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Artificial Intelligence for Cancer Detection Using Medical Image: Highlights and Limitations

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Abstract: Artificial intelligence refers to systems capable of performing tasks, imitating human intelligence. These novel techniques are already being applied in various fields, and medical diagnosis is one of them. For this work, a bibliographic review of scientific literature was used. In this way, some relevant results that show the benefits of using artificial intelligence techniques in the medical field and the limitations and problems that still exist were addressed. The most relevant results indicate that, although there are limitations such as cost or lack of development, artificial intelligence has great potential in clinical diagnosis since it allows automating many analysis and decision-making processes, equating its precision to that of humans. Likewise, there is a promising outlook for these techniques since there is still much room for improvement and enhancement, starting from the academic foundations.

Keywords: Artificial Intelligence · Clinical Diagnosis · Machine Learning · Medical Image

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1. Introduction

Artificial intelligence (AI) is a field of computer science that seeks to simulate human intelligence processes by machines, especially computer systems [1]. This field has gained prominence recently due, in part, to the large amounts of data or the increased velocity, size, and variety of data that companies are collecting [2]. Using this data, and after a series of processes, it is possible to find efficient and effective solutions to various problems. The applications of AI range from parallel versions of existing methods to solutions for new problems related to autonomous agents (software programs with autonomy to make decisions and interact with others) [3]. Therefore, the goal of AI is to enable machines to approach the human cognitive capacity; in other words, it seeks that machines can abstract, learn, categorize, reason, and act similarly, equal to, or even better than a human being [4, 5].

Medicine is one of the fields of knowledge that could benefit most from close interaction with computation and mathematics. This multidisciplinary communication makes it possible to optimize complex and imperfect processes such as differential diagnosis [6–8]. Currently, the clinical diagnosis begins with gathering information about a patient's condition. This procedure can be done through simple questions and local observations to more complex processes such as laboratory tests imaging, among others. Subsequently, the health professional, sometimes together with a team, analyzes, compares, and contrasts all this information to arrive at a specific diagnosis.

Two important points can be highlighted from this: first, medical diagnosis is a series of steps that must be carried out in order to reach a conclusion that is capable of providing relief to the patient; second, it indicates that during the process involved in making a medical diagnosis, a large amount of data is involved that is processed, analyzed, classified and contrasted in order to conclude. This is what machine learning (ML) is all about, a branch of AI that builds and studies systems capable of learning from a training dataset and improving classification and prediction processes [9–11].

Therefore, with the help of AI, not only can the decision-making process be automated, but the answer obtained would be one that has sufficient arguments to be accepted as valid. All this with the bonus of obtaining an accurate diagnosis in less time than it would take a person. An electronic or computational aid facilitates this process because it makes it systematic and exhaustive, not dependent on the clinician's experience, and eliminates the need for a working memory beyond human capacity [6, 9]. A well-trained diagnostic program can be, at least, as effective as an expert clinician and greatly simplify the work of human doctors [6].

This paper discusses and describes some relevant research results related to the application of AI in clinical diagnosis. The focus is on cancer diagnosis through the analysis of medical images. A systematic literature review is used to identify the positive points of the results of these studies and the existing limitations and barriers. Finally, the aim is to conclude the feasibility of applying AI techniques in the clinical diagnosis of cancer, with projection to the present and future.

2. AI in medical image analysis: Highlights

Given that cancer continues to be one of the leading causes of death worldwide, optimizing the process of its diagnosis is a job of great importance [12]. Medicinerelated activities accelerate to produce a large amount of health and disease data [13]; this with the aim that, with the help of AI, health professionals can provide more efficient and accurate medical services [14]. Thanks to being a worldwide trend, AI has already begun to be applied in cancer diagnosis, and some results are beginning to be evident.

The capacity and power that AI can have in information classification and decision making has been mentioned, but this may lead one to think that it works only with previously collected data. However, this is not an accurate assumption since AI can also collect information efficiently and effectively [15–17]. One of the standard procedures for suspected cancer or tumors is imaging tests. A health professional carefully analyzes the image in search of any outstanding data or indicator, collects that information, and then performs the entire analysis process until a diagnosis is reached. However, there is a possibility that the professional may not get the diagnosis right, and more invasive interventions may be required to find the right one. Because of this, AI promises to be a great ally in image analysis, data collection, and subsequent decision-making for diseases such as breast and lung cancer [18].

AI is especially useful in the field of pattern recognition and image analysis [19]. Its usefulness is since a machine, or trained program could analyze an image in a more complete, detailed, and faster way and collect more and better information than a human being can due to its physical or mental limitations [18, 20, 21]. The process of data collection and analysis is usually a qualitative and subjective task when performed by an individual; but, with the help of AI, it is possible to transform it into a quantifiable and reproducible task without much effort [18].

Some types of cancer, such as colorectal cancer, are mostly diagnosed by endoscopy [12]. AI has been extensively investigated in colonoscopy as a tool to improve the detection and classification of lesions [22]. In this field, AI has been shown to limit operator variability. In other words, AI can overcome the inexperience of novice endoscopists and even the errors of more experienced ones [23]. Therefore, endoscopy's detection rate of polyps and adenomas improves markedly with AI [23, 24]. The programs trained for this task extract and analyze specific features such as microsurface topological patterns, color differences, microvascular patterns, pit patterns, appearance under filtered light such as narrow-band images, and more to detect, predict, and diagnose pathologies [23–25].

Finally, AI plays an increasingly important role in tracking changes in a tumor over time, either in natural history or in response to treatment [18]. Without a doubt, AI is already part of some procedures in the oncology area. It is beginning to be used daily in some tumor detection centers and image analysis. It also supports professionals in the area, both novices, and experts, since the combination of man and machine provides the best results [26].

3. AI in medical image analysis: Limitations and Challenges

Despite the reported successes of AI in medical image processing, several limitations and obstacles must be overcome before widespread adoption [18]. It should be remembered that AI models work with data streams. However, these data often need to be curated as they do not always have labeling, segmentation, or categorization. Therefore, data quality assurance is not always guaranteed [27], and models can be vulnerable to well-designed false inputs, causing diagnostic uncertainty and false positives to persist [27, 28].

The security of AI systems is also a crucial issue. This is because, like any computer system, these techniques can be victims of cyber-attacks. Since these procedures are directly related to human lives, a possible cyber-attack can not only threaten the proper functioning of a system but cause deaths [29].

In addition, the models need further refinement in order to reduce some of the existing gaps in accuracy and efficiency. For example, some models do not consider other elements that can alter the output in medical image analysis, such as folds, subepithelial lesions, extrinsic compressions, blood vessels, and lumen [25]. Also, when some systems work with complex images and noisy features, they generate inconsistent results [30]. For these reasons, one of the objectives and challenges of AI within this field is to develop more sophisticated algorithms that can work with many variables, old and new, involved in clinical decisionmaking [27], and in the future, to be able to reduce the gap between human precision and AI. [31].

Another challenge is to generalize the use of artificial intelligence techniques in clinical diagnosis [27]. The cost, difficulty of acquisition, development, and learning of these techniques are factors that limit their daily use. Not all countries can apply these techniques because technological development is not the same for all. In fact, there is a significant economic, technological, and even human gap that does not allow the development of these and other techniques to be promoted at the same pace in all countries [32]. Therefore, it is a pending task for governments and private enterprises to promote, support, and develop these techniques, starting from the academy and supporting local talent.

4. Conclusions

AI is a potent tool with multiple applications. Among all the fields in which AI techniques can be applied, medicine, specifically medical diagnostic imaging, is where AI can help automate and improve many processes. Although there is still much work to be done to increase the accuracy and sensitivity of AI systems, early applications of these techniques show significant improvements in image analysis. This is because a well-trained system can analyze an image equal to or better than the human eye.

Thanks to the application of AI techniques in medical imaging diagnosis, it is possible to improve the processes of pattern recognition, finding relationships, estimations, and predictions that allow the medical professional to provide a better conclusion. Moreover, since these are algorithms created by a person, there is the possibility of developing more and better techniques and systems to solve the existing problems and limitations. Finally, it is essential to support the study and development of these techniques in order to exploit the full potential offered by AI. These techniques can improve current diagnostic systems and revolutionize the entire field without harming medical professionals.

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