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Diagnosis of diseases based on the analysis of saliva photographs using artificial intelligence and mobile technologies

Annotation

The article emphasizes on the method and technology used for early diagnosis of human diseases based on the analysis of photographs of saliva taken under a microscope at a magnification over 1000 X. The resulting photograph, taken using a special nozzle and a smartphone, is transmitted via mobile communication to a medical center, where the images of the sample (saliva) were processed using algorithmic and software with elements of artificial intelligence, in order to make a preliminary diagnosis with subsequent clarification by a specialist doctor. The proposed technology is non-invasive, affordable and provides an opportunity to diagnose remote patients who do not have nearby medical laboratories and institutions.

Keywords: saliva, microscope, diagnostics, artificial intelligence, mobile devices

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Introduction

In most cases, viral and even chronic diseases are not diagnosed until the painful symptoms become apparent at later stages. To diagnose the disease at an early stage, medical researchers direct their work to the search for biomarkers of molecular diseases. These markers can be DNA, RNA, or protein molecules that act as indicators of certain physiological states. Over the past decades, molecular diagnostics has proven its value in clinical applications. However, the need for mass screening of the population is required, when a virus pandemic is suspected or for preventive purposes, necessitates the search for a simpler and cheaper method, suitable, including for remote users, for example, in rural areas. At the same time, it is necessary to use technologies and devices that almost every person currently has. This is a mobile phone and a smartphone. This is especially true in conditions where the necessary diagnostic equipment is not available or is located at a considerable distance from a person.

Main part

Early diagnosis of human diseases is possible on the basis of the analysis of its physiological fluid. Recently, more attention has been paid to saliva as, saliva diagnostics has great prospects as an effective method for early diagnosis, prognosis and monitoring of the condition after therapy. Whole saliva is a mixture of minor salivary gland secretions, mucosal extravasation, gingival sulcus fluid, serum and blood derivatives from oral wounds, desquamated epithelial cells, expectorated bronchial and nasal secretions, bacteria and bacterial products, viruses and fungi, other cellular components and leftover food. It is a complex fluid containing a whole library of hormones, proteins, enzymes, antibodies, antimicrobial components, and cytokines.[1–3]

Technologies for laboratory and functional diagnostics of diseases based on saliva analysis make it possible to detect many diseases at an early stage and in a very short time.

Saliva might replace blood in future from the view point of analysis and interpretation. American physicians and biologists from the University of Rochester Medical Center, the University of Southern California, the Universities of California at San Francisco and Los Angeles, and the Scripps Research Institute for the first time in the history of medicine have compiled the most complete map of saliva, which reflects all 1166 unique proteins that make up human salivary gland secretions.[4]

Since then, there have been discussions that saliva can serve as a material for rapid tests. The proteins contained in it can serve as a kind of indicator of the risk of various types of cancer - cancer of the digestive system, lungs, breasts, as well as Alzheimer's, Parkinson's and diabetes. For example, in diabetes, saliva contains a sharply reduced insulin content and an increased sugar content. Recent studies performed by American Scientists disclosed the prominence of saliva and has validated the role of saliva in detecting cancer.[5]

Australian scientists have developed a test to detect heart disease by saliva.[6] Biochemical analysis of saliva allows you to identify various diseases of the gastrointestinal tract. Tests are also carried out for infections, viruses. It is noteworthy that in almost any modern pharmacy you can purchase a special system for home study of the composition of this biological fluid, however, experts question the information content of such a test.

Which diagnosis, from the point of view of physicians, is quite justified, because in addition to 99% of water, saliva contains anions of chlorides, phosphates, bicarbonates, thiocyanates, iodides, bromides, fluorides, sulfates, cations Na+, K+, Ca2+, Mg2+ and microelements Fe dissolved in it , Cu, Mn, Ni, Li, Zn, organic substances - protein and its fractions (albumin, globulins), amino acids, mucin; enzymes - amylase, lactase, lysozyme, kallikrein, parotin, as well as cholesterol, glucose, lactic acid and vitamins C, B1, B12, H, K..[7] In addition, saliva is a dynamic environment compared to blood, reflecting daily changes in the body.

Important information about pathologies is also provided by examining saliva under a microscope. Examining saliva under a microscope, it is possible to determine its structure and composition with high accuracy (Figure 1).

The most important question is how exactly the researcher will be able to interpret the resulting image. And whether the optical characteristics of the device will fully show the real microflora and its changes.

In modern clinics, it is possible to display images on a computer and take photographs by connecting a digital video eyepiece to the visual attachment. Software tools can take photos, videos, simple linear and angular measurements.

The method of determining ovulation in women using saliva is also considered original. During the release of the egg from the ovary, saliva has a fern-like structure. And it is these days that are considered favorable for conception (Figure 2).[8]

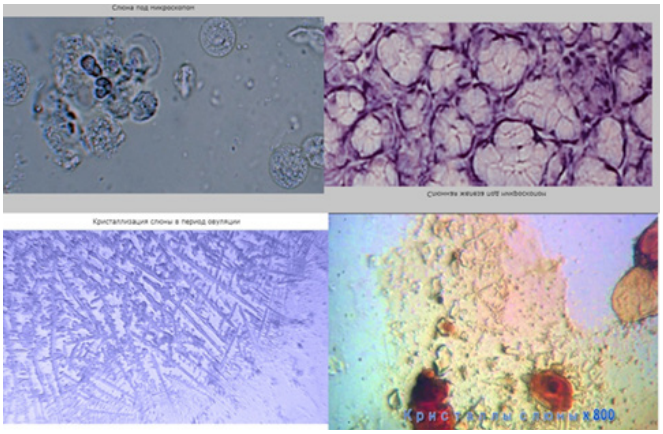

Figure 1 Photographs of saliva under a microscope with different magnifications.

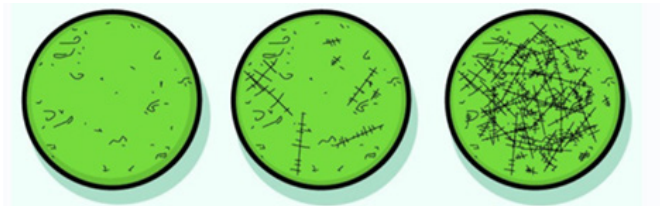

Figure 2 Dynamics of changes in the structure of saliva.

The price of such microscopes is very economical, given that this is an apparatus for multiple use. The cost ranges from $20 to $70. The total amount depends on the manufacturer and additional options available for a particular microscope.

Pacific Northwest National Laboratory (USA) has developed a very cheap smartphone attachment that allows you to take pictures of liquids and other materials magnified from 100 to 1000 times (Figure 3-5).[9]

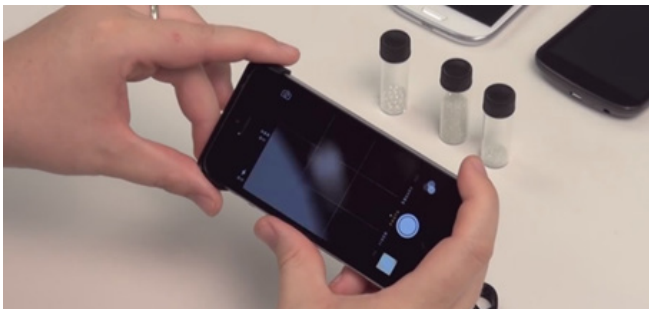

Figure 3 3D Printed Microscope for Mobile Devices that Cost Pennies. Source: Yandex.ru.

This technology was developed as part of the development of a mobile healthcare system in the United States. Work on the creation of mobile health systems in the US, Canada, Britain and India has been going on since the 90s, when the governments of countries developed in terms of mobile technologies realized the need to create remote health care systems.

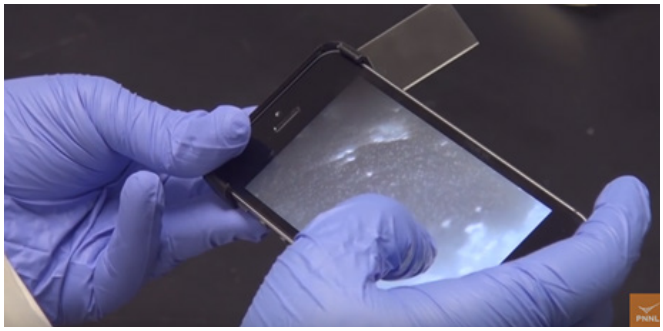

Figure 4 Photo in a smartphone. Source: Yandex.ru.

Figure 5 Photos with different magnification. Source: Yandex.ru.

One of the first Health systems was developed in 2005 at the University of London under the supervision of Professor Brian Woodward with the participation of Indian scientists. The unique system made it possible to monitor the state of human health and transmit data from a mobile phone to a clinic anywhere in the world. The device transmitted data on blood oxygen saturation, pressure, blood glucose levels, heart beats.

Images of saliva taken under a microscope can be processed in the smartphone itself, which is a powerful computing device. However, in order to recognize pathological changes in the body based on a saliva image, it is necessary to have access to databases with thousands of case histories, clinical trial results, available similar cases (and other ordered information) and, using machine learning algorithms, to classify a particular medical case and propose a plan of action to eliminate the negative consequences. That is, artificial intelligence is indispensable here.

An example of the use of artificial intelligence in medicine is the IBM Watson project.[10] It is based on a supercomputer that can answer questions formulated in natural language. He has access to various data sources: encyclopedias, databases of scientific articles, anthologies of knowledge. Thanks to the huge computing power, having processed the sources, it gives the most accurate answer to the question asked.

Conclusion

a. Diagnosis based on saliva analysis has significant development prospects in order to create a personalized and mobile medical technology for early diagnosis of diseases, including the onset of a pandemic, as it may also be suitable for mass prevention of the population

b. Creation of a technology for early warning of diseases based on the analysis of photographs of saliva with a magnification of 1000 times or more will contribute to the emergence of new promising medical technologies with elements of artificial intelligence.

Acknowledgments

None.

Conflicts of interest

Author declares that there is no conflict of interest.

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