

USING IoT FOR WEB APPLICATIONS WITH FACE RECOGNITION METHOD IN DISTANCE LEARNING

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Abstract

The article is devoted to the methodology and new technology of image and face recognition, which are relevant during the pandemic and distance learning. The methods used to create image recognition technologies and their practical results are considered in detail. The result of the Face ID algorithm using the face recognition method was shown in a web application. During the experiment, the advantages and disadvantages of the face recognition method were determined. The article contains a comparative indicator of facial recognition methods in the following categories: facial recognition accuracy; face recognition time; the occurrence of a problem in facial recognition. Among the methods of facial recognition for a web application, the Viola-Jones method showed the best results. The article shows the result of using the Viola-Jones method for authentication and identification on a real example. The program code of the Viola-Jones method in the PHP programming language is given.

Keywords: distance learning, methodology, image recognition, identification of a person, Viola-Jones method, PHP, MySQL.

Аңдатпа

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ҚАШЫҚТЫҚТАН ОҚЫТУДА БЕЙНЕНІ ТАНУ ӘДІСІ БАР ВЕБ-ҚОСЫМШАЛАР ҮШІН ІОТ ТЕХНОЛОГИЯСЫН ПАЙДАЛАҢУ

Мақала пандемия және қашықтықтан оқыту кезінде өзекті болып табылатын бейнені тану әдістемесі мен жаңа технологиясына арналған. Кескінді тану технологияларын жасауда қолданылатын бейнені тану әдістер және оның практикалық нәтижелері жан-жақты қарастырылады. Бейнені тану әдісін веб қосымшасында пайдаланып Face ID алгоритмінің нәтижесі көрсетілді. Эксперимент барысында бейнені тану әдісінің артықшылығы мен кемшіліктері анықталды. Мақалада келесі санаттар бойынша бейнені тану әдістерінің салыстырмалы көрсеткіші келтірілген: бейнені тану дәлдігі; бейнені тану уақыты; бейнені танудағы мәселенің пайда болуы. Веб-қосымшасына бейнені тану әдістерінің ішінен Виола-Джонс әдісі жақсы нәтиже көрсетті. Мақалада нақты мысалда аутентификация және идентификация үшін Виола-Джонс әдісін қолдану кезіндегі нәтижесі көрсетілген. Виола-Джонс әдісінің программалық коды PHP бағдарламалау тілінде көрсетілген.

Түйін сөздер: қашықтықтан оқыту, әдіснама, бейнені тану, бейнені анықтау, Виола-Джонс әдісі, PHP, MySQL.

Аннотация

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ИСПОЛЬЗОВАНИЕ ІоТ ДЛЯ ВЕБ-ПРИЛОЖЕНИЙ С МЕТОДОМ РАСПОЗНАВАНИЯ ЛИЦ В ДИСТАНЦИОННОМ ОБУЧЕНИИ

Статья посвящена методологии и технологии распознавания образов и лиц, актуальные во время пандемии и дистанционного обучения. Рассматриваются методы, используемые для создания технологий распознавания изображений и их практические результаты. Результат работы алгоритма Face ID с использованием метода распознавания лиц показан в веб-приложении. В ходе эксперимента определены преимущества и недостатки метода распознавания лиц. В статье содержится сравнительный показатель методов распознавания лиц по следующим категориям: точность распознавания лиц; время распознавания; возникновение проблемы в распознавании лиц. Среди методов распознавания лиц для веб-приложения наилучшие результаты показал метод Виолы-Джонса. В статье показан результат его применения для аутентификации и идентификации на реальном примере. Приведен программный код метода Виолы-Джонса на языке программирования PHP.

Ключевые слова: дистанционное обучение, методология, распознавание изображения, идентификация лица, метод Виолы-Джонса, PHP, MySQL.

1. Introduction

On March 16, 2020, a state of emergency was declared in the Republic of Kazakhstan. The main purpose of the state of emergency was to ensure the security of the Kazakh people. In this regard, all educational institutions in the country have switched to distance learning technology.

This educational platform differs from other educational platforms in that students were provided with video, theory of all learning materials and self-checking tasks during the approval of the material. In addition, teachers can use this platform to conduct online conferences.

Within the walls of the university, different platforms were used to establish communication between students and teachers. For example: ZOOM, Microsoft Teams worked with training platforms.

Distance learning technologies have been used since the advent of computers and the Internet. For example, a teacher and a student correspond with each other. The teacher sent the assignment by letter. The student received a letter, completed the task and sent the decision back to the teacher. Later, with the advent of audio and video technology, users began to make extensive use of distance learning.

Thus, the definition of distance learning technology is as follows: as one of the objects of the system of continuing education, which realizes the human right to education and access to information, allows to improve the knowledge and skills of professionals while performing their main functions [1].

In this regard, in the education system: online, offline and webinar training systems began to be used freely. An online learning system is a form of organization of training through an electronic device that teaches a teacher at a certain time, at a certain distance, using resources through a global network.

An offline learning system is a form of face-to-face exchange of information between teacher and student [2]. A webinar is a form of conducting classes and seminars using a global network and using different learning platforms [3].

2. Problem statement

Teachers working in the education system today have a special role to play. After all, in distance learning, the use of technologies used in different education systems to draw students' attention to the lesson, to check the task assigned to each student and monitor their timely completion.

In this regard, pattern recognition is a scientific discipline aimed at which is the identification of objects by several criteria or classes. The theory of object recognition is a branch of computer science, which is based on the development of fundamentals and methods for identifying objects, phenomena and signals. The need for such recognition arises in many areas, starting with machine vision, character recognition, diagnostics in medicine, speech recognition and ending with narrowly specialized tasks. Despite the fact that some of these tasks are solved by a person on a subconscious level with great however, to date, no computer programs have been created that solve them in the same general way in the form of [4].

In this regard, the problem of pattern recognition has become widespread, including in the field of artificial intelligence and robotics. The recognition capability is based on the similarity of similar objects. Despite the fact that all phenomena and objects are not similar to each other, it is always possible to find similarities between some of them in one way or another. All object recognition methods are divided into two types: methods based on decision theory and structural methods. The former are based on the calculation using quantitative quantities, such as length, texture, etc. The latter are focused on images, for descriptions of which are more suitable for qualitative values, for example relational. Also, learning based on a known sample plays an important role in object recognition. By image is meant some ordered set of features. An image class is a collection of objects with the same properties. A classifier or a decisive rule is the rule of attributing an image to one of the classes based on its feature vector. In practice, three forms of representation of signs are widely used: feature vector (for quantitative quantities), character string and feature trees (for structural quantities) [5].

Methods based on matching are sets of feature vectors for each class of objects. The new image will be assigned to the class that will be closest, within a predefined metric. Obviously, the simplest approach is to find the minimum distance, which is calculated using Euclidean norms between the feature vectors of an unknown object and the prototype vectors. The conclusion that an object belongs to a certain class occurs at the smallest of these distances. The minimum distance classifier works well in cases where the distance between the points of mathematical expectation of classes is large compared to the range of scattering of objects of each class.

Equally important are pattern recognition methods based on probabilistic classifiers, due to the randomness that affects the generation classes of images. Therefore, it is necessary to develop such an optimal approach, when using which there will be the least probability of errors. It is very difficult to answer unequivocally what

the optimal method describing computer vision looks like. However, it is possible to divide all existing methods into three stages: primary processing and filtering, logical evaluation of filtering results and decision-making algorithms [6]. As a rule, it is necessary to apply all these steps to recognize objects in an image, but two or even one may be enough.

The filtering group includes methods that allow you to determine the objects of interest in the image, without preliminary analysis. The bulk of such methods use a single operation to all points of the image at the same time. At this level, the analysis is usually not carried out to all points of the image at the same time.

We are introducing FaceID technology to the educational portal to check that the teacher is doing his own homework, practical tasks during distance learning. We present experimental works of this technology used in distance learning. First of all, let's understand the concept of image recognition technology.

Image recognition appeared much earlier than modern computer systems and technologies as a method of decision-making based on the results of observation of objects and processes in the environment. The first methods of recognition were developed for electronic analog systems and considered in the framework of signal processing theory.

In the process of development of computer technology and information technology, this subject, like the concept of video itself, has undergone significant changes and is developing rapidly.

Nowadays, it is difficult to define classes of tasks related to image recognition and to provide a definition in this area.

An object is a description of an object or process that allows it to be separated from the environment and grouped into other objects or processes to make the necessary decisions [7]. Classes are the objects we need or divide into sets.

Any image recognition algorithm should be represented as an abstract functional system R , which consists of three components: $R = \{A, S, P\}$,
this,

$A = \{A_k\}$, $k=1, \dots, K$ -class alphabet - a set of categories, division of images

$S = \{S_j\}$, $j=1, \dots, n$ - descriptive dictionary - a set of properties that characterize the image

$P = \{P_l\}$, $l=1, \dots, L$ is a set of rules for choosing a solution [8].

The solution of facial recognition tasks is relevant both in the field of intelligent environments, as well as in security systems. For example, Tsinghua University in Beijing has developed an image recognition system for security in public places [8]. The Japanese division of Omron has developed an image recognition system for mobile phones [9]. Riya, a company of image recognition scientists at Stanford University, has developed an open-ended testing Web service for searching facial images in digital photo albums [10-14].

Today, image recognition technology is a convenient and practical function of password-free identification. Technology itself belongs to the field of application of the theory of image recognition, which appeared much earlier than modern computer systems. Image recognition is an integral part of brain function. Therefore, the problems of recognition in the spectrum of computer disciplines are associated with the problems of artificial intelligence.

The algorithm of image recognition technology consists of two stages: identification (who is this person?) And verification (is this the person he said?). The sequence of actions is usually as follows:

1. **Face detection**- Distinguishes a person's face from a picture

2. **Facial features detection**- Anthropometric points are determined. The system finds points that determine the individual characteristics of the person. The algorithm for calculating the characteristics is different for each system and is the main secret of the developers. Previously, the main reference point for algorithms was the eye, but algorithms have evolved to take into account at least 68 points on the face (located along the contour of the face, determine the location and shape of the jaw, eyes, nose and mouth, the distance between them).

3. **Face normalization**- To get a clear frontal image, additional image modifications are performed (removal of head curvature, facial color correction, etc.).

4. **Feature extraction and descriptor computation**- Descriptor is calculated - a set of characteristics that characterize a person, regardless of external factors (age, hair style, makeup). Special local symbols are analyzed and described, for example, the structure of certain areas on the page. Comparing different descriptors allows you to assess the relevance of two received page images to one person.

5. **Verification**- The resulting page vector (digital model) is compared with the pages in the database.

Image recognition has several advantages over other methods of identification:

1. No special and expensive equipment is required;
2. No physical contact with the equipment is required. In most cases, you have to stand in front of the camera for a while and wait for the system to work.

Disadvantages of this system:

1. The system does not provide 100% reliability. When high reliability is required, a combination of several biometric methods is used;
2. In addition, the system can send errors due to a number of other factors: signs of aging, facial expressions, lighting and viewing angle. As the size of the page image database increases, so does the proportion of errors.

In this work, we used the results of the Viola-Jones method to recognize the image of a person.

3. Calculation experiment

Main part. Image recognition is one of the most popular trends in cybernetics today. Today, video recognition technology is used in various fields: information security, mobile applications, websites, marketing, etc. Today there are different methods of this technology. This article describes the advantages and disadvantages of the methods used to recognize this image, as well as the results of the method used as an experiment. The main idea of using the Internet of Things in an automated web application is to create a smart system that recognizes the user by biometric data and connects sensors to the system to verify the data.

According to American sources, they record the following statistics that in 2020, more than 50 billion devices will be connected through IoT technology [10].

From American sources, today we see that video recognition is developing rapidly. Before starting the experiment, let's first determine the general method of image recognition (Figure 1).

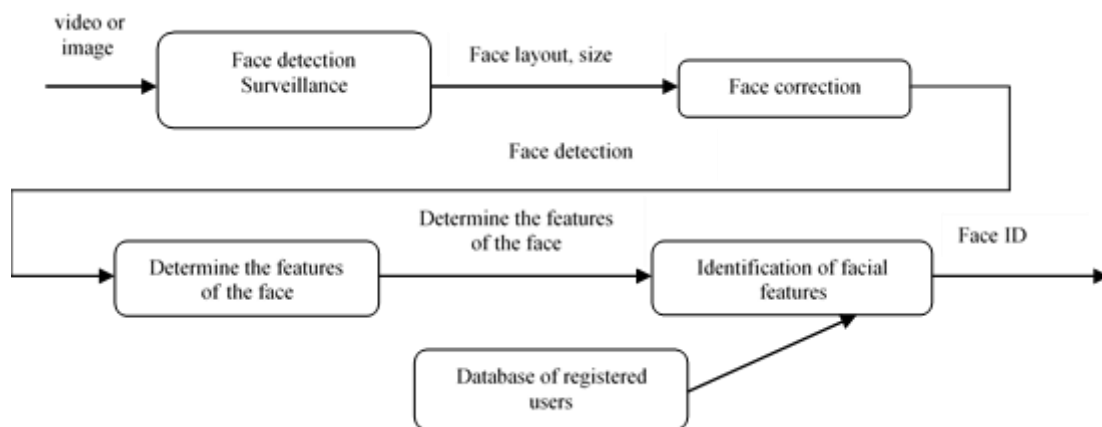


Figure 1. General method of image recognition

Determines the size and layout of the first page, as shown in the figure. Then defines the features of the page. At the last stage, the image of the person is compared with the database, and this face is given a personal identification number. There are two popular ways to recognize a person's face:

- Highly efficient neural network;
- Viola-Jones method [11].

Describe the integration of video recognition component into the educational platform

We found that there are two popular methods of image recognition. We used the Viola-Jones method as an experiment on the educational platform.

Viola-Jones method

This method is used to search for the video in real time and is less likely to provide false information. In this algorithm, the Haar symbol (search for the desired object) and AdaBoost work [12]. The advantage of this method is that it recognizes the image of the user at an angle of up to 30 degrees, if it is greater than 30 degrees, the effectiveness of this method can be zero. Therefore, this method is the most effective for recognizing the user's image.

Let's analyze the main methods of the Viola-Jones algorithm. Thus, the definition of a person's face in a digital image works as follows: There is an image that contains the objects that the user is looking for. It is represented by a two-

dimensional matrix of piskels $w * h$, where; if the information is from 0 to 255, then the image is a black-and-white image; If the information is from 0 to 2553, then the image is a color image (components R, G, B).

We used the Viola-Jones method to enable biometric video access on the education platform. We introduced this feature when registering on the user's site. We used PHP to create an educational platform. The following figure shows the main page of the educational platform (Figure 2).

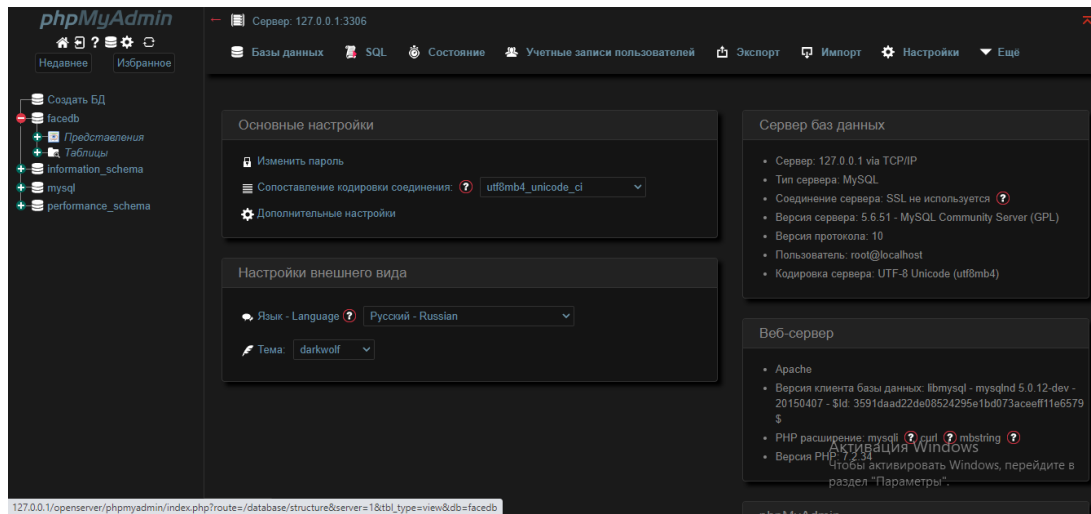


Figure 2. The structure of the educational platform

We will look at an algorithm for adding a biometric method (FaceID) as part of IoT technology to an educational platform for these students and show you how to add it to a database.

To add this function to the database, you need to write the following algorithm. This feature must be integrated with the user table, as the user is allowed to continue working on the site via FaceID when he logs in again.

```
UPDATE wp_option SET option_value =replace (option_value, 'newurl.com') WHERE option_name= "home" OR
```

```
Option_name= 'siterl'; UPDATE wp_posters SEL quid=replace(quid, "older1.com", "newurl.com");
```

```
UPDATE wp_posters SET post_content=replace (post_content, "older1.com", "newurl.com");
```

```
UPDATE wp_postermeta SET meta_value=replace (meta_value, "older1.com", "newurl.com")
```

The variables "older1.com" and "newurl.com" in this function are the main variables that link the table of users in the database. When a user of one variable is registered, the computer camera stores the data when it takes a picture, and the second variable compares it with the first variable when the user enters the site. Gives identification if the pictures match.

As a result of the experiment, the algorithm must determine the user's image and facial features and mark them - the search is carried out in the active area of the image with rectangular symbols, which describes the image found and its features:

$$rectangle = \{x, y, w, h, a\}$$

Where x, y are the coordinates of the i -th center of the rectangle, w is the width, h is the height, and a is the angle of the rectangle.

Let's see how this function works in the education portal. Once the user has entered their full details, the FaceID window will appear (Figure 3).

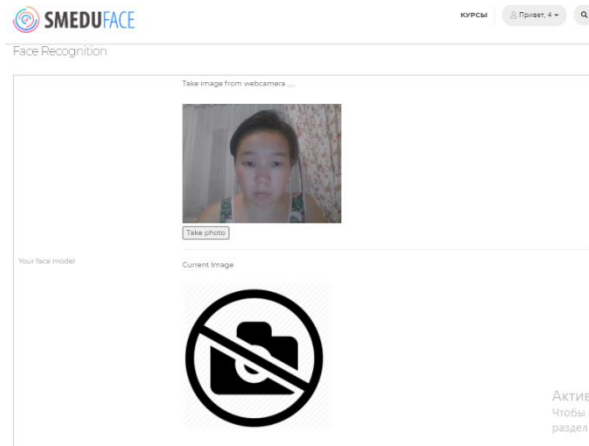


Figure 3. Registration page for the educational platform

When you click the Take photo button, the camera automatically takes a picture of the user and sends the information to the database. When a user logs in to a site, he compares the next picture to the first one he took. It is shown in the following figure. Once authenticated, it allows you to log in to the site with authentication (Figure 4).

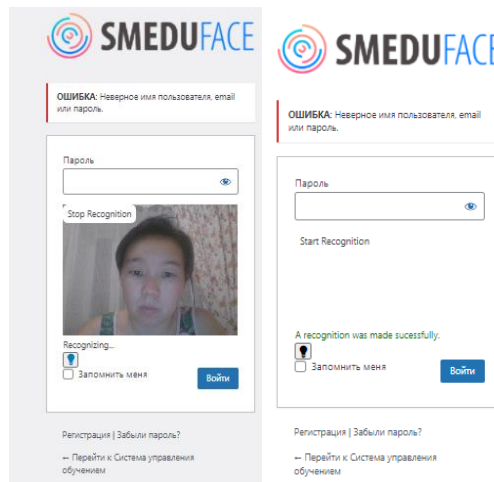


Figure 4. FaceID check box

Currently, 26 users are registered on the site as an experiment. The list of registered users is shown on the following picture (Ошибка! Источник ссылки не найден.5), and each registered user has an ID number.

ID	user_login	user_pass	user_nicename	user_email	user_url	user_registered	user_act
1	admin	\$PSBCHjirFYQEH1QcRZqFHndK0h1.1ZM0	admin	asylbekzhardkov@gmail.com	https://lt-startup-projects.kz	2021-05-15 15:02:06	
2	aseke	\$PSBYn4QhH30XxyYfJLdRgH/eUQv0	aseke	zhardkov@yandex.kz		2021-05-20 05:20:22	
13	shyryn	\$PSBnh.jpVpjMqHJC.8cXp6Uba.O2uL	shyryn	shyryn_1986@bk.ru		2021-07-18 14:09:11	16293502
14	shyryn2	\$PSByTDFB8loflwEJRsmSpzR/mggjzmPI	shyryn2	shyryn.tutkysbaeva@gmail.com		2021-07-24 15:08:48	
15	Samat	\$PSBG2ikYuu4fqSuaBl6bhDn37ZP6jF.	samat	hakay27548@spinwinds.com		2021-08-01 15:37:06	16278322
16	Erzhan	\$PSB7JRZK.r0WF9ycb/w0o682JUB89l.	erzhan	besinh122@697av.com		2021-08-08 06:33:44	
17	Didar	\$PSBFFzKpChG.lnmpr.960MqIUP.p5mvT/	didar	petrunyde@biyac.com		2021-08-08 06:42:42	
18	Saken	\$PSBAUkEuVwV08ccPZpPVOqH1v2IHfzV0	saken	tultupignu@biyac.com		2021-08-08 06:55:11	
23	Shynar	\$PSByBEn6cRY/Qwzz3Bz.91fC52ANTjy1	shynar	shynar_7676@bk.ru		2021-09-01 09:25:22	16304883
24	Aiaru	\$PSBxk5YBwF19IMUz0gkyC18mgQL.bn/1	aiaru	pator77200@enpaypal.com		2021-09-01 18:29:01	16305205
25	Aika	\$PSB36MDFGXldZgTnb0105k7DmwwWTVEd/	aika	cutovy@acrossgracealley.com		2021-09-02 16:16:26	16305993
26	Aijan	\$PSBFqjub6ColKdLzHeskKMIw/kgtJrg01	aijan	tuculzy@acrossgracealley.com		2021-09-02 19:34:53	

Figure 5. Database of users

4. The result of the experiment

MySQL was written in the PHP programming language to recognize the image of the person in the picture in real time and to collect information about registered users.

The main purpose of the experiment is to compare the image of users with the information provided and to allow further work on the educational site. The experiment was based on data from 26 key users registered on the educational portal (Figure 5). There are 98 images of different people in the database, Each with 3 or 4 pictures. During the creation of the database, the size of the image and the conditions of capture were the same. The image is saved in JPEG format for 24 bits. The database contains images of men and women.

When the user visits the educational site, the verification method is performed (Figure 4). The program currently compares the user's image with the data stored in the database and displays the result. Check speed 7-14 frames / sec.

To verify the data of these algorithms, US scientists have developed a program FERET. U.S. scientists have tested the above algorithm and other methods.

This experiment can identify two main shortcomings in the recognition of the user's face:

- Lighting;
- The position of the user's face in space;
- Depending on the quality of the camera, the user may not recognize it;
- It may take a long time to recognize the user.

The use of this image recognition technology in distance learning has facilitated the work of the teacher. For example, during distance learning, the question arises as to whether the students completed the task themselves or copied the task from someone else. To avoid this shortcoming, we share the results of FaceID technology. With the help of this technology, the teacher makes sure that the student is responsible for the task itself and the tasks to consolidate knowledge. After all, when accessing the educational portal, the student can access only through image recognition technology. Another user cannot access his account.

5. Conclusion

Thus, the results of the experiment:

1. A new algorithm for testing current video and written in PHP by the Viola-Jones method has been proposed. In using this method, we used other methods of image recognition. The comparative table shows the results of the methods (Table 1).

Table 1. Comparative data

<i>Method</i>	<i>The accuracy of the face recognition</i>	<i>The time recognition of persons</i>	<i>The emergence of the problem in the face recognition</i>
<i>Viola-Jones</i>	<i>>90%</i>	<i>++</i>	<i>+</i>
<i>High-performance neural network</i>	<i>>90%</i>	<i>+</i>	<i>+</i>
<i>Flexible graph comparison</i>	<i>~90%</i>	<i>+</i>	<i>++</i>

As a result of this table, Viola-Jones showed good results in the experiment.

1. A user image recognition site has been created for the educational portal in the PHP programming language and connected to the MySql database.

2. The developed algorithm was tested as an experiment and showed high results.

3. Facilitated the work of teachers in the distance learning of image recognition technology.

Thus, concluding the article, the proposed technology (video recognition) facilitates the work of teachers in the distance learning, during a pandemic. When asked how to make it easier, the teacher does not take the time to check the students and is sure that the student has answered the given control tasks and test questions. We believe that a video or face recognition system is a good solution for a system of teaching and testing for remote identification of students. When using the educational portal, users can access course materials, test and exam tasks, which previously could use the educational portal with a standard system login and password. If you implement this technology in the educational portal, the system will allow the user to access the educational portal only. According to teachers, about 5% of students tried to use third parties during the exam, but the system (image recognition technology) prevented all intentional actions.

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