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EVALUATION OF THE USE OF AUTOMATED CONTROL SYSTEMS FOR SOLVING TRAFFIC CONTROL PROBLEMS

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One of the most pressing problems of megacities is traffic jams. With the growth of the urban population, there are more and more of them. Given the fact that there is no metro in Astana, the number of vehicles is growing quite quickly and urban public transport is also replenished with new buses every year. Attempts to introduce bus lanes partially eliminate the problem for public transport, but at the same time creates problems for private individual transport.

Theoretically, there are various solutions to the problem of congestion on urban highways, but in practice we face a number of additional problems. Attempts to create intelligent systems for regulating urban transport do not yield tangible results due to a chaotic approach to the main problem.

Transport system management is a set of various measures aimed at the effective functioning of this system through coordination, organization, and ordering of the elements of this system, both among themselves and with the external environment. The Intelligent Transport System (ITS) is a management system that implements innovative developments for managing traffic flows. As a result of using such systems, we get the so-called ”smart roads”. The article examines one of the components of ITS – the smart traffic light system.

Keywords: algorithms, information systems, traffic jams, integrated systems, information modeling, program code.

ЖОЛ ҚОЗҒАЛЫСЫН БАҚЫЛАУ МІНДЕТТЕРІН ШЕШУ ҮШІН АВТОМАТТАНДЫРЫЛҒАН БАСҚАРУ ЖҮЙЕЛЕРІН ПАЙДАЛАНУДЫ БАҒАЛАУ

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Мегаполистердің ең ауыр проблемаларының бірі-көлік кептелісі. Қала халқының өсуімен олардың саны артып келеді. Астанада метро жоқ екенін ескерсек, автокөлік саны тез өсуде және қалалық қоғамдық көлік жыл сайын жаңа автобустармен толықтырылып отырады. Автобус жолақтарын енгізу әрекеттері қоғамдық көлік мәселесін ішінара жеңілдетеді, бірақ сонымен бірге жеке жеке көлікке қиындық тудырады.

Теориялық тұрғыдан қалалық магистральдардың кептелісі мәселесін шешудің әртүрлі нұсқалары бар, бірақ іс жүзінде біз бірқатар қосымша мәселелерге тап боламыз. Қалалық көлікті реттеудің интеллектуалды жүйелерін құру әрекеттері негізгі проблемаларға хаотикалық көзқарасқа байланысты айтарлықтай нәтиже бермейді.

One of the problems is that congestion and situations are created at the main intersections of roads when flows of cars from one direction do not have time to complete the maneuver when turning and do not allow cars to move from the other direction accordingly. Attempts to create prohibited ”islands” have not yielded

any special results, since they do not allow automating the operation of traffic lights in terms of setting the glow time of the warning yellow color. There have even been illegal attempts to impose fines for driving through yellow traffic lights. The purpose of this article is to evaluate the use of automated control systems to solve traffic control problems.

Түйін сөздер: алгоритмдер, ақпараттық жүйелер, көлік кептелісі, интеграцияланған жүйелер, ақпараттық модельдеу, бағдарлама коды.

ОЦЕНКА ИСПОЛЬЗОВАНИЯ АВТОМАТИЗИРОВАННЫХ СИСТЕМ УПРАВЛЕНИЯ ДЛЯ РЕШЕНИЯ ЗАДАЧ КОНТРОЛЯ ДОРОЖНОГО ДВИЖЕНИЯ

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Одной из наиболее наболевших проблем мегаполисов являются автомобильные пробки. С ростом городского населения их становится все больше и больше. Учитывая тот факт, что в Астане отсутствует метро количество автотранспорта растет довольно быстро и городской общественный транспорт также ежегодно пополняется новыми автобусами. Попытки введения автобусных полос частично снимают проблему для общественного транспорта, но в то же время создает проблем для частного индивидуального транспорта.

Теоретически существуют различные варианты решения проблемы загруженности городских магистралей, но на практике мы сталкиваемся с рядом дополнительных проблем. Попытки создать интеллектуальные системы регулирования городского транспорта не дают ощутимых результатов по причине хаотичного подхода к основной проблем.

Одной из проблем является то, что на основных перекрестках дорог создаются заторы и ситуации, когда потоки автомашин с одного из направлений при повороте не успевают завершить маневр и не позволяют соответственно двигаться автомашинам с другого направления. Попытки создавать запрещенные «островки» не дали особых результатов, так как не позволяют автоматизировать работу светофоров с точки зрения установки времени свечения предупреждающего желтого цвета. Даже были незаконные попытки введения штрафов за проезд на желтый свет светофора. В данной статье поставлена цель сделать оценку использования автоматизированных систем управления для решения задач контроля дорожного движения.

Ключевые слова: автоматизированные системы управления, алгоритмы, информационные системы, транспортные пробки, интегрированные системы, информационное моделирование, код программы.

Introduction. Traffic in conditions of congestion of roads with traffic and pedestrian flows requires innovative ways of regulation. Automated traffic management systems, which are a complex of technical means implementing certain technological algorithms for traffic flow management, have recently become increasingly relevant. The algorithm assumes the implementation of the principle of decomposition of decision-making, which can be considered generally accepted for network adaptive management methods. The decomposition of management is based on the division of the area into mutually overlapping zones. The center of each zone is an adjustable intersection, and the zone itself covers all intersections adjacent to the central one. The main purpose of the introduction of automated traffic management systems is to reduce the total delays of vehicles on

a certain section of the road network, in the area of operation of this system – at an intersection, in an area or city [1-2].

Microcontroller intellectualization of traffic lights is a modern and promising direction for improving traffic light facilities. The presence of a digital reprogrammable microcontroller, such as the Siemens LOGO! 230rce, and small microcontrollers with built-in ESP32 Cam video cameras open up wide opportunities for the use of modern software and hardware that allow interactively intellectualize the process of optimizing traffic flows without significant material costs.

Materials and methods. The Siemens LOGO! 230RCE microcontroller in combination with the updated DC-2 linear controller allows you to optimize the algorithm of the entire information intelligent system. The technology of improvement of the DC-2 linear controller does not present great electrical complexity. Figure 1 shows the internal arrangement of the elements of the DC-2 controller. The device of the 230RCE programmable logic controller (PLC) is also presented here [3].

DC-2 controller **LOGO!230RCE**

Figure 1 - The layout of the DC-2 and the general view of the Siemens LOGO! 230RCE microcontroller

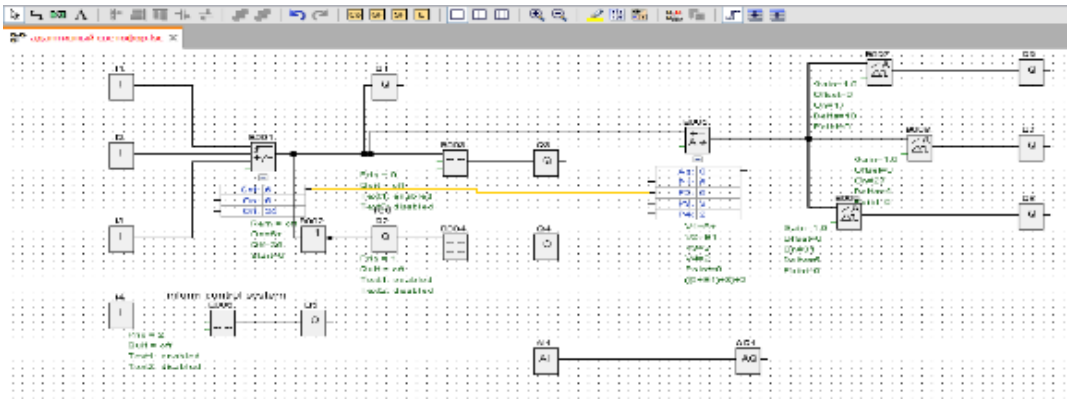

Figure 2 - The code of the adaptive traffic light program

The dimensions of the DC-2 and the length of the DIN rail PLC LOGO! they are compact enough. Please note that the 230rce allows you to attach the rail without significant structural changes. In

practice, an additional relay with the function of reprogramming and data exchange over Ethernet networks is installed in the housing of the DC-2. An important feature of the new hardware is the constantly expanding libraries of application programs and software LOGO! and the presence of a simulator in Soft Comfort. This is the personal logo of the microcontroller! The Web editor can be supplemented with a web server, which allows you to process network data streams, images obtained from video cameras specific to the OOP application.

Figure 2 shows the program code written in the FBD graphical language [4-5].

The algorithm of the traffic light with a recognition sensor located in the traffic light zone of cars takes into account their number and if the specified number of cars is exceeded (in our case, 15 cars), the green light turns on [6].

Figure 3 shows the standard program for switching on the temporary phases of green, yellow and red light.

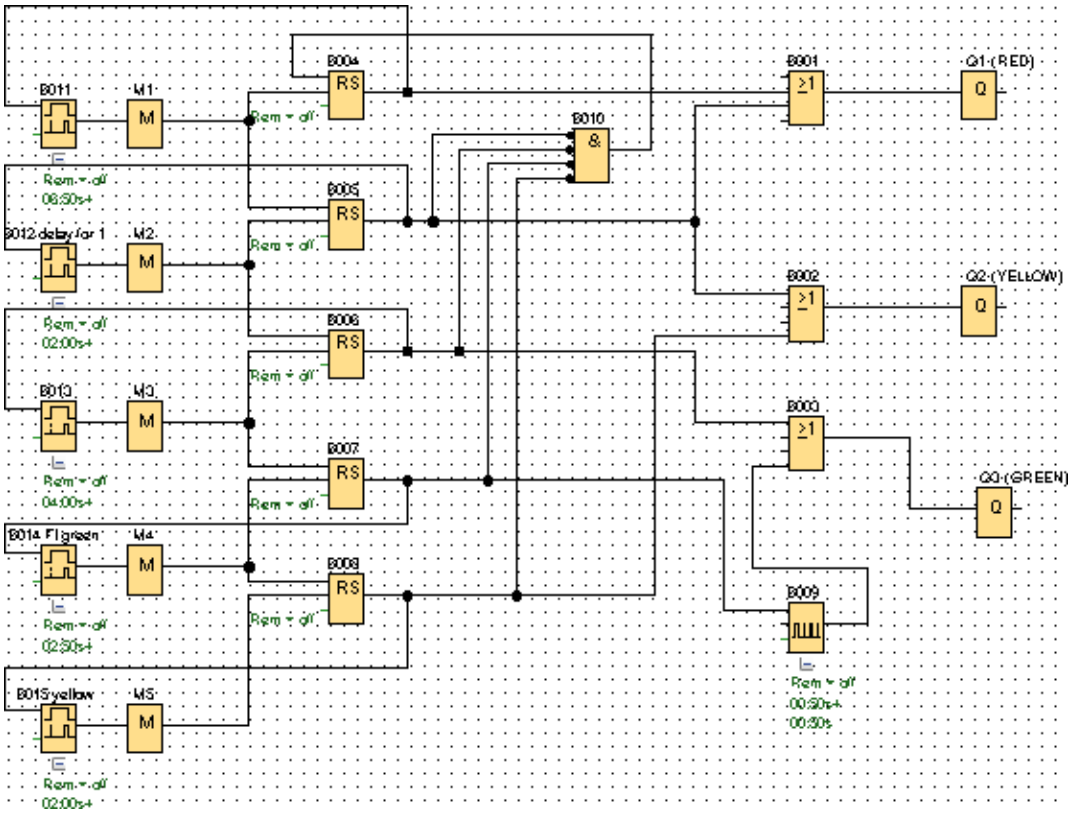

Figure 3 - The standard operating program of the traffic light in the ”green wave” mode

The special feature of the code is that it can be reloaded taking into account traffic jams, emergencies and night mode (yellow, which lights up again).

Various software solutions are used to eliminate the phenomena of congestion and forced unreasonable delays of cars at intersections in front of traffic lights[7]. The algorithm and Program for calculating the number of vehicles can be adapted to a pedestrian traffic light, which is of particular relevance for streets with divided lanes near the centerline of the bus (for example, on Timiryazev Street in Almaty).

In this regard, an upgraded computer traffic management system in Almaty is needed, which should calculate online the optimal and coordinated time intervals for switching on the phases of red, yellow, and green traffic lights at adjacent intersections, ensuring traffic flow along the ”green” wave. Among such intelligent control systems, we

note the automated control system ”Smart traffic lights” of New York City.

The intelligent traffic light control system of large cities is a complex and expensive automated system, however, reducing travel time, reducing vehicle downtime at intersections, reducing harmful emissions into the atmosphere, increasing the mobility of the population as a whole compensate for these costs. So, traffic management of a megalopolis is a complex and multilevel technological process.

Complex automation requires a powerful computer network with central controllers of supercomputers, on the periphery of which the IoT device constantly transmits data to the traffic control center via communication channels.

A promising task of modern automation of the traffic management information system is research on ”advanced” traffic management and traffic light regulation. The implemented software products should calculate indicators interactively, taking into account the requirements of local government systems installed at the nodal points of the city’ s road network. Also promising tasks are the creation of network simulators for microcontroller control of ”smart intersections”, and then their localization into more complex networks on the scale of a polycentric district and the city as a whole.

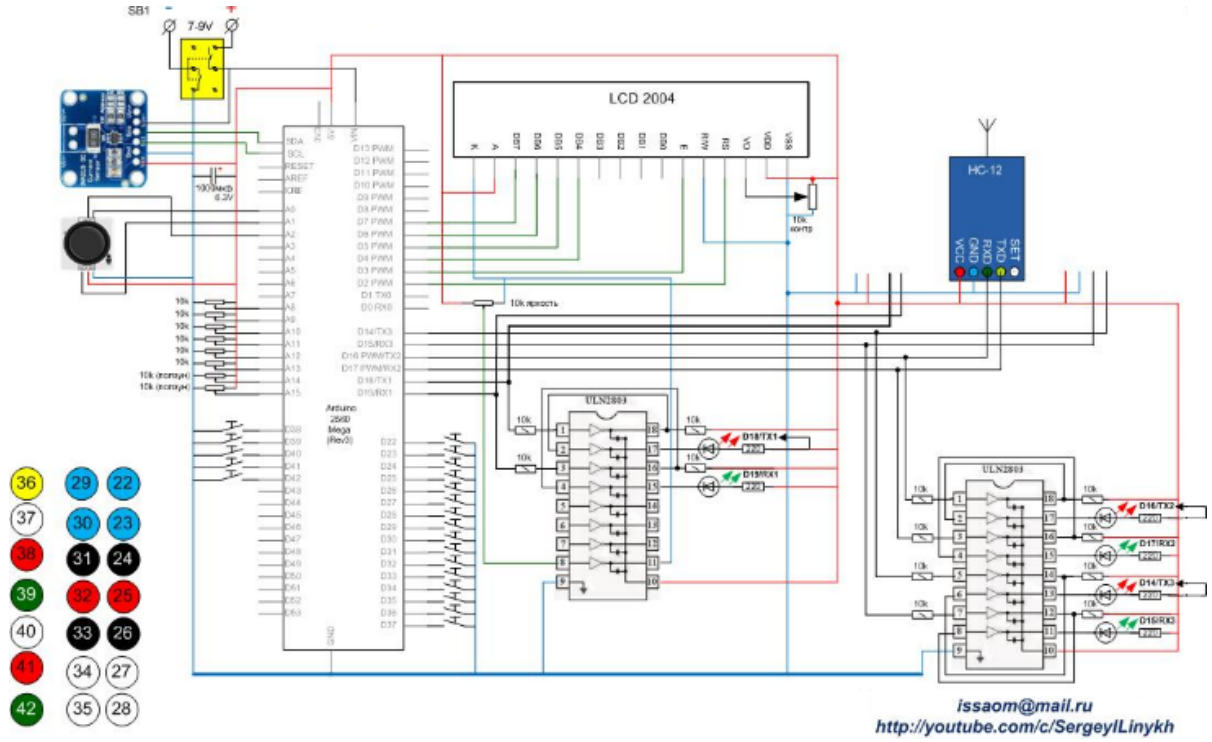

Figure 4 - Electrical diagram of an intelligent interface for controlling a ”smart” traffic light using a QR code

In urban conditions, the following methods of traffic management are used:

- Control by stopping vehicles. For example, by means of traffic lights. Each traffic flow moving through the intersection is affected by three light signals — green, yellow and red.

- The direction of traffic flow bypassing the area where congestion is formed.

- Information management. The driver receives information about the traffic situation on his way, and decides on the further route on his own.

- Coordinated management. It allows you to increase the capacity of roads and reduce the risk of accidents by streamlining traffic. The following

methods are used to implement coordinated management

- Rigid software control. Coordination programs and the order of their change are calculated in advance based on movement data collected, as a rule, by field measurements.

- Software management with forecast. The selection of the program activation points, the duration of their operation and their adaptation to the speed of traffic flow is performed based on data from transport detectors.

-Adaptive control. Each cycle is implemented with the calculation of coordination programs based on traffic flow data at each intersection and in each control phase.

Results and discussions. As a result of the conducted research, the software and hardware of the ESP32 Cam interface was developed on the principle of a ”green wave” for special services vehicles using a QR code. Similarly, the hardware and software of the ESP32 QR Code Reader interface for medical vehicles was developed. The ”smart” HR software appeared during the implementation of a library program in which, with standard QR code recognition, a text message transcribing the text of the QR code was displayed on the screen of the COM port of the Arduino IDE environment [8, 9] (Fig.4).

In the case of fire trucks, often driven by a small column, the ”Green Wave” has a longer turn-on time, and this information is entered into the QR code. Below is a program that implements an algorithm for adaptive activation of the ”green wave” in the codes of the Arduino IDE environment:

```
Void setup()
{
  TM1283 mod;
  Byte num();
  int pinA = 3;
  int pinD = 5;
  pinMode (pinA, input);
  digitalWrite(pin1);
Boolean dSW(pinC);
}
Int encoderPosCount(stepsPerrevo5){
  myStepper = 7;
  int pinDLast = 8;
  Serial.begin (362);
  Value_Y = analogRead (axis-X);
  Bool isvalid = false;
  MFRC522 mfrc522(DD_PIN;
  Byte uidCar;
  delay(1);
  mode = cloc() / 5;
  if X=4 then {
    go to 10(“.”);
    delay(100);
}
```

As can be seen from the text of the application, the webcam reads the QR code, analyzes the text and selects from it the number specified in the text format and converts it to a digital format. Then the coil of the intelligent traffic light relay turns on to turn on the yellow light and then the green light.

Conclusion. In conclusion, it should be noted that the assessment of the informativeness of adaptive control algorithms makes it possible to optimally select the necessary operating mode for traffic flows, which in turn will significantly reduce the number of congestion on the streets of megacities.

The use of this system has made it possible to increase the efficiency of the automated control system by 18%. The developed software and hardware of the ESP32 Cam interface based on the ”green wave” principle for special services vehicles using a QR code has shown its viability and practicality. The created program code for the Arduino IDE environment is adapted to these requirements. The article is based on the results of research carried out within the framework of the funded project ”A neural computer view of the smart traffic light of megacities of the country”.

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