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Remote controlled car model with video broadcast

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***Abstract* — This article deals with the creation of a car model that can be controlled via the Internet in an HTML interface, whether on a smartphone or on a computer. In this environment, it is also possible to shift speeds like on a real car. The model has a built-in camera, which serves to ensure direct video transmission from the driver's point of view, which allows you to control the car even out of your sight. The car also has an autonomous mode, it can prevent a collision with an obstacle. Infrared sensors are used for this purpose and they are in the front and back. It also includes a speed sensor, based on which it can measure its instantaneous speed.**

***Keywords* — Car, model, RC, FPV, live broadcast, HTML, autonomous**

I. Introduction

The typical effort of mankind from long ago is the desire to improve the world around them. Discovering new means, technologies and phenomena. The main advantage of the time is the realization of models even in smaller dimensions. This creates a miniature of vehicles with sensors that can be used as a prototype vehicle of normal size. This thumbnail helps us eliminate as many errors as possible. In the age of technology, people are increasingly attracted to automate things. Receive alerts from sensors, for example, about missing screen washer in the washers. This type of automation makes our lives easier. The idea of making life easier can be developed to the level of a fully autonomous car, where the driver does not have to pay attention to the road. The carmakers and their development team are constantly improving their autonomy and exceeding the limits of what is possible. Therefore, we decided to create an autonomous vehicle with video broadcast.

II. Car model hardware

A. *Chassis and body*

The chassis is supporting part of all components, Fig. 1. For example, hardware for vehicle control, sensors for autonomous mode and the battery itself for power supply. Mechanical, rotating and flexible parts are also connected to the chassis. An important part of the chassis is also dampers, which are made of softer springs to be able to dampen even smaller vibrations. The chassis is made of hardened plastic, which reduces its cost of production and is sufficient for this purpose. The sides of the chassis are reinforced with steel parts for higher durability.

The body is also made of plastic, which is completely satisfactory because it is light, does not shield the Wi-Fi signal and its strength is abundantly sufficient.

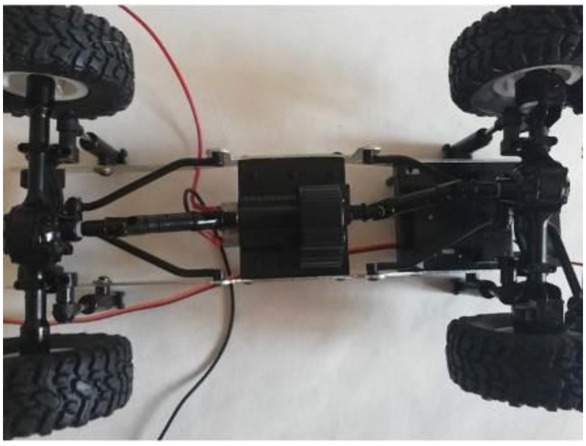

Fig. 1: Vehicle chassis with engine

B. Arduino UNO R3

One of the most important electronic parts used is the Arduino UNO R3. It serves as the main control electronics, which processes all signals from the sensors, controls all used motors and ensures data transmission. Data transfer is performed using the Wi-Fi module ESP8266, which has this type of Arduino built-in.

C. Vehicle drive

The vehicle is driven by a DC electric motor. The electric motor transmits the torque to a single-speed gearbox with a permanent transmission and it transmits the torque to all 4 wheels by means of cardan shafts, (see Fig. 1). They have high quality tires that are designed especially for off-road.

However, the motor cannot be powered directly via the Arduino output pin, because the maximum safe value of current it can supply is 20mA, which is very little for the motor drive. Therefore, an H-bridge is used, which is powered directly from the battery and can switch high currents using the input signal from the Arduino. Another advantage of the H-bridge is the 4-quadrant control, which means that the motor can rotate in both directions and the voltage peaks that occur in the motor due to its own inductance are eliminated by means of zero diodes. [1]

D. Infrared sensors

For autonomous mode, the car model uses 2 infrared sensors, one of them is at the front and the other at the rear. Sensors are used to detect obstacles and measure the distance from them. These sensors are necessary to avoid obstacles in autonomous mode.

The front sensor marked GP2Y0A21YK0F consists of an integrated combination of PSD (Positive sensitive detector), IRED (infrared emitting diode) and signal processing circuit. Its output is a voltage signal, and its value is proportional to the detected distance. [2]

Sensor at the back of the vehicle, is marked FC-51. This sensor has the same sensing principle as the previous one, but this one is not intended for continuous distance measurement, but only for determining whether a given distance from an obstacle has been exceeded or not. This means that the output is a discrete signal that can have only 2 states, whether the obstacle is closer than the set distance (comparison distance) or whether it is at a greater distance. The trimmer is used to set this distance, with which it is possible to set the comparison distance in the range from 2 to 30 cm. For our purpose, the distance is set to the maximum value. [3]

E. Speed sensor

Speed sensing is provided by the Hall sensor TLE4906, which is mounted near one cardan shaft. A body with a neodymium magnet at its end is mounted on the shaft. After each revolution of the shaft, the magnet passes through the sensing surface of the Hall sensor. The output of the Hall sensor is a discrete signal that has only 2 states whether the magnet is in the sensing area or not. This ensures that the speed is sensed. From this frequency it is possible to calculate the instantaneous speed using the circumference of the wheels, the magnitude of the transmission between the cardan shaft and the shaft on which the wheels are mounted.

F. Model power supply

Power supply of the whole model is a 3-cell lithium-ion (Li-Ion) accumulator, which is very suitable for this purpose. Li-Ion batteries can supply a relatively large current and have a high capacity in relation to their size. Its maximum voltage is 12.6V. The capacity of the battery is 1800mAh, which at current consumption allows you to use the car for 30 minutes on a single charge. The battery has a built-in ON / OFF switch, which guarantees its disconnection from the circuit. The charging time of the battery with the original charger is usually more than 8 hours.

G. Camera

An ESP32-CAM camera is used to capture the image, which is used to ensure transmission with a delay of 60 ms. It has a built-in ESP32 Wi-Fi module, which sends data to a second ESP8266 Wi-Fi module connected to the Arduino development board.

The camera is mounted on an assembly, printed by a 3D printer, Fig. 2. Thanks to this, the vertical angle of the camera as well as its height is adjustable. In order to make the view through the camera as similar as possible to the driver's view in a real car, this camera is located inside the body, also in the driver's seat. Since the windshield is made only of transparent plastic, through which it is not easy to see, it was necessary to cut a hole in it. The assembly is fixed with double-sided tape from the inside of the top of the body. The camera itself is not glued, it is held in the assembly only by friction.

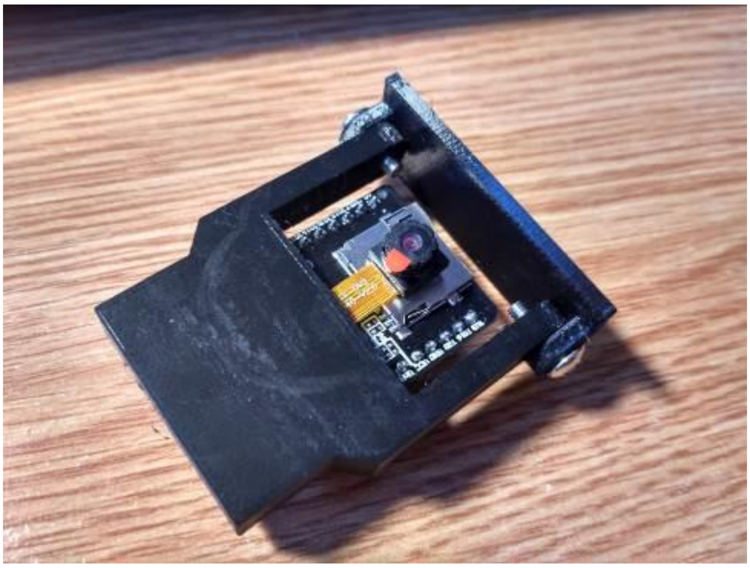

Fig. 2 Camera mounted in the assembly

III. PROGRAM AND CAMERA BROADCAST

A. Program in ESP32-CAM

A small camera module with ESP32. In the project, it is used to transmit the image almost in real time. The ESP32 microcontroller has a program loaded that serves as a client for the ESP8266. After a successful connection to the server created in ESP8266, the video stream will start.

B. Program in ESP8266

The algorithm in ESP82666 is designed to create a Wi-Fi network and then forward data from the website to ATmega328 and vice versa. The microcontroller in this case works as a server. The client connects to the Wi-Fi generated by the ESP8266 and then uses the TCP protocol to connect to the local IP address of the ES8266 Wi-Fi module in a web browser.

C. ATmega328

The program in ATmega328 microcontrollers is more complex. It receives data from the ESP8266, which is processed and thus the operation of the car is controlled. When using the car manually, the TLE4906 speed sensor sends log.1, which is recalculated and then delivered to the ESP8266 via the serial line. The diagram for manual control is created so that the value is distinguished into positive, negative and zero value. For example, if a positive speed value arrives, the value is set to the motor output and the motor starts to rotate forward. In the last part is the value of the servo motor.

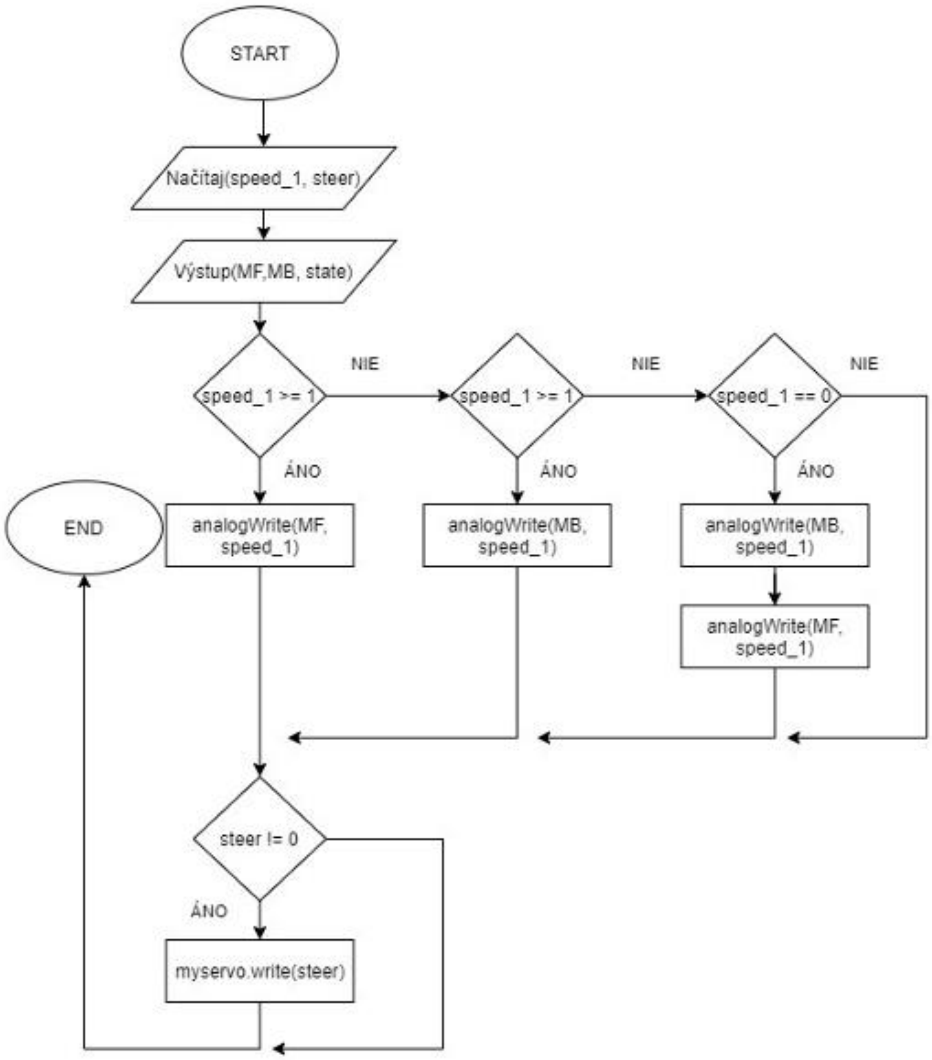

Fig. 3 Manual mode

The program further evaluates the sensors that help in autonomous mode. Infrared and ultrasonic sensors are mainly used in this mode. The ultrasonic sensor for HC-SR04 consists of an input echo value and an output trigger value. There is a time delay between digital on and off of the trigger. In the later part, the pulseIn function reads the pulse of either HIGH or LOW on the echo pine. If the function is set to HIGH, it waits for the LOW value to change to HIGH, turns on the timer, and counts until the value changes to LOW again. It works on pulses from 10 microseconds to 3 minutes, if it takes longer it returns 0. The default value of pulse return is 1 second. In the last part, the pulse calculation is divided by the constant 58.31.

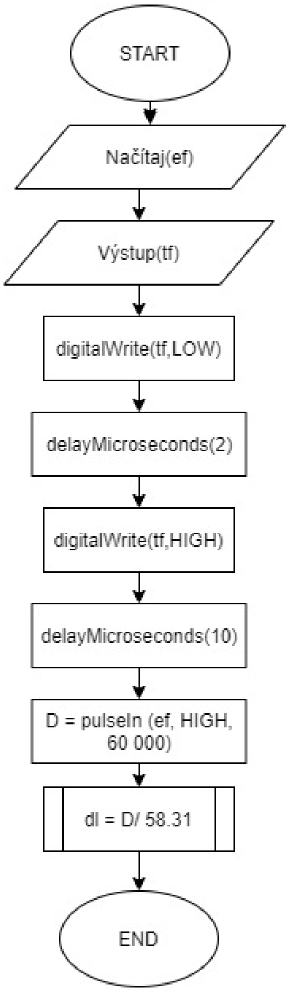

Fig. 4 HC-SR04

The FC-51 infrared sensor is used to control safe reversing. If the car gets in front of an obstacle, either with an ultrasonic sensor or at the same time with an infrared sensor. The car will reverse if the value 200 is incremented in the four cycles or unless the cycle is interrupted by an infrared sensor located at the rear of the vehicle. The wheels turn according to where there is more space or: where there is a larger value on the ultrasonic sensor. All this is written in the Reverse () function.

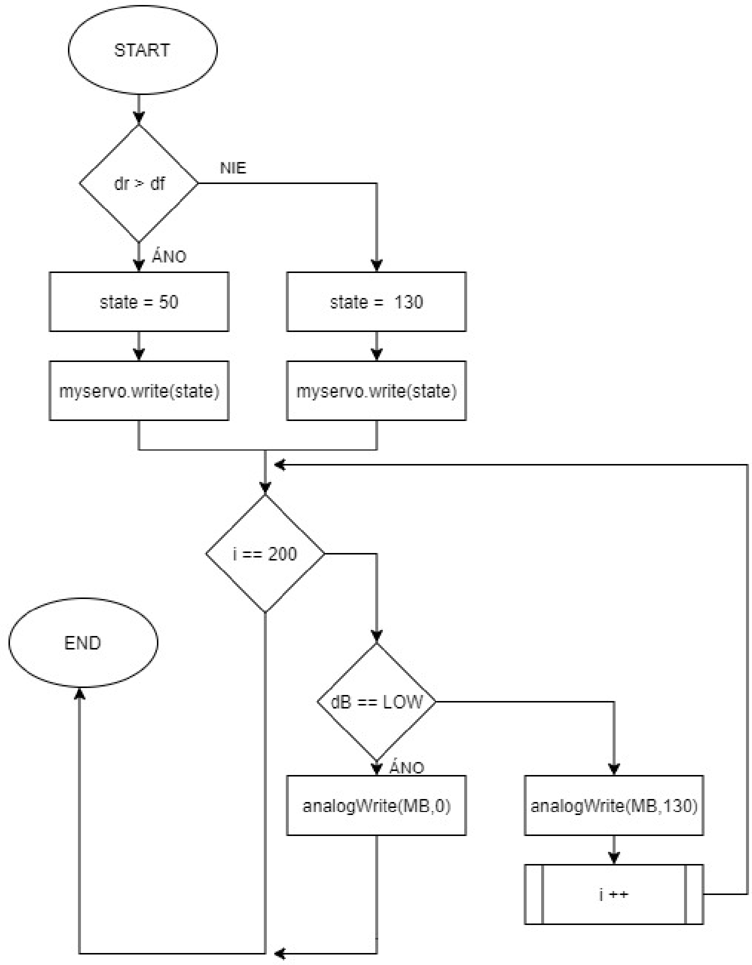

Fig. 5 Function Reverse

All this is part of one function called autonomy_mode(), which is capable of moving the car independently. Obstacles closer than 21 centimetres are avoided on the left and right. For example, if the obstacle on the left side of the mobile vehicle is 15 centimetres away, the wheels will turn according to the formula given in the diagram to 110 °. And by precisely turning the wheels according to the formula. Otherwise, the car still goes straight. If the forward value is greater than 70 centimetres, the speed is set to 140. With a distance less than 70 centimetres and at the same time greater than 50 centimetres, the value of the motor is set to 100. A distance less than 50 centimetres is multiplied by 2 and the value is written to the motor to prevent collision. E.g. if the obstacle is 25 centimetres in front of the car, it is multiplied by the number 2 and the value 50 is written to the motor.

This whole algorithm is a connection from the main function of the loop. This function is to receive data, load it into a variable and then call the function intended for it. The last condition is to turn on autonomy, as shown in the diagram below.

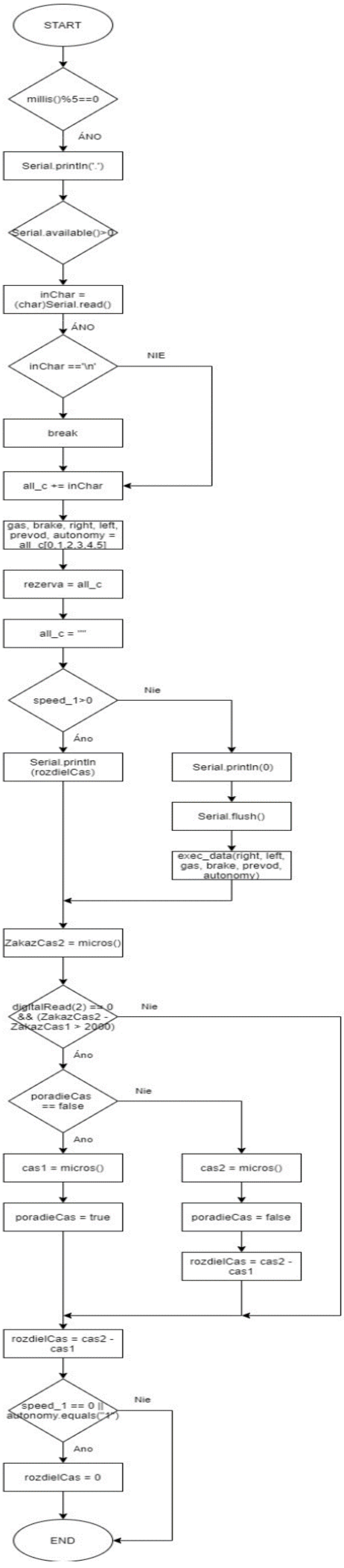

Fig. 6 Loop function

D. HTML

The html file is part of the ESP8266 program. It is designed to control a car with input and output variables. There are two input variables in the HTML page. Kilometres per hour, which are located within the screen layout in the middle down between the control of engine movement and the direction of rotation of the wheels. The second variable is the current video transmission of the location on the entire screen background. Most of the output parameters are the movement of the car. The variables for values 0 and 1 are throttle, brake, and right and left directions. There is also a 4-speed transmission that starts on stage 1. When the minus button is pressed, the value R will be set, which is the value for reversing the car.

E. Broadcast

Data transfer between individual microcontrollers is based on the client and server, as mentioned several times above. Communication is based on of simplicity and especially a fast process. Many libraries are designed for data transfer, but their processes are lengthy, unreliable and, most importantly, time consuming. Therefore, a custom system for sending and receiving data was designed. The principle is to call the data of the ATmega microcontroller from ESP8266. After receiving the data into ATmega, the values are written to the individual variables, but before they are processed, ATmega sends data to the ESP8266 when the serial line is empty. Since the ESP8266 achieves a faster processing speed, there was no need to think about fast processing. At the same time, in ESP8266 the program is not so complex. The ESP8266 microcontroller is most heavily loaded with HTML pages, on which it must process data from the page every 30 ms and send information about kilometers every 400 ms.

IV. Method of control and usage

The control method is designed to be easy to use for all ages. At the same time for experts and laymen in technology. The image below shows the layout of the website, as well as the controls.

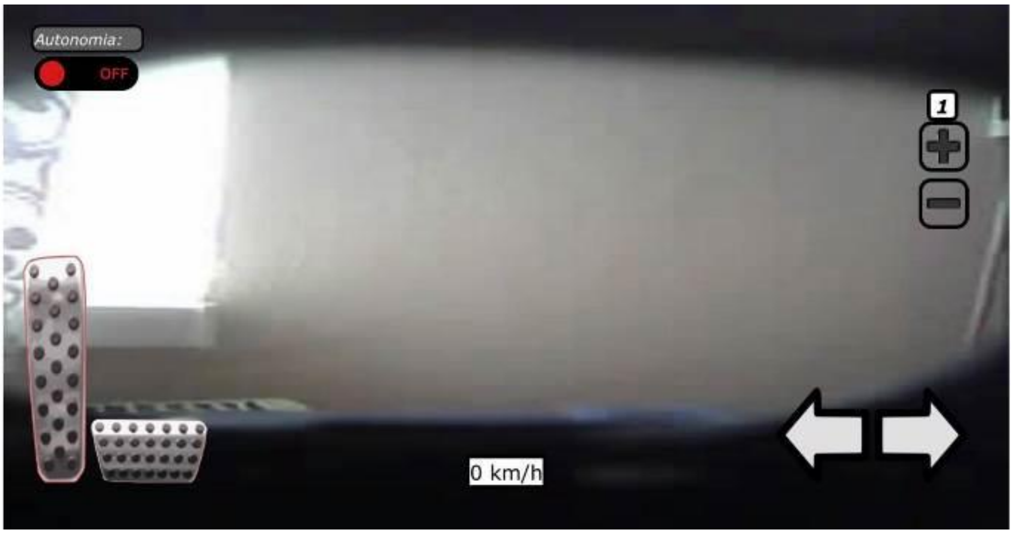

Fig. 7 Car control interface

The controls have been designed according to standard applications and our decision. Video transmission is mentioned several times in the background. In the upper left corner is the autonomy on and off. In the lower left corner, the large pedal represents the accelerator. The smaller pedal on the right side of the accelerator represents the brake. There are kilometers per hour in the middle. In the lower right corner of the web application, the arrows are for turning the servomotor in the car. Above these arrows is a gearbox, the functionality of which is described in the HTML code section. The main disadvantage is the visible, cut-out of the windscreen in live transmission, which could not be removed due to design limitations.

A. Usage in real life

The car can be used in the future as a study tool for students with programming knowledge. Thanks to the camera and the possibility to amplify the wifi signal, the car can be used in places inaccessible to humans. By adding sensors and increasing the battery capacity, the vehicle can be used to collect data. There would be a subsequent evaluation of the web application. This kind of vehicle can be used also used the military industry to spy on enemies and, last but not least, for destructive purposes. Its biggest advantage is playing indefinitely. The car model is also suitable for the promotional purposes of the university department.

V. Conclusion

The design and implementation of the toy car taught us to work in a group team and especially taught us to be patient. It brought us many new experiences. During production, there were several problems that occurred and needed to be solved. Such as weak shock absorbers on the RC model, where it was necessary to add a compensating spring. During the implementation itself, it was necessary to solve the correct location of all sensors, so that there are no unnecessary problems with the overlap of angular detection. The good location of the camera means a lot for this project, because it was necessary to think about the shocks caused by the terrain. Furthermore, it was necessary to think about the external conditions, the location of the sensors, the resolution of the camera and the range of the scanned part. After evaluating this analysis, the driver's cab was designed. After testing the camera at the given place, it was found that this is sufficient and suitable for the conditions. After designing the functional circuit diagram of the sensors and its implementation, the transition to the programming part, in which it was necessary to answer a series of questions. With critical thinking, an algorithm was designed for all microcontrollers. At last, all the functional requirements, such as reliability, smoothness, stability and connection quality, had to be met. We managed to meet this and the result is a Remote Controlled Car Model With Video Broadcast.

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