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DEVELOPMENT OF A SYSTEM FOR COLLECTING AND PROCESSING INFORMATION VIA A MOBILE NETWORK.

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Abstract
The rapid advancement of mobile communication technologies has enabled embedded systems to play a crucial role in distributed data acquisition and processing. This paper explores the application of embedded systems for collecting and processing information over mobile networks, emphasizing their architecture, communication protocols, and practical implementations. Modern embedded devices, equipped with sensors and microcontrollers, can gather environmental or operational data and transmit it through mobile technologies such as GSM, LTE, or 5G. These systems allow real-time monitoring, remote control, and cloud-based data analysis, offering significant advantages in fields such as smart energy management, industrial automation, transportation, and environmental monitoring. The integration of mobile communication modules within embedded platforms enhances system flexibility and scalability while reducing infrastructure costs. Additionally, the paper discusses challenges related to data security, and network reliability, as well as possible optimization strategies. Overall, embedded systems connected via mobile networks represent a key enabler for the Internet of Things (IoT), bridging the gap between physical devices and digital intelligence.
Keywords: Modbus-RTU, SIM800, ESP32, GWU, Gateway.

INTRODUCTION

Embedded systems are specialized computing devices integrated into larger technical systems to perform specific tasks – control, measurement, monitoring or communication. They are characterized by compactness, low power consumption, high reliability and real-time operation. Thanks to advances in microcontroller technologies and communication interfaces, embedded systems have become a key element for automation and digitalization of various industries [1,2,3,4,5,6].

In parallel, the development of mobile communication standards – from GSM and GPRS to modern LTE and 5G networks – has created conditions for the construction of intelligent, interconnected devices that can exchange data over long distances without the need for a fixed infrastructure. As a result, a new generation of systems has emerged, in which the embedded microcontroller or microprocessor is connected to a wireless communication module (e.g. SIM800, Quectel, BG96, etc.), which allows the collection, processing and transmission of information over the mobile network [7,8].

These solutions are widely used in various fields:

- In energy – for remote consumption metering, distribution network management and facility monitoring

- In transportation – for vehicle tracking, control and logistics operations, and real-time diagnostics.
- In industry – for monitoring production lines,

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collecting technological parameters and optimizing processes.
- In environmental systems – to measure parameters such as temperature, humidity, air pollution or water level.
- In security systems – for alarm and security solutions that notify the user via the mobile network.

Connecting embedded systems via mobile communication offers a number of advantages – real-time data access, centralized management, flexible deployment, and low infrastructure costs. However, there are also challenges related to mobile connectivity reliability, data security, transmission latency, and device energy efficiency [9, 10].

In this context, the development of efficient architectures and protocols for data exchange over mobile networks is becoming a key aspect of modern research and engineering solutions. The present work aims to examine the principles of operation, communication mechanisms and applications of embedded systems that use mobile connectivity to collect and process information, as well as to analyze possible directions for their improvement in the context of the Internet of Things (IoT) and smart networks of the future.

EXPOSITION

This development considers a module for collecting, processing and sending data over a mobile network called "Gateway (GWU)". The device is based on an ESP32 microcontroller and a SIM800 GSM module, through which a 2G mobile connection is established, and communication via Wi-Fi is also possible. In this way, it becomes possible to automate and digitize a system that previously required direct human intervention. The ability to monitor and control a system remotely saves both time and resources.

The ESP32 controller was used, which is programmed and tested via UART communication, and the communication with the GSM module SIM800 was also implemented in the same way. The device has the ability to add an additional memory card to prevent a mobile network failure. The collected data is stored and processed until the network is restored, after which it is sent to a web-based application. A block diagram has been developed (Fig. 1), based on which an electronic module for collecting and processing information has been implemented and implemented (Fig. 2).

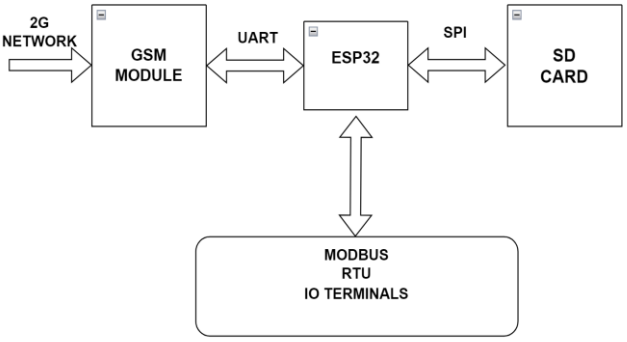

Fig. 1. Block diagram of a controller with GSM communication.

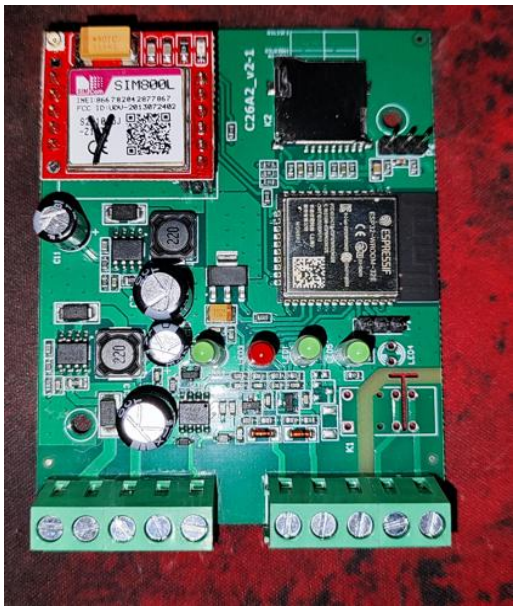

Fig.2. Developed module for collecting and processing information "GWU"

The GWU module requires a power supply of 12-36 VDC, and communication with other modules is possible through additional terminals - Fig. 2. The protocol used is MODBUS-RTU for transmitting and receiving information from peripheral devices connected to the Gateway module. The device has 2 digital inputs that can be connected to a magnetic sensor for the door of an electrical panel, monitoring the status of the panel, whether it is open or not.

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The LEDs indicate available power to the device, established communication with a mobile network, and active digital input.

A real project has been implemented using the GWU for street lighting control and monitoring. For this purpose, an RTC (real time clock) device with a relay is connected to the Gateway module, mounted in a cabinet supplying power to the street lighting of a given sector, and the clock relay controls the main contractor for the lamps.

Since the system is connected to a mobile network, this allows the clock to be adjusted to geographical coordinates, so that the exact time for a specific location can be correctly calculated and discrepancies can be avoided when turning on and off lighting at different points in the country.

In order to have a full need for such a system, it is necessary to be accompanied by an application to which the monitoring information is sent and commands are sent back from the application to the GWU module, which will use the MODBUS-RTU protocol to transmit this command to the corresponding peripheral module. In this particular case, through the development of such an application, the system also has the ability to manage the lighting status as well as set a time offset for a given area or for an entire city completely remotely (Fig. 3). This allows the user to reduce electricity costs since it is possible to send a command to turn off the lighting earlier than sunrise or vice versa to turn the lamps on included, in addition, the possibility of remote control reduced the need for direct human intervention to perform on-site manipulation, as other similar systems require.

There is also a reason for improving specific inter-building areas where the light fall is different, the solution is for this sector to continue to operate the lighting until it is exposed to direct natural light. (Fig. 4)

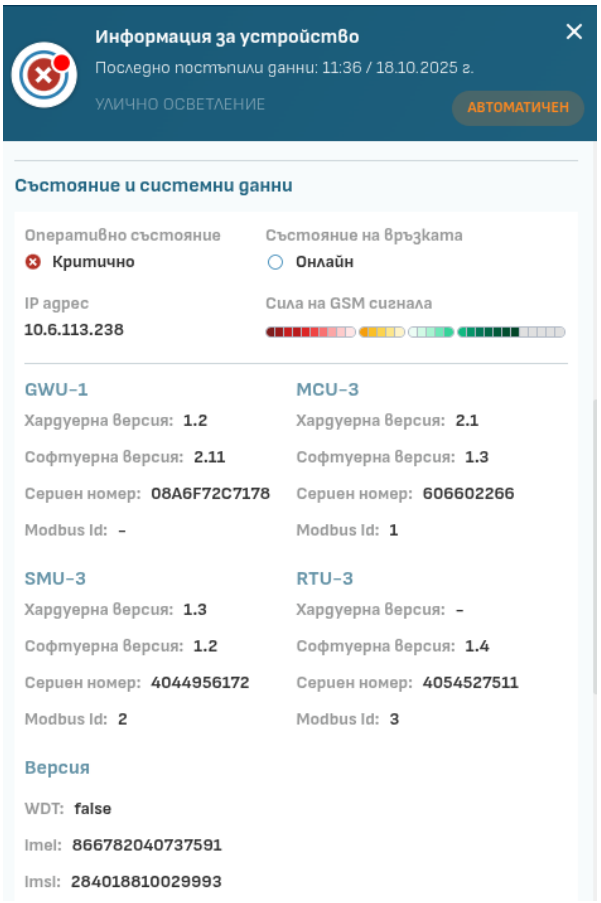

Fig.3 Developed WEB application.

Fig.4 Graphical view of the built infrastructure

CONCLUSION

The technologies considered and the developed module prove that the use of mobile networks significantly expands the scope of embedded systems - from local controllers to

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globally connected devices that exchange data with cloud platforms. This connectivity creates prerequisites for increasing efficiency, optimizing resources, and implementing autonomous monitoring and control systems.

Despite the many advantages, challenges remain significant, especially in the area of data security, connection stability, energy efficiency and standardization of communication protocols. Solving them requires an integrated approach, including both hardware optimization and development of software algorithms for reliable data transmission and analysis.

In conclusion, an embedded system using mobile networks for information collection and processing has been developed. Systems of this type will continue to be a key factor in the development of modern cyber-physical systems, intelligent industry, and digital infrastructures of the future [11].

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REFERENCE

[1] Bing Zhang & Jin Yuan - Research on embedded-based IoT information data collection technology, Institute of Information Engineering, Suqian University, ISSN 2444-8656

[2] Jianwei Zhang & Hao Yang - Mobile service aware opportunistic embedded architecture of mobile crowd sensing networks for power network measurement, EURASIP Journal on Embedded Systems, s13639-016-0023-0

[3] José Bravo, Vladimir Villarreal, Ramón Hervás, Gabriel Urzaiz - Using a Communication Model to Collect Measurement Data through Mobile Devices, MAmI Research Lab, University of Castilla-La Mancha, s120709253

[4] Krasen Angelov, Panagiotis Kogias, Nikolay Manchev, Stanimi Sadinov, Development of a Universal Integrated Monitoring System for Communication Networks, Conference: 2024 5th International Conference on Communications, Information, Electronic and Energy Systems (CIEES), DOI:10.1109/CIEES62939.2024.10811395

[5] Petar Panaiotov, Goran Goranov, Development of Control System Based on the Fuzzy Controller, X National Conference with International Participation (ELECTRONICA), May 16 - 17, 2019, Sofia, Bulgaria, Electronic ISBN: 978-1-7281-3622-6, DOI: 10.1109/ELECTRONICA.2019.8825635

[6] Petar Panaiotov, Goran Goranov, Development of a Solar MPPT controller with AI for control SEPIC converter, XXVIII International Scientific Conference Electronics - ET2019, 12 - 14 September, Sozopol., Electronic ISBN: 978-1-7281-2574-9

[7] Cesar Isaza, Jonny Paul Zavala De Paz, Ely Karina Anaya, Jose Amilcar Rizzo Sierra, Cristian Felipe Ramirez-Gutierrez, Pamela Rocio Ibarra Tapia – An Efficient Data Transmission Protocol Based on Embedded System Using Cellular Technology Infrastructure, University of Queretaro, El Marques 76240, Queretaro, Mexico

[8] Aamir Shahzad, René Landry Jr, Malrey Lee, Naixue Xiong, Jongho Lee, Changhoon Lee - A New Cellular Architecture for Information Retrieval from Sensor Networks through Embedded Service and Security Protocols, Chonbuk National University, PMC4934247

[9] Farzad Samie, Lars Bauer, Jörg Henkel - IoT Technologies for embedded computing, Karlsruhe Institute of Technology

[10] John Steenbruggen, Maria Teresa Borzacchielo, Peter Nijkamp, Henk Scholten - Mobile phone data from GSM networks for traffic parameter and urban spatial pattern assessment: a review of applications and opportunities, Institute for Environment and Sustainability, s10708-011-9413-y

[11] Bhavana BC, Vathsala Gowda CT, Rakshitha BH - Internet of Things (IOT) Technologies, Applications, International Journal for Research in Applied Science & Engineering Technology, ISSN: 2321-9653.

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doi: www.doi.org/10.70456/.....