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THE SYSTEM OF FINDING PEOPLE IN AN EMERGENCY SITUATION

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ABSTRACT

Nowadays the issue of maximum survival of people in a fire and their immediate evacuation is still under consideration. In this regard, many different methods are offered from all over the world — intelligent devices and intelligent wireless systems. We have considered this issue in detail. The main goal is using time efficiently, inform people regularly and take them out, reduce human casualties. The article also describes the concept of an emergency and its causes. The article discusses in detail modern methods of detecting people and navigation in case of fire, and also clearly describes using of wireless equipment and intelligent algorithms. It also shows the system architecture, goals, tasks and solutions. Examples are given of why this research is important and useful for people. The article provides information about using sensors. There are tables of their usage, interconnection, wireless communication with the central server. As a result, a system was created that works on the basis of electronic signs indicating the direction to a safe place in case of an emergency. It receive the signal from the central server.

Keywords: *Sensor, Algorithm, System, Wireless Sensor, Microcontroller*

1. INTRODUCTION

The system proposed in the study is designed to increase the efficiency of evacuation of objects in the event of a fire. Our solution is to develop a system of intelligent sensors and navigation signs that people can use to navigate the building in the event of a fire. The issues of fire safety in residential buildings, shopping and entertainment centers and enterprises are very relevant. The situation with fires in territories not subject to state fire supervision has not changed for more than five years [1]. This is confirmed by the official statistics of the Emergency Situations Committee of the Ministry of Internal Affairs of the Republic of Kazakhstan. It is impossible to control the fire, which can lead to mass death of people. In most cases, the cause of fires is a malfunction of electrical equipment, careless handling of fire and people's ignorance of fire safety rules. Panic can negatively affect evacuation, which can increase the number of victims. In addition, many facilities in our country are equipped with outdated detection and fire extinguishing equipment. A person's life depends on the correct organization of fire-fighting measures. A state of emergency is a temporary regime declared by the President or Parliament in response to various threats to the state [2]. These include natural disasters, the threat of war, man-made disasters, unrest among the population, etc. At the same time, the rights and freedoms of citizens are deliberately restricted, the laws of peacetime are suspended and laws on the state of emergency are introduced. By declaring a state of emergency, the head of State assumes many absolute powers. Various state bodies are changing their functions. They will have to serve in the new legal space with strict discipline. The time, date of the declaration of a state of emergency and the scope of powers delegated to the authorities for this time are determined by the Constitution of the country. An emergency situation is an accident, earthquake or catastrophe in a certain territory that caused or could cause the death of people, damage to their health, the environment and economic

facilities, caused significant material damage to the population and disrupted its vital activity.

Emergencies are divided into natural and man-made emergencies, depending on the cause [3]. Reasons: Today, due to the rapid development of scientific and technological progress, such activities as production, construction, mining, and the introduction of new chemicals into production are carried out. Although such rapid development has a positive impact on the economy, there is also a risk of environmental disaster. Sometimes the rules for the use of new equipment and technologies, materials are not observed, security measures are not implemented. Such mistakes can lead to accidents. Another cause of accidents is the storage of toxic, flammable, explosive substances, compliance with the rules of transportation, errors in handling them. Accidents largely occur due to non-compliance with labor regulations, negligence of employees, lack of proper knowledge, ignorance of equipment and safety regulations. This can lead to industrial accidents, explosions, fires, destruction and contamination with toxic or radioactive substances [4]. For example, in 1971, an explosion at the Minsk TV and Radio Plant destroyed the plant and led to human casualties. In 1986, a major explosion at the Chernobyl nuclear power plant led to a catastrophic accident.

The same situation is likely to occur at the Atyrau Chemical and oil refineries. Another danger of an accident is the release of highly toxic substances into the air. Toxic fumes from the fire rise into the air and spread to the ground. In particular, the gorenje of polyethylene, polystyrene-like materials is harmful to humans, animals, birds, etc. very life-threatening [2].

The following structure of the article is proposed: The second section reviews the literature on the development of intelligent emergency warning systems using modern intelligent devices.

The third section describes the methods of solving the problem. The fourth section presents the results of the study and discussion. The fifth section contains a conclusion and a list of references.

The problem statement is constructed as follows: Development of a new system for organizing a safe evacuation trajectory using artificial intelligence.

In this regard, several tasks were completed:

1. Study of existing fire extinguishing systems;
2. Analysis of the shortcomings of the system;
3. Determine the hardware solution required for alarm systems;
4. Optimization of the evacuation plan, implementation of algorithms;
5. Study of possible integrations with notification systems;
6. Development of software for notification devices to interact with the algorithm.

2. LITERATURE REVIEW

In recent years, the use of new technologies has rapidly changed management methods and productivity. The article [5] presents an experimental study of an emergency situation using modern mobile devices. The development of smart applications to inform about any special cases is described. [6] presents the basic principles and practice of designing local information systems for emergency services. Such an information system will significantly increase their productivity and reduce risks when introducing new technologies. [7] The Help me system has been developed. It provides mobile phone users with self-rescue instructions. HelpMe has a hospital, a police station, a gas station and much more. A new "time-cost" model has been introduced for delivering people to ambulances, as well as showing the shortest route to their destination. The results showed how effective this system is. [8] describes the design and management of an inexpensive robotic search and rescue system based on an immunosuppressive system for managing decentralized systems. The study [9] proposes a simple upgraded autonomous fire alarm system. Schematic solutions for the creation of an alarm system with electricity consumption are proposed. The citywide network is graphically connected using a simple digital and encoded frequency signal. New approaches to design and implementation based on BIM modeling are described in [10]. They significantly increase the level of managerial decision-making when evacuating people and saving property in the most difficult scenarios in case of fire and emergency. In [11], an intelligent fire extinguishing system is described, including building information modeling (BIM) and intelligent technologies. The results show the capabilities and advantages of the system for determining the best evacuation methods. [12] represents an important game engine for solving several key problems in BIM-based virtual environments and creating an emergency management system that supports virtual reality (VR). The system has been tested in real time for reliability and functionality in accordance with the development requirements. The results showed effective emergency management. [13] presents an interactive mapping game that can help emergency

personnel by imagining an imaginary fire in a building. A list of information elements necessary for emergency services personnel in this process is also presented. Accordingly, the importance of each element of information is evaluated. [14] presents the results of the implementation of EvacuSafe, a valuable tool for the design and planning of evacuation. This provides a comprehensive assessment of the effectiveness of evacuation in comparison with existing indicators and safety measures in the industry.

The conducted literature review and the study itself once again proves that a person's life will always come first. We are confident that this research will help save a person's life. Therefore, this work can be said to occupy a special place in the development of such information systems.

3 MATERIALS AND METHODS

As a result of the comparison, the most promising solution for the objects turned out to be the use of wireless fire alarm systems. It is effective for several reasons:

1) allow to reduce the installation time in buildings without cable lines;

2) In case of fire, the cable may catch fire before the source of ignition is detected.

Thanks to the continuous communication between the devices, the wireless system allows you to monitor the dynamics of the fire and manage evacuation in any case.

The main components of the equipment include: a central panel, sensors, a keyboard, additional controls, keys or proximity cards, a siren, a backup battery, executive modules for controlling any devices. Technical specifications depend on the specific application and manufacturer. The central alarm system receives alarm and service signals: sensors, control panel, actuators, etc. It has the ability to send information to the remote control of the security company or directly to the homeowner. The control panel is connected to the network. In addition, it has a backup power source — the battery lasts for 4-8 hours of continuous operation, depending on the model.

Receiving devices automatically monitor the condition of the equipment, allowing you to install additional programs to expand the available capabilities. If there are problems with individual nodes of the system, the devices send a message to the control panel, which allows you to work continuously.

The short algorithm of the system is as follows:

Step 1. Initial fire detection;

Step 2. Creating an effective escape route;

Step 3. Report a fire in the building and point the way through the signs.

Next, let's look at the system performance diagram (Figure 1).

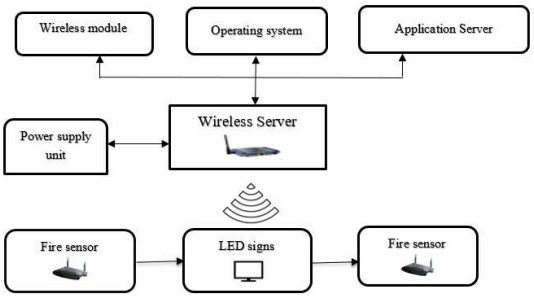

Figure 1: The information model of device

The system has a wireless connection that collects data from sensors via a central radio and a server that processes and detects fires. This is a central board that can receive and process information. A fire sensor is a sensor that allows you to detect signs of a fire.

LED signs are used to signal a fire to the central server. Power supply unit. To use the wireless server, you will need a power supply. A wireless module is a set of devices that send data wirelessly to a central server. The operating system is software. All this equipment is closely interconnected.

The next step is to describe the flowchart of the software running on the hardware (Fig. 2). Drivers are used to interact with other hardware and get all the data. Then it needs to be processed and the program must perform certain actions.

Here, the system is controlled through a user interface, allows you to receive and process data, data is transmitted through a wireless driver and sensors. In the event of a fire, alarm systems will be triggered and an effective evacuation route will be calculated. LED signage (electronic signage) shows people how to stay away from fires. Otherwise, the system will be in a normal state.

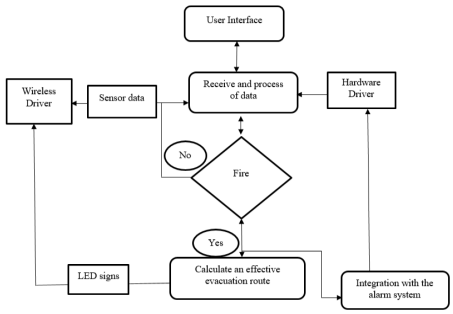

Figure 2: Software Flowchart

The algorithm of an intelligent system that effectively organizes the evacuation of people in an emergency consists of the following 9 main steps:

Step 1. System management via the user interface;

Step 2. Wireless driver and sensor data reception;

Step 3. Receiving and processing data coming to the server;

Step 4. In case of alarm information, alarm systems are activated;

Step 5. The hardware driver is started;

Step 6. If the information is confirmed, an effective evacuation route will be determined;

Step 7. LED indicators (electronic displays) are turned on and the trajectory of the fire exit is shown to people;

Step 8. If the information is not confirmed, the data will be received and processed again;

Step 9 The system returns to normal.

4 RESULTS AND DISCUSSIONS

Research and numerous publications show that the topic of intellectual improvement of the organization of safe evacuation trajectories is relevant today.

The article uses the method of indicating the optimal direction through electronic scoreboards to rescue people in case of fire. The principle of operation is as follows: sensors and electronic displays that determine the types of gas are installed on each floor of the institution. There will be a central server that will receive information wirelessly. From there, you can monitor the general condition of the institution. In case of fire, the first alarm system is triggered. The signal is sent to the central server via a wireless connection. Electronic boards are activated. Sensors detect the place of fire in the building. If the fire occurs in the right part of the location of the electronic shield, the image of the left turn will be displayed on the electronic shield, otherwise the direction of the right turn will be displayed. The whole situation is managed wirelessly via a central server. Wireless communication is the main focus of the work. Note: The central server must be installed outside the institution, for example: security points, etc. Electronic displays clearly show where people need to go. In this way, we will reduce the time it takes people to get to an effective place. It should be noted that the optimal use of time is the most important in case of fire.

The next step is to find the most likely way to the exit door from anywhere in the room:

```
from PIL import Image, ImageDraw
images = []

a = [
list(map(int, (list("1 1 1 1
1 1 1 1 1
1 1 1 1 1
0 1 1 1
1".split("\t"))))),
list(map(int, (list("1 0 0 1
0 1 0 0 0
0 0 0 0 0
0 1 0 0
1".split("\t"))))),
list(map(int, (list("1 0 0 0
0 1 0 0 0
0 0 0 0 1
0 1 0 0
1".split("\t"))))),
list(map(int, (list("1 1 1 1
0 1 0 0 0
0 0 0 0 1
0 1 0 0
1".split("\t"))))),
list(map(int, (list("1 0 0 0
0 1 0 0 0
0 0 0 0 1
0 0 0 0
1".split("\t"))))),
list(map(int, (list("1 0 0 1
0 0 0 0 0
0 0 0 0 1
0 0 0 0
1".split("\t"))))),
list(map(int, (list("1 1 1 1
0 1 1 1 1
1 1 1 1 1
0 1 1 1
1".split("\t"))))),
list(map(int, (list("1 0 0 0
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0 0 0 0 0
0 1 0 0
1".split("\t"))))),
list(map(int, (list("1 0 0 0
0 0 0 0 0
0 0 0 0 0
0 1 0 0
1".split("\t"))))),
list(map(int, (list("1 0 0 1
0 1 0 1 1
1 0 1 1 1
0 1 0 0
1".split("\t"))))),
```

```
list(map(int, (list("1 0 0 1
 0 1 0 0 0
 1 0 0 0 1
 0 0 0 0
 1".split("\t"))))),
list(map(int, (list("1 1 1 1
 0 1 1 1 1
 1 1 1 1 1
 1 1 1 1
 1".split("\t"))))),
]

d = [
  [1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
  [1, 0, 1, 0, 1, 0, 0, 0, 0, 1],
  [1, 0, 1, 0, 1, 0, 0, 0, 0, 1],
  [1, 0, 1, 0, 1, 1, 1, 1, 0, 1],
  [1, 0, 1, 0, 0, 0, 0, 1, 0, 1],
  [1, 0, 1, 0, 0, 0, 0, 1, 0, 1],
  [1, 0, 0, 0, 0, 0, 0, 1, 0, 1],
  [1, 0, 1, 0, 0, 0, 0, 0, 0, 1],
  [1, 0, 1, 0, 0, 0, 0, 0, 0, 1],
  [1, 1, 1, 1, 1, 1, 1, 1, 1, 1],
]

c = [
  [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1],
  [1, 0, 1, 0, 0, 0, 0, 0, 0, 1, 0 ,0, 0, 0, 0, 0, 0, 0, 0, 0,
1],
  [1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0 ,0, 0, 0, 0, 0, 0, 0, 0, 0,
1],
  [1, 0, 1, 0, 1, 1, 1, 1, 0, 1, 0 ,0, 0, 0, 0, 0, 0, 0, 0, 0,
1],
  [1, 0, 1, 0, 0, 0, 0, 1, 0, 1, 0 ,0, 0, 0, 1, 0, 1, 1, 1,
1],
  [1, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0 ,0, 0, 0, 1, 0, 0, 0, 0,
0],
  [1, 0, 0, 0, 0, 0, 0, 1, 0, 1, 0 ,0, 0, 0, 1, 1, 1, 1, 1,
1],
  [1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0 ,0, 0, 0, 0, 0, 0, 0, 0,
1],
  [1, 1, 1, 0, 0, 0, 0, 0, 0, 1, 0 ,0, 0, 0, 0, 0, 0, 0, 0,
1],
  [1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
1],
]

zoom = 20
borders = 6
start = 10,17
end = 11,4

def make_step(k):
  for i in range(len(m)):
    for j in range(len(m[i])):
      if m[i][j] == k:
        if i>0 and m[i-1][j] == 0 and a[i-1][j] == 0:
          m[i-1][j] = k + 1
        if j>0 and m[i][j-1] == 0 and a[i][j-1] == 0:
          m[i][j-1] = k + 1
        if i<len(m)-1 and m[i+1][j] == 0 and a[i+1][j]
== 0:
          m[i+1][j] = k + 1
        if j<len(m[i])-1 and m[i][j+1] == 0 and
a[i][j+1] == 0:
          m[i][j+1] = k + 1

def print_m(m):
  for i in range(len(m)):
    for j in range(len(m[i])):
      print( str(m[i][j]).ljust(2),end=' ')
    print()
def draw_matrix(a,m, the_path = []):
  im = Image.new('RGB', (zoom * len(a[0]), zoom
* len(a)), (255, 255, 255))
  draw = ImageDraw.Draw(im)
  for i in range(len(a)):
    for j in range(len(a[i])):
      color = (255, 255, 255)
      r = 0
      if a[i][j] == 1:
        color = (0, 0, 0)
      if i == start[0] and j == start[1]:
        color = (0, 255, 0)
        r = borders
      if i == end[0] and j == end[1]:
        color = (0, 255, 0)
        r = borders
      draw.rectangle((j*zoom+r, i*zoom+r,
j*zoom+zoom-r-1, i*zoom+zoom-r-1), fill=color)
      if m[i][j] > 0:
        r = borders
        draw.ellipse((j * zoom + r, i * zoom + r, j
* zoom + zoom - r - 1, i * zoom + zoom - r - 1),
                     fill=(255,0,0))
  for u in range(len(the_path)-1):
    y = the_path[u][0]*zoom + int(zoom/2)
    x = the_path[u][1]*zoom + int(zoom/2)
    y1 = the_path[u+1][0]*zoom + int(zoom/2)
    x1 = the_path[u+1][1]*zoom + int(zoom/2)
    draw.line((x,y,x1,y1), fill=(255, 0,0), width=5)
  draw.rectangle((0, 0, zoom * len(a[0]), zoom *
len(a)), outline=(0,255,0), width=2)
  images.append(im)
m = []
for i in range(len(a)):
  m.append([])
  for j in range(len(a[i])):
    m[-1].append(0)
```

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```
i,j = start
m[i][j] = 1
k = 0
while m[end[0]][end[1]] == 0:
    k += 1
    make_step(k)
    draw_matrix(a, m)
i, j = end
k = m[i][j]
the_path = [(i,j)]
while k > 1:
  if i > 0 and m[i - 1][j] == k-1:
    i, j = i-1, j
    the_path.append((i, j))
    k-=1
  elif j > 0 and m[i][j - 1] == k-1:
    i, j = i, j-1
    the_path.append((i, j))
    k-=1
  elif i < len(m) - 1 and m[i + 1][j] == k-1:
    i, j = i+1, j
    the_path.append((i, j))
    k-=1
  elif j < len(m[i]) - 1 and m[i][j + 1] == k-1:
    i, j = i, j+1
    the_path.append((i, j))
    k -= 1
  draw_matrix(a, m, the_path)
for i in range(10):
    if i % 2 == 0:
        draw_matrix(a, m, the_path)
    else:
        draw_matrix(a, m)
print_m(m)
print(the_path)
images[0].save('maze.gif',
               save_all=True,
append_images=images[1:],
                optimize=False, duration=1, loop=0)
```

The coordinates of a point are given by matrices, passing the coordinates of obstacles along the way, and the most optimal path is found (Fig.3, Fig.4).

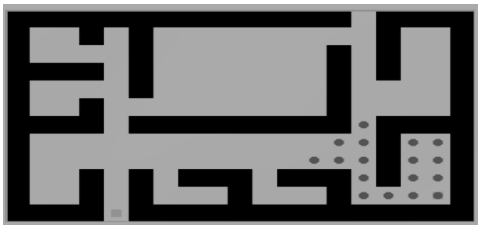

Figure 3: Search for an exit door from a random point

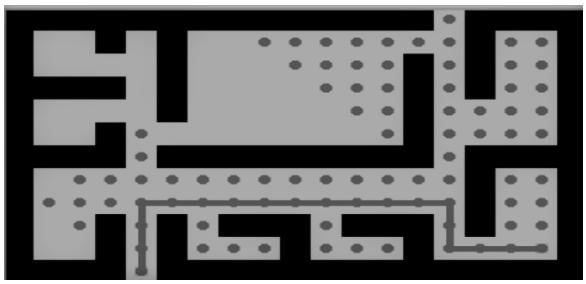

Figure 4: The optimal direction was found

Program code for sending temperature results to a central server:

TRANSMITTER

```
#include <SPI.h>
#include <nRF24L01.h>
#include <RF24.h>
#include <DHT11.h>

int pin = A0;
DHT11 dht11(pin);
float temperature[2];

double Fahrenheit(double celsius) {
return ((double)(9 / 5) * celsius) + 32;
}

double Kelvin(double celsius) {
return celsius + 273.15;
}

RF24 radio(8, 9);
const uint64_t pipe = 0xE8E8F0F0E1LL;
 void setup(void) {
radio.begin();
radio.openWritingPipe(pipe);
}

void loop(void)
{
float temp, humi;
dht11.read(humi, temp);
temperature[0] = temp;
temperature[1] = humi;
radio.write(temperature, sizeof(temperature));
delay(1000);
}
```

The result of the program code (Fig.5):

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Figure 5: Temperature and humidity indicators

Graph of program code (Fig.6):

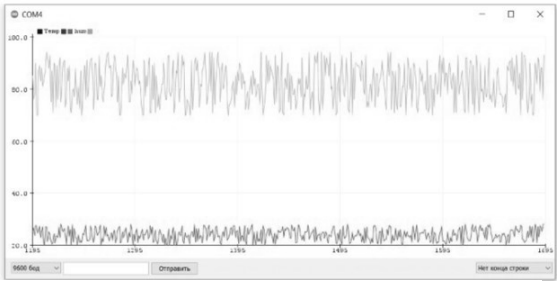

Figure 6: Graph of temperature and humidity indicators

Figure 6: The yellow indicators on the graph are the results of humidity in the institution, and the red indicators are the results of temperature. It has different meanings over time. This allows you to process incoming data.

As for the equipment needed to organize this system:

1) NRF240L Radio module
2) Arduino Nano
3) DHT11 temperature and humidity sensor

The principle of operation is as follows: every second, data on temperature and humidity in the institution is sent via radio channel to the central server at the pip address 0xE8E8F0F0E1LL.

The system uses the HC-SR501 infrared motion sensor, MQ-9 combustible gas sensors and carbon monoxide sensors [15].

MQ series gas sensors are devices that detect the presence of one or more types of gas in the environment (Fig. 7) [16]. These sensors have a wide range of applications, for example, in the security systems of oil refineries, production centers and even homes. These sensors detect flammable gases, toxic gases, polluting gases, etc. There are several ways to detect gas, the most commonly used electrochemical sensors. These sensors measure the concentration of a certain gas by a chemical reaction on their heated electrodes and the resulting electric current.

Figure 7: Sensor of combustible gases and carbon monoxide MQ-9

The MQ-9 sensor is sensitive to carbon monoxide and combustible gases. It can determine the density of carbon monoxide from 10 to 1000 parts per million and the density of combustible gases from 100 to 10000 parts per million. The MQ9 has an internal heater operating from a voltage of 5 V.

The internal resistance of this sensor changes as the density of the detected gases changes. This value can be read from a simple diagram. To get accurate data from the MQ9 gas sensor, you must first perform the following steps: The MQ9 sensor requires a preheating time of 24-48 hours. The power must be turned on and left on for the required time until it is ready. The gas sensor also requires calibration.

Connection of the MQ9 sensor [17]. The MQ9 module has 4 contacts. Connects Vcc to 5V and GND to GND. The AO output returns an analog value based on the gas concentration. If the gas concentration is above a certain value, the output at the DO contact will be higher. This value can be set using a potentiometer on the board.

Calibration of the MQ-9 sensor [18,19]. The module must be calibrated before use (Fig. 8).

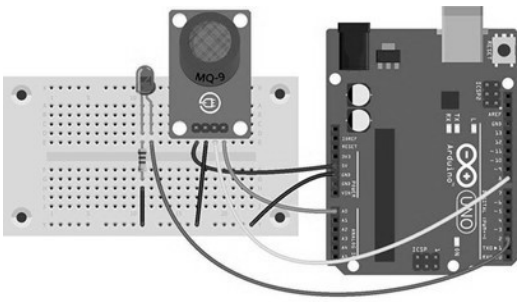

Figure 8: The module MQ9

This sensor measures the gas concentration based on the resistance coefficient. This coefficient includes R0 (sensor resistance at a concentration of LPG 1000 ppm) and Rs (internal resistance of the sensor, which varies depending on the gas concentration). In the fresh air, after preheating,

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download the following code and wait about 15 minutes until R0 reaches the set value.

```
void setup() {
Serial.begin(9600);
}
void loop() {
 float sensor_volt;
 float RS_air; //  Rs таза ауада
 float R0;  // R0 1000 ppm LPG
 float sensorValue;
// Орташа
  for(int x = 0 ; x < 100 ; x++)
 {
  sensorValue = sensorValue + analogRead(A0);
 }
 sensorValue = sensorValue/100.0;
//-----------------------------------------------/
 sensor_volt = (sensorValue/1024)*5.0;
 RS_air = (5.0-sensor_volt)/sensor_volt; // Сіздің модулыңізге байланысты RL
 R0 = RS_air/9.9; // MQ9 деректер кестесі бойынша
 Serial.print("sensor_volt = ");
 Serial.print(sensor_volt);
 Serial.println("V");
 Serial.print("R0 = ");
 Serial.println(R0);
 delay(1000);
 }
```

As shown in the above code, an average of 100 data is obtained (in some cases) to achieve a constant value. Then the sensor voltage is measured and Rs is calculated according to the stability of RL (in our case 5K). Then R0 is found by the table given in the data table. Now you need to use the variable R0 found in the previous step when working with the sensor (the code is shown below).

```
const int LED = 2;
const int DO = 8;
void setup() {
 Serial.begin(9600);
 pinMode(LED, OUTPUT);
 pinMode(DO, INPUT);
}
void loop() {
 int alarm = 0;
 float sensor_volt;
 float RS_gas;
 float ratio;
//- Бірінші тесттің көрсетіліміндегі «R0» атауын R0 мәнімен ауыстырыңыз -/
 float R0 = 0.91;
 int sensorValue = analogRead(A0);
 sensor_volt = ((float)sensorValue / 1024) * 5.0;
 RS_gas = (5.0 - sensor_volt) / sensor_volt; // Модульге байланысты RL-ды белгілеңіз
 ratio = RS_gas / R0; // ratio = RS/R0
//-----------------------------------------------------------/
 Serial.print("sensor_volt = ");
 Serial.println(sensor_volt);
 Serial.print("RS_ratio = ");
 Serial.println(RS_gas);
 Serial.print("Rs/R0 = ");
 Serial.println(ratio);
 Serial.print("\n\n");
 alarm = digitalRead(DO);
 if (alarm == 1) digitalWrite(LED, HIGH);
 else if (alarm == 0) digitalWrite(LED, LOW);
 delay(1000);
}
```

Now the Arduino IDE monitor opens (Figure 9) and the gas concentration is determined:

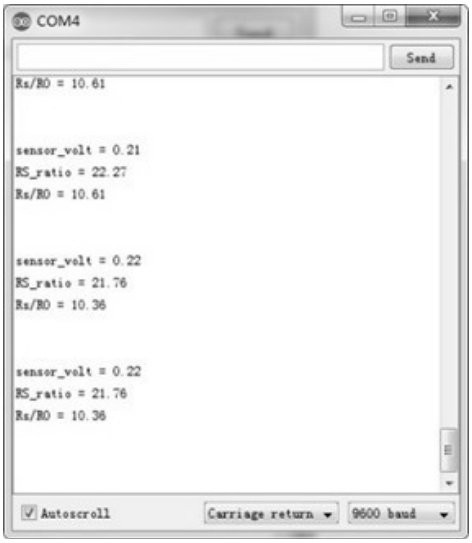

Figure 9: The monitor of Arduino IDE

Any person or animal at a temperature above zero emits thermal energy in the form of radiation. This light is invisible to the human eye because it is an infrared wave below the visible spectrum. The principle of operation of the HC-SR501 infrared motion sensor is simple [20], when turned on, the sensor adjusts the "Normal" infrared radiation in its detection zone. Then he looks for changes that have occurred or have been moved to the human control zone. The detector uses a pyroelectric sensor that generates an electric current in response to infrared radiation to detect infrared radiation. The sensor is considered a passive sensor because it does not emit a signal like an ultrasonic sensor. If the

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module detects a change, it changes the output current on the information pin.

To increase the sensitivity and efficiency of the HC-SR501 [21] sensor (Fig. 10), the device uses the method of focusing infrared radiation through a "Fresnel lens" [22].

Figure 10: HC-SR501 infrared motion sensor

The plastic dome-shaped lens [23] (Fig. 11) consists of several small Fresnel lenses. Although the plastic is cloudy for humans, in fact it is completely transparent to infrared rays, so it can also serve as a filter [24].

Figure 11: Domed lens made of plastic

HC-SR501 is an inexpensive IR sensor that can work independently or with a microcontroller. The sensor adjusts the sensitivity, which detects movement from 3 to 7 meters, and its output can be set from 3 seconds to 5 minutes. The sensor also has a built-in voltage regulator, so it can be powered from 4-5 to 20 volts DC and consumes a small amount of current [17]. HC - SR501 with 3-pin connector, works as follows:

- VCC - DC voltage from 4.5 to 20 V
- OUTPUT- a logical output of 3.3 volts. There is no definition of LOW, HIGH means that someone has been found.
- GND - earth.

There are two potentiometers on the board for setting several parameters [24]:

- SENSITIVITY - sets the maximum and minimum distance (from 3 meters to 7 meters).
- TIME (time) - remains HIGH after the output is detected. Minimum 3 seconds, maximum 300 seconds or 5 minutes.

HC - SR501 connecting the sensor to the Arduino [25] is shown in Figure 12.

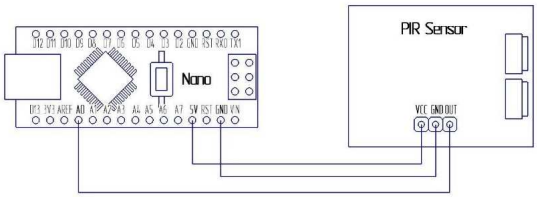

Figure 12: HC-SR501 Sensor connection diagram to Arduino

The contacts of the HC-SR501 sensor [20] must be connected according to the following scheme, as shown in Figure 8;

- To the Arduino GND pin
- VCC - 5V;
- Connection to pin OUT - A0.

The connection of the module output to the analog output depends on the fact that the Arduino digital pins work with 5-volt logic, and our module is designed for 3.3 V. In the program, we get the value 500 on the analog port as a logical block, which is approximately 2.44.

All devices used operate with a voltage of 12V in accordance with the standard of the low current system. The excess current charge regulator is installed on the controller. And the internal logic does with a voltage of 5V. To do this, a converter controller is installed.

The visual representation of the program is shown in Figure 13:

Figure 13: The drawing of the room is in a stable state

The visual representation of the program (in case of fire) is shown in Figure 14:

Figure 14: Drawing of the room in case of fire

In the event of a fire, the alarm system is activated immediately. The central server will detect the room where the fire occurred through temperature sensors. The path to the room where the fire occurred is blocked. Exit routes are calculated and the route is indicated to the victims through electronic signs.

In the section "Literature Review" a review of a number of works is carried out. As a result, the advantage of this work over other work is the use of electronic boards connected to the server. This approach is one of the best ways to automate and save time. Modern and affordable devices are also used in the work. A good result can be achieved if residential buildings use this work.

5 CONCLUSIONS

In conclusion, an optimal wireless communication system has been created in the article in order to determine the location of people in case of emergency situations, in particular, in case of a fire at the facility, their early evacuation to a safe zone. As a result, the following works were carried out: review of modern fire extinguishing systems, identification of shortcomings of existing systems, elimination of these shortcomings and search for ways to develop a new system.In this regard, several tasks were performed: the study of existing fire extinguishing systems, the analysis of system failures, the definition of hardware solutions necessary for alarm systems, the optimization of evacuation plans, the introduction of algorithms, the study of possible integrations with alarm systems, the development of software for alarm devices. The main functions in the system are sensors and electronic boards. The software is based on the Arduino Nano system. The program code is fully disclosed. The sensors used are described. The advantage of the proposed system is the principle of its wireless operation and optimal use of time.

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