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Car Access Control Automation

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Abstract

An analysis of the automation object has been carried out, a system of vehicles entering the parking lot has been designed. It was found that the average daily rate of free parking spaces increased. The waiting time for arrival at the parking has also decreased. To achieve this goal, the design of the subsystem was performed. The following tasks were solved: functional and non-functional requirements were developed; the design of the functional model, use case diagram, event flow, activity diagram and class diagram has been completed. As a result of the work, an automated access control system with vehicle license plate recognition was designed and implemented. This made it possible to increase the efficiency of parking and increase the speed of vehicle arrival by automating the verification of vehicles, as well as by reducing the human factor. A project analysis of the subject area was carried out, in which the main algorithms were described, the entities and the main functional model of the system were identified, which should be implemented in the software product. The analysis showed that the development of an automated control system is necessary to improve the efficiency of parking. The most optimal way of system design was determined, functional and non-functional requirements were formed.
Keywords: control; automation; program; controller; system.

I. INTRODUCTION

To ensure the highest profitability of its work, any organization needs to be as clear as possible about all its expenses, income, active and passive funds, business processes and many other aspects of doing business. Information also plays an important role in the above, and the clearer and clearer it is, the easier it is to analyze it and draw correct conclusions, which can ultimately lead to lower costs or increase profits. A high degree of visibility of almost any process can be obtained by introducing an automated control system (ACS).

The relevance of this work and, in general, the implementation of ACS lies in the fact that an employee, due to the human factor, cannot ensure the absolute quality of work, and many processes are inaccessible to him due to their complexity or transience. Automated control systems are almost completely devoid of this drawback. Also, the relevance is determined by the widespread introduction of ACS and AWP in all areas of activity, without exception, both organizations and individuals.

Car parks have become an inevitable companion of any organization, and automation is becoming an inevitable companion of any parking. The main goal to improve the efficiency and profitability of the shopping center parking is to design and develop an automated car parking management system.

Based on the above factors and taking into account the existing design solutions, we will define a number of functions that the projected system should have:

a) storage of customer information;
b) automatic opening of the barrier in the parking lot by a sign that clearly verifies vehicles;
c) keeping a log of applications (permits) to enter the parking area.

II. METHODS

A use case diagram is needed to build a model of a designed or already designed system from the point of view of an external observer. A use case diagram schematically reflects all use cases (events) and all subjects of the system. In addition, the diagram clearly shows the connections and dependencies between these two entities.

An actor is any entity that interacts with the system from the outside or a set of logically related roles that are performed when interacting with use cases. According to the accepted specification, the subject in the diagram is designated as a schematic representation of a person. It should be understood, however, that the subject is not necessarily human. Also, a subject can be a process, software or a device, in general, everything that can affect the described system. Therefore, each subject is obliged to subscribe briefly and unambiguously.

Use cases are strictly sequential descriptions of system events aimed at obtaining the desired result by the subject.

At the same time, nothing is said about how the interaction of subjects with the system will be implemented; this is one of the most important features of developing precedents. The standard graphical designation of a use case in diagrams is an ellipse, inside which is a short name of the use case or a name in the form of a verb with explanatory words.

The purpose of the use case diagram is to clarify the functionality of a system that is being designed or already designed.

Using the use-case model, you can map the main user scenarios for working with the module.

During the analysis of business requirements, business processes, as well as alternative solutions in the field of CRM, two main roles were identified:

a) administrator - a role with full functionality: creating, deleting, editing applications for arrival, changing the operating mode of the barrier.
b) Driver - An indirect role required to give the diagram logical integrity.

It is also worth noting that this model has an implicit role - the vehicle verification module (precedents that are executed by the system are represented in a different color).

III. RESULTS AND DISCUSSION

In accordance with the requirements of the UML language, diagrams for presenting information about the model of the designed system should be self-sufficient [1]. The use case diagram above gives an idea of what the system should do, but does not describe how it will do it. In this regard, a specification was drawn up for use cases in the form of a stream of events. The template for specifying each use case looks like this:

- use case (use case name);
- description (short description);
- actors participating in the precedent;
- main stream;
- inclusion (include); this option is optional.

The use case "License plate recognition" from the use case diagram was not described as a stream of events, because this type of description does not allow to reveal all possible cases.

The module for working with the camera is required to receive images from the camera in real time and to recognize the license plate.

In order to reduce the load on the system and being guided by the fact that entering the parking lot does not require a full-fledged online broadcast (as it could be implemented in the case of a speed camera), it was decided to request a frame every 5 seconds.

To access the current camera frame, an http request is used to the web interface provided in the camera manufacturer's API.

For authorization in the web interface, along with the request, a cookie is sent, which contains the "login @ password" pair.

After receiving a frame from the camera, it is checked for the presence of vehicles on it. In the positive case, an attempt is made to recognize the license plate.

In case of successful license plate recognition, the recognized license plate is transferred to the module for working with the barrier and in the module for working with the database.

The barrier control module is required to open and close the barrier in both manual and automatic modes.

The module for working with the database is required for the operation of reading, changing, deleting and writing data to the database.

This module also contains all the auxiliary functions for working with the database.

The presence of the module is due to the need for a fast and simple interface for working with the database.

IV. SUMMARY

After conducting a comprehensive analysis of the functional and non-functional requirements for the designed system, the following classes were developed:

a) MainForm - Form class. Responsible for data input and output. Aggregates data from other classes. Is an intermediary between them. [2]
b) Connection - A class responsible for working with a database. Adding, deleting, changing values. Also output of values from the database. [3]
c) LtvAPI - The class responsible for working with the camera, namely for authorization in the WEB interface, for receiving a frame from the WEB interface.
d) SiemensAPI - Class responsible for managing the barrier. [4]
e) Recognition - The class responsible for recognizing the license plate.

The Recognition class is responsible for interacting with the Emgu.CV library.

The Emgu.CV library is an add-on to the Open.CV library that allows you to use the power of the Open.CV project when working in C #. [5]

OpenCV (Open Source Computer Vision Library) is an open source library of computer vision, image processing and general purpose numerical algorithms. Implemented in C / C ++, also developed for Python, Java, Ruby, Matlab, Lua and other languages. [6]
The process of license plate recognition itself consists of several stages and is described below (for the sake of clarity of the description, we will take it for the fact that the frame from the camera was received and there is a car number on it). [7]

First step. After receiving a frame from the camera, the frame is checked by a previously trained Haar cascade to detect the coordinates of the boundaries of the number area. Further, the area of the number is cut out according to the obtained coordinates. [8] This method was proposed by Paul Viola and Michael Jones in their article "Rapid Object Detection" using an extended cascade of simple functions. [9] The features used by the algorithm are based on the summation of pixels from rectangular regions. [10]

Second phase. The lower limit of the number is determined using the brightness histogram.

Stage three. The number area is cropped at the bottom. Then it flattens out. Thus, the horizontal orientation of the number occurs. [11-14]

Stage four. The upper limit of the number is determined using the brightness histogram. The area of the number is also cut off along the upper border.

Fifth stage. To improve the readability of characters, the contrast of the number area is increased. Its binarization is also performed.

Sixth stage. The previously prepared license plate area is checked again by the Haar cascade, but now trained for the vehicle license plate characters.

V. CONCLUSIONS

To ensure the convenience of using the ACS, all controls were divided into three blocks using the TabControl component.

The block “Applications for check-in” provides basic information about vehicles eligible to enter the parking area.

It is also possible to add an application for arrival from this form. To do this, enter data into the table and click the "Add" button. If you enter incorrect data or if you do not enter all the data when you click on the "Add" button, a dialog box appears indicating the input of incorrect data.

As a result of this stage, an automated access control system with license plate recognition was developed and tested. The architecture of the application was built on the basic principles of OOP, taking into account the further increase in functionality. The basis for the development of this ACS was the design analysis described in the second section of this work.

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REFERENCES

[1] Khuzyatov S, Valiev R. The Method of Automated Configuration Objects of the WinCC Project for the Oil and Gas Industry. InInternational Russian Automation Conference 2019 Sep 8 (pp. 986-993). Springer, Cham.

[2] Galiullin LA, Valiev RA, Valieva DI. Automation of the ICE Testing Process. InInternational Russian Automation Conference 2019 Sep 8 (pp. 806-815). Springer, Cham.

[3] Zubkov EV, Khairullin AK. Neural-network simulation of diesel operation under a nonsteady load. Russian Engineering Research. 2016 Apr 1;36(4):262-5.

[4] Lenar G, Jamila M, Egor P, Rustem V. Application of Learning Analytics Tools in Learning Management Systems. In2019 12th International Conference on Developments in eSystems Engineering (DeSE) 2019 Oct 7 (pp. 221-224). IEEE.

[5] Khuzyatov SS, Valiev RA. Organization of data exchange through the modbus network between the SIMATIC S7 PLC and field devices. In2017 International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM) 2017 May 16 (pp. 1-3). IEEE.

[6] Petrov EV, Mustafina J, Alloghani M, Galiullin L, Tan SY. Learning analytics and serious games: Analysis of interrelation. In2018 11th International Conference on Developments in eSystems Engineering (DeSE) 2018 Sep 2 (pp. 153-156). IEEE.

[7] Mustafina J, Galiullin L, Al-Jumeily D, Petrov E, Alloghani M, Kaky A. Application of learning analytics in higher educational institutions. In2018 11th International Conference on Developments in eSystems Engineering (DeSE) 2018 Sep 2 (pp. 163-168). IEEE.

[8] Galiullin LA, Valiev RA. Development of Hardware-Algorithmic System for ICE Diagnostics. InInternational Conference on Industrial Engineering 2019 Mar 25 (pp. 457-467). Springer, Cham.

[9] Khuzyatov SS, Galiullin LA. Methodology for developing a web configurator for technology cabinets. Indonesian Journal of Electrical Engineering and Computer Science. 2020;19(1):42-46.

[10] Galiullin LA, Valiev RA. Internal Combustion Engines Fault Diagnostics. InInternational Russian Automation Conference 2019 Sep 8 (pp. 305-314). Springer, Cham.

[11] Galiullin LA, Valiev RA. Developing a Technical Diagnostic Systems for Internal Combustion Engines. InInternational Russian Automation Conference 2019 Sep 8 (pp. 797-805). Springer, Cham.

[12] Valiev RA, Khuzyatov SS. Pattern-design software of automated control systems. In2016 2nd International Conference on Industrial Engineering, Applications and Manufacturing (ICIEAM) 2016 May 19 (pp. 1-4). IEEE.

[13] Zubkov EV, Khaziev ML. Method for Controlling Tracking Actuator. InInternational Russian Automation Conference 2019 Sep 8 (pp. 26-34). Springer, Cham.

[14] Khaziev E, Galiullin L. Automation of ICE production planning. SCOPUS-2019-11-8-SID85073473275. 2019 Jan 1.

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