AI in Oral Health: Dental Fluorosis

Team 3
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Dental and skeletal fluorsis

Source: ChemoAquatech, Every Life Counts
# Dental Fluorosis: The problem

<table>
<thead>
<tr>
<th>The problem defined</th>
<th>Long term implications</th>
<th>Problem statement</th>
</tr>
</thead>
</table>
| Dental fluorosis is a permanent irreversible defect of tooth enamel that is caused by a high level of fluoride intake within the first 8 years of life | Long-term can lead to skeletal fluorosis, where fluoride accumulates in the bone over several years  
  - CDC  
  - WHO | No existing data-enabled predictive pathway widely used by general dentists for early detection of dental fluorosis |
Solution

Apply image recognition and classification algorithm with CNN to enable early periodic detection and screening for dental fluorosis

Machine learning, specifically CNN, in pediatric dentistry for the early detection of fluorosis, combined with clinical observation to increase quality of predictability and ultimately prevention of long-term implications of dental fluorosis and bone density
What does it look like?

Fluorosis makes the teeth become porous. Mild forms are indicated by scattered white spots/flecks, frosty edges, or fine, lacy chalk-like lines. These changes are barely noticeable and difficult to see except by a dental health care professional.

Moderate and severe forms of dental fluorosis are a result of the teeth becoming overly porous. They will have larger spots ranging from white to brown in color and in severe form, which is rare, rough, pitted surfaces.

Source: CDC
Data acquisition & labeling

Acquire data from typically disaggregated sources
- photographic images
- X-rays
- Diagnosis codes for pre-processing

Example of data labeling:

<table>
<thead>
<tr>
<th>id</th>
<th>photo</th>
<th>x-ray</th>
<th>fluorosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>001</td>
<td>001_p.png</td>
<td>001_x.png</td>
<td>0</td>
</tr>
<tr>
<td>002</td>
<td>002_p.png</td>
<td>002_x.png</td>
<td>1</td>
</tr>
</tbody>
</table>

1D array
Image Classification
Range of fluorosis

Source: CDC
### Example of data labeling (sensitivity):

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### Example of data labeling (sensitivity & severity):

<table>
<thead>
<tr>
<th>id</th>
<th>photo</th>
<th>x-ray</th>
<th>fluorosis</th>
<th>Dean’s index</th>
</tr>
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<td>001_p.png</td>
<td>001_x.png</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>002</td>
<td>002_p.png</td>
<td>002_x.png</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>003</td>
<td>003_p.png</td>
<td>003_x.png</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

1D array

2D array
Model development & testing

Source: Matthew Engelhard, fluorosisindex.com
Dual-input CNN

Multiple Convolutional Layers

CONCATENATE

OUTPUT

Multiple Convolutional Layers

Photograph

Multiple Convolutional Layers

X-ray
Challenges deep-dive

**Type of tooth**
- Exposure to fluoride
  - Incisors, molars, premolars, canines
  - Certain teeth may have less enamel
  - Less enamel, higher risk of discoloration

**Tooth shape**
- Variations in tooth shape
  - Different sizes of types of teeth per patient and between patients

**Directionality**
- Straight or crooked
  - Need to rotate to capture a tooth despite any level of ‘crookedness’ captured in image or photo
Model performance

Metrics used to measure outcome

Sensitivity: Fluorosis accurately identified

Specificity: Healthy teeth accurately identified

False Positive Rate: Fluorosis predicted when not present

False Negative Rate: No fluorosis detected when fluorosis is present

Accuracy: Number of total correct predictions out of the number of total predictions made

➢ Retrain the model
Future performance
Future performance
Multi-task model

Detecting oral cancer early using same data set