Ortho-Vision: Optimal therapeutic plan for implants

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Abstract

This report documents the progress of the Ortho-Vision project, an AI-powered system designed for dental implant planning using segmentation models. The project aims to provide an optimal therapeutic plan for dental implants by leveraging deep learning techniques through segmentation and detection using dental imagery from radiographs.

1 Introduction

The Ortho-Vision project aims to assist dental implant planning by leveraging AI for accurate segmentation and detection of dental structures in radiographs. This system is designed to improve the planning process by providing clear and consistent implant guidance.

2 Base Flow

2.1 Application Functionality

The application is designed with functionalities that support end-to-end dental implant planning. It allows users to upload radiographs, segment dental features, and generate suggested implant plans based on segmented regions.

2.2 Problem Description

The goal of this project is to develop a solution for automatic segmentation of dental images, and detection of dental structures. This includes both a descriptive

and formal problem analysis, aiming to create a reliable AI-based tool that can assist in identifying key dental regions necessary for implant placement.

2.3 Related Work and Useful Tools and Technologies

We explored existing dental segmentation models, including pre-trained options on Hugging Face, and reviewed literature on segmentation techniques commonly applied in medical imaging. Our toolkit includes TensorFlow and Keras for model development, OpenCV and PIL for image processing, with additional experimentation using open-source pre-trained segmentation models to accelerate initial testing.

3 Experimental Phase 1: Segmentation

3.1 Data Collection

We collected a dataset of multiple dental single-channel radiographs datasets from public sources with corresponding segmentation masks for key dental features.

3.2 Methods and Algorithms

We tested two primary models for segmentation:

- **Pre-trained Dental Segmentator (Hugging Face):** A pre-trained model was initially tested, but results were suboptimal, likely due to dataset-specific variations. This model was tested on 100 2-dimensional radiographs and it was not trained on specific masks, as it should have already been trained specifically for dental segmentation.
- **U-Net Model:** Our U-Net model, from an existing deep-learning architecture, implemented with TensorFlow and Keras, was trained on 500 images with their masks and achieved a high accuracy of approximately 92% on the validation set.

3.3 Results and Discussion

The U-Net model significantly outperformed the pre-trained Dental Segmentator, achieving accurate and reliable segmentations on our dataset. This model is expected to be central to the overall implant planning application, given its robust performance.

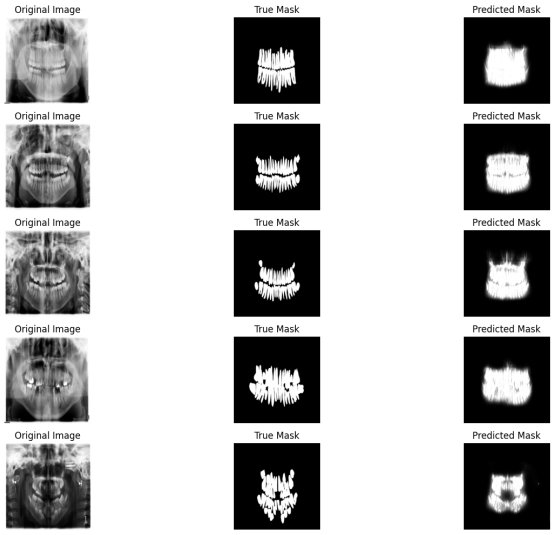

Figure 1: Results from our U-Net segmentation model showing accurate predicted masks of dental features.

4 Experimental Phase 2: Incoming

In this upcoming phase, we plan to incorporate additional data, from Medical University Cluj-Napoca with the help of prof. Mihaela Hedesiu, and refine our approach to improve segmentation accuracy further. We will explore techniques such as fine-tuning pre-trained models with our dataset and experimenting with different augmentation techniques. We will also leverage object-detection algorithms for comparison purposes.

4.1 Results and Discussion

Results for this phase will be included once testing is complete.

5 Experimental Phase 3: Model Improvements

This phase will focus on further optimizing our winning models model, introducing additional data preprocessing steps, and experimenting with ensemble methods or advanced architectures to improve accuracy further.

5.1 Results and Discussion

We expect that these improvements will lead to higher accuracy and more reliable segmentation outputs, particularly in complex or noisy images. Results from these experiments will be detailed as they are completed.

6 Future Work

Future improvements will focus on integrating post-processing techniques for refinement of segmentation, expanding the dataset with 3-dimensional radiographs, and evaluating additional model architectures. We also aim to implement the system as a complete dental implant planning tool with a user-friendly interface and easy-to-interpret outputs.