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STRUCTURE AND COMPONENTS OF INTERNET OF THINGS NETWORK FOR IT PATIENT DIAGNOSTICS

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Abstract. Internet of Medical Things (IoMT) technologies increase the operational productivity and efficiency of healthcare organizations by optimizing clinical, information and operational processes. An overview of the use of IT development directions in remote diagnostics is given. For the development of IoT diagnostics (IoTD), an analysis was carried out in three directions: the iris, changes in voice characteristics, indicators of smart gadgets. The use of artificial intelligence technology and machine learning for IT diagnostics is considered. The structure of the IoTD patient diagnostic network is discussed.

Keywords: IoTD network concept, IT patient diagnostics iris, voice, smart gadget.

Introduction

The Internet of Medical Things (IoMT) is an Internet of Things network that includes medical devices (sensors), communicators, a server, software applications, and healthcare services. The interaction between sensors (devices) and the server allows healthcare organizations to optimize their clinical operations and workflow management, as well as improve patient care from remote locations [1, 2]. The main advantages of IoMT [1, 3]:

– rapid diagnosis: monitoring devices with intravenous infusion support constantly monitor the condition of patients, help diagnose diseases or health problems at an early stage;

– cost reduction: with the help of IoMT, the patient can receive high-quality medical consultations in real time without visiting doctors and hospitalization;

– improving access to health care in remote areas: villages and cities in some countries do not have sufficient access to modern medical services;

– reducing the number of manual errors: the data collected by connected medical devices does not allow errors, which improves the overall quality of diagnostics.

– improvement of medical care: since doctors can constantly monitor patients with medical devices based on intravenous infusion, there are more opportunities for specialized and individual treatment;

– effective management of medical equipment and medicines;

– detection of side effects of drugs in the early stages;

– medical insurance companies can use the data collected using connected medical devices to process claims, which ensures full transparency of their consideration.

The use of the Internet of Things (IoT) in healthcare makes it possible to move to a new level of disease diagnosis, treatment accuracy and monitoring of patients' health using micro- and nanodetectors and other «smart devices». Remote monitoring reduces the risks of unscheduled hospitalization and reduces the burden on hospitals, and the interaction between doctors and patients online is simplified.

Next, we will consider individual areas of medical diagnostics for building IoT diagnostics (IoTD).

IT gadget diagnostics

In 2008, a storm of «smart medical care» was set off around the world, and smart devices such as smart bracelets and smart robots began to emerge in public medical places such as hospitals [4]. Nowadays, medium-sized and large-scale hospitals and other public medical places have begun to upgrade and transform their medical systems intelligently, and apply advanced medical equipment [5] to the medical field of helping patients, which greatly improves the work efficiency of medical staff, saving a lot of manpower and material resources. Therefore, under the background that hospitals and other public medical places have been in the traditional working mode for a long time, and wearable devices are developing rapidly in the medical industry, this project researches and designs a patient data collection platform based on smart bracelets. The research value of this topic lies in that the smart bracelet can collect a variety of vital sign signals and apply them to patients in hospitals and other public health medical places. Its main significance and value are as follows:

1. The smart bracelet terminal hardware performs long-term, 2-hour uninterrupted real-time tracking and medical monitoring of vital sign signals of patients, and collects comprehensive and specific medical data of patients, so as to quickly find the cause, realize disease prevention and early medical treatment Favorable convenience is provided.

2. Integrate patients' data in the cloud, build medical servers and improve telemedicine-related hardware equipment, and carry out telemedicine treatment-related activities with tertiary hospitals and their medical experts and attending physicians. Realize the function from manual early warning to automatic early warning when the patient has an emergency. At this time, the system immediately feeds back the current status information of the patient to the medical experts and attending physicians, so as to realize the prevention of the disease and the high efficiency of medical treatment. The life, health and safety of seriously ill patients opens a green and intelligent acceleration channel to prolong the life cycle of patients.

3. When the patient is admitted to the hospital, the smart bracelet is distributed to the patient. When the patient is discharged, it is recycled, cleaned, disinfected and reused. It can be reused many times, reducing medical costs and avoiding the waste of medical resources. Therefore, it is very meaningful to research and design a patient data collection platform based on smart bracelets.

IT iris diagnostics

Modern iris medicine began at the end of the 18th century, and was first developed in Europe and North America. In modern iris medicine, the accuracy of the atlas is high, and it is widely used in the world. It has been recognized by iris doctors all over the world. The International Iridologist Practitioners Association, or IPA for short, is the largest international iris medicine organization in the world, which takes promoting and continuously improving the research and development of iris medicine as its mission. The development and application of iris medicine in developed countries have been widely recognized in recent years. Iris diagnostics is an effective means of preventive medicine. Through the detection of 800000 patients in Russia, it was found that the detection rate of iris medicine for diseases was as high as 85 % [6].

In recent years, iris medicine and iris diagnosis and treatment have been developing in various countries. Iris medicine (iris medicine, iridology, iris diagnostics, etc.), based on morphology, observes, predicts and infers the overall physique of the human body, the reality of the overall health, the occurrence and recovery of diseases by studying the morphological changes of the iris of the human eye, such as changes in color, color spots, structure, and pupil. It is a scientific and practical technology that reflects the genetic constitution of the human body and the defects of various organ systems, it is also a complete medical system including examination (detection), diagnosis (judgment and evaluation) and treatment (conditioning). The IoT for human health diagnosis based on iris data can provide more detailed and accurate diagnosis for iris medicine.

The purpose of first step is to detect the features corresponding to the established features in the reference image in the image to be registered. To this end, we will use various descriptors and similarity measures in the spatial domain composed of these features. Our second task is to find the correspondence of some feature points between two images. Since the transformation of iris texture is non rigid and

extremely irregular, which increases the difficulty of finding corresponding point pairs, here we use the method of Local jet model plus LBPs (local invariant binary patterns).

IT voice diagnostics

One application of IoT in healthcare is the use of speech analytics to diagnose human lung diseases. The Internet of Things (IoT) network for diagnosing human lung disease through speech analytics is an innovative approach to healthcare that uses IoT technology to collect and analyze patient data remotely. Once voice data is collected, machine learning algorithms can be used to analyze voice patterns and identify potential indicators of lung disease. For example, changes in pitch, tone and frequency can be used to detect the presence of lung diseases such as asthma, chronic obstructive pulmonary disease (COPD) and pneumonia. This approach works by using IoT-enabled devices, such as smartphones or wearables, where patients can record their voices and transmit the data to a central database for analysis. Machine learning algorithms can then be used to analyze voice patterns and identify potential indicators of lung disease. This approach enables remote monitoring of patients and eliminates the need for frequent in-person visits by healthcare providers. In addition to improving patient outcomes, an IoT network for diagnosing lung disease through speech analytics can reduce healthcare costs by minimizing the need for costly diagnostic tests and reducing hospital readmission rates.

However, there are some challenges with this approach. Including data accuracy, privacy and security issues, one issue is the potential for inaccurate or incomplete data. For example, if a patient does not speak clearly or has background noise, this may affect the accuracy of the diagnosis. Another issue is privacy and security. The collection of patient voice data raises concerns about data privacy and security. It is important to ensure the confidentiality and security of patient data and to take appropriate measures to prevent data leakage.

The proposed system is designed to make classifications and detect cough sounds [7]. There are four main stages after selecting the sound classification dataset. The first stage is extracting the features from audio files such as the MFFCs, chromagram, Mel-spectrogram, spectral contrast, and tonal centroid features. The second stage is labeling, it categorized the sound samples into cough and non-cough, then fed the inputs into a neural network. It reached the training stage and record the results until reached the optimal parameters according to the best results (changing epochs number, learning rate, etc.). The final stage, after generating the model, several tests were being applied on recorded sounds from volunteers.

Machine learning in IT patient diagnostics

The application of machine learning techniques in medical diagnostic analysis is becoming increasingly important. It works by building a model based on known information, and then using the model and related data to detect whether a patient has a specific condition or disease.

Machine learning techniques in diagnostic medical imaging hold great promise for detecting pathologies in images and identifying diseases present in images. It can effectively detect cancer brain damage, heart disease and other conditions, which require high-quality medical images to provide effective reference. In addition, it can detect earlier conditions, thereby helping to judge clinically earlier disease [8].

Functional imaging can help doctors accurately understand the pathological changes of patients and better judge the patient's condition. Machine learning technology can identify the characteristics of each patient and can provide effective tips for doctors, so that they can better judge the patient's disease.

The use of machine learning technology for medical diagnosis and analysis will bring more convenience to doctors, enabling faster and more accurate diagnosis of diseases, optimizing medical treatment experience, reducing possible diagnostic errors of doctors, thereby improving the efficiency and level of medical treatment, and better Ensure the health and safety of patients.

Structure of IoTD network

The structure of IoT diagnostics of patient (IoTD) network consists of the following components:

1. IoT devices are the physical devices that collect and transmit data. In the IoT diagnostics (IoTD) network, IoT devices can include smart phone, wearable devices, or other devices that can capture and transmit data.

2. Sensors are used to collect data about the patient's environment, such as temperature, humidity, and air quality. This information can be used to provide context for the data and improve the accuracy of the diagnosis.

3. Cloud or edge computing is used to process and analyze the data collected by the IoT devices. In the process of disease diagnosis, machine learning algorithms can be used to analyze disease characteristics and identify potential indicators of disease.

4. Data storage is used to store the disease data and other relevant information about the patient, such as medical history and demographic information. This information can be used to provide personalized care and improve the accuracy of the diagnosis.

5. User interface is used to provide healthcare providers with access to the patient data and diagnostic results. This can be a web-based interface or a mobile application.

6. Security and privacy measures are used to protect patient data and ensure that it is kept confidential and secure. This can include encryption, access controls, and other measures to prevent data breaches.

Overall, the Internet of Things Diagnostic (IoTD) network is structured to collect and analyze data from multiple sources to provide accurate diagnosis and personalized care to patients. In the IoT structure proposed by the author for the diagnosis of patients, data will be collected from patients' smartphones or from smart gadgets. These will be photos of the iris, the results of voice tests, parameters from gadgets (pulse rate, blood pressure, body temperature, etc.). The collected data will be transmitted to the IoT server for recording in the database, preliminary analysis, making decisions about the health of patients. The server will include deep neural networks trained on data sets of patients with certain diseases (by iris, voice markers, etc.). The results of the analysis will be sent to the smartphones of the attending doctors.

The application of machine learning techniques in medical diagnostic analysis is becoming increasingly important. It works by building a model based on known information, and then using the model and related data to detect whether a patient has a specific condition or disease.

Conclusion

The concept is given and the advantages of using IoT technologies in medicine are described, as well as the directions of IoT diagnostics development. To develop of IoT diagnostics approaches, an analysis of three directions was carried out: on the iris, indicators of smart gadgets, changes in voice characteristics. The use of artificial intelligence and machine learning technologies for the diagnosis of patients is discussed. The author's structure the IoT network for patient distance diagnostics is considered.

References

1. Aksenova E.I., Gorbatov S.Y. Internet of Medical Things (IoMT): new opportunities for healthcare. M.: GBU «NIIOZMM DZM», 2021.
2. Deloitte. Medtech and the Internet of Medical Things. How connected medical devices are transforming health care. [Electronic resource]. URL: https://www2.deloitte.com/global/en/pages/life-sciencesand-healthcare/articles/medtech-internet-of-medical-things.
3. Embitel. IoT in Healthcare – Connected Devices, Telemedicine and Remote Monitoring. [Electronic resource]. URL: https://www.embitel.com/blog/embedded-blog/iot-in-health-care-connected-devices-tele-medicine-and-remote-monitor-ing.
4. Fuqiang C. // Microprocessors and Microsystems. 2021. Vol. 82(5). P. 103901.
5. Shanguo L. // Microprocessors and Microsystems. 2021. Vol. 82(5). P. 103856.
6. Iridodiagnostics. [Electronic resource]. URL: https://mgkl.ru/patient/stati/iridodiagnostika.
7. Visniakou U.A., Shaya B.H. // Modern means of communication: materials of the 27th International Scientific Conference, Minsk, October 27−28. Minsk: BSAC. 2022. P. 29.
8. Kulkarni P. Machine learning in Medical Diagnoses. [Electronic resource]. URL: https://medium.com/ai-techsystems/ml-in-medical-diagnosis-1370b8ecfe31.