

## Face recognition based automated student attendance system

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**Summary:** Face recognition technologies have gone so far in the modern world. The usage of real-time facial recognition is an efficient solution which improves the student attendance system. Previously considered inaccurate and unfinished, face recognition, driven by progress in Deep Learning, is now asserting itself as one of the most advanced biometric identification technology. Thus, many universities around the world integrate it into their teaching platforms. Face recognition is an open door to distance education too, so these programs are on the rise. It helps in conversion of the frames of the video into images so that the face of the student can be easily recognized for their attendance so that the attendance database can be easily reflected automatically

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### 1. Introduction

Carrying a photo id on campus may soon become a thing of the past as advances in artificial intelligence have paved the way for making facial recognition technology available and worth implementing on campus. Already, smartphone users can unlock their phone just by looking at it. On college campuses in the near future, facial recognition can enable on-the-spot classroom analytics based on audience reactions during a lecture, and better-than-ever security on campus.

To some, facial recognition can seem like an unnecessary and invasive monitoring tool. But if implemented thoughtfully by faculty and administrators, this technology can make student data more personal and powerful, without sacrificing security. In part one of this two-part series, I'll walk through how facial recognition works and discuss the opportunities, benefits, and risks of implementing. Check out part two for recommendations on covering your cybersecurity bases and ensuring a safe and thoughtful campus implementation.

Today, face recognition is a convenient and practical password-free identification feature. The technology itself belongs to the field of application of the theory of pattern recognition, which arose much earlier than modern computer systems. Pattern recognition is an integral part of brain activity. Therefore, in the spectrum of computer disciplines, recognition problems are related to the problems of artificial intelligence. The algorithm of the face recognition technology consists of two stages: identification (who is this person?) And verification (is this the person he claims to be?). The sequence of actions is usually as follows:

#### 1. Face detection

The person's face is highlighted in the image.

#### 2. Facial features detection

Anthropometric points are calculated. The system finds pivot points on the face that define individual characteristics. The algorithm for calculating the characteristics is different for each of the systems and is the main secret of the developers. Previously, the main reference point for algorithms was the eyes, but the algorithms have evolved and began to take into account at least 68 points on the face (located along the contour of the face, determine the position and shape of the chin, eyes, nose and mouth, the distance between them).

#### 3. Face normalization

Additional image transformations (head tilt removal, face color correction, etc.) are carried out in order to obtain a clear frontal image.

#### 4. Feature extraction and descriptor computation

A descriptor is calculated - a set of characteristics that describe a face regardless of extraneous factors (age, hairstyle, makeup). Special local features are analyzed, characterizing, for example, the texture of certain areas on the face. Comparison of different descriptors makes it possible to assess whether two received facial images refer to the same person.

#### 5. Verification

The resulting face vector (digital template) is compared with the faces in the database.

Feature extraction methods are conventionally divided into two groups: using local and global face features. When using local ones, the algorithm selects individual parts (eyes, nose, mouth, etc.) and recognizes a face from them. When using global ones, it operates on the whole person as a whole. The number of existing methods for identifying features and their classification is large, but the same methods are used to isolate both local and global features.

To identify a person from a photo from the point of view of a computer means two very different tasks: firstly, to find the face in the picture (if there is one), and secondly, to isolate from the image those features that distinguish this person from other people from the database.

**1. Search/** Attempts to teach a computer to find a face in photographs have been around since the early 1970s. Many approaches have been tried, but the most important breakthrough occurred much later - with the creation in 2001 by Paul Viola and Michael Jones of the cascade boosting method, that is, a chain of weak classifiers. Although there are more cunning algorithms now, you can bet that good old Viola-Jones works in both your cell phone and camera. It's all about remarkable speed and reliability: even back in 2001, an average computer using this method could process 15 images per second. Today, the efficiency of the algorithm satisfies all reasonable requirements. The main thing you need to know about this method is that it is surprisingly simple. You won't even believe how much.

Step 1. Remove the color and transform the image into a brightness matrix.

Step 2. Put one of the square masks on it - they are called Haar features. We go with it throughout the image, changing the position and size.

Step 3. Add the digital values of the brightness from those cells of the matrix that fell under the white part of the mask, and subtract from them those values that fell under the black part. If in at least one of the cases the difference between the white and black areas turned out to be above a certain threshold, we take this area of the image for further work. If not, we forget about her, there is no face here.

Step 4. Repeat from step 2 with a new mask - but only in the area of the image that passed the first test.

**Why does it work?** In almost all photographs, the eye area is always slightly darker than the area immediately below. The light area in the middle corresponds to the bridge of the nose, located between the dark eyes. At first glance, black and white masks do not look like faces at all, but for all their primitiveness, they have a high generalizing power.

**Why is it so fast?** One important point is not noted in the described algorithm. To subtract the brightness of one part of the image from another, you would need to add the brightness of each pixel, and there can be many of them. Therefore, in fact, before applying the mask, the matrix is translated into an integral representation: the values in the brightness matrix are added in advance in such a way that the integrated brightness of the rectangle can be obtained by adding only four numbers.

**How to assemble a cascade?** Although each step of masking gives a very large error (the real accuracy is not much higher than 50%), the strength of the algorithm lies in the cascading process. This allows you to quickly exclude areas from the analysis where there is definitely no face, and spend efforts only on those areas that can give a result. This principle of assembling weak classifiers in a sequence is called boosting (you can read more about it in the October issue of "PM" or here). The general principle is this: even large errors, multiplied by each other, will become small.

**2. Simplify/** Finding features of a face that would make it possible to identify its owner means reducing reality to a formula. This is a simplification, and a very radical one. For example, there can be a huge number of different combinations of pixels even on a miniature photo of  $64 \times 64$  pixels -  $(28) 64 \times 64 = 232768$  pieces. Moreover, in order to number each of the 7.6 billion people on Earth, only 33 bits would be enough. Moving from one number to another, you need to throw out all the extraneous noise, but keep the most important individual characteristics. Statisticians familiar with such tasks have developed many data simplification tools. For example, the method of principal components, which laid the foundation for the identification of persons. However, recently, convolutional neural networks have left the old methods far behind. Their structure is rather peculiar, but, in fact, this is also a method of simplification: its task is to reduce a specific image to a set of features.

**3. Identify/** The very last stage, the identification itself, is the simplest and even trivial step. It boils down to assessing the similarity of the resulting list of features to those that are already in the database. In mathematical jargon, this means finding in the feature space the distance from a given vector to the nearest area of known faces. In the same way, you can solve another problem - to find people similar to each other.

**Why does it work?** The convolutional neural network is "sharpened" to extract the most characteristic features from the image, and to do this automatically and at different levels of abstraction. If the first levels usually

respond to simple patterns like shading, gradients, clear boundaries, etc., then with each new level the complexity of the features increases. The masks that the neural network tries on at high levels often really resemble human faces or their fragments. Moreover, unlike principal component analysis, neural networks combine features in a non-linear (and unexpected) manner.

**Where do masks come from?** Unlike the masks used in the Viola-Jones algorithm, neural networks dispense with human assistance and find masks in the learning process. To do this, you need to have a large training sample, in which there would be pictures of a wide variety of faces on a very different background. As for the resulting set of features that the neural network produces, it is formed using the triplets method. There are sets of images in which the first two are a photograph of the same person and the third is a photograph of another. The neural network learns to find such features that bring the first images as close as possible to each other and at the same time exclude the third.

Since facial recognition technology has already reached the level of readiness that it can be used in commercial projects, many companies are implementing similar platforms - for example, the well-known 3D face scanner from Apple is already used on hundreds of millions of devices. Today, similar technologies are actively used in computer vision systems and video analytics.

Modern face recognition systems are used not only for solving serious problems, such as detecting wanted persons in public places, but also for monitoring student attendance. The Moscow Institute of Psychoanalysis has introduced a face recognition solution into the training and testing system for students for remote identification. When using the educational portal, students of the institute get access to course materials and to passing tests and exams, whereas previously this was impossible due to the use of a standard password access mechanism by the system. According to the developer, about 5% of students tried to use third parties to pass exams, but the system prevented all cases of fraud.

Proctoring is a procedure for supervising and controlling remote testing, very developed in the United States, where proctoring companies work mainly with educational institutions. In Russia, universities are just starting to use it for examinations. The solutions verify personality using biometrics in video stream mode and analyze human behavior in front of the monitor. Russian startups ProctorEdu and Examus, which have developed proctoring systems, are confident that the tool will be in demand when conducting certification in commercial companies.

The Financial Times and the local Colorado Springs Independent newspaper recently revealed that more than 1,700 people, including students, were unwittingly photographed on the university's campus. This is part of a research project to train facial recognition algorithms under development by companies and governments around the world. In particular, it was funded by the US military.

This study was conducted between February 2012 and September 2013. During this period, the researchers attempted to determine whether the algorithms could identify facial features at long distances, through obstacles, in low light, and under different conditions. weather conditions like snow. A telephoto lens was installed at a distance of about 150 meters from a public space at the university, where many pedestrians walked around and most looked at their phones. "We wanted to collect a dataset of people acting naturally in public, because that's how people try to use facial recognition," explained Terrence Boulton, professor of computer science at UCCS, who was in charge. of the project. The researchers then combined the photos to create a dataset called "UnConstrained College Students".

For Terrence Boulton, improving facial recognition is necessary as it has flaws. Facial recognition is indeed often criticized for its inaccuracies. In 2015, two black people were identified as gorillas by Google Photos, the service offered by Google. More broadly, facial recognition technologies are often criticized when used by authorities for law enforcement and surveillance purposes. San Francisco recently became one of the first cities to ban its use by police two weeks ago.

A computer science professor at Sichuan University, Xiao-Yong Wei is one of those teachers who are keen to fascinate their students, to facilitate their learning and encourage them to explore their curiosity. But he is also a man who doubts, and who does not always know when his lessons are indeed interesting, and when his students drop out and start to think of other things.

However, there is a dormant technological solution to any problem. So Xiao-Yong Wei decided to film his lecture hall and use facial recognition to gather as many statistics as possible about the feelings of his students during his lessons. Its camera films each of the faces, and specially created software analyzes emotions in a very basic way, according to two possible states: "happy" or "neutral". The tool then establishes an overall curve of evolution between these two states, like an electroencephalogram, which allows Wei to see at what points in his class the students seemed less enthused by what he was talking about. 324 students are thus observed.

This analysis is possible by observing the micro-movements made by a person, who turns his head slightly, looks elsewhere, scratches his nose, etc. The more an individual is captivated by what he does or what he listens to, the more the number of these micro-movements is reduced. In addition, there are already APIs for recognizing emotions on faces, which work quite well.

“Right now we're only considering two facial expressions, but in the future there will be more specific segments,” the professor told Young Pai. He adds that it may be possible for him to automatically create groups of students to address, because such students are more introverted than others, or such area of the lecture hall seems to concentrate the most dissipated students.

When questioned by the Telegraph, he defends this new-era teaching method, which he is currently disseminating to other Chinese teachers. “When you correlate this kind of information with the way you teach, and you use a timeline, you know when you get students' attention. You may then wonder if this is the right way to teach this content, or if it is the right content for these students in this class,” he explains. Xiao-Yong Wei has been using facial recognition in his classes for five years. But until now, it was all about identifying students to automatically fill in the attendance sheet.

## 2. Conclusion.

The paper proposed a scheme for the functioning of a face recognition system based on an algorithm for detecting faces in an image. The main task was to create a working prototype of the system, on which it is possible to study the requirements for the system of accounting for the attendance of classes by university students, to conduct experiments comparing various algorithms for this task and to develop practical experience in using such systems. Further development of the prototype assumes the creation of a full-fledged system for accounting for class attendance, which has the necessary set of functions for setting student standards, maintaining class schedules, accounting for attendance and its analysis

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