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Artificial Intelligence Techniques for Colon Cancer Detection: A Review

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تقنيات الذكاء الاصطناعي للكشف عن سرطان القولون: مراجعة

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Abstract: Cancer is the uncontrolled expansion of growth cells in any part of the body producing a tumor or neoplasm. Breast cancer, skin cancer, mouth cancer, colon cancer, and prostate cancer are just a few of the more than a hundred different forms of cancer. Treatment delays can lead to serious health issues and even death. This research reviews various artificial intelligence techniques for colon cancer screening. The methods used for detection include automated and computer-aided detection systems with artificial intelligence, additionally; they excel at processing large datasets to generate reliable results for the identification of colon cancer. To apply these processing systems on a big scale, however, they must overcome several challenges, such as pre-processing, feature detection, and classification algorithms that are compatible with AI. This essay examines a number of distinct approaches. To accommodate the expanding patient population and for the betterment of the healthcare system, these procedures have become urgently necessary.***Keywords***- *Colon Cancer, Artificial Intelligence, Deep Learning, Machine Learning, Computer-Aided Detection.*

الخلاصه:

السرطان هو التوسع غير مسيطر عليه لنمو الخلايا في اي جزء من الجسم والناتج عن هذا التوسع هو الورم او الورم الخبيث.. سرطان الثدي، وسرطان الجلد، وسرطان الفم، وسرطان القولون، وسرطان البروستاتا ليست سوى عدد قليل من أكثر من مائة شكل مختلف من السرطان. تأخير العلاج يمكن أن يؤدي إلى مشاكل صحية خطيرة وحتى الموت. يستعرض هذا البحث مراجعه تقنيات الذكاء الاصطناعي المختلفة لفحص سرطان القولون. تشمل الطرق المستخدمة للكشف أنظمة الكشف الآلية والمدعومة بالكمبيوتر مع الذكاء الاصطناعي، بالإضافة إلى ذلك؛ إنهم يتفوقون في معالجة مجموعات البيانات الكبيرة لتوليد نتائج موثوقة لتحديد سرطان القولون. ومع ذلك، لتطبيق أنظمة المعالجة هذه على نطاق واسع، يجب التغلب على العديد من التحديات، مثل المعالجة المسبقة، واكتشاف الميزات، وخوارزميات التصنيف

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المتوافقة مع الذكاء الاصطناعي. تتناول هذه المقالة عددًا من الأساليب المتميزة. لاستيعاب العدد المتزايد من المرضى ولتحسين نظام الرعاية الصحية، أصبحت هذه الإجراءات ضرورية بشكل عاجل.

1. Introduction

Computer software that replicates human learning and problem-solving abilities is known as Artificial Intelligence (AI) [1]. The two main subfields in medicine are virtual and physical AI. Machine Learning (ML) and Deep Learning (DL) are the virtual components of AI in medicine; AI is a wide field that encompasses several disciplines such as artificial intelligence, robotics, computer vision, natural language processing, and machine learning. By repeatedly performing certain tasks, to develop predictive and descriptive models, machine learning (ML) uses computer statistics and analytics. Unsupervised machine learning, as the name suggests, finds groupings based on the data's similarities and requires no prior knowledge when feeding the data, as shown in Figure (1). Finding patterns in incoming data without pre-existing goal labels is known as unsupervised learning. The technique of teaching intelligent agents to perform better is called reinforcement learning [2][3][4].

Multiple data types are accepted as input by a deep learning system, data layers from which it takes the data points of interest [5]. Most common models are educated using supervised learning, where datasets are made up from labels for the output data and input data that go with them [6]. Two steps make up DL: pre-training and fine-tuning. The first step, the deep learning typical generates outputs unsupervised while attempting to understand the distribution of the underlying data. Step two involves tuning the output produced for a particular task available to guarantee peak performance[8]. Physical intelligence, which includes robotics and medical equipment, is the second use of artificial intelligence in medicine [9].

One of the most prevalent malignancies and the second leading cause of death worldwide is colon cancer. In 2018, there were 551,269 colon cancer-related fatalities and more than a million new instances of the disease[10]. Even if it still occurs more frequently in Western countries, it is also rising in developed nations as a result of the quick uptake of urban living. By 2025, the incidence of colon cancer in China and India is expected to treble from what it was in 2002 [11]. Colonoscopy is one of the most popular and effective screening techniques, and early diagnosis is a critical first step in lowering colon cancer mortality. The likelihood of CC in the general public varies and the linked to things like a family history of the disease, lifestyle choices, dietary habits, and, most importantly, the existence of polyps, whether they are isolated or part of polyposis genetic syndromes. Then, CC can be avoided with dietary and lifestyle changes, rapid diagnosis and treatment[12].

Since 1966, Computer-Aided Diagnosis (CAD) mechanisms have been recommended, created, and employed in clinical settings, particularly in breast and thoracic imaging, as well as the assessment of risk for cancer[13][14]. The goal of CAD is to locate or identify unusual or suspicious regions in order to boost detection rates while lowering False Negative Rates (FNR). Additionally, CAD offers an objective second opinion on the diagnosis of an illness using image-based data [15] .

The application of AI in gastroenterology is rapidly growing the study of cystic fluid, precise forecasting models, and the identification and classification of dysplastic and neoplastic alterations in colonies, in addition to the requirement for computer-aided detection and analysis of the problem [16]. The application of AI and its techniques with conventional screening techniques for colon cancer may improve diagnostic precision and reduce colon cancer-related mortality. AI can help lessen the needless excision of benign tumors by differentiating neoplastic and benign tumors in real-time, which lowers total cost, length of treatment, and related difficulties. We intend to address recent developments in the use of Artificial Intelligence to colon cancer showing in a variety of methods in this descriptive review.

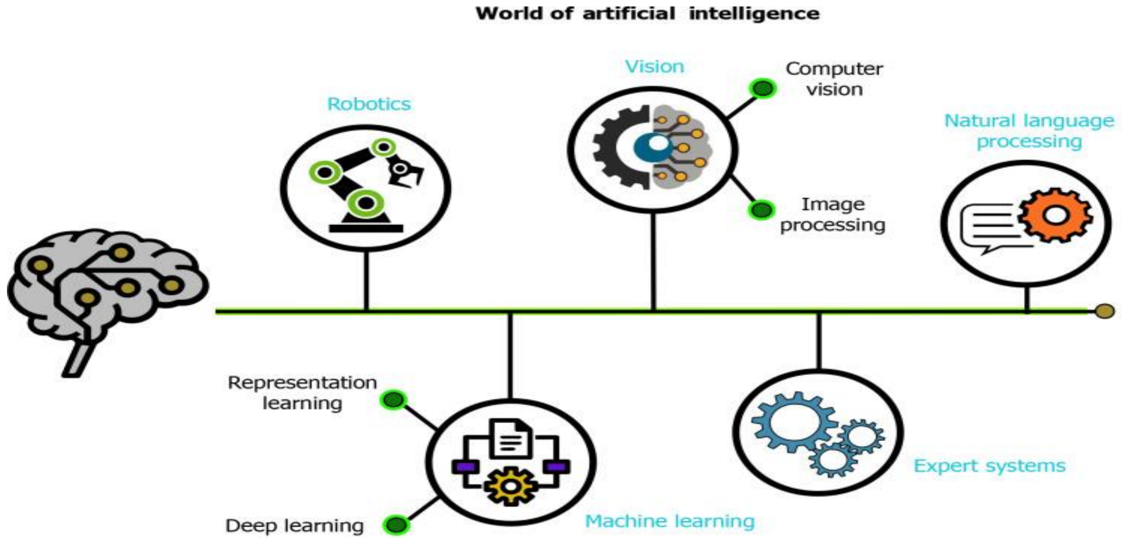

Figure 1: A group of sciences known as artificial intelligence are combining [17].

2. Artificial Intelligence

The goal of Artificial Intelligence (AI) is to build intelligent machines that replicate human intelligence[18]. AI offers greater prospects for disease diagnosis, prognosis, and clinical response versus treatment; enabling medical professionals to thoroughly assess their patients used AI system-specific Natural Language Processing (NLP) to track the outcomes of a colonoscopy[19]. This diagnostic technique could become the benchmark for colon cancer screening. It is a mobile device-integrated application with an AI foundation. It is possible to obtain the most recent information for CC prevention and shares information about raising public awareness of CC. There are numerous additional AI-based applications altogether around and they are used in a variety of contexts. Virtual and physical applications of AI are the two main categories in the medical industry. Machine learning (ML) a division of ML, and deep learning (DL), a subset of ML, make up the virtual component of AI. Algorithms for machine learning can be classified as either supervised, unsupervised, or reinforcement learning. Founded on prognostic modeling, which determines a class label based on the supplied data, these are categorized. In general, ML algorithms are not properly defined; nevertheless, the more thorough and extensive definition of supervised knowledge raises to an algorithm that is skilled using input/labeled data, and the best model is independently constructed while the best model is created by training an unsupervised algorithm with an unlabeled input dataset [20]. Through image analysis of tumor samples, AI technology, in particular deep learning, aids in our understanding of colon cancer at the molecular level, leading to additional advancements in colon cancer surveillance, diagnosis, prognosis, staging, and treatment[21].

2.1 Machine learning

To categorize fresh picture samples, ML must select the most pertinent or predictive characteristics from a large pool of evaluated data [22] .The attributes will aid in the imaging diagnosis of CC. Accurate colorectal tumor segmentation in MRI images is crucial, but the manual or semi-manual approach takes a long time, labor-intensive, and operator-dependent. The CAD is crucial to many medical analyses, particularly the examination of Computed Tomography (CT) images. Although various approaches have been developed, structural segmentation still has some flaws [23]. The baseline CAD system's accuracy could be increased and classification performance might be improved using ML techniques like SVM and logistic regression [24]. The NN method might be used to eliminate the big intestine's murky liquid is a CT picture to provide the perfect colon segmentation effect [25]. The discrepancy between the photos was lessened using the normalizing technique. Using the concept of transfer learning from standardized data the segmentation method might extract features photos and produce related estimates for reference [26]. The ultimate tumor boundary was established by fusing all predictions. When segmenting T2 weighted MRI images of CC the based segmentation method showed a higher degree of accuracy than manual segmentation[27]. The time-consuming manual technique might be replaced with the FCN-based segmentation method, as shown in Figure (2).

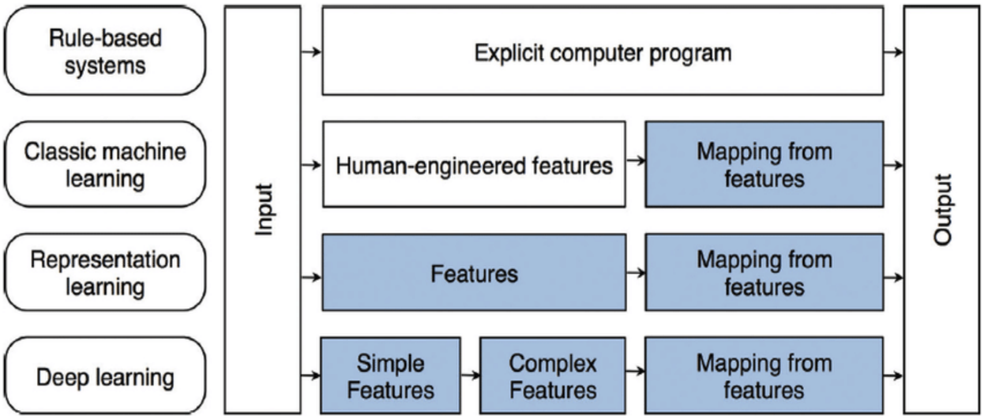

Figure (2). This demonstrates a basic model of the differentially expressed cancer gene classification system [28].

2.2 Deep Learning

The clinical diagnosis and treatment of CC may be aided by the DL intelligent assisted diagnosis system. Utilizing illuminating features of the recognized potential construction, usually, a computer-aided diagnosis organization evaluates if the chosen location is malignant or not[29]. Radiologists can use the CAD system to diagnose CC by looking for visual cues (CAD marks) linked to possible disease. Additionally, computer-aided detection can be used to locate the disease and evaluate whether the abnormality is benign or malignant. Doctors must finally determine whether to "believe" the CAD mark, regardless of the result [21]. Other colorectal pathological morphologies, including polyps and cancer, are uncommon, which may help to explain the reasons behind the rapid advancement of CAD solutions for computed tomography colon cancer[30]. A study on CAD for CC in CT is currently relatively restricted, despite the fact that the consequences of CC misdiagnosis are far worse than those of polyp misdiagnosis. The dearth of research on the features of early CC detection it is still difficult to accurately identify according to the design aspects of mathematical images, masses from normal colonic anatomy could be the culprits [31]. Discovered that the CAD approach in conjunction with CT was reasonably successful for discovering flat cancer. In order to differentiate cancer from healthy tissue structure, they located tumors and collected the morphological parameters of flat tumors. CAD can accelerate picture interpretation, uncover polyps that experts have overlooked, lessen observer variability, and boost the polyp detection's sensitivity. The efficiency, however, could be decreased by the rise in FP caused by CAD [32]. The accuracy of polyp discovery in CC may be considerably increased by deep transfer learning. The Deep Convolutional NN (DCNN) may recognize polyps since it can be modified by the CAD system's filtering of virtual intracavity images of polyps. The DCNN was trained with millions of non-medical images. Using a CT visualization system can dramatically increase the diagnosis of polyps for unskilled clinicians. When used in conjunction with a CAD system, the visualization technique can speed up colon tumor detection in CTC and cut down on radiologists' interpretation time[33]. The shortest cut edge was automatically analyzed using segmentation, and the results were very similar to the evaluations of the experts, as shown in Figure (3).Table 2 gives us a fast overview of the work that has been done in this important medical field by focusing happening the mouth assortment and extraction technique and summarizing the most recent advancements in the colon cancer prediction system.

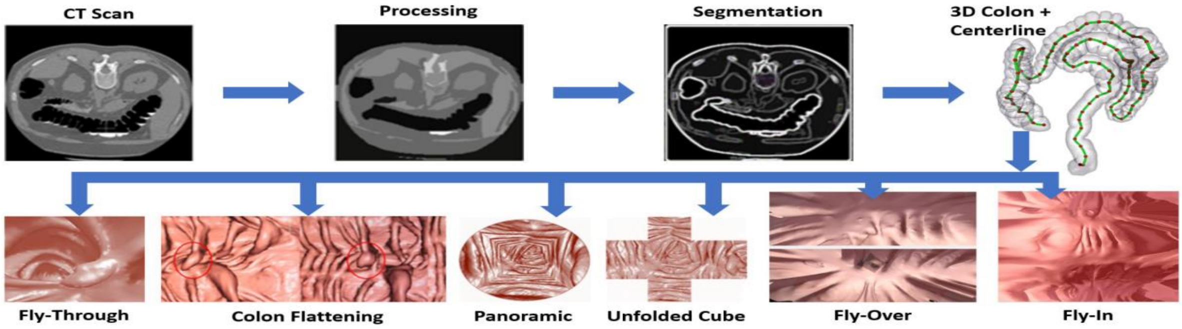

Figure 3: The main steps of computer-aided image analysis[34].

3. Literature Review

This section reviews current methods that have been implemented using artificial intelligence techniques.

Wimmer et al., [35] proposed K-Nearest Neighbours(KNN) approach for the classification of binary class image datasets. Feature selection is carried out using the (KNN) method to identify an optimal subset of feature and to address the dimensionality problems. They used in their study eight standard cancer datasets namely Colon. The results indicated that the accuracy of the above model for the dataset as follows: (0.81).

Tajbakhsh et al., [36] Utilized the following two kinds of machine learning models: Random Forest (RF) and Decision Trees (DT); Random forest to analysis of colon cancer patients and normal peoples. The best feature subset is chosen using the statistical t-test method, which has a significance level of p-value 0.05. The outcomes showed that the aforementioned models' accuracy was as follows: (88%).

Wang et al., [37] used machine learning model which is Support Vector Machine (SVM). The optimal feature subset using as a feature selection method. The outcomes showed that the aforementioned models' accuracy was as follows: (96%).

Tan et al., [38] used deep learning model which is CNN. The best feature subset is chosen using the statistical t-test method, which has a significance level of p-value 0.05. The outcomes showed that the aforementioned models' accuracy was as follows: (90%).

Viscaino et al., [39] used machine learning model which are SVM, DT, KNN, and RF. the optimal feature subset using as a feature selection method. The outcomes showed that the aforementioned models' accuracy was as follows: (97%).

Hwang et al., [40]used deep learning model which is CNN. When choosing the best gene subset, the is utilized as a gene selection method. The outcomes showed that the aforementioned models' accuracy was as follows: (94%).

Fonolla et al., [41] used deep learning model which is CNN. The optimal feature subset using as a feature selection method. The outcomes showed that the aforementioned models' accuracy was as follows: (95%).

Pool et al., [42] used deep learning model which is Deep Neural Network (DNN). The optimal gene subset is chosen using the statistical t-test approach with p-value significance of 0.05. According to the findings, the aforementioned models were accurate to the following degrees: (97%).

Russo et al., [43] used deep learning model which is CNN. Used to choose the optimal feature subset using a feature selection method. According to the findings, the aforementioned models were accurate to the following degrees: (90%).

Paksoy et al., [44] used machine learning model which is KNN. The best feature subset is chosen using the statistical t-test method, which has a significance level of p-value 0.05. The outcomes showed that the aforementioned models' accuracy was as follows: (98%).

Pacal et al., [45]used deep learning model which is CNN. The optimal feature subset by using as a feature selection method. The outcomes showed that the aforementioned models were accurate to the following degrees: (94%).

Table 1: compiled studies for the categorization of colon cancer using ML and DL classifiers.

References	**Data type**	**AL – based algorith**	**Accurac**
Wimmer et al., [35]	Image	KNN	81%
Tajbakhsh et al., [36	Image	RF, DT	88%
Wang et al.,[37]	Image	SVM	96%
Tan et al.,[38]	Image	CNN	90%
Viscaino et al., [39]	Image	SVM,DT,KNN,RI	97%
Hwang et al.,[40]	Gene express	CNN	94%
Fonolla et al.,[41]	Data publi	CNN	95%
Pool et al.,[42]	Gene express	DNN	97%
Russo et al.,[43]	Image	CNN	90%
Paksoy et al., [44]	Image	KNN	98%
Pacal et al.,[45]	Data publi	CNN	94%

4. Discussion

In the realms of computer, internet, and automobile engineering, AI is crucial. "Personalization, precision, minimal invasion, and remoteness" are the four primary areas for medical advancement in the future, according to 159. One of the more prevalent types of cancer in people is CC, and the prognosis is significantly impacted by early detection and standardized care. Following are the stages that the process of creating AI for CC includes: Understanding cancer at the molecular and cellular levels using DL, support with CC identification based on pictures and pathology specimens, developing and evaluating clinical drugs, and promoting the personalization of CC diagnosis and therapy are the first three goals. Imaging finding and pathology diagnosis are the two basic categories used to classify CC diagnoses. The majority of images are objective data sets that have highly standardized information. By using expert-derived features, thorough mathematical models, classification rules, and image training, the DL-based CAD system makes it possible to automatically analyze and optimize a variety of images. The examination of medical images benefits from AI, as well. Fast and effective picture processing and analysis can produce speedy results for supplementary judgment. A high sensitivity can lower the rate of missed diagnoses. Analysis of quantitative data and expert knowledge acquisition can enhance the quality of the fundamental inspection. Third, there are numerous digital CC sections that have been generated in clinical pathology, some of which have been preliminary developed using DL and image recognition technologies. AI cannot, however, currently be distinguished from the supporting role. At the functional level, AI is mostly used to support disease diagnosis and treatment selection. Treatment decision support is actively advancing illness diagnosis support. As they become more integrated with medicine, advanced technologies help in early detection and diagnosis of serious diseases.

Although artificial intelligence is progressing quickly, it is still in the experimental stage and still has a lot of development roadblocks. For instance, the development of AI overemphasizes "probability association," although diseases are always present in uncharted territory. The advancement of picture AI depends on how to effectively mix data and medical expertise. Second, numerous label data are necessary for training AI-based DL. Though the data is labeled has a greater impact on preparation outcomes than algorithms, acquiring reliable data for training is a significant challenge. Third, there is little uniformity of picture data. There is little imaging system contact happening between hospitals. Additionally, there is little contact between all of each imaging system's datasets, which are dispersed across the nation. Fourth, annotating data is really challenging. The results of the AI training are directly impacted by the amount of tagged image data needed for training and the high manual cost of annotation.

Surgical and chemotherapy procedures are the principal CC treatments. Through the comparison and analysis of massive data, AI enables personalized medicine by choosing the most relevant treatment options. In addition, the advancement of robot technology ensures excellent surgical precision and precise drug delivery for chemotherapy. The caliber of the information gathered, however, is yet not enough to enable AI to act independently decide which course of action to take. The human body's complexity also slows down AI's operational analysis and decision-making speed. Furthermore, due to their high economic cost, robots cannot be widely deployed. Giving a specified survival period might ease the psychological stress on patients because they frequently worry about the unknown recovery period after surgery. Through patient data, surgery, and pathology, AI can forecast survival times and recurrence risks as well as direct prognosis and nursing for patients. As a result, reliable, accurate data as well as standard operating guidelines are needed.

The information available to clinicians is getting increasingly complex as diagnostic technology advances. New medications are frequently created, and innovative treatment plans and techniques are continually appearing. AI will be a key component of CC diagnosis and therapy as image recognition and AI technology continue to advance along with other areas of technology. Therefore, the main focus of future research will be the creation of an AI organization. Robotic surgery will be made possible with the complete integration of DL and ML. Medical services range from the use of medical technology to counseling regarding patients' mental health. Robots will eventually administer care and make adjustments to patients' psychological states. To employ AI robots in today's medical setting, however, requires careful moral and ethical consideration.

5. Conclusion

In general, our research found that the use of artificial intelligence to diagnose colon cancer had promising outcomes. The majority of the studies' training and validation datasets were generally of a size and quality that made it difficult to use this method in clinical settings. Future research will therefore be needed to validate routine practice-level procedures using a broader selection external cross-validation and datasets with high-quality annotations. In terms of using AI clinically in place of the conventional microscopic diagnostic in pathology, we are now one step behind.

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