Dental Charting Assistant Utilizing Deep Convolutional Neural Networks

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Significance

- A dental check-up visit includes a visual and radiographic examination of teeth:
  - Dental charting, can be done by a dentist or a dental assistant (Ritter et al., 2019)
    - Time consuming.
    - Prone to overlooked details.

Automate?

Photo by Geo Days on Unsplash

Significance

- Several studies discussed the potential use of deep convolutional neural networks (DCNNs) for Identifying :
  - Dental caries.
  - Existing teeth conditions.

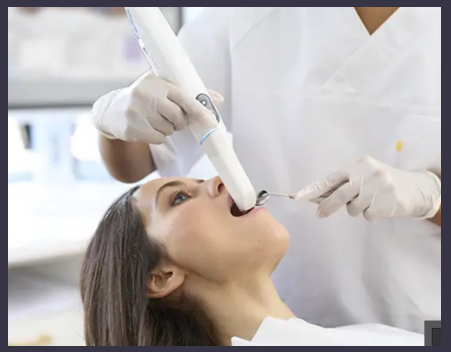
(Chen et al., 2022; Bayrakdar et al., 2022; Lee et al., 2021; Antolin et al., 2021; Tian et al., 2019).

Significance

- No attempt was made to recognize existing teeth conditions from digital 3D models using DCNNs.
- Proposed system will:
  - Combine information from radiographs and intraoral 3D scans.
  - Acquiring more than one documentation type in one step.

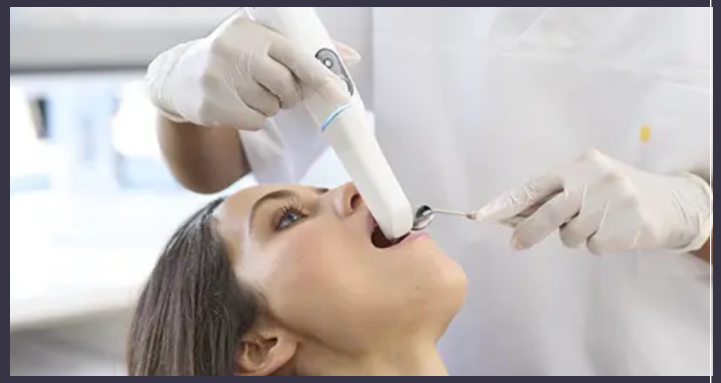
Research Questions

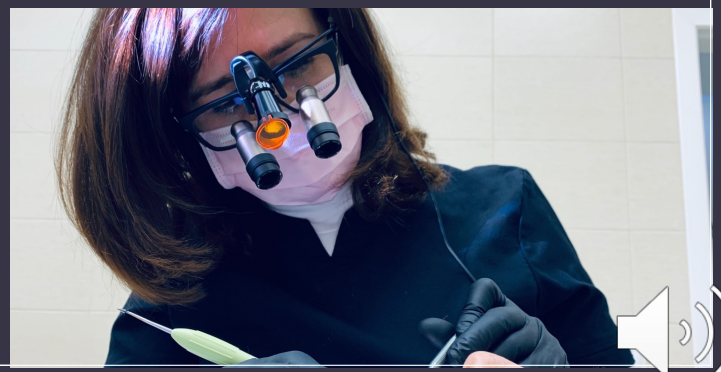
- Will it be possible to automate most of the dental charting process using information gathered by intraoral scans and radiographs?
- The second research question is: What is the accuracy of such a protocol?



Aim and Objectives

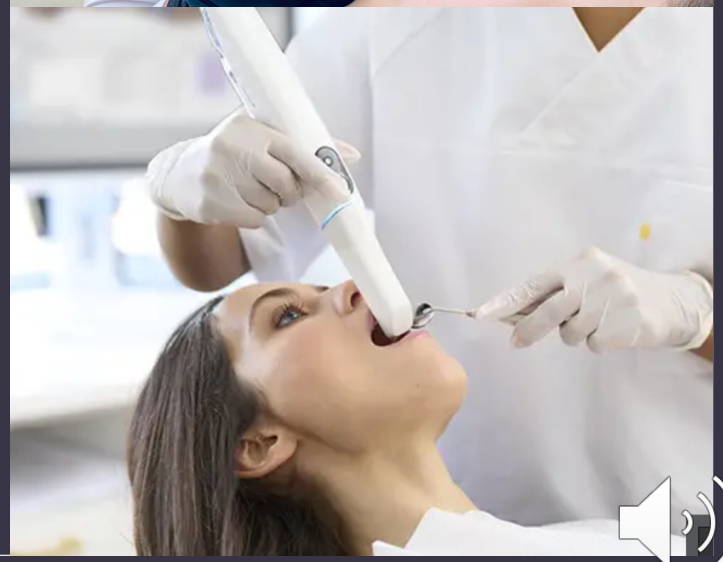
- Investigate the possibility of developing a system that can automate the dental charting process using DCNNs.
- Objectives:
  1. Combine and modify three previously published protocols to increase the data collected for dental charting purposes.
  2. Test the accuracy of this protocol compared to a reference standard composed of two skilled dentists.





Hypotheses

- H_0: Accuracy of automated charting ≥ Accuracy of reference standard
- H_1: Accuracy of automated charting < Accuracy of reference standard



Key Literature

- Three static intraoral images to detect and recognize the status of the teeth (Antolin et al., 2021).
  - Accuracy = 88%.
  - Didn't include the buccal surfaces of posterior teeth, and the lingual surfaces of all teeth.
  - Utilized static images that are hard to obtain.

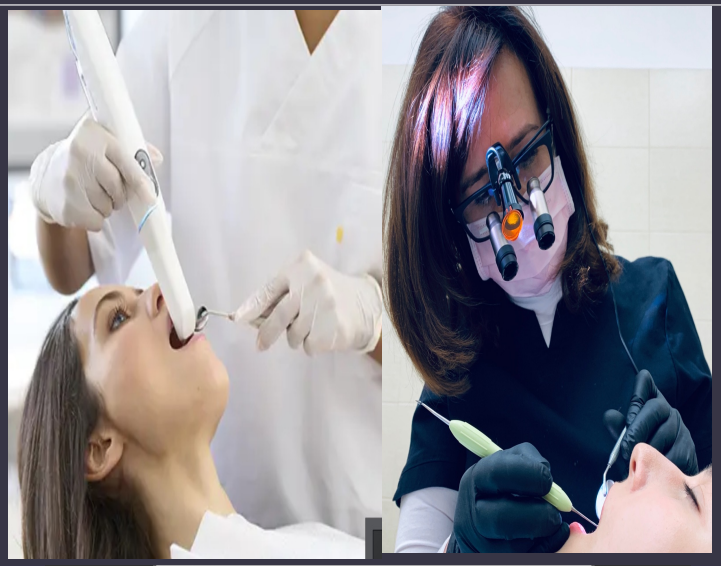
3D Models?

Key Literature

- Malalignment vs recognition and segmentation processes:
  - Tian et al. (2019) proposed a protocol that uses 3D DCNNs for the segmentation and recognition of teeth with 92% accuracy.

Key Literature

- Caries detection on bitewing radiographs:
  - Several studies explored the use of DCNNs for that with accuracy reaching above 80% (Bayrakdar et al., 2022; Chen et al., 2022).
  - Lower accuracy has been reported too (Lee et al., 2021; Prados-Privado et al., 2020).



More sources → ⇈ Detection?

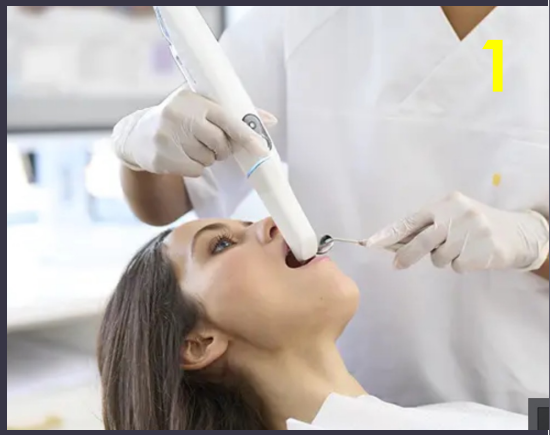
Key Literature

- Lee et al. (2021) showed that restorative materials could also be detected using DCNNs.

More sources → ↑↑Charting Details?

Methodology

- IRB approval and consent forms.
- Sample = 30:
  - Intraoral scan of the upper arches (e.g., 3shape TRIOS 5 intraoral scanner)
  - Complete sets of bitewing radiographs (e.g., Carestream RVG 6200)

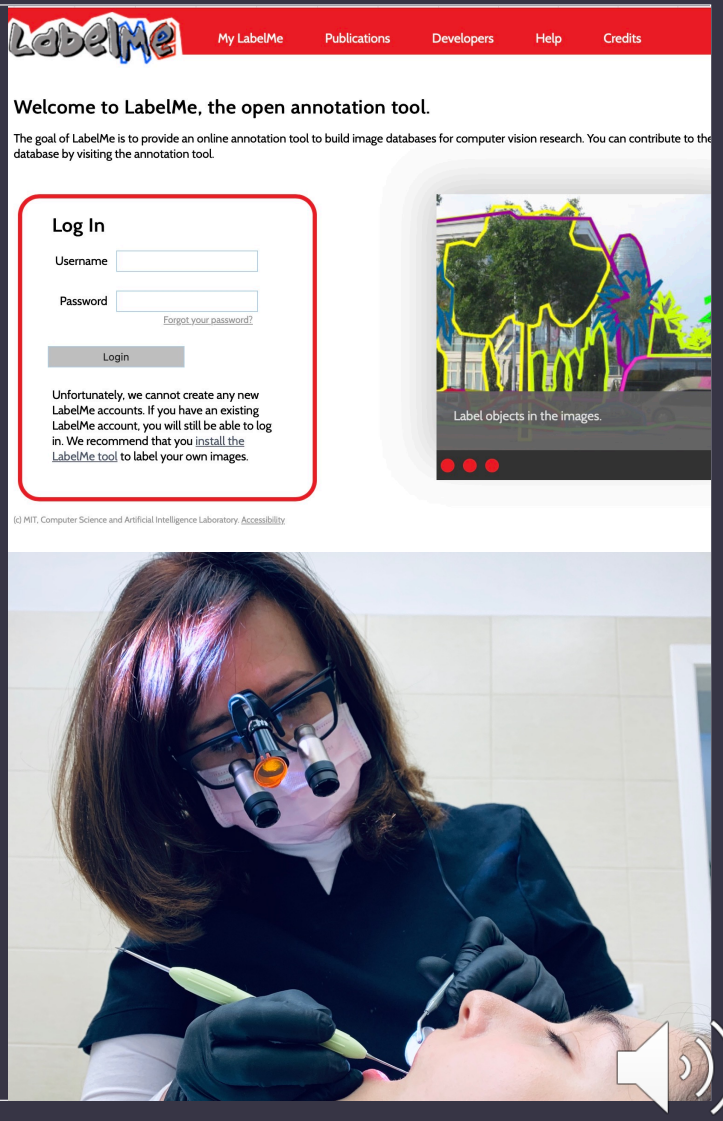


Methodology

- **Frist Stage (80% training and validation, and 20% testing):**
  - Step one:
    - Segmentation and Tooth Classification (Tian et al., 2019):
      - 3D models → Sparse Octree models → 3D CNNs.
  - Step two:
    - Tooth Status Recognition (Antolin et al., 2021)
      - Using 3D CNN on segmented and classified teeth from step one.
  - Step three:
    - Caries Detection using Faster Region Based CNN (Chen et al. (2022).

Methodology

- **Reference Standard**:
  - Bitewing radiographs:
    - Two skilled dentists label carious lesions using LabelMe:
      - Labels per tooth.
  - Clinical Tooth status:
    - Same 2 examiners:
      - Carious, filled, or extracted



Statistical Analysis

- A confusion matrix will be utilized.
- Sensitivity (recall), specificity, and accuracy.
- McNemar's test for statistical significance between the two methods (α=0.05).

		Actual			
		Caries	Missed	Restored	All
Predicted	Caries	xxx	xxx	xxx	xxx
	Missed	xxx	xxx	xxx	xxx
	Restored	xxx	xxx	xxx	xxx
	All	xxx	xxx	xxx	xxx

Artefact

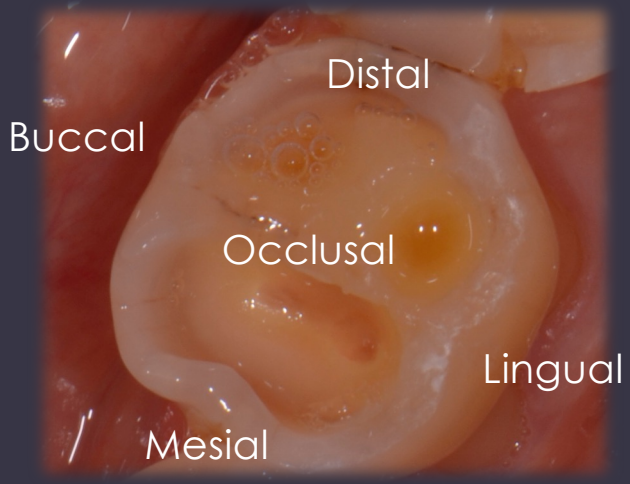
- A software application using Python → Output information related to the status of each tooth in a spreadsheet format.

Timeline

Task	Expected time
Proposal submission and ethical approval	1 month
Research subjects' recruitment and data collection	4 months
Python code	2 months
Training, validating, and testing the neural networks	1 months
Statistical Analysis	2 weeks
Writing	2 months

Future Directions

- This research proposal discussed the possibility of automating the dental charting process per tooth.



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THANK YOU!