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SEMANTIC SEGMENTATION OF BRAIN TUMOR FROM MRI IMAGES AND DNN CLASSIFICATION USING GLCM FEATURES

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ABSTRACT

Brain tumors are a serious health concern, affecting or harming the brain with unwanted tissues. Detection of brain tumor tissues from whole brain images is a challenging task. Early detection of tumors is crucial for successful treatment and patient survival. Detection or segmentation techniques are used to identify and separate the brain tumor region from MRI images of the brain. Magnetic resonance imaging (MRI) is a valuable tool for medical diagnosis, but it is particularly challenging for brain tumor detection due to the need for high accuracy. MRI images are used as input data for brain tumor segmentation, which involves separating brain tumor tissues from brain MRI images. The brain tumor segmentation process begins with pre-processing steps such as median filtering to remove noise and skull stripping to isolate the brain tissue. Next, thresholding is applied to the pre-processed MRI images using the watershed segmentation method. This step helps to extract the tumor region from the background brain tissue. Features are then extracted from the segmented tumor region using gray level co-occurrence matrix (GLCM) methods. These features capture the texture and pattern information of the tumor tissue. Finally, the extracted features are used to classify the images as either tumor or normal using a support vector machine (SVM) classifier. This system achieved an average accuracy of 93.05%, outperforming conventional models..

INTRODUCTION

Machine learning algorithms are poised to revolutionize the field of medicine, transforming every aspect of healthcare from drug discovery to clinical decision making. The remarkable success of machine learning in computer vision tasks in recent years coincides with the increasing digitization of medical records. Electronic health records (EHR) adoption among office-based physicians in the US quadrupled from 11.8% to 39.6% between 2007 and 2012 [1]. Medical images, an integral part of a patient's EHR, are currently analyzed by human radiologists, who face limitations such as speed, fatigue, and variability in expertise. Training a qualified radiologist requires years of extensive training and significant financial investment. As a result, some healthcare systems outsource radiology reporting to lower-cost countries like India via tele-radiology. Delayed or erroneous diagnoses can have severe consequences for patients. Therefore, automating medical image analysis using accurate and efficient machine learning algorithms is an ideal solution.

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Medical image analysis is an active area of research for machine learning due to the relatively structured and labeled nature of the data. It is likely that medical image analysis will be the first area where patients interact with functioning, practical artificial intelligence systems. This interaction is significant for two reasons. First, medical image analysis serves as a litmus test for whether artificial intelligence systems can improve patient outcomes and survival. Second, it provides a testbed for human-AI interaction, allowing researchers to assess patient receptivity to health decisions made or assisted by non-human actors.

LITERATURE REVIEW

The field of medical image analysis has witnessed a significant transformation with the advent of machine learning algorithms, particularly convolutional neural networks (CNNs). CNNs are capable of automatically extracting features from medical images and utilizing these features to perform a variety of tasks, including image classification, localization, detection, segmentation, and registration. The availability of large labeled datasets and hardware advancements, particularly in Graphical Processing Units (GPUs), have played a crucial role in enhancing CNN performance. Consequently, CNNs have become the dominant architecture in medical image analysis, demonstrating superior accuracy compared to traditional methods. The application of machine learning algorithms in medical image analysis offers numerous potential benefits for both patients and healthcare providers. For instance, CNNs have demonstrated superior accuracy in detecting certain types of cancer, such as breast cancer and skin cancer, compared to human radiologists. Additionally, CNNs can significantly reduce the time required for analyzing medical images, leading to shorter patient wait times. Moreover, CNNs can extend the accessibility of medical imaging by enabling the analysis of images that are unsuitable for human radiologists, such as low-quality images or images from remote Moreover, CNNs can effectively determine which patients are likely to benefit from invasive procedures, such as biopsies, minimizing the number of unnecessary interventions. Overall, the utilization of machine learning algorithms in medical image analysis holds immense promise for enhancing patient care, improving healthcare outcomes, and reducing healthcare costs..

SYSTEM ARCHITECTURE

The Unified Modeling Language (UML) is a standardized modeling language that is used to specify, visualize, construct, and document the artifacts of software systems. It is also used for business modeling and other non-software systems. UML is a collection of best engineering practices that have proven successful in the modeling of large and complex systems.Raspberry Pi, the Arduino Uno is employed as a data repeater, facilitating the transmission of data from the PZEM-004T to the Raspberry Pi 4. These components are interconnected via serial communication, as depicted in Figure 1.

UML is an important part of developing object-oriented software and the software

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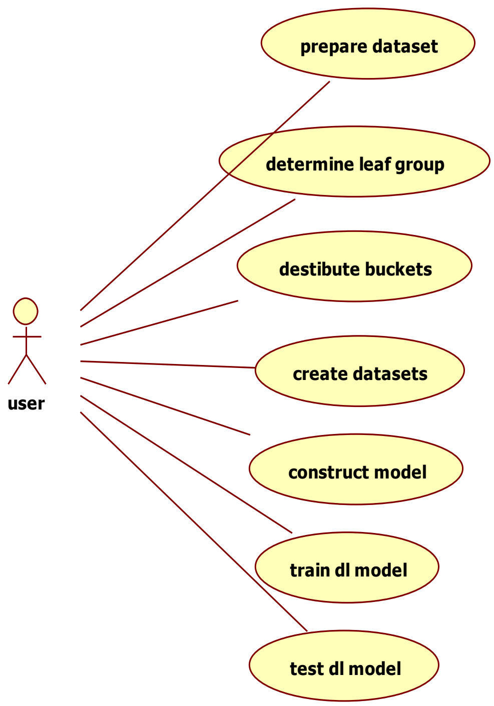
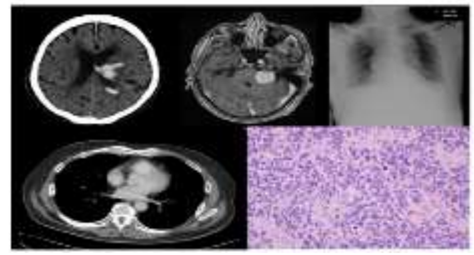
development process. UML uses mostly graphical notations to express the design of software projects. This makes it a powerful tool for communicating the design of software systems to stakeholders, including developers, testers, and users.



A use case diagram in UML is a type of behavioral diagram that provides a graphical overview of a system's functionality. It depicts the actors who interact with the system, their goals (represented as use cases), and any dependencies between those use cases. The primary purpose of a use case diagram is to illustrate the system functions performed for each actor.

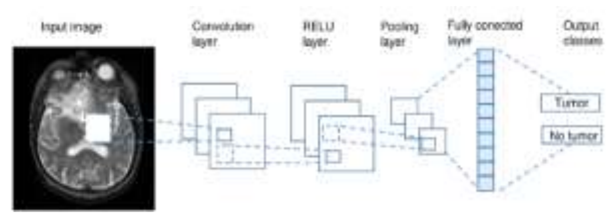
EXISTING SYSTEM:



The use of imaging modalities is increasing rapidly. Smith-Bindman et al. found that over the study period from 1996 to 2010, CT, MRI and PET usage increased by 7.8%, 10% and 57% respectively.

In the field of artificial intelligence (AI), there has been a shift from rule-based expert systems to supervised learning techniques. Unsupervised machine learning methods are also being researched, but the majority of the algorithms from 2015-2017 in the published literature have employed supervised learning methods.

PROPOSED SYSTEM



Convolutional neural networks (CNNs) have gained prominence in medical image analysis due to their ability to preserve spatial relationships while processing input images. These relationships are crucial in radiology, as they allow for accurate interpretation of anatomical structures and disease patterns. CNNs achieve this by employing a series of convolutional layers, ReLU layers, and pooling layers, ultimately leading to a fully connected layer that assigns class scores or probabilities for classification.

Detection of lesions in medical images is a critical task, as missing a lesion can have serious consequences. CNNs have demonstrated remarkable performance in this area, as exemplified by Fangzhou's winning solution in the Kaggle Data Science Bowl of 2017. Their 3D CNN architecture, inspired by U-Net, effectively isolated local patches for nodule detection and achieved a logarithmic loss score of 0.399. Similarly, Shin et al. evaluated various CNN architectures for thoracoabdominal lymph node detection and Interstitial lung disease on CT scans, achieving a mediastinal lymph node detection AUC score of 0.95 with a sensitivity of 85% using GoogLeNet. These studies highlight the potential of CNNs in improving detection accuracy and aiding clinicians in making informed decisions.

REQUIREMENT ANALYSIS

The project aimed to enhance the user-friendliness of several applications. A well-structured navigation flow and minimal typing requirements were key considerations. To ensure accessibility, a browser compatible with most web browsers was chosen.

Functional Requirements

- Graphical User Interface (GUI) for user interaction

Software Requirements

- Programming language: Python
- Web framework: Django

Operating Systems Supported

- Windows 10 64-bit OS

Technologies and Languages Used for Development

- Python

Debugger and Emulator

- Any web browser, with Chrome being a preferred choice

Hardware Requirements

- Processor: Intel i3
- RAM: 4 GB
- Hard disk space: Minimum 1 TB

OBJECTIVES

Input design is a crucial aspect of system development, ensuring accurate and efficient data entry. It involves converting user-oriented input requirements into a computer-based system. This process is essential to prevent data entry errors and provide accurate information for management decisions.

Effective input design involves creating user-friendly screens that can handle large volumes of data. The goal is

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to make data entry effortless and error-free. These screens should be designed to accommodate all necessary data manipulations and provide record viewing facilities. Additionally, data validity checks should be implemented to ensure the accuracy of entered information. Appropriate messages and guidance should be provided to assist users throughout the data entry process. The ultimate objective of input design is to create an easy-to-follow input layout that minimizes user errors and streamlines data collection

IMPLEMENTATION

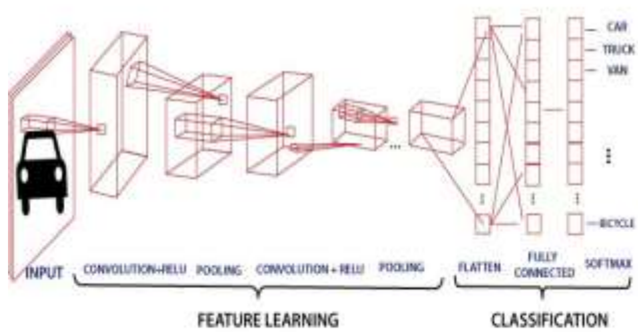
The field of artificial intelligence (AI) has evolved significantly over the past few decades. In the 1970s, the symbolic AI paradigm led to the development of rule-based expert systems, such as MYCIN, which suggested different antibiotic therapies for patients. However, these early AI systems were limited by their reliance on handcrafted features and heuristics.

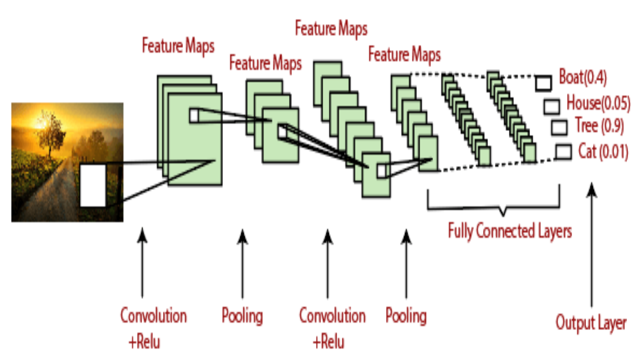
In recent years, the field of AI has shifted towards machine learning techniques, particularly supervised learning methods such as convolutional neural networks (CNNs). CNNs have been particularly successful in medical image analysis, due to their ability to automatically learn features from large datasets of medical images. This has led to significant improvements in the accuracy of tasks such as image classification and segmentation.

CONVOLUTIONAL NEURAL NETWORKS

Convolutional Neural Networks (CNNs) have become the dominant machine learning algorithm in image recognition and visual learning tasks. They are particularly well-suited for medical image analysis due to their ability to preserve local spatial relationships and perform dimensionality reduction. This allows them to capture important feature relationships in images, such as how pixels on an edge join to form a line. CNNs can also take as inputs and process both 2-dimensional images and 3-dimensional volumes. This makes them a versatile tool for medical image analysis, as some modalities like X-rays are 2-dimensional while others like CT or MRI scans are 3-dimensional.

CNNs are supervised machine learning algorithms, which means that they require significant amounts of training data. However, there are a number of resources available to help researchers find and access medical image data, including the Cancer Imaging Archive and the National Institute of Health's ChestX-ray 8 dataset. Additionally, there are a number of open-source frameworks available, such as Nifty-Net, that can help researchers develop and deploy CNN-based medical image analysis systems.





CONCLUSION

A recurring theme in machine learning is the limited availability of labelled datasets, which can hinder training and task performance. However, the lack of data is particularly acute in medical image analysis, where publicly available data is scarce and high-quality labelled data is even more so. Despite these challenges, researchers have developed various techniques to overcome data limitations, such as using smaller filters on deeper layers, novel CNN architecture combinations, and hyperparameter optimization. Generative models, such as VAEs and GANs, may also be used to create synthetic medical data. Data or class imbalance in the training set is another significant issue in medical image analysis, and can be ameliorated by using data augmentation to generate more training images of rare or abnormal data.

Despite the challenges of data limitations and interpretability, machine learning algorithms have surpassed human performance in image recognition tasks and are likely to do so in medical image analysis as well. However, questions remain regarding legal and moral culpability when a patient is misdiagnosed or suffers morbidity as a result of AI or AI-assisted medical management.

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