DATA698 - Analytics Master's Research Project

Review of Literature

Title: Integrate Image Recognition technology in Radiology Practice

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Abstract

The purpose of this study is to explore some of the image recognition technology that exists currently and how we can take leverage this technology in radiology. The study seeks to answer various questions for example, how image recognition works? How can we integrate image recognition technology with radiology practice? Is image recognition technology reliable? Can Machine Learning (ML) applications help the Radiologist to detect anomalies as well as other abnormalities?

Introduction

Various clinical diagnosis requires medical imaging, such as early detection, monitoring, diagnosis, and treatment evaluation of various health conditions. In the health care system, there has been a significant increase in demand for medical image services, e.g., Radiography, endoscopy, Computed Tomography (CT), Mammography Images (MG), Ultrasound images, Magnetic Resonance Imaging (MRI), Magnetic Resonance Angiography (MRA), Nuclear medicine imaging, Positron Emission Tomography (PET) and pathological tests. Due to a shortage of radiologists, medical images can often be challenging to analyze and time-consuming. Machine Learning (ML) applications can help the Radiologist to detect anomalies as well as other abnormalities. ML applications can function without being specifically programmed, which learn from data and make predictions or decisions based on past data.

The term machine learning refers to a wide range of statistical techniques to analyze algorithms that iteratively improve in response to training data to build models for autonomous predictions. In other words, computer programs become more efficient as they learn from data. The objective of a machine learning algorithm is to develop a mathematical model that fits the data. Once this model fits known data, it can be used to predict the labels of new data. The field of radiology involves inherently interpreting data—extracting features from images and analyzing them with the help of a wide knowledge base that includes these features—which provides an excellent opportunity for implementing ML tools in practice.

Review of Literature

Medical Image Analysis: Medical image analysis using modern technology is growing interest recently due to the need for efficient and objective evaluation of large quantities of data. As the amount of data is growing with the help of modern devices, it's getting inevitable to apply different image recognition methods for the analysis of medical images. With the help of ongoing studies, the methods are becoming more mature and coming closer to routine clinical application. Although there are challenges involved in reading medical images, the qualities of different methods are getting developed that can be applied to standard clinical images. Medical image analysis is very critical when another type of screening provides high false negative results. Modern machine Learning (ML) and deep learning (DL) offer fast, automated, and effective methods to identify abnormalities as well as extract key features from the image which can be used for further study.

Saha et al. published an article that gives an overview of fundamental concepts in machine learning (ML), reviews the literature on ML applications in imaging analysis of pituitary tumors for several years, and highlights the future directions on potential applications of ML for pituitary tumor patients.

Obermeyer & Emanuel mentioned in their article that developing statistical tools from the field of machine learning will be critical for anyone practicing medicine in the 21st century.

Deep learning approach: The use of medical imaging facilitates early detection, diagnosis, and treatment evaluation of various medical conditions in various clinical applications. Among several methods available in Machine learning, Deep Learning is considered one of the most sophisticated and effective methods in ML to predict the outcome. Deep Learning Approach (DLA) in medical image analysis emerges as a fast-growing research field. DLA has been widely used in medical imaging to detect the presence or

absence of the disease. There are multiple papers available that discussed the development of artificial neural networks, and comprehensive analysis of DLA, which delivers promising medical imaging applications. Most of the DLA implementations focus on X-ray images, computerized tomography, mammography images, and digital histopathology images. Those provide a methodical review for the classification, detection, and segmentation of medical images based on DLA.

Ethical Dilemmas: Although the results of using Machine Learning technology to review medical images is phenomenal, the technologist should consider ethical and legal risk very seriously. The radiologists, on the other hand, should be able to evaluate machine learning projects, including common algorithms, supervised as opposed to unsupervised techniques, statistical pitfalls, and data considerations for training and evaluation.

Geis and Spencer et al, published an article focusing on the ethical use of AI in radiology and mentioned that using AI in radiology should bring well-being, minimize harm. The article also highlights that the "AI in radiology should be appropriately transparent and highly dependable, curtail bias in decision making, and ensure that responsibility and accountability remain with human designers or operators". In addition to the data scientist, the radiologists will remain responsible to acquire new skills to do their best for patients in the new AI ecosystem.

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