РОЗДІЛ IV. ЕЛЕКТРОЕНЕРГЕТИКА, ЕЛЕКТРОТЕХНІКА ТА ЕЛЕКТРОМЕХАНІКА

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PROPOSAL OF MONITORING OF THE HEAT EXCHANGER STATION

The presented paper describes the creation of a "low-cost" monitoring security system based on the IoT platform connecting to the cloud. We focused on heat exchanger station, which is used in a block of flats. A simulation solution was developed together with 3D visualization and a practical test.

Final monitoring system informed the operator about the current state of the heat exchanger station and operator can intervene in time so that heat exchanger station is not suddenly damaged or cause some damage. Such monitoring system will find application in practice, but also in the teaching process, as the preparation of graduates for the modern monitoring systems, which are increasingly used in practice, will be improved. The presented paper is a scientific and methodological publication.

Keywords: *Monitoring; Security; Internet of Things; Cloud, Arduino.*
Fig.: 7. References: 12.

Urgency of the research. Currently, there is a significant trend in the use of IoT technology with a cloud connection. Such deployment is carried out for various reasons, such as increasing production efficiency - economic, pollution monitoring - environmental, health monitoring - medical, weather monitoring - agriculture, traffic monitoring - transport, etc. The data obtained using IoT technology are then processed and based on them we can predict the further development of the monitored parameters. It is estimated that by 2025 there will be approximately 75.44 billion IoT devices worldwide [1].

Target setting. The aim of the research was to create a low-cost system for monitoring and securing heat exchanger station.

Actual scientific researches and issues analysis. IoT technology is used in various fields. Applications can be found, for example, in smart environment monitoring [2], energy management [3], security monitoring [4], parking management [5], condition monitoring [6], health monitoring [7], disaster and forecast monitoring [8] and others. At the same time any object can be transformed into an IoT object, thanks to an internet connection. For example, a light bulb that can be turned on using a mobile application is an IoT device, as well as a motion sensor or intelligent thermostat, or a connected street light. In some larger objects, multiple IoT components can be used, such as an engine, to which we connect a number of sensors and they collect and transmit data to ensure that the engine works as it should. Sensors on conveyor belts control the amount and speed of moving objects. Or various smaller objects, such as a boiler, air, heat, water exchange stations and various others. To a greater extent, smart city or industrial complex projects fill large units with sensors that help us understand, control and manage the environment [9].

Specific solutions used in industry are offered, for example, by Amper Technologies [10] or Axzon [11]. The Amper Technologies system and their Factory OS effectively use sensors to improve the manufacturing process. Sensors register a range of important aspects, including energy consumption and downtime, so management can better plan individual processes, reduce costs and pinpoint growth areas. Axzon sensors provide real-time data during the manufacturing process in the automotive industry, and their predictive maintenance technology monitors the condition of factory equipment to prevent failures and time-consuming repairs.

Uninvestigated parts of general matters defining. Existing professional solutions are costly, and this can be an obstacle to setting them into practice. The present article aims to contribute to the development of affordable monitoring and security systems.

The research objective. Our goal is to point out the possibilities of deploying IoT technology on devices that do not primarily contain this technology and to point out that it is not a problem to modernize any older device to meet current monitoring trends. The benefits of these technologies are far greater than the costs involved. Our goal was to create the security of the heat exchanger station. The intention was to apply security elements, such as monitoring the required parameters, using the cloud platform to store the monitoring data, evaluating the data and the very security of our object. Another goal is to contribute to the teaching of modern monitoring and security systems and thus prepare students for the current requirements of industries.

The statement of basic materials. Our goal was to design a system that had the task of monitoring the parameters of the heat exchanger station and based on them to ensure its functionality, to prevent failures of the heat exchanger station, which could cause damage. The aim was also to design the security of the room against unwanted entry of a stranger.

The proposed system monitors the inlet temperature of the outer circuit and the outlet temperature of the inner circuit. The system also monitors the pressure in the pipe that leads the water to the station. In the event of low inlet pressure, the pump would switch off to prevent idling. These monitoring parameters relate directly to the heat exchanger station.

Indirect effects on the exchanger station are monitoring by several sensors. Water detection sensors were used to secure the room against flooding. In an emergency like a major flood, the system can start a pump that drains the water. The purpose of the smoke detector is to warn on the presence of smoke or fire.

The power failure sensor is used to switch the power supply of the exchanger station to a backup source.

In terms of securing of the object against unwanted entry, motion sensors were designed and the entrance door was secured with a coded lock.

The whole system is connected to the cloud, thanks to which the operator is notified of the status of the heat exchanger station. The operator can remotely control the monitoring and security system of the heat exchanger station.

In the first step of solving the task, we created a flowchart of the proposal system based on the selected parameters. In (Fig. 1) we can see an example of a part of the flowchart describing the security of the object.

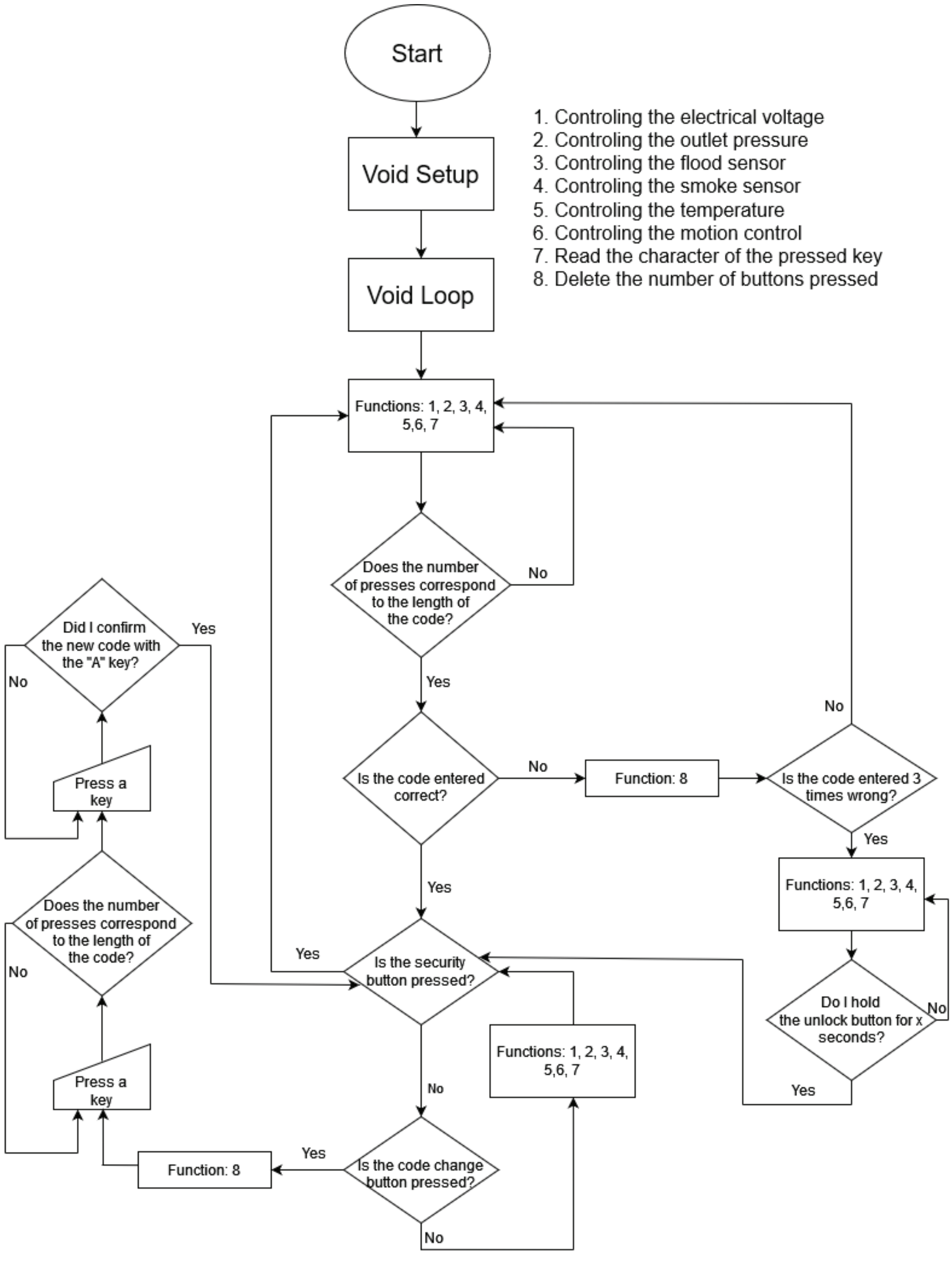


Fig. 1. Flowchart of the security part

Based on the resulting flowchart, we created a simulation solution for the entire system, which was made in the Tinkercad environment. The connection of our simulation solution is shown in (Fig. 2). Components such as the servomotor, numeric keypad, light emitting diodes, speaker and PIR sensor take care of controlling the input and movement in the building. We assigned element control to the tilt sensor and the smoke sensor. The role of the tilt sensors is to start the drain pump and inform about the probable flooding in the building. We used TMP36 sensors for temperature sensing. We simulated the drop in electrical voltage or output pressure using a potentiometer and a force sensor.

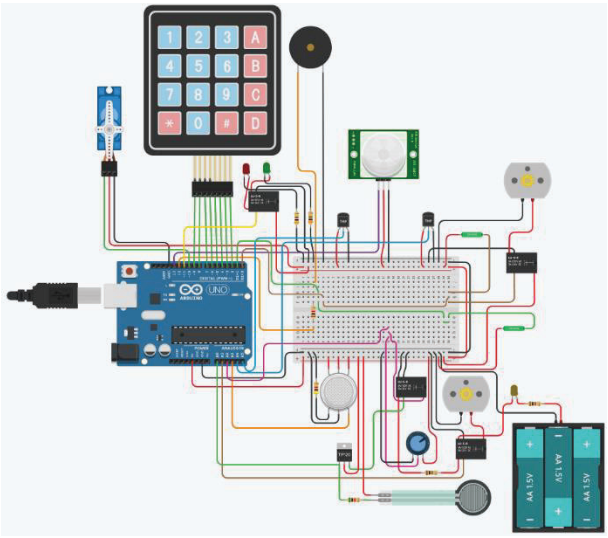
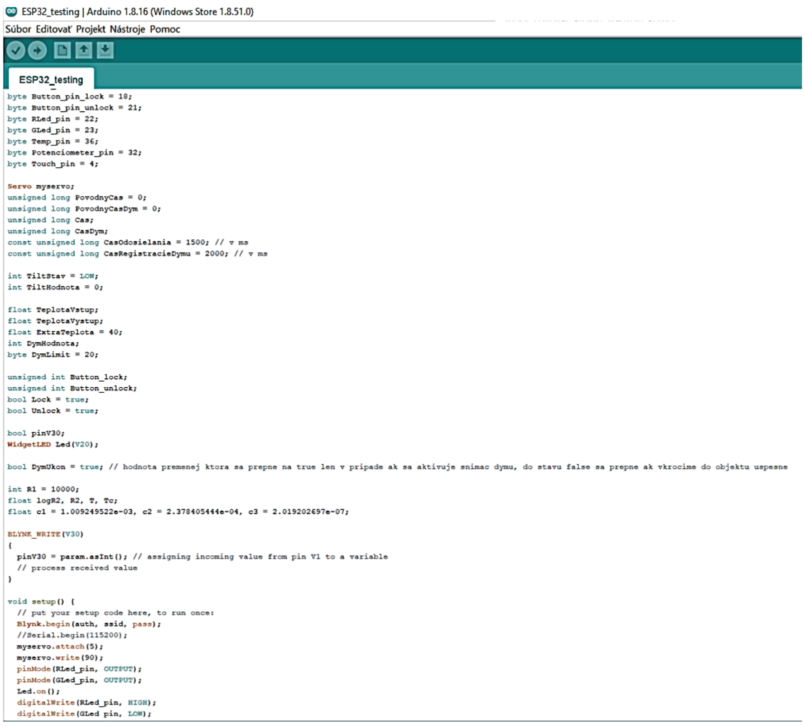


Fig. 2. Simulation solution

The control software was created in the Arduino IDE environment. An example of the resulting code can be seen in (Fig. 3).



```
ESP32_testing | Arduino 1.8.16 (Windows Store 1.8.51.0)
Súbor Editovať Projekt Nástroje Pomoc
ESP32_testing
byte Button_pin_lock = 18;
byte Button_pin_unlock = 21;
byte RLed_pin = 22;
byte GLed_pin = 23;
byte Temp_pin = 36;
byte Potenciometer_pin = 32;
byte Touch_pin = 4;

Servo myservo;
unsigned long PovodnyCas = 0;
unsigned long PovodnyCasDym = 0;
unsigned long Cas;
unsigned long CasDym;
const unsigned long CasOdosielania = 1500; // v ms
const unsigned long CasRegistracieDymu = 2000; // v ms

int TiltStav = LOW;
int TiltHodnota = 0;

float TeplotaVstup;
float TeplotaVystup;
float ExtraTeplota = 40;
int DymHodnota;
byte DymLimit = 20;

unsigned int Button_lock;
unsigned int Button_unlock;
bool Lock = true;
bool Unlock = true;

bool pinV30;
WidgetLED Led(V20);

bool DymUkon = true; // hodnota premenej ktora sa prepne na true len v pripade ak sa aktivuje snimac dymu, do stavu false sa prepne ak vkrocime do objektu uspesne

int R1 = 10000;
float logR2, R2, T, Tc;
float c1 = 1.009249522e-03, c2 = 2.378405444e-04, c3 = 2.019202697e-07;

BLYNK_WRITE(V30)
{
  pinV30 = param.asInt(); // assigning incoming value from pin V1 to a variable
  // process received value
}

void setup() {
  // put your setup code here, to run once:
  Blynk.begin(auth, ssid, pass);
  //Serial.begin(115200);
  myservo.attach(5);
  myservo.write(90);
  pinMode(RLed_pin, OUTPUT);
  pinMode(GLed_pin, OUTPUT);
  Led.on();
  digitalWrite(RLed_pin, HIGH);
  digitalWrite(GLed pin, LOW);
```

Fig. 3. Example of the code

We used hardware to test the function of the simulation solution. The system is primarily based on the Arduino UNO microcontroller, which meets the requirements for deployment to the system, but we created our test solution using the ESP32 DEVKIT V1 DOIT microcontroller, which we had available and considering its hardware and software capabilities offered us sufficient functions to verify the system. We connected this microcontroller to a breadboard, where we used the appropriate components and sensors (Fig. 4).

We used a thermistor and a potentiometer to simulate temperatures. By turning the potentiometer, we simulated fluctuations in the inlet temperature. Holding the thermistor in our hand increased the temperature and thus we simulated fluctuations in the outlet temperature. In this way, we verified the functionality of the thermistor and potentiometer as well as data acquisition. We used the red and green light emitting diodes to simulate the security of the system. If the green LED is on, the system is unlocked, if the red LED is on, the system is secured or blocked. We used the serial monitor function in the Arduino IDE program to list system security status notifications. We used the buttons to unlock and lock the system. One button represents system security, the other button represents system unlocking. Another button was used to simulate entering an incorrect passcode. Attempts to re-enter the passcode were counted by pressing the button. Individual experiments were recorded again on a serial monitor. We also used the touch sensor option that the ESP32 has. We simulated the registration of smoke in the building with a touch sensor. We have programmed the code so that if there is a signal on the touch sensor for a certain period of seconds, an information message will be displayed, notifying us that it is burning in the building. The last button was used to simulate the on and off of the drain pump in case of flooding in the building. With this physical test element, we verified the basic functions of the simulated solution.

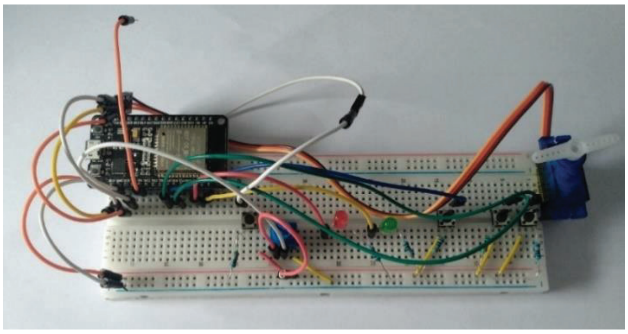


Fig. 4. Testing of the proposed solution

After verifying the functionality of the created solution, we proceeded to create a cloud part. We used the Blynk platform for the cloud environment. Two solutions have been developed. The first was to use a Blynk server. The second solution was built on our local server and thus we achieved higher security of the resulting solution. In Figure 5 we can see a part of Blynk app, which can be used to monitor the inlet and outlet temperature of the system. The solution includes an "Unlock" button that allows you to unlock the room remotely.

Fig. 5. Monitoring Blynk app

In the next step, we proceeded to create a 3D visualization of the room of the heat exchanger station together with the proposed monitoring system. Thanks to which we gained an overview of the location of individual components. The 3D visualization was created in Blender. All designed components of the monitoring system are marked in green. We marked the cabinets in which our components are located with blue. The rails in which we laid the cables are yellow. The resulting visualization can be seen in (Fig. 6 and Fig. 7) [12].

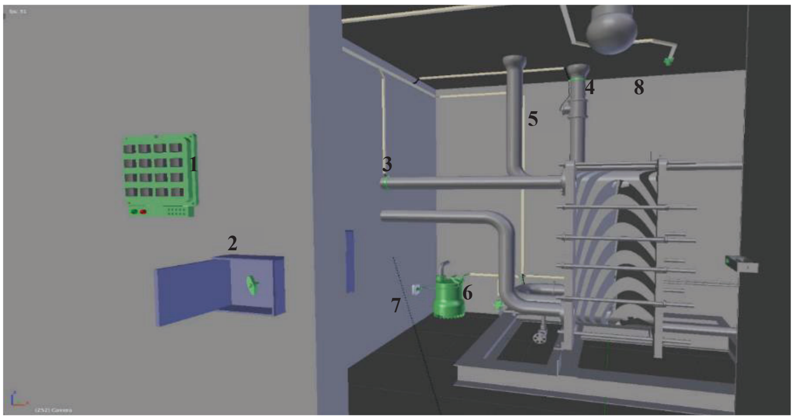


Fig. 6. Visualization of the solution, view 1
(1 – numeric keypad, 2 – emergency door opening, 3 – inlet temperature sensor, 4 – outlet temperature sensor, 5 – pressure sensor, 6 – flood sensor, 7 – drain pump, 8 – smoke sensor)

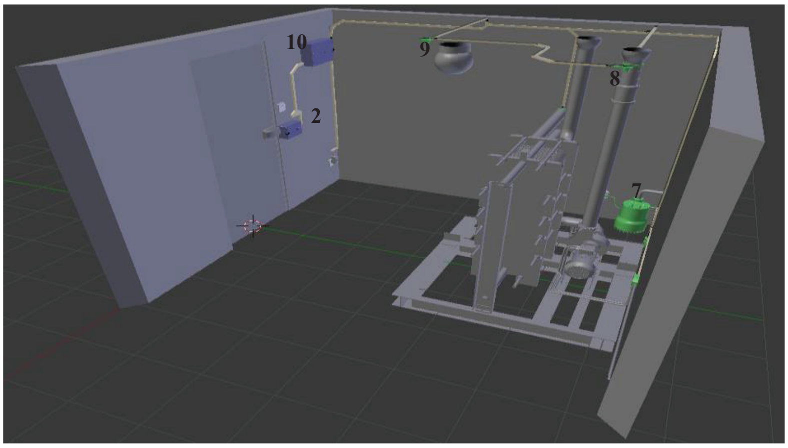


Fig. 7. Visualization of the solution, view 2
(2 – emergency door opening, 7 – drain pump, 8 – smoke sensor,
9 – motion sensor, 10 – box with control unit)

Conclusions. Based on the created simulations and visualizations, the entire proposed system was debugged, thanks to which the full functionality of the proposed solution was achieved. In the next phase, the system will be deployed on the real heat exchanger station. The following findings will be used to further optimise and supplement other system features. The result will be a sufficiently functional, inexpensive monitoring system of the heat exchanger station, which can be deployed in practice.

The result of the research is the creation of an IoT monitoring system on an object that does not contain such functionality. Based on this solution, it was confirmed that it is possible to innovate "obsolete" equipment to meet current monitoring trends. Another benefit obtained from the research is that the knowledge will be used in the teaching process of students focused on modern monitoring systems.

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ПРОПОЗИЦІЯ МОНІТОРИНГУ ТЕПЛООБМІННОЇ СТАНЦІЇ

Нині є значна тенденція у використанні технології IoT з хмарним з'єднанням. Таке розгортання здійснюється з різних причин, таких як підвищення ефективності виробництва - економічні, моніторинг забруднення - навколишнє середовище, моніторинг здоров'я - медичне, моніторинг погоди - сільське господарство, моніторинг руху - транспорт тощо. Дані, отримані за допомогою технології IoT, потім обробляються та базуються на них ми можемо передбачити подальший розвиток параметрів, що контролюються. За оцінками, до 2025 року у світі буде приблизно 75,44 млрд пристроїв Інтернету речей.

Метою дослідження було створити недорогу систему моніторингу та захисту теплообмінної станції.

Технологія IoT використовується в різних областях, про що свідчать публікації. Конкретні рішення, що використовуються в промисловості, пропонуються, наприклад, компаніями Amper Technologies або Axzon. Система Amper Technologies та їхня заводська ОС ефективно використовують датчики для покращення виробничого процесу. Датчики реєструють ряд важливих аспектів, включаючи споживання енергії та простої, тому керівництво може краще планувати окремі процеси, зменшувати витрати та визначати зони зростання. Датчики Axzon забезпечують дані в режимі реального часу під час виробничого процесу в автомобільній промисловості, а їх технологія прогнозного обслуговування відстежує стан заводського обладнання, щоб запобігти відмовам та тривалим ремонтам.

Існуючі професійні рішення є економічно ефективними, і це може стати перешкодою для їх втілення на практиці. Ця стаття має на меті сприяти розвитку доступних систем моніторингу та безпеки.

Наша мета - вказати на можливості розгортання технології IoT на пристроях, які в першу чергу не містять цієї технології, і зазначити, що модернізувати будь-які старіші пристрої з урахуванням сучасних тенденцій моніторингу не є проблемою. Переваги цих технологій набагато більші, ніж витрати.

Розроблено повністю функціональну недорогу систему моніторингу теплообмінників.

Випробування підтвердили повну функціональність системи моніторингу. На наступному етапі система буде введена в експлуатацію, а потім оптимізована.

Ключові слова: *моніторинг; безпека; інтернет речей; хмара; Arduino.*

Рис.: 7. Бібл.: 12.

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