Development of a system for analyzing and unloading road traffic using artificial intelligence

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Abstract. Every year, the growth rate of cars in Russia will continue to grow, which makes it extremely difficult to organize road traffic. To solve this problem, innovations in the automotive industry, such as smart traffic lights, are needed to more effectively regulate traffic on public roads. Therefore, an urgent issue is the development of a system for analyzing and unloading road traffic to improve the situation at intersections and subsequent automation through the introduction of artificial intelligence. The Arduino Uno was chosen as the layout for the organization of a smart traffic light.

1. Introduction

This paper considers the possible solutions to the low-level traffic light control algorithm problem at intersections, which do not allow improving the vehicles' movement on regulated road segments. The approaches outlined in this paper describe an intersection optimization mechanism using artificial intelligence and an unloading algorithm. This system is reasonable to apply on the most congested road sections in many Russian cities.

With this article, we hope to improve poorly regulated traffic lights and promote artificial intelligence technology in cities.

Traffic analysis and offloading system development aim to track the traffic amount in real-time and interact with traffic lights using a computer [1].

The system functioning principle is that a pre-trained neural network recognizes vehicles and analyzes them through cameras. Depending on the vehicles' number on the road on each side, the traffic light changes colour [2]. For example, if there are 6 vehicles on the road on one side and 2 vehicles on the other side, the traffic light timer will be set for 20 seconds. The duration depends on the ratio of objects on the road.

2. Materials and methods

The traffic light layout is assembled on Arduino UNO, which is a microcontroller board based on ATmega328P [3]. The main characteristics of Arduino UNO, are shown in table 1.
Table 1. Main characteristics of the platform.

| Characteristics                        | Value          |
|----------------------------------------|----------------|
| Microprocessor                         | ATmega328      |
| Operating voltage                      | 5 V            |
| Input voltage (recommended)            | 7-12 V         |
| Input Voltage (acceptable)             | 6-20 V         |
| Digital I/O                            | 14             |
| Analogue inputs                        | 6              |
| DC current through the input/output    | 40mA           |
| DC current for 3.3V output             | 50mA           |
| Flash memory                           | 32KB           |
| RAM                                     | 2KB            |
| EEPROM                                  | 1 Kb           |
| Clock frequency                        | 16MHZ          |

The device basic principle is to transfer a video signal to a computer via 2 webcams in the neural network, the vehicles' number on the road is determined, then there is the situation a visualization at the intersection in the application and through the COM-port this information is transmitted to the Arduino board and the traffic light turns on [4].

The traffic light layout an illustration is shown below in figures 1, 2. The layout consists of:

- 6 LEDs;
- 6 220 ohm resistors.

Traffic light mechanism:

- Red.
- Red + yellow.
- Green.
- Yellow.
- Repetition.

The traffic light software implementation in Arduino IDE (figure 3).
3. Results

To start the program, 2 webcams, a computer and the Arduino board connection to the COM port, followed by the program itself activation [5] are required.

Let's break down the program main advantages and interface:

- Capabilities.
- Intuitiveness.

The following Python libraries were used to create the desktop application:

- OpenCV, a library focused on real-time applications, is used for the cars number webcam video analysis on the road [6].
- ImageAI is a library for image prediction, video object detection and tracking.
- PyQt5 is a library for developing the application user interface.
- PySerial is a COM port library used to communicate between the Arduino UNO microcontroller and Python.

Cars recognition on the road is performed using the ImageAI library and pre-trained model "yolo.h5" tools [7]. In the while loop in each iteration, the program checks the image obtained from webcams using the OpenCV library and compares the obtained objects with the yolo pre-trained models. If the models match, the program saves the recognized object x and y positions and draws a rectangle around it (figure 5).

![Figure 4. Code for detecting vehicles on the road.](image)

After all the script manipulations, the processed image is displayed on the screen using the imshow function (figure 6).

![Figure 5. Object demonstration example.](image)

4. Conclusions
A mock-up traffic light based on an Arduino UNO microcontroller interfaced with a computer, capable of simulating and unloading road traffic, solving the low-level traffic light regulation algorithm problem at intersections, allowing to improve vehicle traffic on congested road segments was assembled [8].
Developed and configured a neural network in Python language that can monitor the video stream and analyze the vehicles' number and unload the road traffic [9]. Considering the above, we can conclude that the development, taking into account the upgrades, can meet all the necessary needs and can significantly improve and automate the situation on the roads.

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