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SELECTION OF THE ARTIFICIAL INTELLIGENCE COMPONENT FOR CONSULTATIVE AND DIAGNOSTIC INFORMATION TECHNOLOGY FOR GLAUCOMA DIAGNOSIS

The most important areas of application of consultative and diagnostic systems are urgent and life-threatening conditions characterized by a lack of time, limited opportunities for examination and consultations, and often little clinical symptoms with a high level of threat to the patient's life and the rapid pace of development of the process. The experience of using consultative and diagnostic systems proves a significant improvement in the quality of diagnostics, which not only reduces unjustified losses, but also allows more effective use of aid resources, regulates the volume of necessary research, and finally, increases the professional level of doctors for whom such a system serves at the same time and educational. Consultative diagnostic systems and technologies are currently rarely and insufficiently used in ophthalmology, although the field of ophthalmology in general and glaucoma diagnosis in particular are in great need of them.

Currently, the problem of using artificial intelligence for the problem of glaucoma analysis is faced with the fact that neural networks themselves and the methods of their use are not made suitable for mass use, with the complexity of development for certain models, with the inaccessibility for mass use, and the difficulty of collecting data for training neural models due to "confidentiality" of data. There is also the issue of cost and diagnostic availability — the availability of a trained professional, the means to collect data, and the time it takes for a patient to receive a diagnosis.

The author's further research will be aimed at creating the neural network itself for the diagnosis of glaucoma with different approaches from the available data types for each individual case, as well as creating programs and instructions for deploying such a neural network in places of use and using it with minimal requirements and resource needs. Compared to other similar products, this will be such an introduction of artificial intelligence that will allow to incorporate all the available experience into a small number of lines of code and will have pros in low budget and mass use.

Keywords: consultative and diagnostic information technology, ophthalmology, glaucoma diagnostics, artificial intelligence.

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ВИБІР КОМПОНЕНТУ ШТУЧНОГО ІНТЕЛЕКТУ ДЛЯ КОНСУЛЬТАТИВНО-ДІАГНОСТИЧНОЇ ІНФОРМАЦІЙНОЇ ТЕХНОЛОГІЇ ДІАГНОСТУВАННЯ ГЛАУКОМИ

Найбільш важливі області застосування консультативно-діагностичних систем – невідкладні та загрозливі для життя стани, що характеризуються дефіцитом часу, обмеженими можливостями обстеження і консультацій і нерідко малою клінічною симптоматикою при високому рівні загрози для життя хворого і швидких темпах розвитку процесу. Досвід використання консультативно-діагностичних систем доводить суттєве підвищення якості діагностики, що не лише зменшує невиправдані втрати, але і дозволяє більш ефективно використовувати ресурси допомоги, регламентувати об'єм необхідних досліджень, і нарешті, підвищити професійний рівень лікарів, для яких така система слугує одночасно і навчальною. В офтальмології наразі рідко та недостатньо ефективно використовуються консультативно-діагностичні системи та технології, хоча галузь офтальмології в цілому та діагностування глаукоми зокрема дуже їх потребують.

Наразі проблема використання штучного інтелекту для проблеми аналізу глаукоми полягає в тому, що самі нейромережі та методи їх використання є мало придатними для масового використання, зі складністю розробки для певних моделей, з недоступністю для масового використання та важкістю збору даних для навчання нейронних моделей через "конфіденційність" даних. Також є проблема вартості та можливості діагностики — наявність кваліфікованого спеціаліста, засіб для збору даних та час, необхідний для пацієнта, щоб отримати діагностику.

Подальші дослідження авторів будуть спрямовані на створення самої нейромережі для діагностики глаукоми з різними підходами від наявних типів даних для кожного окремого випадку, а також створення програм та інструкцій для розгортання такої нейромережі на місцях використання та використання її з мінімальними вимогами та потребами в ресурсах. В порівнянні з іншими подібними продуктами це буде таке впровадження штучного інтелекту, яке дозволить втілити весь наявний досвід у невелику кількість рядків коду і буде відрізнятись бюджетністю та масовістю використання.

Ключові слова: консультативно-діагностична інформаційна технологія, офтальмологія, діагностування глаукоми, штучний інтелект.

Introduction

Modern information technologies are increasingly more often used in the field of health care, which is convenient, and sometimes simply necessary. Thanks to this, medicine, including non-traditional, acquires completely new features today. In many medical studies, it is simply impossible to do without a computer and special software for it. This process is accompanied by significant changes in medical theory and practice, associated with the introduction of corrections both at the stage of training medical workers and for medical practice.

Historically, consultative diagnostic systems began to develop as one of the first medical diagnostic systems. Currently, consultative and diagnostic systems are represented by numerous systems for diagnosing pathological conditions (including prognosis) in diseases of various profiles and for different categories of patients. The input information for such systems is data on the symptoms of diseases, which are entered into the computer in dialog mode, or in the format of specially developed information cards. Diagnostic conclusions, in addition to the diagnosis (or possible diagnoses), as a rule, also contain recommendations for choosing a tactical solution and therapeutic measures.

The most important areas of application of consultative and diagnostic systems are urgent and life-threatening conditions characterized by a lack of time, limited opportunities for examination and consultations, and often little clinical symptoms with a high level of threat to the patient's life and the rapid pace of development of the process.

The experience of using consultative and diagnostic systems proves a significant improvement in the quality of diagnostics, which not only reduces unjustified losses, but also allows more effective use of aid resources, regulates the volume of necessary research, and finally, increases the professional level of doctors for whom such a system serves at the same time and educational

Consultative diagnostic systems and technologies are currently rarely and insufficiently used in ophthalmology, although the field of ophthalmology in general and glaucoma diagnosis in particular are in great need of them.

In the field of eye health, glaucoma stands out as a silent threat to vision, often progressing imperceptibly until irreversible damage occurs.

Glaucoma is known for its insidious onset, with patients often experiencing no symptoms until significant vision loss occurs. Traditional diagnostic methods such as intraocular pressure measurement and visual field tests are important, but in some cases may not be sufficient for early detection. The elusive nature of glaucoma makes timely diagnosis a serious challenge for medical professionals. In order to detect glaucoma, it is necessary not only to use traditional diagnostic methods, but also to take pictures and diagnose pictures of the patient's fundus. In order to take pictures of the fundus, expensive equipment is needed, which not every state medical institution of Ukraine can afford. In addition, high-quality diagnosis requires extensive experience in recognizing and diagnosing similar diseases. Also, patients need to allocate time and money for diagnosis, which also reduces the likelihood of timely diagnosis of glaucoma.

Challenges related to the diagnosis of glaucoma (difficulty of early diagnosis, asymptomatic early stages, the need for a complex technique and sufficient qualification for diagnosis, the allocation of time by the patient for diagnosis) require the search for innovative solutions for the early diagnosis of glaucoma.

One of the promising and innovative ways to process diagnostic data in order to detect minor and barely noticeable changes to the human eye are components of artificial intelligence, since artificial intelligence ensures the accumulation of experience, the absence of forgetting experience with insufficient use, and the ability to freeze the training of an artificial intelligence unit at the highest point of efficiency. In addition, for example, machine learning algorithms (as one of the components of AI) have the ability to analyze huge amounts of data with unprecedented speed and accuracy.

Therefore, *the task of this study* will be the selection of an artificial intelligence component for consultative and diagnostic information technology for diagnosing glaucoma.

Analysis of known methods and solutions

Analysis of known works and solutions for detecting eye diseases by fundus imaging:

1) Algorithm based on artificial intelligence for early detection of glaucoma. Used by a hospital in Singapore for diagnosis. Created by scientists from Nanyang Technological University (Singapore) in collaboration with doctors at Tan Tok Seng Hospital. Claimed accuracy of 97%. Pros: all the above-mentioned advantages of artificial intelligence [1];
2) Algorithm for screening diabetic retinopathy in the early stages with the help of artificial intelligence. Created by the Ukrainian medical IT startup CheckEye in association with the private medical center "Zakarpatska Endoclinic". For screening using this method/algorithm, it is possible to make an appointment by phone on the website check-eye.com in the version of the website localized in the Ukrainian language. Pros: localized in Ukraine Disadvantages: personal data is required (personal data is not required for fundus screening), small distribution of places of use/examination, a certificate from a doctor about diabetes is required, does not apply to glaucoma [2];
3) Intelligent technology of computer diagnostics of eye pathologies. Accuracy: not specified. Pros: detailed mathematical description [3];
4) Computer tools for diagnosing diseases based on a neural network. Accuracy: not specified. Pros: mathematical description [4];
5) Artificial intelligence in glaucoma: posterior segment optical coherence tomography. Pros: The standard machine learning pros. Disadvantages: the requirement of expensive equipment to obtain tomography [5];

6) Using machine learning with regular positive reinforcement and feedback from doctors. Pros: Feedback to improve accuracy [6];
7) Comparison of different machine learning classifiers for glaucoma diagnosis based on the SPECTRALIS retinoscope. Pros: description of different methods [7];
8) Overview of data processing of different machine learning methods for ophthalmology. Pros: Using different methods and recording results [8];
9) Development and verification of a deep learning optical glaucoma diagnosis system using coherence tomography. Pros: detailed description of the results, partial description of the method [9];
10) Investigating the potential of neural networks for the identification of eye diseases. Pros: ready-made code with a solution [10];
11) Glaucoma detection on retinal fundus images based on transfer learning and fuzzy clustering. Pros: the transfer method allows you to reduce the time of study [11];
12) Segmentation and Classification Algorithms for Glaucoma Detection Based on Machine Learning. Pros: A list of approaches leading to the highest accuracy is provided [12];
13) Detection of glaucoma using a hybrid deep learning model. Pros: the specified method for the least data loss when moving between model layers [13];
14) IoT-Based Predictive Modeling for Glaucoma Detection in Optical Coherence Tomography Images Using a Hybrid Genetic Algorithm. Pros: high accuracy of the method, clear description of the approach [14];
15) Advances in glaucoma detection using deep machine learning [15];
16) An online platform for early detection of eye diseases using deep machine learning. Pros: mass approach to using the result of machine learning [16].

Role of artificial intelligence in the diagnosis of glaucoma

As the analysis showed, in the context of glaucoma diagnosis, artificial intelligence can solve several key problems:

1) Early diagnosis detection – one of the main advantages of artificial intelligence in the diagnosis of glaucoma is its ability to detect subtle changes in the eye that may not be visible to the human eye. By analyzing image data, such as optical coherence tomography (OCT) scans or images taken during fundus screening, artificial intelligence algorithms can identify early signs of glaucomatous damage, allowing for intervention before irreversible vision loss occurs;
2) Personalized diagnostics and risk detection – AI systems can integrate a variety of patient data, including medical history, genetics and lifestyle factors, to create personalized health records with risk information for various diseases. This specialized approach enables healthcare professionals to identify individuals at increased risk of developing glaucoma, facilitating early monitoring and early intervention;
3) Increased accuracy when analyzing the field of view – traditional visual field tests are subjective and can vary depending on the patient's interpretation of the words. AI-based algorithms can improve the accuracy of visual field testing, minimizing variability and providing more reliable results. This may lead to more accurate and consistent monitoring of glaucoma progression;
4) Optimization of the diagnostic process – artificial intelligence can significantly reduce the burden on healthcare professionals by automating time-consuming tasks such as image analysis and data interpretation. This efficiency allows physicians to focus on patient care and decision making, ultimately improving the overall diagnostic process. Also, artificial intelligence can be combined with existing means of information dissemination for mass application and simplifying obtaining advice from an experienced and qualified mind to determine glaucoma;
5) Medical ethics – although the potential benefits of artificial intelligence in glaucoma diagnosis are exciting, ethical issues must be acknowledged. Ensuring the privacy and security of patient data, eliminating errors in AI algorithms, and establishing clear guidelines for the integration of AI into clinical practice are key aspects that require close attention. And all medical ethics depends little on artificial intelligence to diagnose diseases. Moreover, personal information is important for artificial intelligence only from the point of view of making a diagnosis — any person is a separate case with a set of information based on which a diagnosis can be made and no more.

The integration of artificial intelligence into the diagnosis of glaucoma represents a transformative step forward in the search for early detection and effective treatment of this sight-threatening condition. By using machine learning, healthcare professionals will be able to overcome diagnostic challenges, offering hope for a future where glaucoma is much less of a threat to vision, as prevention of glaucoma will occur much earlier than the negative consequences of late detection.

Conclusions

Currently, the problem of using artificial intelligence for the problem of glaucoma analysis is faced with the fact that neural networks themselves and the methods of their use are not made suitable for mass use, with the complexity of development for certain models, with the inaccessibility for mass use, and the difficulty of collecting data for training neural models due to “confidentiality" of data. There is also the issue of cost and diagnostic availability—the availability of a trained professional, the means to collect data, and the time it takes for a patient to receive a diagnosis.

The author's further research will be aimed at creating the neural network itself for the diagnosis of glaucoma with different approaches from the available data types for each individual case, as well as creating programs and instructions for deploying such a neural network in places of use and using it with minimal requirements and resource needs. Compared to other similar products, this will be such an introduction of artificial intelligence that will allow to incorporate all the available experience into a small number of lines of code and will have pros in low budget and mass use.

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