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Section 01 – Dr Nies Hui Wen

Group 8

**Class Project – Classification of Periodontal
Disease Using Convolutional Neural Network
(CNN)**

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1.0 Introduction

The publication, "Classification of Periodontal Disease Using Convolutional Neural Network (CNN)," focuses on an important use of deep learning technology in dentistry. Periodontal diseases are prevalent health problems that need a precise diagnosis and prompt treatment. The purpose of this study is to use Convolutional Neural Networks (CNNs), an efficient class of deep learning models ideal for image processing, to create an automated system for detecting periodontal diseases using dental radiographs. A system like this has the potential to improve the accuracy and speed of dental pathology diagnosis, providing vital assistance to dental practitioners and, ultimately, improving patient outcomes. The technique, results, and consequences of the CNN-based dental pathology categorization system are examined in this research, providing light on its potential in the field of dental healthcare. It is possible to conclude that the convolutional neural network suggested can be used in actual clinical practice based on the final accuracy achieved in both tooth detection and tooth numbering (Prados-Privado et al., 2021).

1.1 Problem Background

Accurate diagnosis and classification of dental conditions has frequently been an issue in dentistry. Traditional diagnostic approaches frequently rely on subjective interpretations of dental radiographs, resulting in inconsistencies and probable misclassifications. In this setting, the precision of the technique approach is critical. This research intends to address the existing problem of accuracy in a fresh and technologically sophisticated method by bringing Convolutional Neural Networks (CNNs) to the dental pathology classification process. CNNs are well-known for their capacity to extract detailed patterns and characteristics from pictures, which might lead to a more exact and consistent approach of dental disease classification. The application of this CNN-based technique has the potential to significantly boost the accuracy of dental pathology diagnosis, lowering the margin for error and increasing patient outcomes, thus addressing a crucial problem in dentistry. The proposed approach relies on deep learning methods, a category of trainable artificial intelligence (AI) algorithms that empower a computer program to autonomously extract and comprehend important attributes from input data, facilitating the interpretation of previously unseen samples (Tuzoff et al., 2019b).

1.2 Problem Statement

The need for a more precise and reliable approach for detecting and classifying conditions in dental healthcare is highlighted in this study. Current diagnostic procedures, which frequently rely on individuals to interpret dental radiographs, might produce variable and subjective results, potentially leading to misclassifications and delayed or incorrect medical treatments. This discrepancy presents a substantial difficulty for both dental professionals and patients, as correct diagnosis is critical for prompt and successful dental care. To deal with this issue, the research indicates the use of Convolutional Neural Networks (CNNs) to create an automated and technologically sophisticated technique for dental pathology classification. This method intends to increase diagnostic accuracy, minimize human error, and improve patient care in the context of dental diseases, eventually solving a critical issue in dental healthcare.

1.3 Objectives

I. Automated Teeth Detection and Localization: The fundamental goal of this project is to develop a CNN-based system that can recognize and locate teeth in panoramic radiographs automatically. This method will decrease the need for dental specialists to manually detect teeth, expediting the diagnosis procedure. The objective is to develop an efficient and reliable model capable of identifying tooth locations in radiological pictures.

II. Accurate Teeth Numbering: Another objective is to build a system that provides precise numerical labels to observed teeth. This automated teeth numbering procedure will allow for the easy identification of particular teeth within a radiograph, hence simplifying diagnosis and treatment planning.

III. Accuracy Assessment and Benchmarking: One goal of evaluating the proposed CNN model's performance in tooth recognition and numbering is to validate its effectiveness. This will entail comparing the model's output to expert human interpretation, creating a standard for accuracy in dental radiograph processing.

IV. Increased Efficiency: This research will examine how the automated teeth recognition and numbering procedure improves the efficiency of dental radiograph analysis in clinical practice. The project aims to minimize the time necessary for diagnosis by automating these procedures, resulting in more effective and timely patient treatment.

V. Radiograph Consistency: This research will evaluate the consistency of the CNN-based technique in tooth identification and numbering across multiple radiographs. The goal is to provide a high degree of consistency in diagnosis by eliminating variances in interpretation, independent of the individual radiograph being evaluated.

1.4 Scopes and Limitations

Scopes :

1. **Classification of Peridental diseases:** The fundamental goal of this research is to accurately classify dental diseases using a deep learning technique, namely a Convolutional Neural Network (CNN).
2. **Dental Radiographs:** The research will make use of dental radiographs to classify dental pathology. These radiographs will be the deep learning model's major input.
3. **Performance Evaluation:** The scope includes a thorough examination of the model's performance, comparing it to existing diagnostic procedures to determine its accuracy and efficacy in categorizing dental disorders.
4. **Literature examination:** To inform the creation of the model, a large portion of the project's scope includes an exhaustive examination of related literature, with a particular focus on deep learning techniques and their applications in medical image analysis.

Limitations :

1. **Data Availability:** There may be a lack of high-quality dental radiographs. The dataset's quality and size can have a substantial influence on the model's performance. Data restrictions may limit the results' generalizability.
2. **Model Complexity:** While the project's goal is to develop a highly effective model, the complexity of deep learning models such as CNNs can be difficult. The project might run into problems with computer resources and the model's capacity to justify its predictions.
3. **Diagnostic Accuracy:** It is critical to recognize that no machine learning model is perfect. The study may have limits in terms of dental pathology categorization accuracy, and there may be instances where the model's predictions do not match clinical results.
4. **Generalizability:** The model developed may be particular to the dataset and research settings. The model may need to be validated and fine-tuned before it can be used to diverse dental healthcare settings or demographics.
5. **Interpretability:** Deep learning models, such as CNNs, are sometimes referred to be "black boxes," which indicates that comprehending the reasoning behind their predictions can be difficult (Cejudo et al., 2021). The project may encounter difficulties in comprehending and communicating the model's choices.

By recognizing these limits and constraints, the project may be carried out with a clear grasp of its aims and possible problems, with a significant emphasis on improving dental pathology categorization utilizing deep learning techniques.

1.5 Conclusion

In short, the goal of this research is to use deep learning technology to enhance the categorization of dental diseases, therefore solving a crucial issue in dental healthcare. The project attempts to improve the accuracy and consistency of dental pathology diagnosis by applying Convolutional Neural Networks (CNNs), thereby benefiting both dental professionals and patients. This promising approach addresses the problem of subjective interpretation and human error in dental disease diagnosis and holds the potential to revolutionize the field by providing more precise diagnoses and reducing the workload on dental practitioners. With its ability to automate certain diagnostic processes, the CNN-based system signifies a significant step forward in improving patient outcomes and streamlining dental practice.

2.0 Software and hardware requirements

2.1 Software Requirements

- Visual Studio Code
 - Python: coding the algorithm, data analysis, and data visualization
 - Python packages library

- Jupyter Notebook
 - To facilitate the organization of code and data analysis, making it easier to demonstrate the analysis process in detail.
 - Arrange the materials such as coding in a step-by-step manner which is possible to demonstrate the analysis of the process in detail.

- Google Cloud Platform
 - To centralize our project data and code, making it easier to showcase the entire project process.
 - Allows deep learning models to scale efficiently and at lower costs using GPU processing power.

2.2 Hardware Requirement

- Computer
 - Intel-based computer
 - Core i5 processor
 - 8GB Random-access memory (RAM)

3.0 Flowchart

