INTELLIGENT ANALYSIS OF CCTV CAMERAS IMAGES AND DEVELOPMENT OF AN ALGORITHM FOR CONTROLLING THE TRAFFIC LIGHTS INSTALLED ON ROADS BASED ON A KNOWLEDGE BASE

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Abstract. *In this scientific research work, as a solution to traffic jams observed on the streets of Tashkent today, an algorithm for controlling the traffic lights installed at the intersection based on the rules of Fuzzy Logic was analyzed intelligently from the data collected by CCTV cameras. The traffic jam observed on the roads causes great inconvenience to road users. This process is especially visible during the peak hours of the day. In addition, it is natural that fuel consumption during traffic jams and harmful gas emitted by motor vehicles are somewhat harmful to the environment. As part of this article, a number of proposals have been made as a conclusion to such problems.*

Keywords*: Intelligent transportation systems, computer vision, traffic, CCTV, IoT, traffic light, fuzzy sets.*

INTRODUCTION

Today, intelligent video surveillance and data analysis technologies are becoming increasingly important in modern road infrastructure. Computer vision systems and analytical tools not only allow for real-time road monitoring but also enable the analysis of traffic situations, the identification, and prediction of potential violations and hazards. These technologies are important because they hold great potential for improving and optimizing road traffic safety [1]. At this stage, the intelligent analysis of images from video surveillance systems and the formation of traffic light control processes based on the developed knowledge base, resulting in the consideration of ways to increase the intersection's throughput capacity, is one of the stages of the intellectualization of the video surveillance system in current road infrastructure [2].

Main part. The algorithm presented below is general and aimed at adaptive management of traffic light signal timing installed on roads. This process also considered the issue of sending incoming commands to the traffic light signal through microcontrollers (Fig. 1).

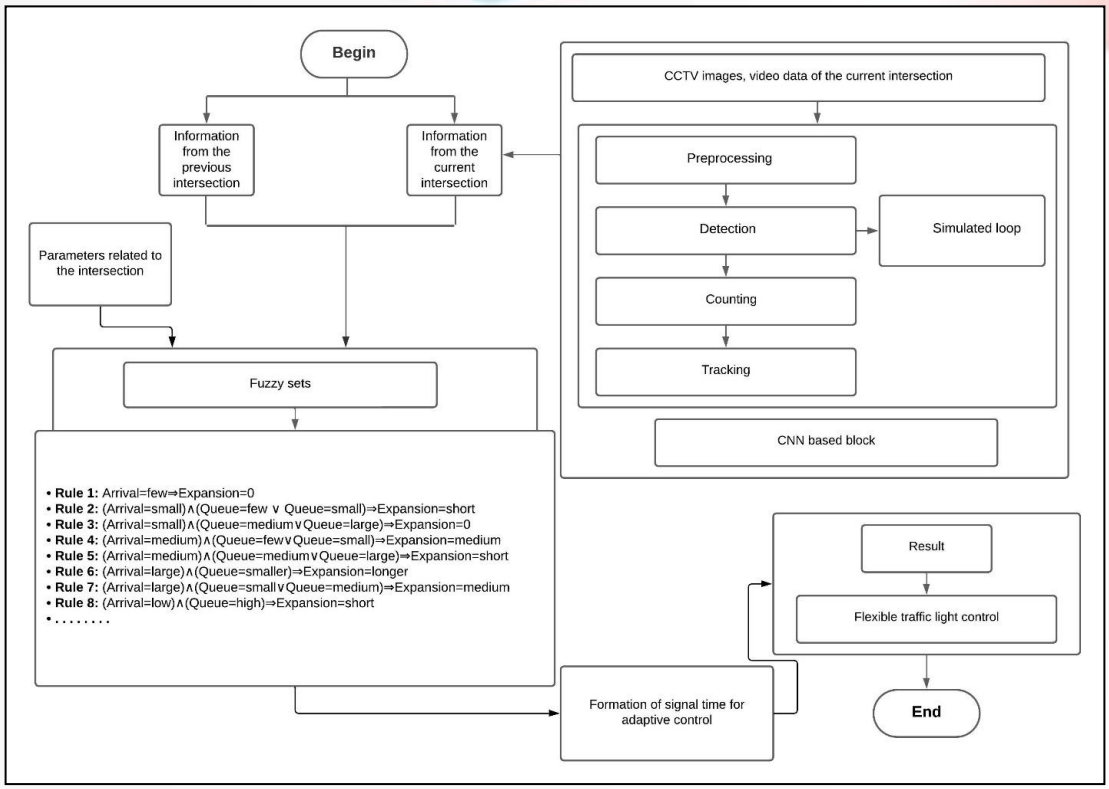

Figure 1. Adaptive Traffic Light Control Algorithm.

The step “Information from the previous intersection” in the proposed algorithm is closely related to the Internet of Things (IoT), where information is transmitted to the next intersection using microcontrollers. The information regarding the step “Parameters related to the intersection” includes parameters related to the intersection from which this data was obtained. Additionally, it is important to note that each intersection is considered as a separate entity because the structure and type of each intersection, its functional capabilities, and similar parameters are significant. In the “Fuzzy Sets” step, the decision-making process for the traffic light takes place. The next step, “Information from the current intersection” focuses on studying the state of vehicle traffic at the current intersection.

Currently, there are many libraries and models available for performing operations on surveillance images. In this part of the research, we have introduced modifications based on existing models. It is titled “Development of Algorithms and Software for Recognizing and Counting Vehicles at Intersections Using Surveillance Images Based on YOLO Architecture” which includes stages such as recognition, counting, and tracking of these vehicles [3].

To control a traffic light, it is important to study its structure and apply it in practice. Below, the model and algorithms developed during this scientific research were partially tested, a prototype of the intersection layout was created, and the initial stages of flexible traffic light control were implemented (Fig. 2).

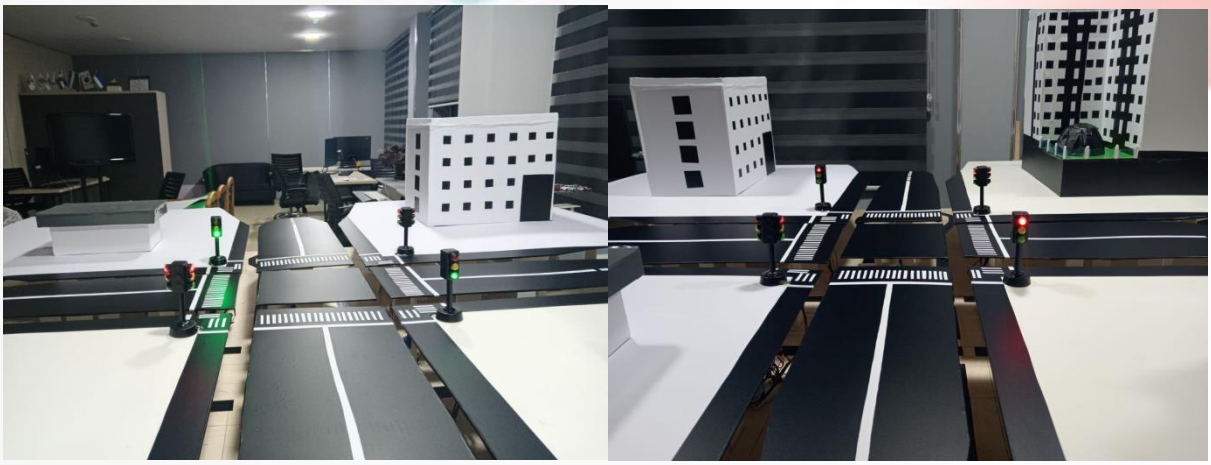

Figure 2. Traffic Light Prototype.

Today, a great process of globalization is taking place. This, in turn, also affects urban transportation. As the number of different regional vehicles increases and the use of private vehicles by the population within the city expands, traffic jams occur on the streets during peak hours. This is undoubtedly an unpleasant situation that can lead to changes in daily plans due to time lost in traffic, as well as to certain other problems.

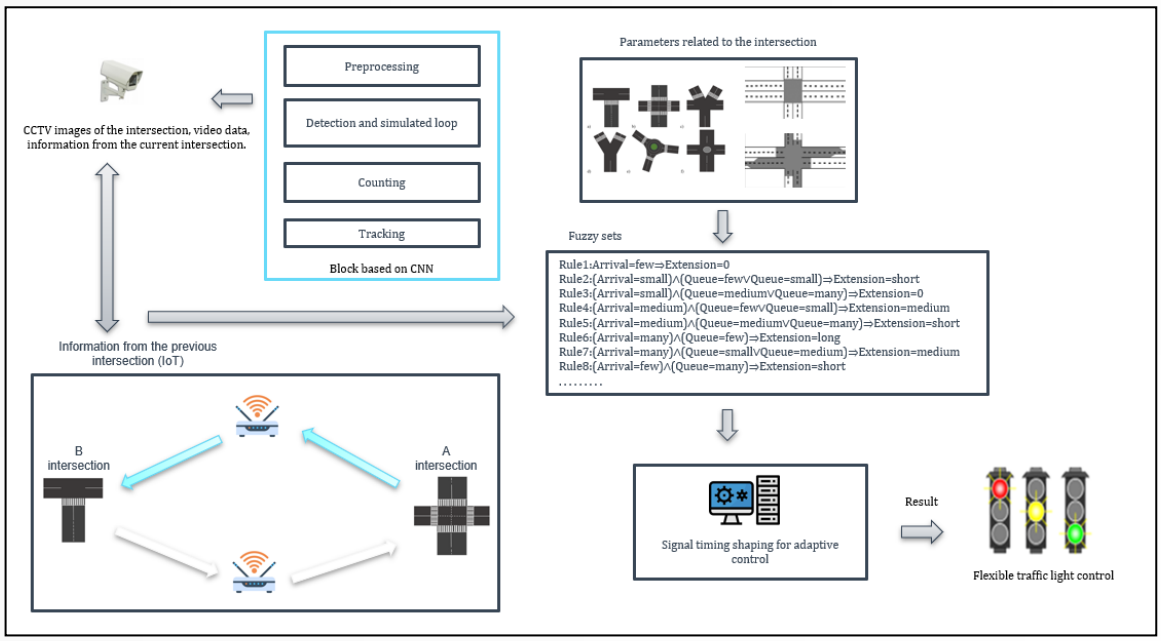

Figure 3. Conceptual Model of the Intelligent Intersection Information System.

The development of software tools for regulating vehicles in cities will enable the management of urban traffic flows and significantly help drivers save on travel time and reach their destinations more efficiently. However, these tools are not yet adapted to serve all cities, nor has a sufficient amount of informational environments been established for the operation of these systems [4].

The following conceptual model serves as the basis for creating a set of software tools designed to regulate vehicle movement and reduce congestion in cities (Fig. 3). However, it should be noted that the effectiveness of the proposed model can be

improved for each intersection based on the structure of that intersection and the parameters associated with it.

The conceptual model presented in Figure 3 involves the situation at the current intersection, including the preprocessing of images obtained from surveillance cameras, vehicle recognition, and ensuring that vehicles of the same color and type are not recognized as a single object, i.e., a single vehicle. It also encompasses the processes of counting vehicles. Additionally, by taking parameters related to the intersection, as well as information from other neighboring intersections, and combining all this information, the system makes automatic decisions based on fuzzy logic rules. It determines how long the traffic light's green signal should remain on for each side of the intersection.

Conclusion. In conclusion, it can be stated that the proposed system can reduce road congestion in the streets of Tashkent by 5-8%. This not only saves time but also reduces the amount of harmful gases emitted into the environment. Additionally, fuel consumption will decrease, bringing economic benefits to both passengers and drivers. As a result of the scientific research conducted, a flexible traffic light control algorithm was developed based on the intelligent analysis of surveillance system images and a knowledge base. This algorithm includes six main steps, which have been described above.

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