Physics and Mathematics in Aktobe

NIS

Nazarbayev Intellectual Schools

PROJECT WORK

“FIRE FINDER”

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I.EXECUTIVE SUMMARY

A. The Problem

Wildfires are blazes that are uncontrolled and fueled by different types of weather, dry underbrush, and wind, which burn land by the acres and take over everything in their paths, in just a few minutes. As we know, every year there are more than 300 thousand cases of fires. The damage from forest fires amounts to billions of dollars. On average, 2.46 million hectares of land were burned in a year and on average, about 100 people died in the deadliest fires, 250 were injured, and carbon dioxide emissions from fires reach a quarter of all human emissions, including emissions from industry and transport. There are such cases when the consequences of fires cannot be remedied, in other cases the state has to spend millions to rehabilitate the land and restore the ecosystem of these places.

Forest and steppe fires release large amounts of carbon into the atmosphere in a short amount of time. Ground fire is often a natural feature of healthy ecosystems, but uninformed past human interventions have left forests and steppe more susceptible to catastrophic fires. Better managing how and when forest and steppe burns can prevent excessive loss of carbon into the atmosphere.

B. Our Solution: Fire Finder

We offer the project “Fire Finder” aimed at solving the ecological situation in forest and forest-steppe (protected) zones, namely the detection and warning of a fire in these places. The main task solved by our project is the development of a system for detecting forest or steppe fires based on a sensor system with high reliability, autonomy, the ability to use this method in areas not supported by a network.

II. DESIGN

A. Mechanisms and solutions

Fire is an uncontrolled burning process that causes material damage and danger to the life and health of people and animals.
The intensity of heat transfer from the fire zone to the environment depends on the temperature of the fire.

Fires are a powerful source of UV and IR radiation. The combustion of hydrocarbons is accompanied by IR radiation, reaching a maximum at a wavelength of 2.7 microns and 4.3 microns. The wavelength of 4.3 μm corresponds to the maximum emission of red-hot carbon dioxide during the combustion of hydrocarbons. The combustion of hydrogen and metals, which are not organic, radiation occurs in the infrared range at a wavelength of 2.7 microns and in the UV range of 0.1-0.35 μm.

According to our idea, the system developed by us will be directed for the detection of forest and steppe fire and transmission of information on the local of burning through the mobile network.

To solve the problem, we decided to use the following sensors:

Used sensors	Application	Advantages/disadvantages
Temperature sensor (DHT11)	Allows you to measure the temperature and monitor its change in case of fire. The sensor will be located at a depth of 5-10 cm in the ground.	In the earth, the temperature remains on average constant in the absence of a fire, which prevents false alarms of the system.
Ultraviolet radiation sensor	The ultraviolet background of the Earth, on average, always remains constant; in case of fire, a sharp increase in the ultraviolet background is observed.	The background radiation of the ultraviolet fire sensor is much less than that of the infrared, so it will provide accuracy when it detects.
Infrared sensor (ys-17)	Aims to track the infrared background at a distance of 500-700 meters (depending on distance). In case of fire, the infrared background increases dramatically.	False positives due to overheating in the sun or other heat sources

In addition to these sensors¬, we used the GSM / GPRS + Bluetooth SIM800C module to provide sending SMS messages over the cellular communication to the specified numbers in case of fire detection.

B. Open Computer Vision

OpenCV (Open source computer vision) is a library of programming functions mainly aimed at real-time computer vision.

OpenCV provides Fire Finder with precision and real-time monitoring of the terrain. The webcam during the monitoring responds to a specific range of a given color. In our case, these are shades of red, which is characteristic of the flame. As soon as a rather intense red color appears in the field of view, it displays a short "Fire" message and sends a signal to the Arduino board via the COM -port. Sensors connected to the Arduino, in turn, check for the presence of fire. If all conditions are met, information about the presence of fire in this area is sent via a mobile network by SMS to the entered numbers, using the GPRS module.

C. Principles of system operation

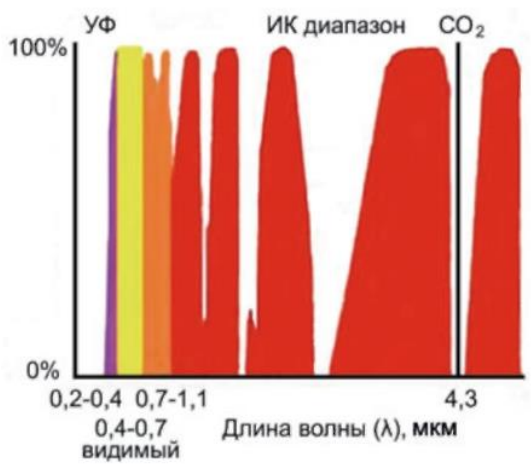
The system of early detection of forest fire works on the following principles.

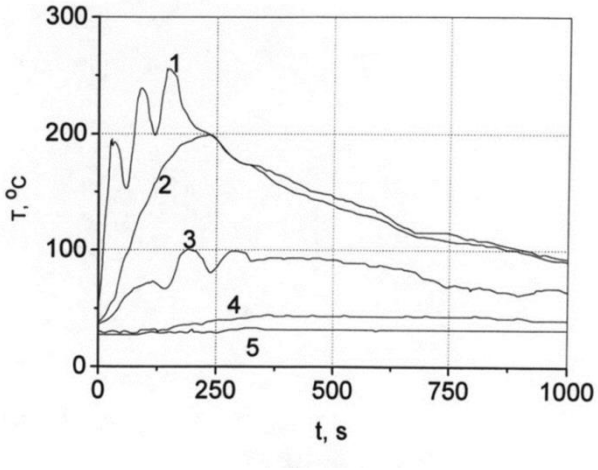
1. Infrared sensors track the background of the monitored territory and are set to 2.9 microns, which corresponds to the H2O water vapor emission band, which makes the IR detector insensitive to solar illumination.

2. The efficiency of IR detection is greatly enhanced when determining the presence of flame flicker, which is observed during the development of a fire. The infrared flame detector detects the presence of a flame by radiation flickering in the frequency range from 1 Hz to 20 Hz. Detecting flame flicker reduces the chance of false alarms for infrared flame detectors.

3. The Earth's atmosphere protects us from harsh UV rays of the sun, and as a result, rays with a wavelength of less than 286 nm never reach the Earth's surface. Therefore, our sensors will be adjusted to the range of 0.1-0.2 microns.

4. The temperature sensor is located in the ground at a depth of about 5 -10 cm From the graph it can be determined that the temperature switch, which is set to a temperature of 75 ° C and located at a depth of 5 cm from the surface, will operate 125 seconds after the start of the fire. The location of the sensor closer to the surface increases its response speed, but it also increases the thermal load on the sensor.





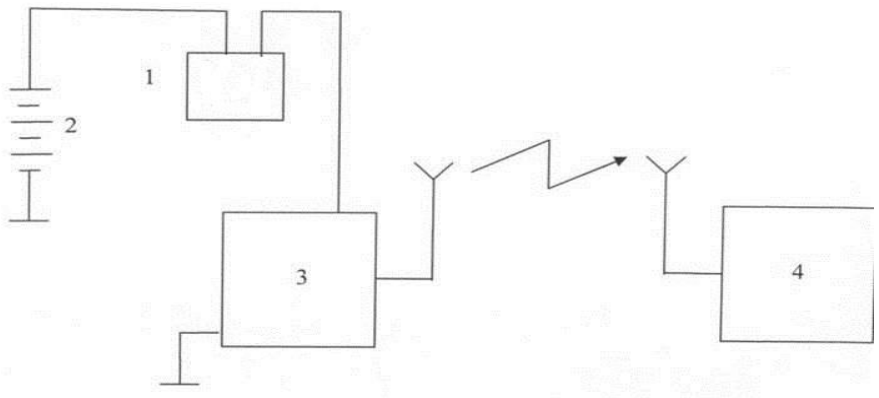
Solar spectrum (at sea level)

D. Detection Range

The power of received radiation is proportional to the area of the source S and inversely proportional to the distance D to the source in the square:
PR = S / D2
In practice, most flame detectors detect signals modulated by radiation level in a limited frequency range, usually from 1 to 20 Hz. Consequently, the dependence of the detection range on the area of the source will not exactly correspond to the above equation.

The actual detection range of the source depends on the sensitivity of the detector and information processing algorithms and varies widely depending on the technology used by the manufacturer.

E. Explanation of the invention in schemes



1- Sensors (infrared light and ultraviolet, temperature)

2- Current source

3- Operating system (on the Arduino platform)

4- Data processing base

The figure shows a schematic diagram of the device.

F. Device analogs

Analog	Description / disadvantages
 Tower	• On a specialized tower (intended for a long stay of a person on it) there is a person on a special platform. Disadvantages: • High cost (The cost of the tower intended only for the placement of equipment is 64756 tg. Per meter of height, the cost of the fire tower is more than 294344 tg. Per meter).
 Aircrafts	Disadvantages: • The very high cost of the flight hour (Example: the flight time of the An-2 plane used to detect forest fires is 158946 tg). • Requires specially trained personnel (navigators) • It is impossible to conduct continuous monitoring of a large area.
 Satellite monitoring	Disadvantages: • Large area of the minimum detectable source of fire, which ranges from 1 to 50 hectares • Low frequency of data acquisition (several times a day) • Strong weather conditions (delays).

G. Advantages and disadvantages of "Fire Finder"

Advantages:

- Does not harm the environment;
- Easy to install and use;
- Data accuracy;
- Efficiency of all work;
- A new method for rapid detection of a fire;
- The Autonomous system will be implemented through the use of solar panels and wind generators;
- Works by tracking infrared and ultraviolet background;
- The ability to transmit information about the location of the detected fire through the mobile network.

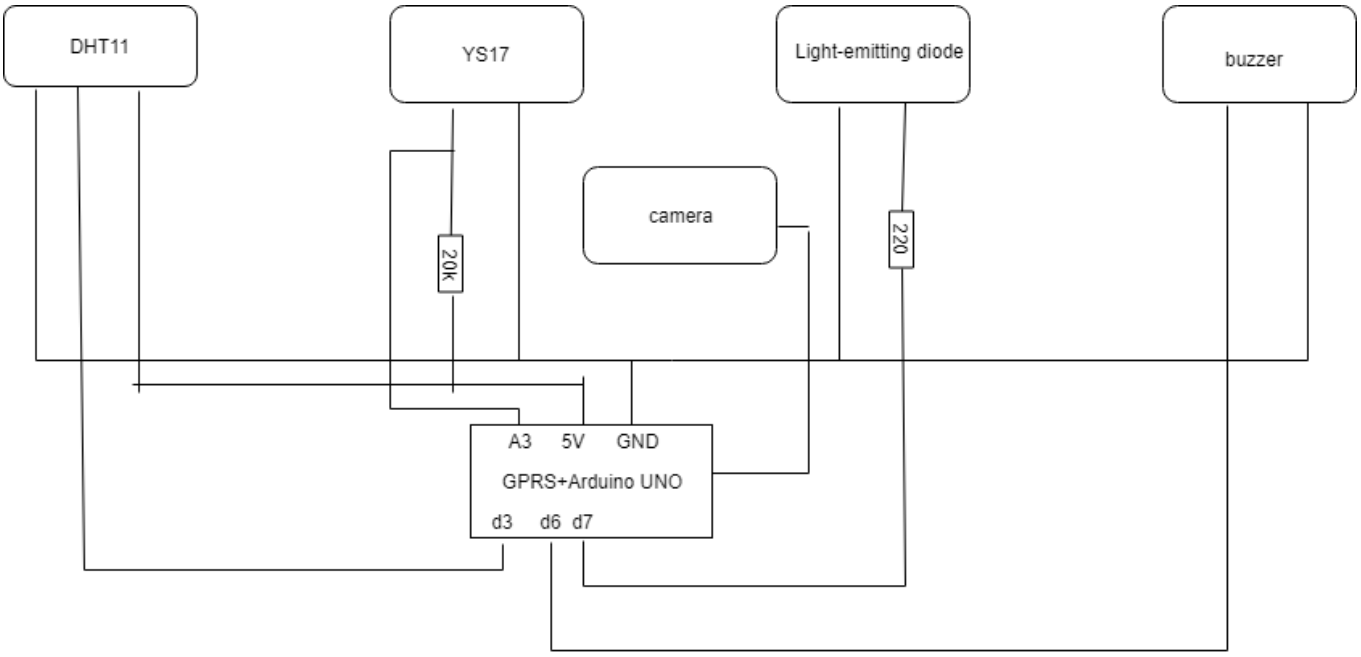
Disadvantages:

- Power dependence;
- Small coverage of the currently used camera
- Instability to sudden temperature changes

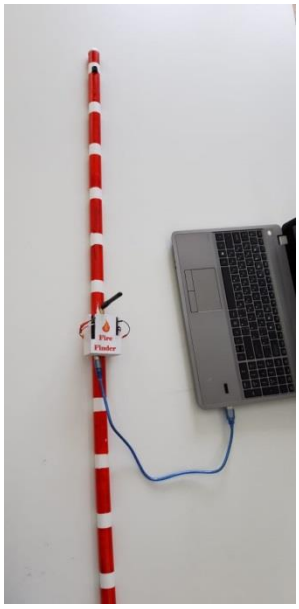
III.PRACTICAL PART

A. Hardware

Diagram of connection of used sensors and modules to Arduino Board:

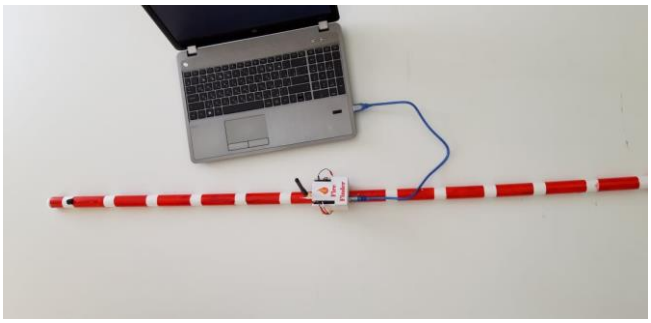


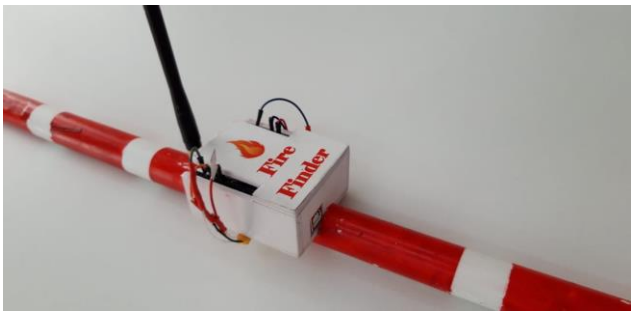
According to this diagram, when a given color is detected by the web camera during monitoring, Arduino receives a signal through the COM- port. After that, the sensors check the current state of a particular area for the presence of fire. If the fire is detected, the led and buzzer are triggered, and an SMS message is sent to the specified number using GPRS.



- DHT tempreture sensor
- Wooden stake, for the convenience of placing the device underground

- Flame sensor ys-17
- Led
- Buzzer





- Small box containing Arduino Board and GPRS module

B. Software part

Python programming

```
# define range of blue color in HSV
lower_blue = np.array([170,50,50], dtype=np.uint8)
upper_blue = np.array([180, 255, 255], dtype=np.uint8)
```

This part of code allows you to detect a given color within a certain range.

```
if fire>10000:
   print("fire")
   ser.write('1')
else:
  print("no fire no fire")
  ser.write('0')
```

Depending on the presence of a potential fire in the field of view sent the right command to the Board Arduino, which in turn performs certain actions.

Arduino programming

```
void sms_from_ff() {
mySerial.begin (19200);
mySerial.print ("\ r");
delay(1000);
mySerial.print("AT+CMGF=1\r");
delay (1000);
mySerial.print("AT+CMGS=\" \"\r"); // your number here
delay (1000);
mySerial.print ( "A fire detected in __ !"); // SMS text
delay (1000);
mySerial.write (0x1A); }
```

Create a function (subroutine) that sends SMS messages to a given number through the mobile network.

```
 if (DHT.temperature> 26 && flame < 1000) {
   digitalWrite(led, HIGH);
   tone (buz, 500);
   delay(50);
   Serial.println("OGON_OGON");
   Serial.println("");
   sms_from_ff();
   delay(30000);    }
    else {
   digitalWrite(led, LOW);
```

```
  noTone (buz); } }
break;
default: break; }}}
```

We use conditional statements if, else to specify the necessary data received from the sensors when a fire is detected and perform the appropriate actions, including calling the created function (subroutine).

IV.CONCLUSION

During the development of forest and steppe fire detection system - “Fire Finder” we faced a number of tasks. In a short time in the system which was connected with Bluetooth and was not able to send messages with information over long distances there was a replacement of the Bluetooth module on GPRS module, which allowed us to significantly reduce the number of shortcomings. Now the “Fire Finder” freely sends an SMS message to the preset number via the cellular network. In addition, OpenCV was used, which allows real-time surveillance using a webcam and provides accuracy by determining the color. That is, in addition to several sensors (parameters), visual recognition is also taken into account. But, there are such disadvantages as dependence on power supply, very small possibilities of the used video camera (built-in computer) and instability to sudden changes in temperature. These problems can be solved by using more powerful, persistent sensors, wireless surveillance cameras with more features such as real-time monitoring over long distances. We plan to address these challenges in the near future.

This project is based on the belief that the fire of forest and steppe zones is one of the most important and urgent problems today. We hope that in the near future the method of solving the problem proposed by us will find its wide application in the field of agriculture, forestry and protection of protected areas. Because it is characterized by speed, uniqueness and novelty. And the speed of fire detection depends on the efficiency of services and clarity of the action plan.