**Justification of Disciplinary Focus Report**

**IBEHS 5P06A**

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**Team 9**

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# Motivation (Problem and Needs Identification)

**High Prevalence of Oral Disease (with Serious Health Implications)**

* It is estimated that oral diseases affect nearly 3.7 billion people. [1]
* Untreated dental caries (tooth decay) in permanent teeth is the most common health condition according to the Global Burden of Disease 2021 [1]. In 2021, there were approximately 2.37 billion cases of caries of permanent teeth [2].
* Periodontal disease affects more than a billion people globally, destroying alveolar bone and leading to tooth loss [5].
* Several reports have highlighted the importance of oral health and disease in systemic conditions, especially cardiovascular diseases and diabetes [7].

**Importance of Early Prevention**

* Most oral health conditions are largely preventable and can be treated in their early stages. Most cases are dental caries (tooth decay), periodontal diseases, tooth loss and oral cancers. [1]

**Socioeconomic and Geographic Disparities**

* Low- and middle-income countries often bear a disproportionately higher burden due to limited access to oral healthcare services, poor oral hygiene practices, and unhealthy diets [2][8].
* Disparities in oral health exist among all age groups. These disparities exist by sex, poverty status, race and ethnicity, education level, and smoking status [3].
* More people are unable to afford dental care than other types of health care [4].

**Need for Accessible Early Detection and Self-Monitoring Tools**

* Studies show smartphone photos + AI can detect caries and gum disease with promising accuracy. There is a similar app called AICarries used to detect Early Childhood Carries (ECC) [6]
* Today, artificial intelligence (AI) has been suggested useful in disease diagnosis, predicting prognosis, or developing patient-specific treatment strategies [9].

# Solution Statement (Design Aspect of the Project)

Our team proposes to develop a mobile application for oral health monitoring that combines machine learning image analysis with a user-friendly interface (if there is time we will also work on creating our own image capturing device). The end goal is for users to take photos of their teeth and gums, which are then analyzed by a ML model to identify potential diseases such as caries, periodontitis, plaque etc.

**High level approach:**

Research image processing techniques as well as conduct interview with relevant stakeholder and potential clients to understand their needs and how various dental diseases are diagnosed. Data Acquisition and preprocessing images from open datasets and label with the help of our stakeholder. Use transfer learning with lightweight CNN architectures to enable accurate detection while maintaining efficiency for mobile deployment. Develop APIs in the backend Infrastructure to host the ML model and handle image processing. Design an interface for capturing images, receiving results, and providing educational resources to users. Integration between frontend and backend, optimize model inference accuracy and speed, and implement testing.

# Educational Background and Expected Contributions

\*Github will be used for documentation over the entirety of Project. All courses listed below without specified course code are under software department with course code SFWRENG.

Jasmine: Backend Development

Jasmine’s previous experience with APIs and ML models in various projects and during CO-OPs makes her an ideal member for AI development and integration. She has experience with Python programming and deep learning frameworks (PyTorch/TensorFlow/Keras) as well as API development and testing using Jest. She has also taken relevant courses such as 4AL3 and 4NL3. She will be responsible for all server-side logic, databases, and the AI model training lifecycle. This includes researching imaging processing techniques as well as data collection and preprocessing. In addition, she will also be responsible for integrating trained models with the application backend, ensuring a unified, secured and robust system.

Ruidi: Frontend Development

The completion of 4HC3 last semester will help Ruidi to design the client-side user interface and experience (UI/UX). Her previous experience of using wxWidgets, Android Studio in academic courses and CO-OP positions will be useful for frontend development. Ruidi will be responsible for user analysis, usability testing, applying design principles to guarantee accessibility and a user friendly, intuitive UI. Furthermore, she must integrate the AI model with the UI and UX to clearly display AI-generated analysis results and present analysis information to the end-user.

**Collaborative Responsibilities (Jasmine & Ruidi):**

Both members are responsible for conducting research on existing dental technologies, dental needs and market standards/gaps to refine project scope. They will conduct interviews and setup weekly meetings with stakeholder and clients to define design elements such as functional and non-functional requirements. Knowledge from core software courses will be used in this project: the requirements course 3RA3, design courses I, II and III trained both members how to form Software Requirements Specification (SAS) and design software architectures from scratch; testing methodologies from the testing course 3S03 will be used for iterative testing to validate functionality and ensuring system integration. If required, both members will be contributing to create a hardware prototype for a low-cost imaging device using concepts from 2DA4.

Knowledge of prototyping from IBEHS 1P10 and economic analysis, cost analysis, financial decision makings from IBEHS 3P04 will be applied during prototype construction to reduce cost.

Presentations, demos, and administrative responsibilities such as documentation/version control, communication, coordination and submission will be split between the two members equally.

# Appendix A

*Table 1: Course Code and corresponding Course Name*

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| **Course Code** | **Course Name** |
| SFWRENG 4AL3 | Applications of Machine Learning |
| SFWRENG 4NL3 | Natural Language Processing |
| SFWRENG 4HC3 | Human Computer Interface |
| SFWRENG 3RA3 | Software requirements and Security Considerations |
| SFWRENG 2AA4 | Software Design I – Intro to Software Development |
| SFWRENG 3BB4 | Software Design II – Concurrent System Design |
| SFWRENG 3A04 | Software Design III – Large System Design |
| SFWREBF 3S03 | Software Testing |
| SFWRENG 2DA4 | Digital Systems and Interfacing |
| IBEHS 1P10 | Health Solution Design Project I |
| IBEHS 3P04 | Health Solutions Design Project III: Analysis and Decision making |

# References [1] <https://www.who.int/news-room/fact-sheets/detail/oral-health>

[2] <https://pmc.ncbi.nlm.nih.gov/articles/PMC12070580/>

[3] https://www.cdc.gov/oral-health/health-equity/index.html#cdcreference\_5

[4] <https://www.healthaffairs.org/doi/10.1377/hlthaff.2016.0800>

[5] <https://pmc.ncbi.nlm.nih.gov/articles/PMC9139975/>

[6] <https://pmc.ncbi.nlm.nih.gov/articles/PMC9645586/>

[7] <https://pmc.ncbi.nlm.nih.gov/articles/PMC10199803/>

[8] [https://pmc.ncbi.nlm.nih.gov/articles/PMC7125002/](https://pmc.ncbi.nlm.nih.gov/articles/PMC7125002/?utm_source=chatgpt.com)

[9] [https://journals.sagepub.com/doi/10.1177/0022034520969115](https://journals.sagepub.com/doi/10.1177/0022034520969115?url_ver=Z39.88-2003&rfr_id=ori:rid:crossref.org&rfr_dat=cr_pub%20%200pubmed)