

UNIVERSITY OF ABERDEEN

PROJECT PLAN
CS5917: MSc Project in Artificial Intelligence

Deep Learning for Dental X-Ray Images

29/05/2021

Yassin Dinana

52094480

Supervised By: Dr. Mingjun Zhong

1. Introduction

Human teeth are a very hard substances, the teeth enamel covering each tooth is the most resilient part of the body. Tooth numbering is very important for dentists, the numbering allows for all 32 teeth, including the wisdom teeth to be designated; if any of the teeth is removed or missing, it will be easily noticed and skipped in the numbering sequence, it also allows precise diagnosis when a tooth is infected. Artificial Intelligence has been used regularly in the dental industry in many ways, such as:

- Using Deep Learning to detect dental decay and oral cancer
- Using Natural Language Processing (NLP) during operation - Where the dentists / clinicians tells the systems what they want, the system processes the speech and performs the task [1].

In order to build systems such as the ones stated above, X-Ray images segmentation and teeth numbering is a very important task. X-Ray image reading and analysis by dentists is time-consuming which may lead to misdiagnosis and negative outcomes, to reduce the incidence of misdiagnosis and optimize dentists' performance when it comes to analysing X ray images, technological tools such as Image Segmentation have been developed to improve accuracy of the output. Image segmentation is important as it extract the objects of interest from the image, which are the teeth, it is also used to isolate the unimportant objects from the image, easing the analysis for the dentists.

Deep learning has seen dramatic developments over the last decade. It is a main technique that will be used to develop the needed tool for the X-Ray image analysis. Image segmentation is an important step in building an effective high-quality system for teeth detection – different libraries will be used to implement segmentation such as TensorFlow and Pytorch.

Segmenting the image separates the 32 teeth and eases the image detection for the teeth numbering process, semantic segmentation is used to extract all 32 teeth from the X-Ray image as one group and instance segmentation is then used to separate each tooth for numbering.

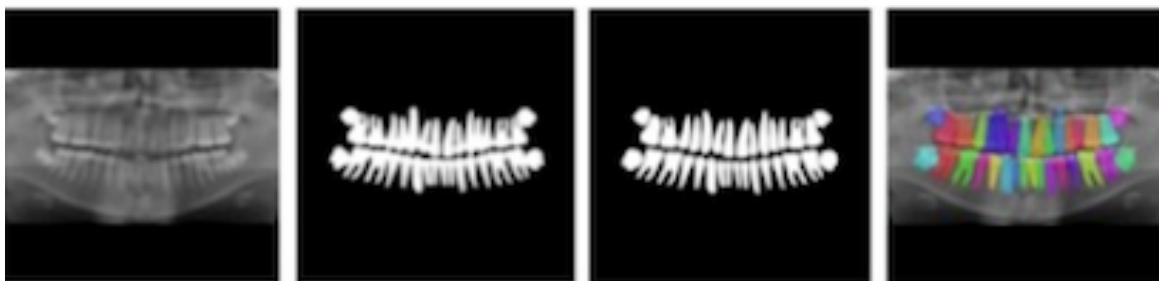


Figure 1: Segmentation Process for Dental X-Ray Images

(left) → raw image

(Centre) → image after segmentation

(right) → colour coded teeth indicating detection

2. Main Goals

2.1. General Objective:

The main objective of this project is to apply an image segmentation method on an extraoral x-ray dataset to detect teeth in the image. Following the detection of teeth, each tooth will be numbered and classified.

2.2. Specific Important Objectives:

1- Research and explore datasets:

- Understanding and displaying the data types and pixels information
- Assessing the quality of images
- Assessing the dimensions using the necessary packages
- Research previous applications deployed using the same dataset

2- Research available tools (Libraries, Frameworks, Simulators):

- Understand libraries that will be used in the project such as libraries and frameworks (Pandas, NumPy, Matplot Library)
- Research frameworks that are helpful for images segmentation such as FastAI and MultiPath
- Understand the GPU power that will be needed for this project (Google Colab is used for development)

3- Images Pre-Processing and cleaning:

- Local illumination can be enhanced using gradient filters, local histogram equalization, and rank filters.
- Blur and Focus enhancements.
- Apply filtering methods for sharpening and blurring
- Images resizing
- Denoise methods

4- Methodology for Images Segmentation:

- There are different methods than can be used for images segmentation, it is important to understand and research the appropriate methodology that will be used for the project, different methods include:
 - Edge-based segmentation
 - Clustering-based segmentation
 - Watershed-based segmentation
 - Artificial Neural Networks based segmentation

5- Implementation of the neural network architecture:

- Implementation of a Convolutional Neural Network

MSC PROJECT PLAN

- Implementation of the U-Net Neural Network Architecture
 - Adjust appropriate hyperparameters for the U-Net architecture
- 6- *Testing and Evaluation:*
 - Apply evaluation techniques on the segmented images output of the Neural Network
 - Tune the model's hyperparameters for better model performance.
- 7- *Teeth numbering and classification*
 - Implement instance segmentation to classify each tooth individually
 - Numbering each tooth for better classification

2.3. Extra Objectives:

- 1- Build and deploy a Graphical User Interface (GUI)
- 2- Classify different teeth diseases after numbering and classifying the teeth.

3. Software Requirements:

- Python 3. 6
- Libraries: NumPy, TensorFlow, Keras, Pandas
- Labelled X-Ray Teeth Dataset (Save on Google Drive)
- Google Colab
- Mat plot Lib and Seaborn for graphs
- High GPU performance

4. Project Timetable milestones:

- Project official starting date – **24 May 2021**
- Project Plan official submission date – **7 June 2021**
- Code submission date – **6 August 2021**
- Report Submission date – **13 August 2021**
- Presentation - **16 August 2021**

5. Risk Assessment:

Risk	Risk Severity	Solutions
Failure in data pre-processing	HIGH	<ul style="list-style-type: none"> ○ Apply different / new pre-processing methods ○ Resize all images ○ Remove all noise ○ Remove corrupted files ○ Adjust all data types ○ Image filtering ○ Gamma Corrections [Brightness]
Software / Hardware power insufficiency	LOW	<ul style="list-style-type: none"> ○ Determine alternative software resources to cope with the image's dataset. ○ Review the IDEs compilation capacity and power.
Image segmentation failure	HIGH	<ul style="list-style-type: none"> ○ Apply different segmentation methods ○ Redefine the configuration and model architecture applied during segmentation
Incorrect neural network architecture	HIGH	<ul style="list-style-type: none"> ○ Apply different architecture to the model. ○ Re-configure architecture and layers size based on input images
Model overfitting / Limited Dataset images	MEDIUM	<ul style="list-style-type: none"> ○ Integrate additional data in the chosen dataset ○ Apply pre-used GAN models to our dataset to increase the training data
Project Deliverables Overdue	LOW	<ul style="list-style-type: none"> ○ Re-visit the project plan due dates ○ Provide most updated version of the project.

MSC PROJECT PLAN

6. Project Plan Dates:

	Task	Duration	Start	ETA	May				June				July				August			
1	Phase 1 (Research):				w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4	w1	w2	w3	w4
2	Research A.I. in the dentistry field	30 Days	1 May 2021	1 June 2021	4W				15D				7D				15D			
3	Research and explore different datasets	15 Days	15 May 2021	1 June 2021																
4	Research and Finalize Literature Review	7 Days	27 May 2021	2 June 2021																
5	Determine available resources (Softwares and Packages)	15 Days	15 May 2021	1 June 2021																
6	Start thesis / project report	58 Days	15 June 2021	13 August 2021																
7	Phase 2 (Programming):																			
8	Methodology	15 Days	1 June 2021	15 June 2021																
9	Data analysis and exploration	5 Days	1 June 2021	10 June 2021																
10	Images Pre-Processing and Cleaning	15 Days	5 June 2021	20 June 2021																
11	Deep Learning model development (Segmentation)	24 Days	21 June 2021	15 July 2021																
12	Teeth numbering and grouping	10 days	16 July 2021	26 July 2021																
13	Model testing and evaluation	9 Days	27 July 2021	5 August 2021																
14	Deadlines																			
15	Project plan submission date			7 June 2021																
16	Code submission date			6 August 2021																
17	Report submission date			13 August 2021																
18	Presentation and Viva date			16 August 2021																