Forest firefighter robot

Introduction

One of the global problems of mankind on planet Earth is climate warming. This is facilitated by a huge number of forest fires, scientists say. Fires are an important driver of climate change. When forests burn, large amounts of carbon dioxide are released into the air.

In addition to the direct consequences of fires, there is their global impact. During a fire, according to scientists, carbon dioxide emissions into the atmosphere amount to 27.6 tons per hectare, which negatively affects people's health.

And this is one of the greenhouse gases that keeps the heat on our planet. The second is black carbon. In a fire, many small burnt particles fly into the air. Unburned particles of the southern regions were found in Antarctica, that is, they are transported by air currents so far. Normally, white snow and ice reflect radiation and do not melt as quickly. When it is gray and covered with this coating, its melting is accelerated and this also contributes to climate change.

The goal of our project is

- to create a prototype fire extinguishing system for fires
- use a neural network to detect forest fires

Our solution

Forest firefighter robot is an automated robot, which will quickly solve the problem of extinguishing forest fires, protect from adverse factors adjacent to the forests of summer cottages, people and equipment, prevent cases of people, reduce the size of the damage caused by forest fires, prevent and put out fires in forests.
Neural networks can qualitatively analyze data in order to eliminate errors associated with the human factor.

CNN (Convolutional Neural Network) is the core technology of DeepLearning.

Working with a neural network

For fire detection, a Convolutional Neural Network was used, using the YOLO architecture, namely versions 3 and 4.

To train our CNN, 943 photographs of various forest fires were collected, from various angles and heights.

The minimum amount for training is 500, but we decided to upload 900+ for even more efficient training.

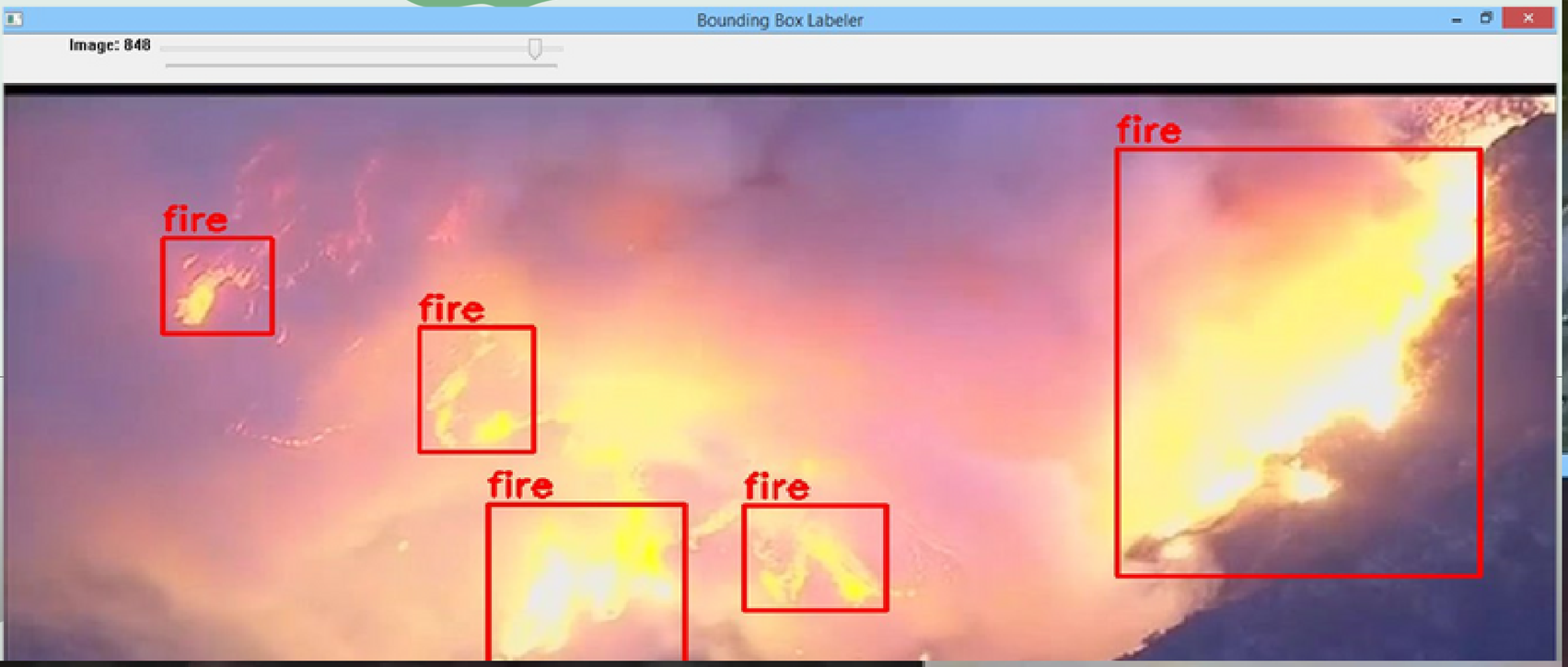
The entire process of loading a dataset, extracting it, and training it requires a Python programming environment.

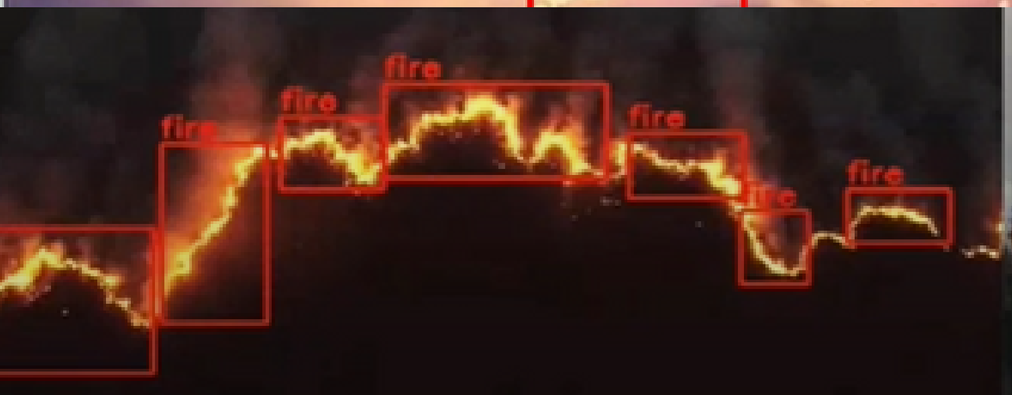
When calculating the model error in the optimization process, it is necessary to select the neural network error indicator, i.e. Loss.

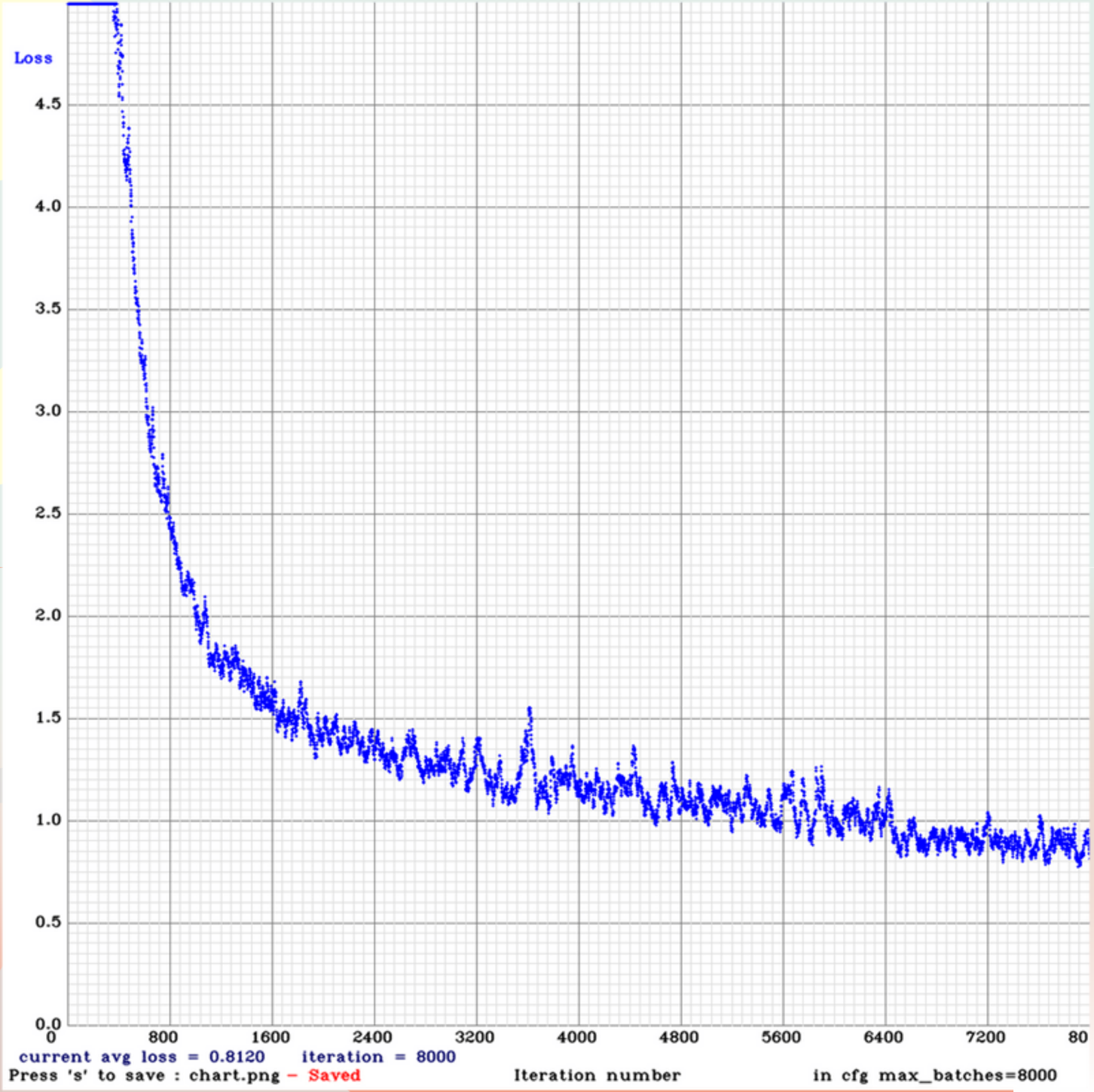
This technique has the gradient values count backwards.

Photography processing process

An example of recognition







LOSS

On the graph, we see that at first the "loss" is 4.5, but after time it is reduced to values of less than 1 (!). This is a very good result, which means that our neural network is accurate and the misfire of recognition is unlikely.

The main elements that make up the robot Forest firefighter

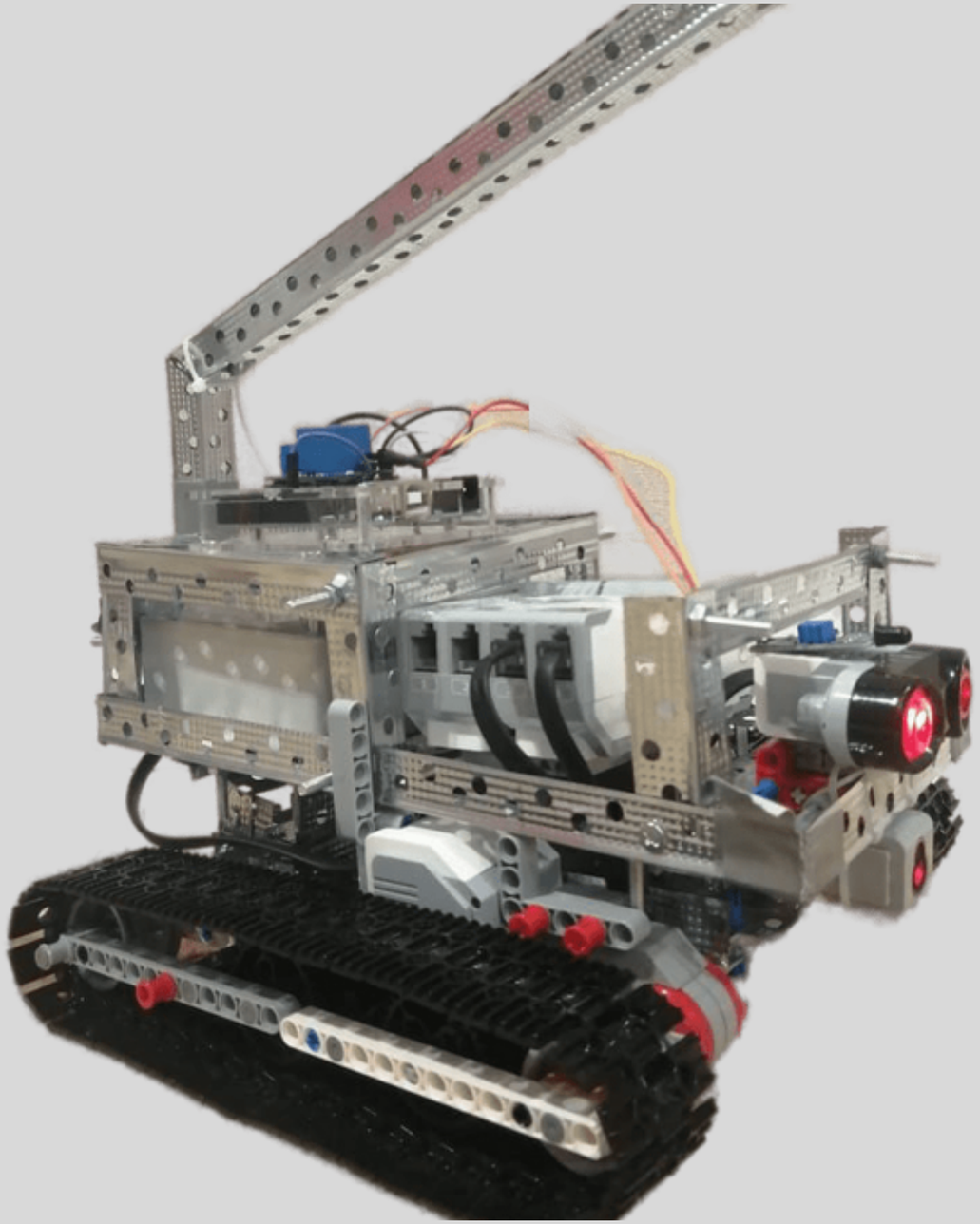
Construction base in aluminum with bolt holes, the desired size can be easily adjusted with a construction knife

The aluminum rails are attached to the track using fasteners from LEGO Mindstorms, no glue required.

The caterpillar was chosen because it contributes to minimal environmental disruption, since when driving in forests on conventional tires, roads are destroyed and eventually they become unusable

Fire Robot uses Arduino Uno microcontroller boards, EV3 microcontroller, to which 2 large motors are connected

Pump control is no different from conventional DC motor control. Therefore, an Arduino relay was used as an intermediate link between the Arduino and the pump.



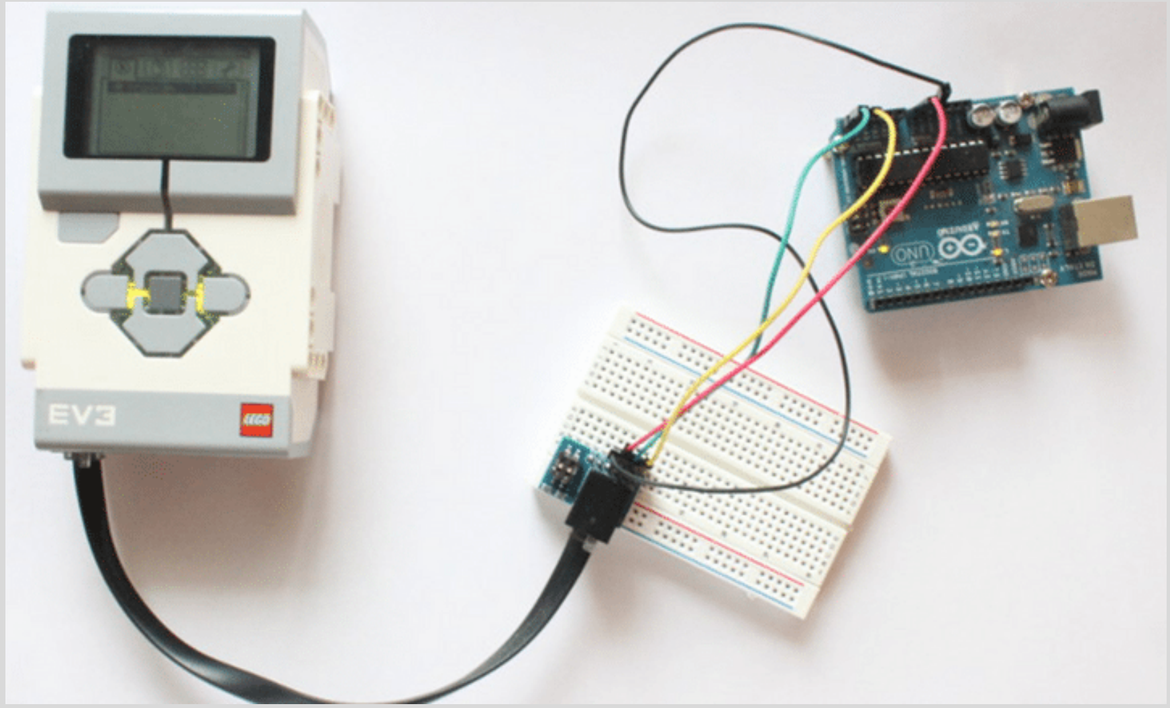
LEGO Mindstorms ev3

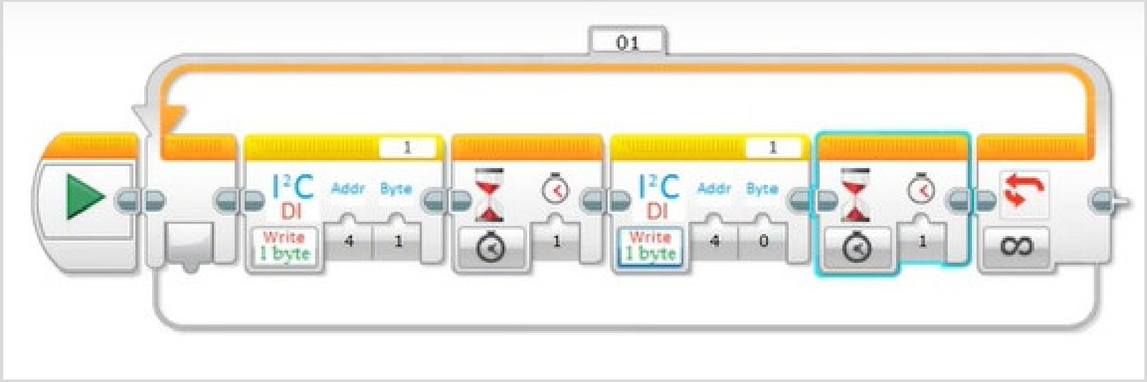
- 2 large motors are used for caterpillar walking
- orientation in space occurs with the help of one ultrasound sensors
- color sensor

Arduino

- fire sensor
- a sealed water tank on the mounts
- RS-360SH submersible pump for pumping water from the tank and directing it to the fire.

Work has been done to integrate LEGO Mindstorms with Arduino. For this, I2C wire was used to connect two microcontrollers.





pyard

```
#include <Wire.h>
int val;
int led = 13;
int flag = 0;

void setup() {
  Serial.begin(9600);
  Wire.begin(0x04);
  Wire.onReceive(ReceiveData);
  pinMode(led, OUTPUT);
  Serial.println("Ready!");
}

void loop() {
  if (flag == 1){
    Serial.println(val);
    if (val == 0){
      digitalWrite(led, 0);}
    else if (val == 1){
      digitalWrite(led, 1);
    }
    flag = 0;
  }
}

void ReceiveData(int byteCount){
  while(Wire.available()>0){
    val = Wire.read();
    flag = 1;
  }
}
```

Programs were compiled using the programming languages LEGO Minstorms EV3 and Arduino IDE, namely Open cv.

sketch_4 | Arduino IDE 2.0.1

File Edit Sketch Tools Help

Arduino Uno

sketch_4.ino

```
#define PIN_FIRE_SENSOR A0  // Пин, к которому подключен датчик пл
#define PIN_RELAY_MOTOR 12  // Пин, к которому подключено реле упр

bool isFire = false;  // Флаг, контролирующий наличие огня

void setup() {
  Serial.begin(9600);
  pinMode(PIN_FIRE_SENSOR, INPUT);  // Пин для датчика огня настра
  pinMode(PIN_RELAY_MOTOR, OUTPUT); // Пин для насоса настраиваем
  digitalWrite(PIN_RELAY_MOTOR, LOW); // Насос по-умолчанию выключ
}

void loop() {
  int adc = analogRead(PIN_FIRE_SENSOR); // Читаем показания с дат

  // Проверяем наличие пламени
  if(adc < 50) isFire = true;
  else isFire = false;

  // Принимаем решение о необходимости тушения
  digitalWrite(PIN_RELAY_MOTOR, isFire);
}
```

Output Serial Monitor