Analysis of Image Processing based on Deep Learning: A Review

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ABSTRACT

Image processing involves image analysis and encompasses various subfields, such as medical imaging, medical image mining, web mining, image mining, etc. This article briefly introduces applying the deep learning algorithm to the image segmentation process. Deep learning techniques are crucial in medical image analysis, particularly those used in convolution neural networks (CNN). This article provides an overview of the various applications of deep learning that can be applied to image extraction. In addition, it explains how to retrieve photographs based on their content and how to identify defects in medical photographs. Each application area is introduced briefly, including musculoskeletal, retinal, digital pathology, neuro, abdomen, breast, pulmonary, and cardiac. It would help if you concluded with a current and relevant point, an essential argument regarding outstanding challenges, and guidelines for future research.

Keywords : Image Analysis, Image processing, Deep Learning, Medical Imaging

1- Introduction

The subfield of Artificial Intelligence known as "deep learning" is essential. Researching adaptable computer algorithms that can pick up new skills is the objective of deep learning. This education that is being received is consistently founded. Based on some experience gleaned from previously acquired information or instructions. Mainly applicable to medical image analysis, Deep Learning has the potential to boost both the quality and the pace of research. The primary goals of image processing are picture enhancement and image analysis. Image processing deals with both of these issues. Among the methods for improving images, some works have been presented in the published research that showcases various applications with a glaring need for improvement. Analyzing the photos to gain better knowledge about the image is also helpful. Methods like clustering and classification are taken into consideration most of the time throughout this procedure. The development of new technologies has led to the creation of a wide variety of applications for image processing, ranging from processing standard photos to examining medical images. If one wants to understand the diseases better, one must have a comprehensive study of the photographs. This is due to the fact that the proportion of people affected by medical conditions is growing at a faster rate. In order to successfully achieve this objective, a number of medical picture segmentation strategies have been developed. These methods are derived from a variety of research approaches, such as edge-based enhancements, shape-based enhancements, region-based descriptors, texture-based procedures, and colour-based methods [1–6]. In addition to the techniques described previously that are considered to be de-generative models, the literature [7–11] highlights several other models that are considered to be de-generative. These models include pattern-based techniques, future-based techniques, depth-based techniques, and model-based techniques. In addition to these models, the focus will also be placed on other models, such as model-based approaches.

Despite this, model-based or creative techniques are frequently superior than other methods in terms of effectiveness. This is due to the fact that the analysis is predicated on making estimates of the parameters during the entirety of this procedure, and the accuracy of these estimates is critical to the overall study. Deep learning methods came into reality in addition to these approaches, each incorporating the most recent discoveries made in machine learning. It is anticipated that these methods will prove to be more fruitful, particularly for examining medical tissues [12, 13].

Some methods for enhancing images and works have been presented in published research highlighting numerous applications with glaring development needs. Additionally, it is helpful to analyze the photos to gain a greater understanding of the image. Techniques like clustering and classification are typically utilized during this phase. The development of new technologies has led to the creation of a wide variety of applications for image processing, ranging from processing standard photos to examining medical images. Because the number of medical cases is rising at a rate roughly proportional to the population, anyone who wants to understand the conditions in question must conduct an exhaustive study on the photos. To accomplish this goal, a significant number of medical picture segmentation approaches have been developed based on a variety of different methodologies. Edge-based enhancements, shape-based enhancements, region-based descriptors, texture-based techniques, and colour-based techniques are a few examples of the various approaches that fall under this category [14, 15, and 16]. Other models, in addition to the techniques described above, considered de-generative models [15, 16, and 17], are highlighted in the literature. These models include pattern-based techniques, future-based techniques, depth-based techniques, and model-based approaches. The techniques [16,17] described above are highlighted in addition to these models. On the other hand, procedures that are based on models or generative approaches are more effective. This is due to the fact that the analysis is dependent on the estimation of the parameters during this phase, and the entire analysis is based on these parameters. Because of this, tactics based on models or approaches that generate new models are thought to be more successful. The most recent findings in machine learning led to developing a new set of methodologies known as deep learning techniques. These methodologies are in addition to the approaches mentioned above. Deep learning is an area of study within the more significant science of machine learning that gives computers the ability to perform tasks such as these. Formally speaking, and Deep Learning comprises many Machine Learning paradigms. These paradigms allow machines to be trained based on the knowledge fed into them, and they perceive the world in terms of a pecking order of concepts. Each concept is unique in how it relates to other, more straightforward concepts. It is anticipated that these methods will prove to be more fruitful, particularly for examining medical materials. In this article, a comprehensive examination is carried out to highlight the many different subfields of image processing that are ideally suited for using deep learning techniques. The topic of convolutional neural networks is covered in further depth in the subsequent section of this article. The application of deep learning techniques to content-based picture retrievals is discussed in this section. The benefits of the deep learning algorithms that are now being proposed for use in various industries are examined in further depth throughout the fourth section of this essay. The article is summed up in its fifth and final section, focusing on its numerous feature directions.

2- Convolutional neural networks (CNN)

The approach of deep learning is a subsection of the subject of convolutional neural networks. It is more adaptable for processing visual pictures and is a component of the machine-learning approaches that deal with knowledge representation. The representation of knowledge is the focus of one subfield within the field of machine learning techniques known as convolutional neural networks. This deep learning algorithm assists in a better understanding of the parameters by separating the images into layers so that each layer is inspected and can be studied more appropriately compared to the standard analysis technique [18, 19]. This helps the algorithm achieve its goal of better understanding the parameters. This facilitates better comprehension of the parameters by partitioning the images into layers. (see Figure 1).

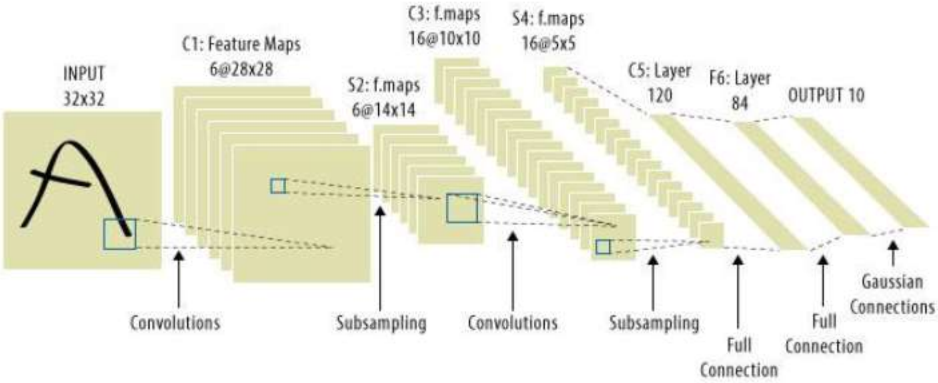

Figure 1. CNN Farmwork

ANN is a paradigm for processing data primarily inspired by the neural systems of living organisms. It comprises many processing units, and neurons, all working together to solve a particular problem. Adjusting the connections between the various processing units is a crucial aspect of learning in artificial neural networks (ANNs), just as in biological systems. Convolutional neural networks are a subfield under the deep learning methodology's umbrella. In addition to being more adaptable for processing visual pictures, it is a machine-learning method that deals with the representation of knowledge. Machine learning strategies focusing on knowledge representation often include convolutional neural networks as an essential component. In comparison to the conventional technique of analysis, deep learning algorithms help better grasp the parameters by splitting the images into layers, enabling each layer to be examined in greater detail and evaluated with greater precision. This is accomplished by separating the photos into layers. The algorithm gains a better understanding of the photos due to this. A horizontal layer, a vertical layer, an input layer, and an output layer are created due to applying the deep learning approach, which results in the construction of several layers in total. Calculating the number of hidden layers requires multiplying the number of channels in the horizontal direction by the number of channels in the vertical direction and then dividing that sum by the total number of channels. [20, 21].

3. CBMIR: Content based Medical Image Retrieval

The field of content-based medical image retrieval, often called CBMIR (content-based medical image retrieval), is rapidly growing and has been shown to be one of the most promising applications of content-based image retrieval systems. The number of patients that contemporary medical institutions have attended enables these establishments to amass enormous amounts of visual data, which is one of the many advantages of these establishments. Unfortunately, major portions of the obtained data are not properly used because of restrictions or barriers relating to scalability, privacy, or integration [22, 23, and 24]. CBMIR systems offer a potential solution to the privacy and scalability issues that are now afflicting the industry because of their capacity to automatically search through millions of medical pictures and obtain a list of relevant matches to a search query with minimal assistance from humans. It is crucial to keep in mind that CBMIR systems are software-based systems, and as such, they are susceptible to the same risks and privacy problems as any other system of this kind. It is important to keep in mind that CBMIR systems are software-based systems. In the past, one of the most significant restrictions placed on medical image retrieval systems was the requirement for stringent control and restriction of picture data to protect the confidentiality of patients. CBMIR systems have helped overcome these challenges because they use computer algorithms to analyze medical pictures rather than human evaluators, and they need to be more aware of the identity of the patients being evaluated.

High-level features, low-level features, and semantic features are all included in these qualities. During the process of analyzing and retrieving the photos, it is anticipated that both low-level and high-level characteristics will lose some of the important patterns that are inherently present in them. These patterns are of fundamental significance. The value of the semantic qualities will not in any way be diminished. It is generally accepted that CBIR is a retrieval technique that is feature-driven. However, when these features are studied, it does not look encouraging for the efficacy of the data because it is expected that the features miss the total of the visual information. This suggests that the data may not be as useful as it could be. Semantically based strategies that are able to maintain the semantic representations are frequently recommended as a solution in order to get around this issue. As a result, the paradigm has moved to one that emphasizes the retrieval of content based on CBIR. As a result of the fact that the deep learning strategy has the most potential, it is the one that is most commonly chosen (See Figure 2).

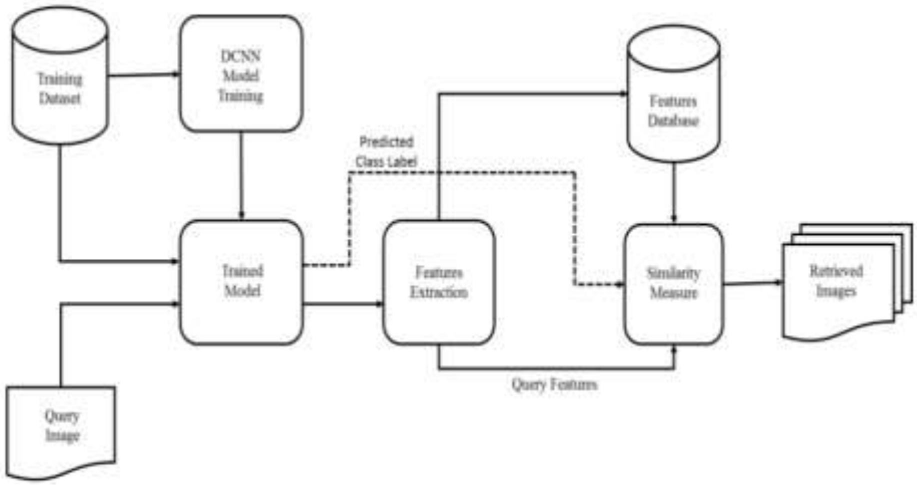

Figure 2. Content based medical framework

The CBMIR [25] systems and the standard CBIR approaches all have a fundamental structure, which may be shown in Fig 2. When a medical image database is first established, which occurs when the CBMIR system is online, representative feature vectors are collected from all of the saved medical images. This is the first step in the formation of a medical image database. In the process of storing feature vectors alongside medical images, specific information about the image itself is encoded into the vectors. Processing database queries is the responsibility of the online component of the CBMIR system. This part of the process involves comparing the feature vectors extracted from an image query and all of the feature vectors that have previously been compared with the database utilizing the similarity measure. After that, a list of potential matches is produced, stored, and eventually presented to the user for inspection and evaluation. Some contemporary CBMIR systems go one step further and ask the user to determine the relevance of the displayed photos to the query image. This is done to boost the accuracy of the CBMIR system. CBIR systems face a significant obstacle while attempting to analyze medical images due to the fact that there are numerous imaging modalities, and the size of the image is typically relatively enormous. It may be computationally difficult to determine how similar a picture query is to an entire database, particularly if the database contains hundreds of millions or even billions of photographs. Conventional CBIR systems deal with this issue by reducing the size of the representative image feature vector to a more manageable size and making use of specialized filters to extract only the aspects of the analysis that are the most important. However, the dimensions of the images as well as the quality of the resolution can shift depending on the imaging system and procedure that was used during the diagnostic imaging procedure. In actual practice, this translates into the generation of longer feature vectors, resulting in a more significant computing burden to process. The fact that a mistake in classification in CBMIR systems might result in potentially lethal effects (i.e., a misdiagnosis) is a factor that exacerbates the difficulties that were discussed before.

- Model of the Training
- Data Generator of Image Function
- Prediction
- Prediction for Load Trained model
- Matrix of Confusion

4- Analysis of Image processing based deep learning

The first finding concerns the distinction that can be made in Deep Learning between natural photos and medical images. Images taken in nature feature various distinct entities, each with a unique composition. Because of this, the network can learn incredibly sophisticated and unique filters, particularly at the deeper layer levels. One of the most promising disciplines now focused on the analysis of medical images is deep learning. Deep learning has opened up a wealth of options in a variety of sectors, including bio-imaging, neuro-imaging, and DNA sequencing, amongst others. The use of deep learning algorithms is beneficial for automatically segmenting medical images, with the focus being placed on a variety of attributes gathered from the medical image collection. It offers a fresh approach to discovering irregularities and helps bring probable explanations to light, leading to improved diagnosis. As mentioned, learning through Supervised Learning is a strategy that calls for using an existing dataset. This set is supplied for you, containing the correct inputs and outputs for the algorithm employed. The computer program is given instructions to create a model capable of making accurate predictions based on this particular collection of examples as its point of departure. At this point in the process, the prediction model must be validated by utilizing an extra known dataset distinct from the training set. When the validation procedure has been adequately completed, and only then can the algorithm be considered trustworthy for unidentified data [26, 27].

Selecting Appropriate Algorithms: The first thing that must be done is to decide which supervised algorithm will be utilized. Every approach has a unique set of advantages and disadvantages. The choice is determined by the nature of the issue at hand and the variety and quantity of the data that is accessible. The Support Vector Machine (SVM), Artificial Neural Network, Decision Tree, and Deep Learning are all examples of these algorithms. Deep Learning, an extension of artificial neural networks, will be the primary focus of this work for various details that will be elaborated upon in the following sections.

Training: The training phase is likely the one that is the most important because the results of the final achievements are dependent on the predictive model that is created.

- A dataset that is already well-known is chosen; it needs to be as representative of the issue as is humanly possible. Overfitting might occur when using a dataset that needs to be sufficiently generic, which can result in poor performance. This set, known as the training set, is required to supply an output (label) for each input.
- Using the data set that was selected, the algorithm is taught to do its desired tasks. Constructing a model that is

capable of handling the data that has been provided is the goal of this stage. More specifically, the objective is to estimate, to the best of one's ability, the output that is most appropriate for each input that has been provided.

Validation: It is vital to test the prediction model's performance established in the previous step, which is done in the validation phase. Another well-known dataset, the test set, will be prepared. The training set the dataset is supposed to give must have accurate input and output for each sample. This set must be as autonomous from the training set as possible, as it is one of its most essential characteristics. In this step, the previously trained algorithm is applied to make predictions about the input data of the test set. The only thing that gets used is the input; the algorithm predicts and saves the outcome. The most crucial distinction between this stage and the previous one is that in this one, the output label is not utilized to improve the predictive skills of the model, but rather, it is just used to evaluate how well the model did its job. The projected outputs are checked against the actual outputs that are now accessible. As a result, the performance is being analyzed and evaluated. If they are content, they can go to the next and final phase. If this is not the case, the algorithm and the training phase need to be reevaluated with other safeguards or settings. Model Deployment The algorithm, once it has been trained and validated, can be used as an automatic system to solve the initial problem on new data once it has been trained (See figure 3).

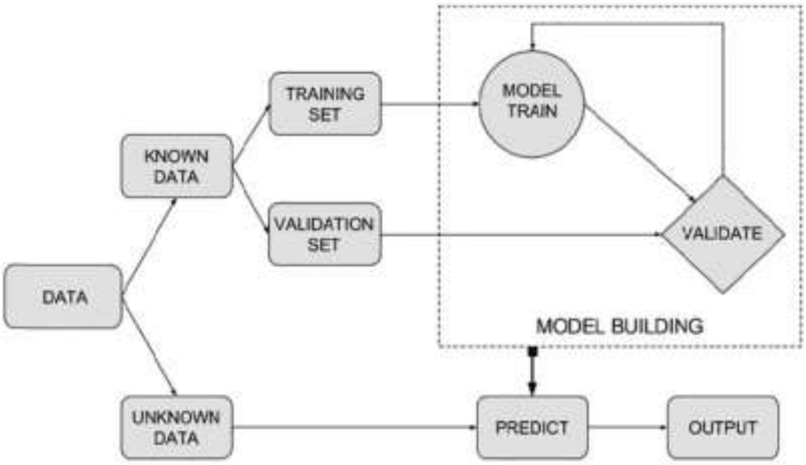

Figure 3. Diagram of the Supervised Learning process.

5- Deep Learning Approaches Applications

The analysis of medical images is currently being led by some of the most promising researchers in deep learning. The fields of bio-imaging, neuro-imaging, and DNA sequencing can all benefit from deep learning opportunities. Deep learning algorithms assist in automatically segmenting medical images by concentrating on the multiple attributes obtained from the dataset, which typically includes medical images. It provides an innovative method for locating anomalies and assists in bringing possible answers to the surface, ultimately leading to an improvement in diagnosis [28, 29 and 30].

6- Conclusion

In medical imaging, the use of computer-assisted study to more precisely interpret images is an extremely ancient topic. In image acceptance, recent developments in machine learning, most notably deep learning, have made significant strides toward recognizing, categorizing, and computing patterns in medical images. This is an important step forward. To be more explicit, the gains are centered on utilizing hierarchical mark representations that have been learnt solely from data, as opposed to handcrafted features that are primarily constructed based on facts peculiar to the domain. Because of this, deep learning is rapidly establishing itself as the foundation of the state-of-the-art, enabling it to achieve improved performance in various medical applications. This article provides a concise overview of the many domains relevant to discussions on deep learning. When it comes to medical image processing, the benefits of utilizing an algorithm that uses deep learning are readily apparent. As a direct consequence, you have been made aware of different fields that could benefit from applying algorithms based on deep learning.

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