https://doi.org/10.5272/jimab.2026321.6698

Journal of IMAB
ISSN: 1312-773X
https://www.journal-imab-bg.org

Journal of IMAB. 2026 Jan-Mar;32(1)

Review article

RISK ANALYSIS THROUGH IMAGE RECOGNITION

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ABSTRACT

Purpose: The paper examines the classical techniques used for imaging diagnostics. A variant of the implementation of a system for recognition by external signs is proposed. The physiological expressiveness of deviations in behavioral reactions is examined. The possibilities and problems of a computer system applied to determine the health status of a group of people through the analysis of external signs extracted from the visualization of previously captured images are described.

Materials/Methods: Examines research conducted by a number of researchers on the behavior of groups of people with common physical characteristics. A computerized system for image recognition and analysis among groups in public places is proposed and reviewed.

Results: Classical image recognition is widely used in medicine. A significant problem still remains the small and incomplete research on the psycho-physical expression of people's behavioral traits.

Conclusion: The use of analysis by external signs can improve management and decision-making during a pandemic, disaster or anarchic situation.

Keywords: image recognition, computer image processing,

INTRODUCTION

In modern medicine, image recognition has an important role in establishing a correct and timely diagnosis of the patient. The term image recognition in medicine refers to the presentation (construction) of a model of the interior of a part or parts of the human body, with the aim of detecting a disease, confirming a diagnosis, studying the impact of a given treatment or establishing the cause of a disease. The development and application of multivariate imaging in biomedicine is a rapid evolving field [1]. Most of the techniques used are non-invasive and do not cause pain, with the disadvantage for some being the long-time interval for their implementation. The following image recognition techniques are most widely used:

• X-ray – can be defined as a photographic method using ionizing radiation that does not damage the integrity of the object being examined. It is widely used in medicine, but is also used in industry and archeology. The rays used are X-rays, and they penetrate every part of the human body. Since individual tissues and organs are characterized by different values of reflection and absorption of the applied rays, as a rule, organs with a higher structural density prevent their passage to a greater extent. Part of the radiation is absorbed by the body of the patient under-going X-ray imaging, which is why this type of imaging cannot be used frequently or for a long period.

• Computed tomography – this method can be defined as an advanced version of radiography, in which, by taking multiple separate X-rays at different angles to the object of study, a three-dimensional model is obtained. Unlike a regular X-ray, it allows for determining the thickness of the visualized objects.

• Nuclear magnetic resonance imaging – uses various isotopes whose atomic nucleus has a non-zero spin. They are subjected to a magnetic field. As a result, imaging of the nervous system, soft tissues, mus-

cles and other organs is obtained. The main advantage is the avoidance of X-ray radiation and the creation of a model with high diagnostic value.

• Ultrasound – is a harmless type of imaging that uses ultrasound waves with a carrier frequency of 3.5 to 7 MHz to visualize internal organs. It is widely used in obstetrics and gynecology.

• DEXA scan – using a minimal amount of radiation, it determines the density of bones in the human body. The name is an abbreviation of dual-energy x- ray absorptiometry (dual-energy X-ray absorptiometry).

• PET / CT scan – is a method in which positron emission tomography and computed tomography are performed sequentially and stepwise after intravenous administration of a positron-emitting radiopharmaceutical. From the obtained results, the structure of tissues and organs, as well as the metabolic processes occurring in the human body, can be observed.

• Spectral analysis (bioresonance diagnostics) – is based on the knowledge gained in quantum medicine. The research is focused on detecting electromagnetic vibrations of different frequencies, created by the weak magnetic fields of the cells that make up the human body. Pathogens create negative frequency patterns, leading to interference with those emitted by healthy cells.

In recent years, image recognition in medicine of the visible part of the human body has also gained popularity. The observed objects are photographed using a common or specialized camera. These techniques include:

• Iris diagnostics - the interpretation of adaptation-trophic changes in the iris, which determine the health status of a person, is studied by the science of iridology. The examination is performed by a device representing a biomicroscope with a camera. In microscopy, most of the analyses of living cells and tissues are carried out by visualizing the samples in brightfield and phase contrast, and the corresponding RGB images are acquired using digital color cameras [2]. By analyzing the resulting image, both acute and chronic current diseases can be detected and previous ones can be identified. The procedure is painless and harmless to the patient.

• Dental analysis – orthopantomography is a classic method used by dentists. The so-called panoramic image provides information about the dentition, jaws, maxillary sinuses and temporomandibular joints. The achievements of radiography are used to obtain it. Some researchers propose new conceptual methods to replace its use. This replacement is usually used during cosmetic procedures. The patient's teeth are photographed with a specialized camera that records in depth and builds a three-dimensional model of the object. Calculations are performed on the resulting image, including determining the size and position of each individual tooth. Based on the results obtained, the number of necessary manipulations and the sequence of their implementation can be determined. The patient's stay at the dentist is shortened. A significant advantage is that if ceramic veneers are made, they are of the correct shape and size relative to the visible area of the dentition.

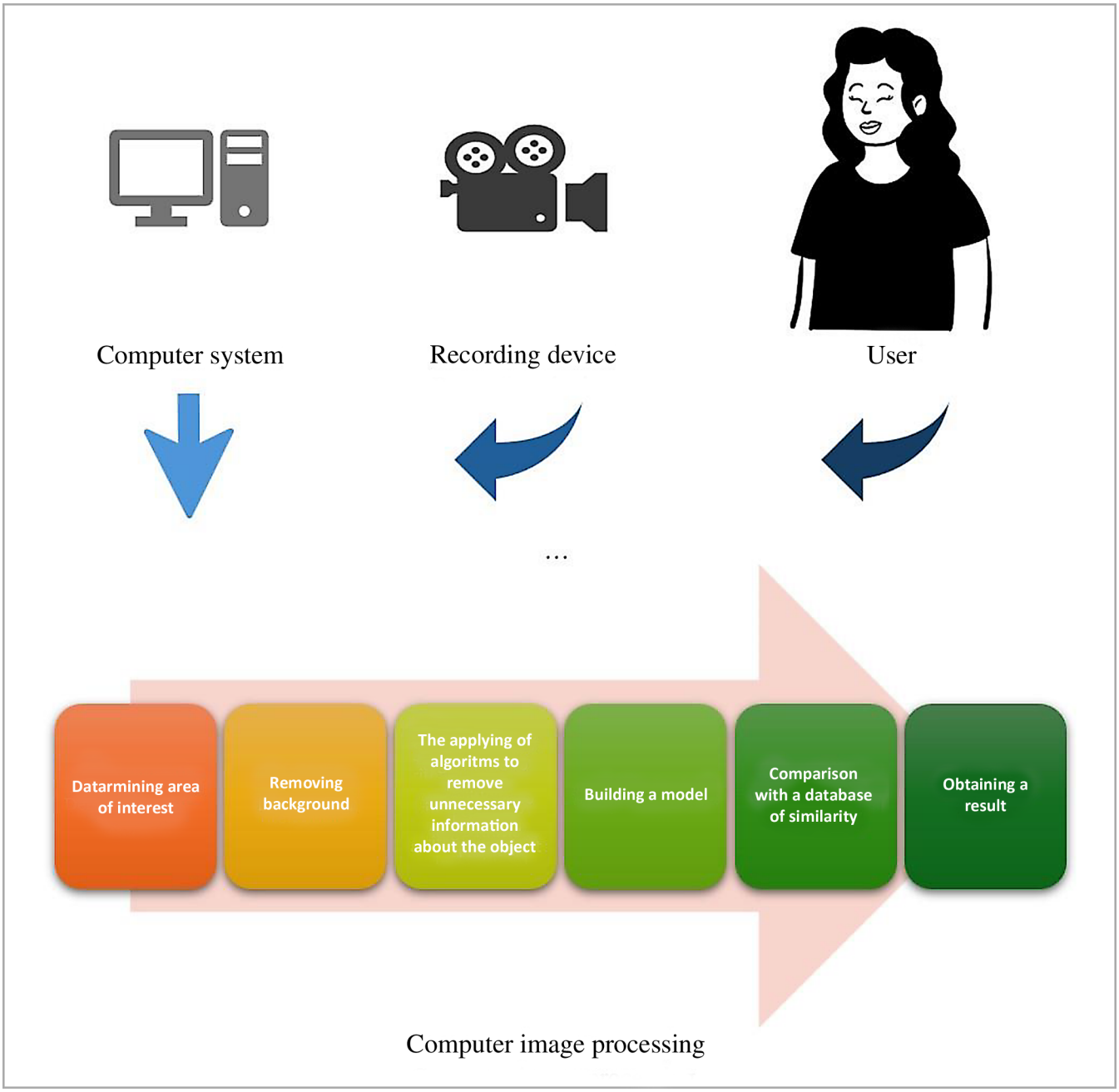
In addition to the widely used imaging techniques described above, image recognition of a person or a specific part of a person's face, has gained popularity in recent years. Various computer algorithms are used to make a diagnosis, determine risk, or provide access.

Analyzing the resulting images

Making a diagnosis, giving some definition or characterization of a person, based on processing a captured image, can be defined as an analysis performed by external features. This technique is widely known and is primarily used to control access to a resource or space. A classic example of this is the built-in function in many phones for unlocking a screen by means of face recognition of the person who has the right to access it. In institutions, private premises, or industrial facilities, access is controlled by cameras that perform analysis based on external features. The hardware and software components of such a system include a camera, a device for storing records, analysis software, and a database used for comparison. Figure 1 presents an exemplary implementation.

The first step in the operation of such a system is to capture the user. This can be done using a common or specialized video camera. The first option is economically advantageous in the case of implementing a system with relatively low expectations for quality, speed and final result. If a detailed analysis and registration of strictly characteristic features and peculiarities of the observed object is required, the recorded image must provide in-depth information, not just a two-dimensional picture. If the condition requires determining the temperature of a person, then the use of an infrared camera is required. For use in public places, from the point of view of the need for quick action, the software performing the analysis by external signs must be installed on a powerful computer system.

Fig. 1. Image recognition system



Computer processing of the captured image usually goes through the following steps:

• Determining area of interest. This could be the face, torso, entire body of a person, or any other part of the image that is of interest for further study.

• Removing background. Anything that does not fall within the area of interest is removed, usually replaced with black pixels.

• The application of algorithms to remove unnecessary information about the object. If only the shape of the object is examined, there is no need to collect information about its color, size or other characteristics. When using image recognition for diagnosis, detailed information is needed about the skin color of the observed person, the position and type of the pupil and other characteristic symptoms of certain diseases, the image of which must be specified in advance. For example, to establish the presence of an elevated temperature, using a captured video frame, after analysis, the eyes of the captured person should generally be moistened, and the skin should have a slight shine resulting from sweating. In order to prevent incorrect diagnosis in people who have undergone cosmetic procedures using botulinum toxin [3], there is a need for additional analysis of the images captured by the recording device.

• Building a model. Once the area of interest has been defined and the necessary algorithms have been applied, the remaining information is used to build a model of the object. This model can belong to 2D or 3D space and contain different amounts and structures of data. The more detailed this model is, the greater the functionality of the developed system. It is important to take measures to protect medical image recognition algorithms from external attacks aimed at obtaining an incorrect result [4].

• Comparison with a database of similarity. A database must first be built, storing different variants and states of a given object. It must have a built-in model of each state in which the object of interest is expected to be from the recorded foot-age. If the goal of the system is to provide access, then it must store models of people who have the right to do so. In a more complex system, the goal of which is to determine a patient's health status, this database must contain a primitive that encompasses all the signs of a specific disease, which can be compared with the model built in the previous step. The advanced deep learning models holds significant promise for augmenting medical image datasets and enhancing diagnostic capabilities [5].

• The last step of computer processing is to obtain the result. It can be a finding or absence of a match, and there is also an option for the system to be unable to respond. In systems using self-learning algorithms, from the built comparison model and the obtained result, it is possible to create a primitive that can be added to the existing database.

Use of risk analysis

The described model of an image recognition system would find application in the fight against crime. The idea is to use specialized cameras placed in public places, the recordings of which are analyzed, and the result can be used to identify groups and factors that pose a risk to public security. When building a model of a potential offender, it is necessary to include knowledge of psychology and medicine in the analysis. The rules and parameters according to which certain qualifications are assigned to a person must be obtained through scientifically and practically proven facts. It is imperative to avoid the erroneous suggestions of the past, when theories about born criminals were created, according to which certain physical features, organs, their combination and proportions, predetermine the level of development of a particular person and him attitude towards performing certain actions contrary to social norms. Some authors and supporters of such views go too far, recommending that people with certain physical features or defects be initially classified as criminals and that restrictive and even punitive measures be taken against them, without them having committed any crime themselves [6]. Cesare Lombroso can be cited as an example of his theory of the "born criminal". The object of the research is numerous prisoners and people with mental disabilities. For Lombroso, the main interest is the structure of the body, its proportions, their combination and the presence of congenital or acquired disabilities and defects. From the results obtained, he creates a theory that only the psycho-physical structure of a person is the cause of his asocial behavior. For him, the leading and only factor in committing crimes is the biopsychic profile with which a person is born and which does not change. Ultimately, Cesare Lombroso accepts as an irrevocable rule the idea that criminals have congenital physical and/or mental disabilities. The anomalies of the internal and external anatomical structure bring man closer to primitive people and even to anthropoid primates. He examined nearly 400 skulls of deceased and nearly 4,000 skulls of living criminals, studying certain functions and states of the body such as temperature, pulse, sensation, intelligence, habits, diseases and handwriting of nearly 27,000 criminals and almost as many decent citizens [6].

Artificial intelligence is now utilised in a wide range of activities in human life. In scientific research, its use has increased in recent years. The artificial intelligence assistants created are used to process large amounts of data, perform image analysis, fact checking, etc. In risk analysis, its use contributes to the faster operation of the system, but measures must be taken to prevent the creation of a situation similar to that in the works of Lombroso, in which people are declared criminals or given the wrong definition.

Use of image recognition for medical purposes

The image recognition techniques described at the beginning of the paper offer sufficient information to establish or confirm a diagnosis for a specific patient. The main disadvantage is the inability to simultaneously examine a group of people. If there is a crowd, the methods described cannot determine what proportion of those present have a fever, have used opiates, or are suffering from some disease. Advances in camera technology have enabled a wide variety of health sensing, including body temperature, pulse rate, and respiratory rate. Whereas conventional photoplethysmography (PPG) requires physical contact with skin, remote photoplethysmography (rPPG) utilizes a standard RGB camera as the photodetector for PPG measurement [7].

Capturing a group of people, applying a facial analysis of each individual captured, and determining their health status would help prevent and manage health crises. The implementation of such a system requires in-depth research into the physical manifestations of diseases occurring during their manifestation – preclinical and clinical. Certain conditions cannot be easily detected, unlike skin diseases, which have a characteristic appearance and can be relatively easily diagnosed by computer processing of the captured image. If such a system is implemented, one of the essential tasks that must be solved is to deal with the discrimination of a given individual. There is an abnormality in certain individuals who can be defined as suffering from a certain disease, and their access to a public environment or activity can be restricted. A significant advantage of a system working through risk analysis by image recognition is that common or specialized cameras are used, eliminating the need to use X-ray radiation, radiopharmaceuticals or other preparations, the quantitative accumulation of which leads to an adverse effect on a person's health.

CONCLUSION

Classical image recognition is widely used in medicine. The software and hardware part are constantly developing and improving. The use of analysis by external signs can improve management and decision-making during a pandemic, disaster or anarchic situation. A significant problem still remains the small and incomplete research on the psycho-physical expression of people's behavioral traits.

Acknowledgments

This study is financed by the European Union-Next Generation EU, through the National Recovery and Resilience Plan of the Republic of Bulgaria, project No. BG-RRP-2.013-0001.

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Please cite this article as: Sabev N, Ralev I. Risk analysis through image recognition. *J of IMAB.* 2026 Jan-Mar;32(1):6698-6702. [Crossref - https://doi.org/10.5272/jimab.2026321.6698]

Received: 12/08/2025; Published online: 23/01/2026

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