Artificial Intelligence Tool for Lower Jaw (Mandible) Segmentation on Panoramic Radiographs

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Introduction

This research aims to address the challenge of automatically identifying and delineating the boundaries of the lower jaw in panoramic radiographic images using u-net. Accurate segmentation of the lower jaw is essential for various dental applications, enabling dental professionals to analyze its structure, position, and relationships with other dental and skeletal features. The development of computer vision for this task is to effectively handle the challenges posed by panoramic radiographs, such as variations in image quality, variations in patient positioning, overlapping structures, and anatomical variations among individuals [1]. The algorithms should be able to handle these challenges to provide reliable and accurate lower jaw detection and segmentation results.

Data Description

- The dataset [2] used comprises of 116 x-rays of panoramic dental x-rays taken at Noor Medical Imaging Center that are anonymous and de-identified.
- The widths range from 2600-3138 pixels, and their heights range from 1050-1380 pixels.
- Preprocessing: resize x-ray/ mask to shape (512x512), converts them to grayscale, and normalize.
- Number of Training images: 105
- Number of Test images: 10

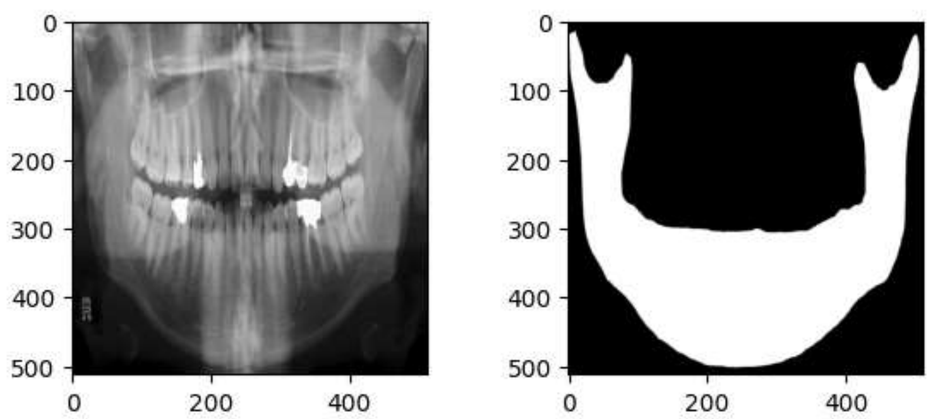

Figure 1. Sample of the data and masks used in this project. Left: Original x-ray Right: Mask annotated manually by human.

Methodology

- **Tools:** Google Colab / TensorFlow library
- **Model:** U-Net
- **Optimizer:** Adam
- **Loss Function:** Binary Crossentropy
- **Metric:** Accuracy
- **Training Hyperparameters:** Learning Rate: 1e-4, batch size: 3, epochs: 200

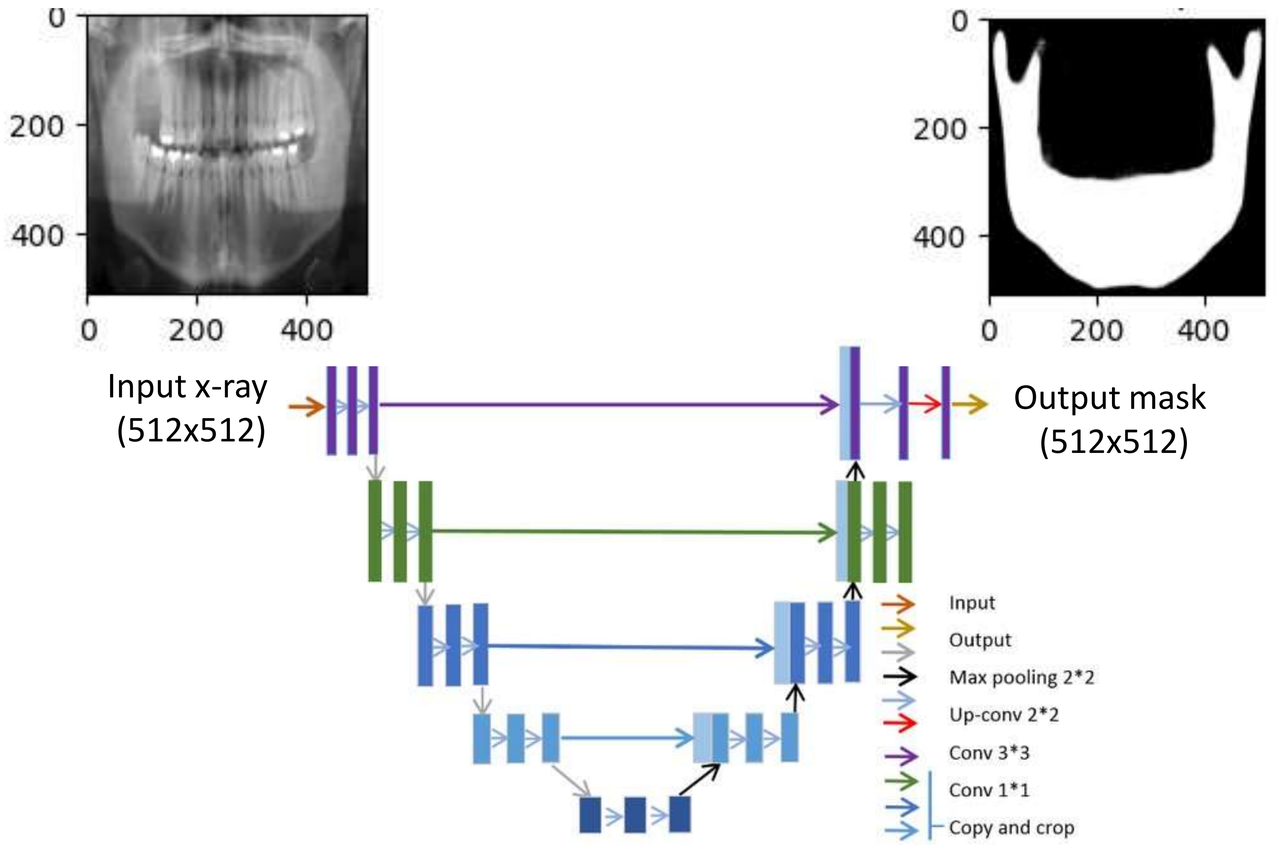

Figure 2. The U-Net Architecture used in this project, adopted from [3]

Results

Table 1. Accuracy results on Training and Test datasets.

	Test Accuracy	Training Accuracy
Learning rate = 0.001	94%	96.79%
Learning rate = 0.0001	95.03%	96.9%

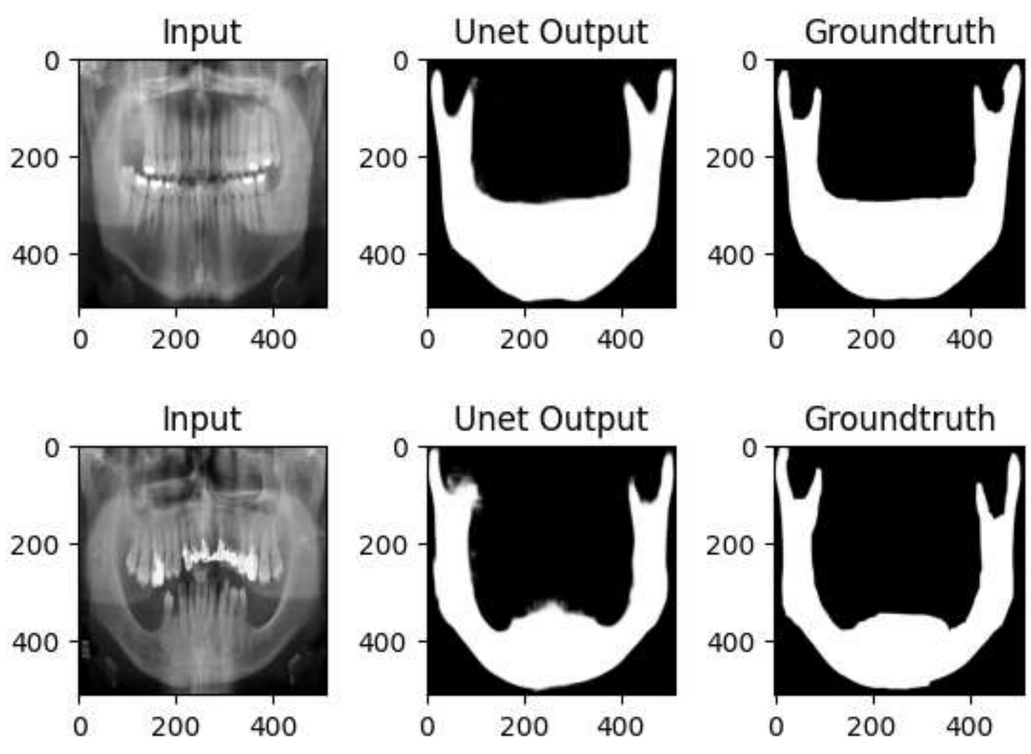

Figure 3. Samples of segmentation results.

Conclusion

- This project aims to automate mandible segmentation using the U-Net artificial neural network (ANN).
- The achieved results show the efficacy of utilizing ANN for automating mandible segmentation.
- Future efforts should concentrate on enhancing model performance by incorporating a larger set of x-rays.
- Subsequently, employing this tool to classify jaw abnormalities.

[1] HELLİ, S., & Hamamci, A. (2022). Tooth Instance Segmentation on Panoramic Dental Radiographs Using U-Nets and Morphological Processing. Düzce Üniversitesi Bilim ve Teknoloji Dergisi

[2] DATASET ref - H. Abdi, S. Kasaei, and M. Mehdizadeh, "Automatic segmentation of mandible in panoramic x-ray," J. Med. Imaging, vol. 2, no. 4, p. 44003, 2015

[3] Ding, Y., Chen, F., Zhao, Y., Wu, Z., Zhang, C., & Wu, D. (2019). A stacked multi-connection simple reducing net for brain tumor segmentation. *IEEE Access*, *7*, 104011-104024.