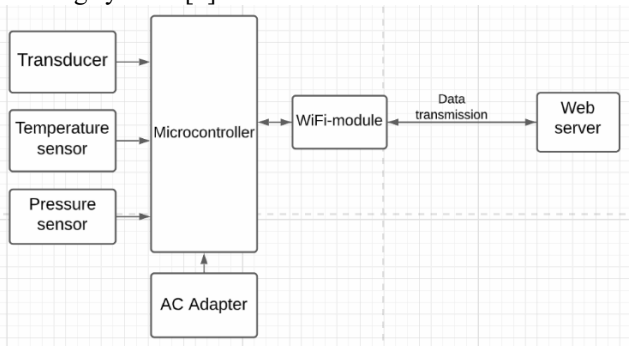

Fig.1. Structure chart of the system of remote accounting and control of water consumption

The system is a complex of functionally combined technical means and software that allows you to obtain information on the measurement, transmission and processing of data for further provision to external software applications, including customer automated workstations of the dispatcher and operator warehouse of the supplier and the consumer of water supply.

The main element of the system is the microcontroller ATmega328P [4], which performs the functions of data collection, processing and transmission and converts the number of pulses into water flow meter readings directly in the water meter unit, calculates the volume of current consumption and collects data from analog temperature sensors DS18B20 and pressure USP-G41, connected to the water supply system.

The main measuring function is performed by a flow meter YF-DN32 equipped with pulse counting output. It directly measures water flow velocity and flow volume. This data is fed to a pulse counting output and is read by the microcontroller for further processing and

transmission. The water flow sensor consists of a plastic housing, a water rotor and a Hall sensor.

Wi-Fi-module ESP8266 provides wireless high-speed data transmission from the microcontroller to the web server for their further visualization and monitoring. Access to the web server is made from a personal computer, tablet or smartphone with Internet access in the window interface of any of the popular web browsers [5].

To power the Arduino Uno Wi-Fi platform and other components of the remote accounting system and water consumption control, the power supply Robiton TN1000S was chosen, which ensures the smooth operation of the module.

The choice of necessary measuring devices that are part of the system directly depends on the following technical parameters: maximum allowable water temperature; maximum allowable pressure in the pipeline; maximum permissible water flow rate; pipeline length; cost per unit of time; total pressure loss in the pipeline; pressure loss per 1 m of pipeline length.

An algorithm of remote accounting and control of water consumption at industrial enterprises (Fig. 2), which consists of five main successive stages: measurement, data collection, data processing, data transmission to ESP8266 and data sending to a web server.

After completing these steps, data is updated at a specified time interval [6].

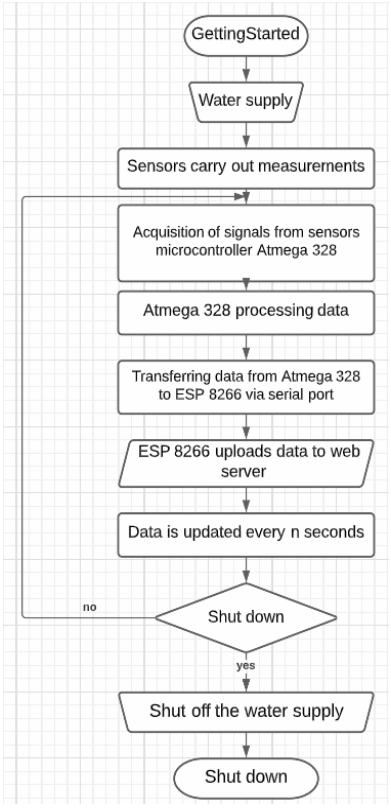

Fig.2. The algorithm of remote accounting and control of water consumption at industrial enterprises

A software tool of the system of remote accounting and control of water consumption at industrial enterprises, which consists of two parts, was developed:

– code for the Atmega328P microcontroller;

– source code for Wi-Fi module ESP8266.

Structural diagram of the software tool is shown in Fig. 3.

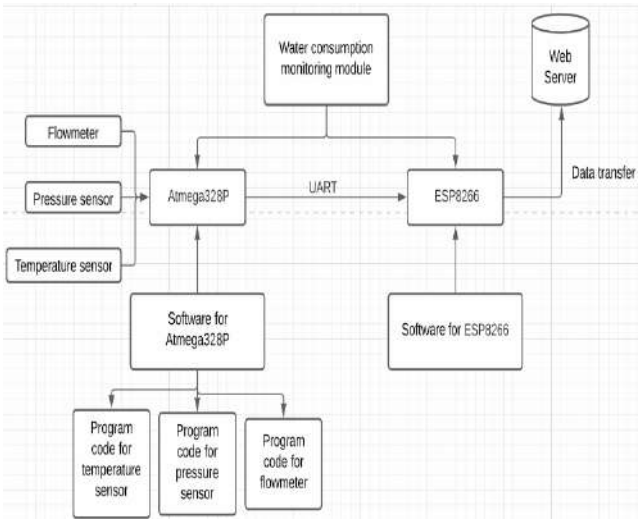

Fig.3. Structural scheme of software of the system of remote accounting and control of water consumption at production enterprises

The source code for the Atmega328P microcontroller consists of three parts:

– code for flow meter;

– software code for temperature sensor;

– code for pressure sensor.

All three code parts are combined into one program and have a similar structure and purpose.

It should be noted that the software is being downloaded to the microcontrollers separately. With switches on the board, a mode is selected for programming a specific device, and in the development environment of Arduino IDE, you also need to choose which microcontroller to program.

After the software is downloaded to the microcontrollers, the switches will activate the ESP8266 and Atmega328P connection mode via serial port. After performing all necessary operations, the water flow control module is ready to work.

The results of the program (the data transfer process on the web service) are presented in Figures 4 (a) and 4 (b).

A natural layout of the system of remote accounting and control of water consumption at manufacturing plants (Fig. 5).

liter/hour=0.00 l/hour
Total=0.00 liter
Temp=22.13°C
Pressure=0.03 bar
---
liter/hour=0.00 l/hour
Total=0.00 liter
Temp=22.19°C
Pressure=0.00 bar
---
liter/hour=-4338.13 l/hour
Total=1.22 liter
Temp=22.31°C
Pressure=0.16 bar
---
liter/hour=2477.87 l/hour
Total=4.34 liter
Temp=22.94°C
Pressure=0.00 bar
---
liter/hour=2205.87 l/hour
Total=7.38 liter
Temp=23.56°C
Pressure=0.00 bar
---
liter/hour=3109.87 l/hour
Total=10.67 liter
Temp=24.06°C
Pressure=0.00 bar
---
liter/hour=4288.00 l/hour
Total=11.86 liter
Temp=24.19°C
Pressure=0.00 bar

Fig.4(a). The result of the program

---
liter/hour=3328.00 l/hour
Total=16.10 liter
Temp=24.56°C
Pressure=0.00 bar
---
liter/hour=-3722.13 l/hour
Total=17.50 liter
Temp=24.44°C
Pressure=0.14 bar
---
liter/hour=-2868.27 l/hour
Total=21.56 liter
Temp=24.94°C
Pressure=0.00 bar
---
liter/hour=2917.87 l/hour
Total=24.79 liter
Temp=25.38°C
Pressure=0.00 bar
---
liter/hour=0.00 l/hour
Total=24.79 liter
Temp=25.06°C
Pressure=0.00 bar

/hour
Total=24.79 liter
Temp=24.56°C
Pressure=0.00 bar
---
liter/hour=0.00 l/hour
Total=24.79 liter
Temp=24.25°C
Pressure=0.00 bar

Fig.4(b). The result of the program

Fig.5. Full-scale model of the system of remote accounting and control of water consumption at production enterprises

III. CONCLUSION

The proposed system allows to improve the quality of accounting and control of water consumption at the production enterprise, the use of which allows to control their volume, to monitor and analyze the flow data, which in turn will help to rationalize the water consumption of the enterprise, which means that the final production cost will decrease, and its quality will improve.

In the future, the system can be upgraded by expanding its functionality by adding sensors (acidity level, water purity, leakage switch, etc.), expanding and optimizing the software, adding backup power supplies.

REFERENCES

[1] United Nations Global Compact Global Opportunity Report 2017. Available online: https://www unglobalcompact.org/library/5081 (accessed on 15 March 2022)

[2] Bragalli, C.; Neri, M.; Toth, E. Effectiveness of smart meter-based urban water loss assessment in a real network with synchronous and incomplete readings. Environ. Model. Softw. 2019, 112, 128-142.

[3] The Smart Water Networks Forum What is a Smart Water Network? Available online: https://www.swanforum.com/swan-tools/what-is-a-swn/ (accessed on 10 March 2022).

[4] Apollo Flowmeters supply meters and instruments for industrial? Chemical? Pharmaceutical and offshore application. Available online: https://www.apolloflow.co.uk/ (accessed on 02 March 2022).

[5] Flow meters https://www.giiq.ca/ (accessed on 02 March 2022).

[6] Sensors http://www.syntextech.com.tw/ (accessed on 10 March 2022).