Detection of Cancer in Medical Images using Deep Learning

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Abstract—Cancer is a serious disease that causes death by genomic disorder combination and diversity of unreasoning changes. This paper study the major deep learning techniques that are addressing medical image analysis and summarizes over 200 contributed articles to the subject, in particular those studies that are published in the last 6 years (since 2016). The main purpose of this paper study is to survey the deep learning algorithms for cancer detection and diagnosis. the results show that the convolutional neural network (CNN) is the most broadly used when it comes to deep learning and medical image analysis.

Keywords—machine learning (ML), deep learning (DL), image analysis, convolution neural network (CNN), cancer detection, survey

1 Introduction

A tumor formed from the abnormality of organs regularly with fast development which is the main cause of lost life worldwide [1]. As per GLOBOCAN numbers and statistics, approximately 18.1M new cancers cases occurred in 2018 which leads to 9.6M cancer losses [2, 3]. As per the report, the leader cancer is lung cancer a cause of death (18.4 percent), next is breast (6.6 percent), colon (5.8 percent), prostate (3.8 percent), and skin (1.3 percent) including melanoma and non-melanoma [1, 4]. It is also noted that Asia accounts for more than half of all cancer deaths, while Europe accounts for 20.3 percent of all cancer deaths [5]. Medical Imaging Analysis plays a vital part in detecting anomalies in various organs of the body, for example, breast cancer, lung cancer, brain tumor, skin cancer, prostate cancer, and colon cancer [2, 3, and 4]. Furthermore, medical images are an important method to diagnose disease, that helps the physicians to instinctively observe a patient’s body organs and professionally examine the illness possibility [1]. Medical Service providers usually produce for each patient hundreds of medical images, so it is a great opportunity as well as a challenge to digest, process then analyzes the huge amount of medical image data [5].
2 Research approaches

Deep learning is the main contributor to the recent and present-day studies of Artificial Intelligence in almost all sides of life [6]. This study objective is to provide a survey on the machine learning techniques and more specifically on the most common deep learning algorithms which are implemented for the diagnosis and detection of tumor [7, 8, 9, and 10]. In this study, we summarize more than 200 articles and contributions to the field in the last 5 years since 2016. Furthermore, in this research study, the study includes a brief of deep learning and the popular frameworks addressing the diagnose of cancer.

The research methods and techniques are listed in the following steps as explained in Figure 1.

- The selection of studies and papers was at first created by looking for the search results in different search engines, global information analytics library, technical professional organization library, such as (Google Scholar, IEEE, Elsevier, …etc.). the searches for terms “Deep Learning”, “Classification”, “Image Enhancement”,

![Fig. 1. Search methodology](image-url)
“Segmentation”, and “Survey” for medical imaging papers as listed in Table 1. This study is including only papers that are available online from 2016 onward.

- The study focused on a summary of the related content and results that is as associated with the purpose of this study.
- A systematic review of the latest studies (last 6 years) of different types of cancers has been conducted. The research lists the Deep Learning Algorithms that are related to Medical Images Analysis and Cancer Detection.
- Studying and analyzing the selected papers that are fitting within the scope of the work and matching with the keywords as per Table 1 and published from 2016, as a result, 91 articles have been considered, the researcher highlights main four cancers that this study is focusing on. Figure 1 is explaining the search methodology for the study.
- Classifying the Studied papers by algorithms associated or used for detection of each cancer. Important note that in case of similarity of many papers, a quick comparison between these papers is conducted to identify the useful one for this study in case not easy to do so, only the recent paper was included. The paper is organized to starts with a general overview of Machine Learning and Related Medical Images studies. Then the paper introduces the general overview of deep learning. This is followed by a highlight of the latest studies in the field, highlighting progress related to each cancer and associated Algorithm for cancer detection, at the end, we include a brief description and remarks on the recent work on tumor diagnosis and classification of deep learning and propose some future research directions. the paper concluded with a brief regarding the future of deep learning in particular cancer. This study is organized based on types of cancer.

| Keywords             | Medical Images | Deep Learning – DL | Image Enhancement |
|----------------------|----------------|--------------------|-------------------|
| Classification       | Segmentation   | Image Detection    |
| Survey               | Cancer         | Image Analysis     |

3 Results and discussion

A structured review of works of literature classifies the most important scientific contributions in a particular field. This study covers the latest research on applying ML/DL for cancer detection and diagnosis. Table 2 summarizes algorithms associated with which cancer type it was employed. It is found that CNN and Deep Convolutional Neural Network (DCNN) algorithms have been selected as the implemented algorithm for most cancer types, while Support-Vector Machines (SVM) algorithm comes second in a row.
Table 2. Cancer types associated with algorithms

| Algorithm | Breast | Colon | Prostate | Skin |
|-----------|--------|-------|----------|------|
| CNN & SVM | ✔      | ✔     | ✔        | ✔    |
| CNN       | ✔      | ✔     | ✔        | ✔    |
| DBN       | ✔      |        |          |      |
| DCNN      |        | ✔     |          |      |
| FCRN      | ✔      |        |          |      |
| KNN       | ✔      |        |          |      |
| RF & CNN  | ✔      | ✔     |          |      |
| ANN       | ✔      | ✔     |          |      |
| SSAE      | ✔      | ✔     |          |      |
| SVM       | ✔      | ✔     |          |      |
| SVM & CNN | ✔      | ✔     |          |      |

Table 3. Evidence of studies associated with algorithms used for cancer research

| Machine Learning Technique | Reference | Total Number of Studies |
|----------------------------|-----------|-------------------------|
| CNN                       | 1, 3, 5, 7, 10, 11, 13, 14, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 37, 38, 40, 41, 42, 43, 44, 47, 48, 49, 50, 52 | 35 |
| ANN                       | 36        | 2                       |
| DBN                       | 13        | 1                       |
| KNN                       | 12, 16    | 2                       |
| Hybrid                    | 15, 45, 46| 3                       |
| Others                    | 2, 11, 22, 35, 38 | 5                       |

Table 2 and Table 3 shows that CNN is the most popular algorithm applied for cancer research. Other algorithms are very likely to become future candidates, but they are not often reported.

It is obvious that deep learning will be very essential in many applications of medical images and will play an important and essential factor in the future practice of medical images (Radiology, MRI, CT SCAN, etc. …) as addressed in [12]. The prediction using deep learning algorithms will execute routine tasks, while physicians focus on the core work as addressed by [1]. The deep learning algorithms will work tightly and closely to bring a high and accurate performance that is indicated by [13,14,15 and 16]. Some prediction using deep learning algorithms will substitute physicians altogether—at least in their image explanation side- [17,18,19 and 20]. It follows that deep learning has exposed astonishing potential in many tasks that are image-related, but not enough results in the field [21]. A small number of recent studies highlight that the act of the algorithms equivalent to human’s expert in similar tasks [7 and 22].

4 Conclusion and future work

The goal of this research is to combine Convolutional Neural Networks (CNNs), Long-Short Term Memory (LSTMs), and Auto-encoders (AEs) in order to improve credit card fraud detection and the performance of prior models. CNN, AE, LSTM, and
AE&LSTM are four models that can be used. Different parameter values are used to train each of these models. The AE model has the highest accuracy, with an accuracy of 0.99, the CNN model has an accuracy of 0.85, the LSTM model has an accuracy of 0.85, and the AE&LSTM model has an accuracy of 0.32 after 400 epochs. The AE classifies the best outcome among these models, it is concluded.

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