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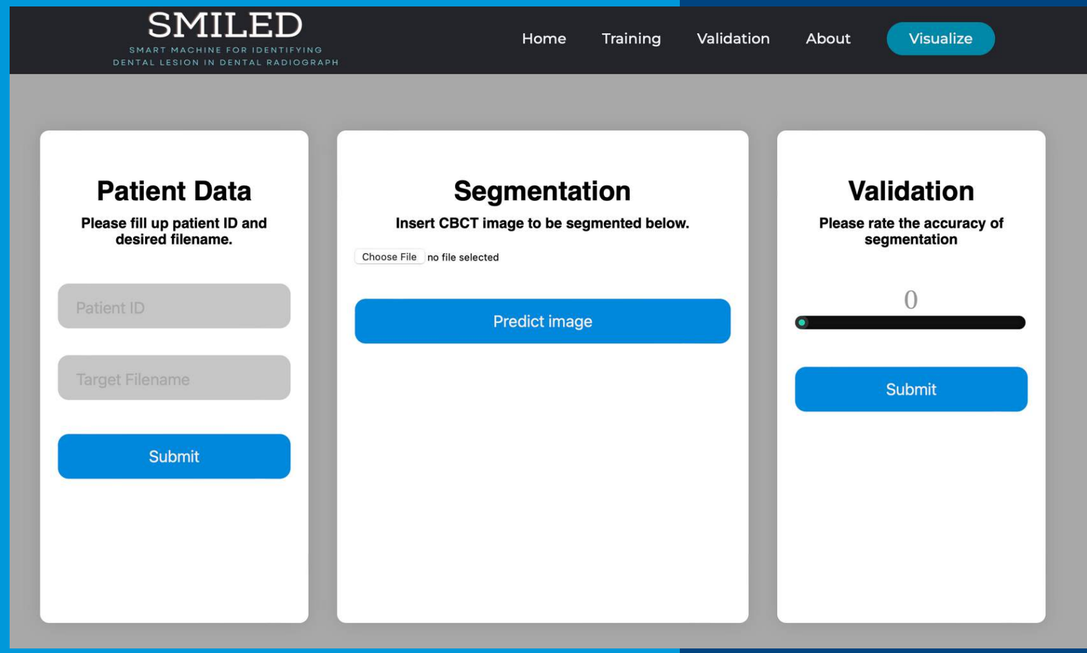
SMILED:

Smart Machine for Identifying dental Lesions with Efficient and accurate Detection



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International Islamic University Malaysia

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SMILED
SMART MACHINE FOR IDENTIFYING DENTAL LESION IN DENTAL RADIOGRAPH

Home Training Validation About Visualize

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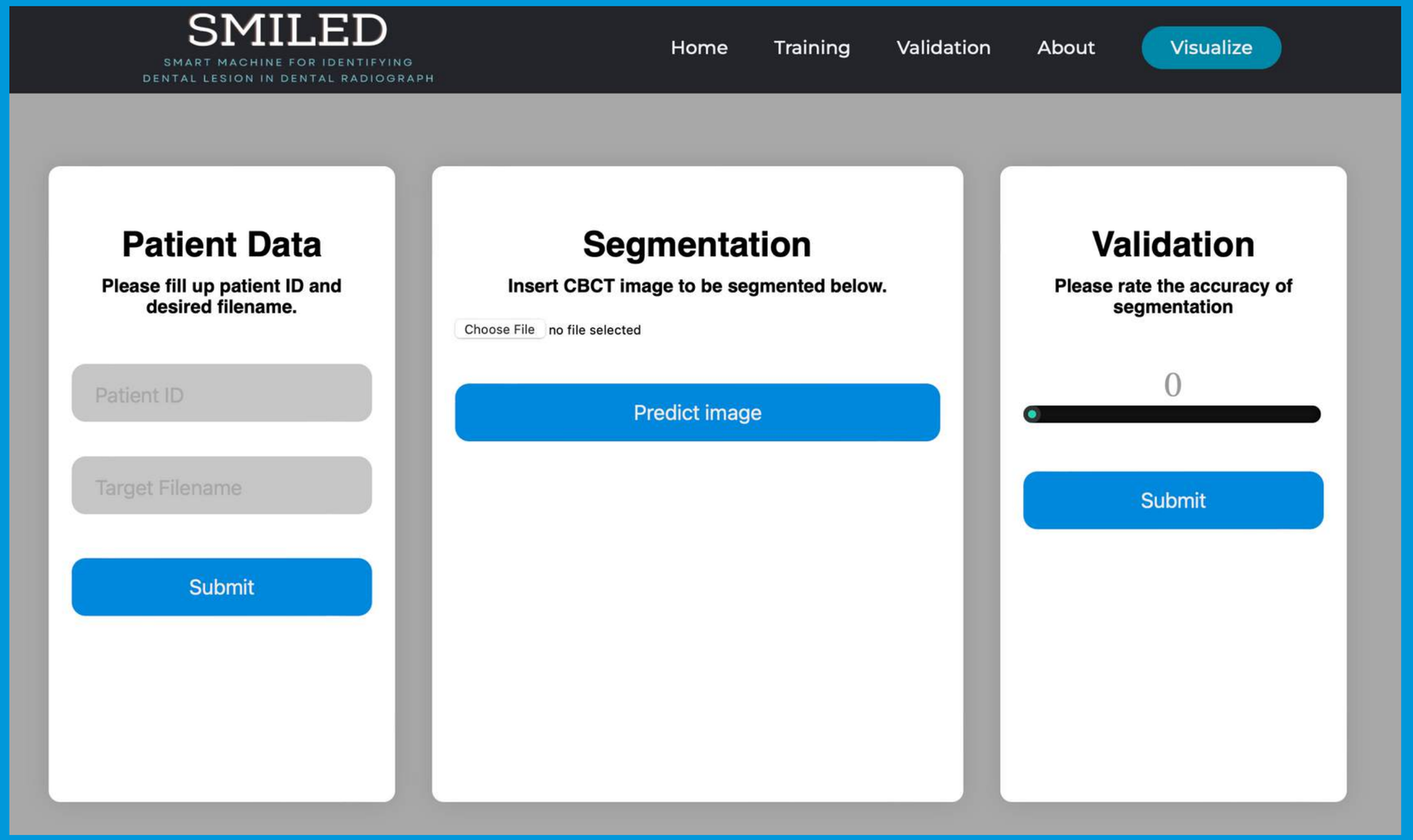

Status of Invention : Prototype

INTRODUCTION

SMILED
SMART MACHINE FOR IDENTIFYING
DENTAL LESION IN DENTAL RADIOGRAPH

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SMILED is an innovative system that accurately segments dental lesions in radiographs using advanced image processing and machine learning

SMILED addresses challenges in dental caries diagnosis by employing hybrid U-Net architectures and integrating various convolutional neural network models.

Privacy concerns are addressed through differential privacy, protecting sensitive medical data during the training process.

SMILED improves dental diagnosis and treatment planning, which aligns with SDG 3 (Good Health and Well-being) and SDG 9 (Industry, Innovation, and Infrastructure), revolutionizing dental diagnostics and enhancing patient car

ROLE OF AI in Dental Lesion Classification & Segmentation

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01

Among all the AI applications in dentistry, the most popular one is diagnosis. AI can make more accurate and efficient diagnoses, thus reducing dentists' workload.

02

It assist dentists in making more accurate diagnoses and develop personalised treatment plans, to identify abnormalities and assist dentists in making more informed treatment decisions.

03

AI based CBCT image visualization offered by SMILED can help increase patient acceptance, help dentists to visualize the lesion to the patient and simplify the data workflow.

PAIN

Based on the preliminary survey, it was found that the waiting time or outpatient services exceeded the standard (> 60 minutes)

The patient-reported maximum acceptable waiting time for non-urgent dental treatment was 45.8 days. Fewer than half (42.0%) of the subjects had received treatment while waiting for comprehensive care;

Patient experiences during waiting time fo
dental treatment

Risto Tuominen & Anna-Leena Eriksson

Pages 21-26 | Received 12 Oct 2010, Accepted 06 Mar 2011, Published online: 19 Apr 2011

Download citation https://doi.org/10.3109/00016357.2011.575079

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Abstract

Objectives . The aim of this study was to evaluate patient experiences of inconvenience and treatment need while waiting for dental treatment. ***Materials and methods.*** A systematic sample of 210 patients with varying lengths of waiting time was drawn from the waiting list for non-emergency treatment in the City of Turku. A questionnaire covering socio-demographic background was mailed to the patients. The level of inconvenience caused by waiting was assessed by a linear visual analogue scale (0–100). ***Results.*** A total of 112 subjects (60%) completed and returned the questionnaire and 109 (58%) gave permission to collect data from their patient records. The average inconvenience score was 42.9, with those who had waited for 3 months or less reporting less inconvenience than those that had waited for 4 months or more.

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PAIN

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Artificial intelligence in prosthodontics: a scoping review on current applications and future possibilities

Mitali Pareek[1]*, Brahmansh Kaushik[2]

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Received: 10 January 2022
Accepted: 02 February 2022

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ABSTRACT

Artificial intelligence (AI) is the data-driven disruptive technology of modern times. AI is reforming every field from space science to dentistry. Bio-medical provides various advantages over conventional diagnosis, treatment planning, patient documentation and management. Every field is implementing AI for the ease of both doctors and patients. In this present work, the review was done for the implementation of AI in prosthodontics. Prosthetic dentistry or prosthodontics is one of the branches of dentistry, mainly deals with replacement and rehabilitation of missing teeth with the help of fixed and removable prosthesis or with biocompatible substitutes like implants. In addition, it also helps to restore proper soft and hard tissues of the mouth, thereby following review highlighted the present-day technology of constructing more patient-specific prosthesis. In conclusio applications and limitations in dentistry.

Keywords: Dentistry, Artificial intelligence, Bio-medical a

A review of deep learning models for medical diagnosis

Seshadri Sastry Kunapuli, Praveen Chakravarthy Bhallamudi, in Machine Learning, Big Data, and IoT for Medical Informatics, 2021

3 MRI Segmentation

Image segmentation is an essential step for brain tumor analysis of MRI images. In the present scenario, the human expert performs tumor segmentation manually. This manual segmentation is a very time-consuming, tedious task, usually involving lengthier procedures, and the results are very dependent on human expertise. Moreover, these results vary from expert to expert and generally are not reproducible by the same expert. Thus automatic segmentation and reproducible segmentation methods are very much in demand. MRI segmentation is used to provide a more

- Dental lesion segmentation need to be done by dental specialist
- Require more excellent technical skills
- Tedious manual efforts and errors
- Excessive workload of the doctors
- insufficient numbers of experienced doctors
- limited time for radiographic intrepetation by dental practitioners

NOVELTY

SMILED
SMART MACHINE FOR IDENTIFYING
DENTAL LESION IN DENTAL RADIOGRAPH

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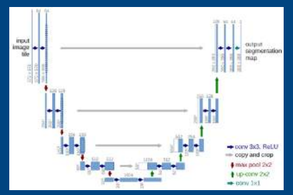
An innovative system designed for accurate segmentation of radiolucent lesions in dental radiographs utilizing :

Cone Beam Computed Tomography (CBCT) images

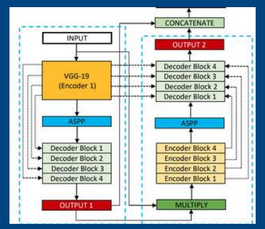
advanced image processing

machine learning

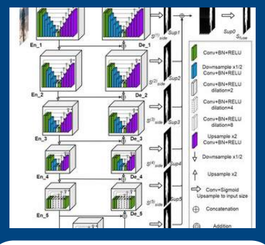
UNET & hybrid U-Net architectures involved:



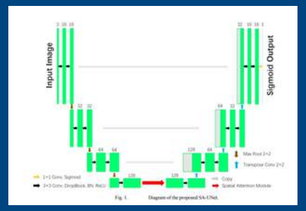
UNET



DoubleUNET



U2-NET



SA-UNET

COMPARISON

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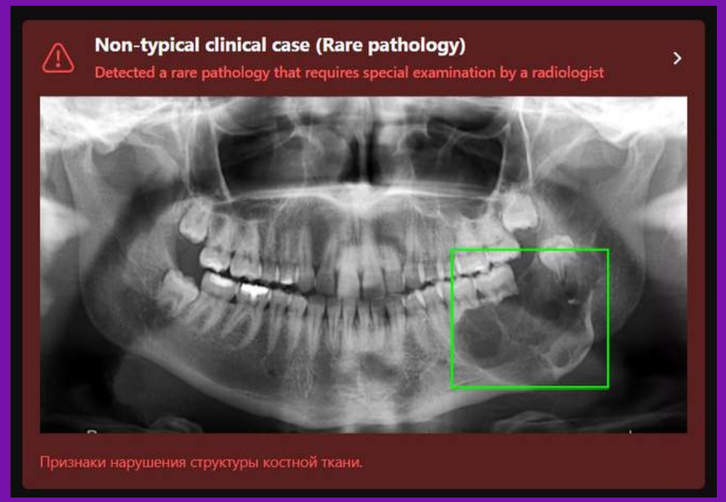
Diagnocat™

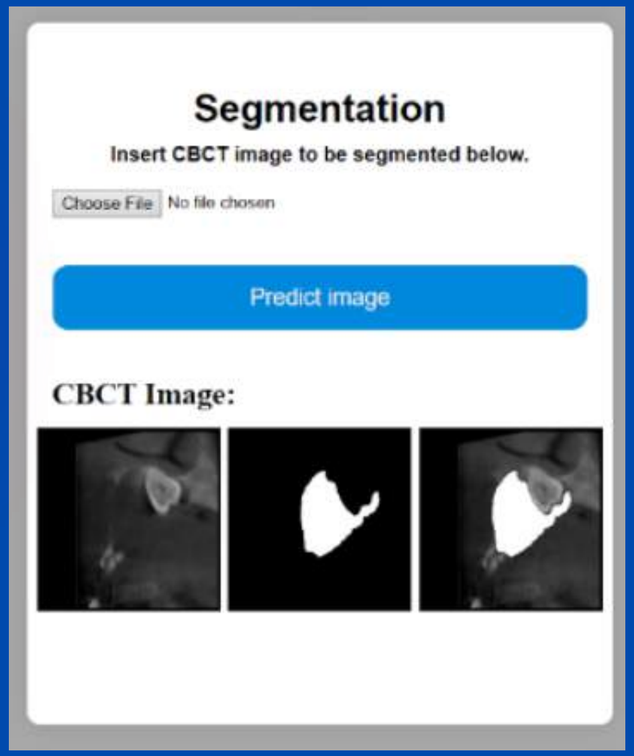


- Complex X-ray images
- Shows the potential segment in box
- Presence of noise due to lack or reliable saperation of between teeth
- Image is not secured

VS

SMILED

SMART MACHINE FOR IDENTIFYING DENTAL LESION IN DENTAL RADIOGRAP



- CBCT Image
- Shows the actual segment of the lesion
- Secured Image (Privacy-preserved)

VALUE PROPOSITION OF SMILE

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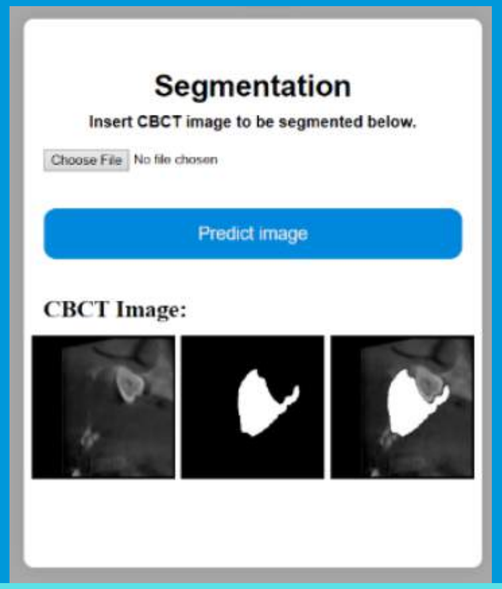
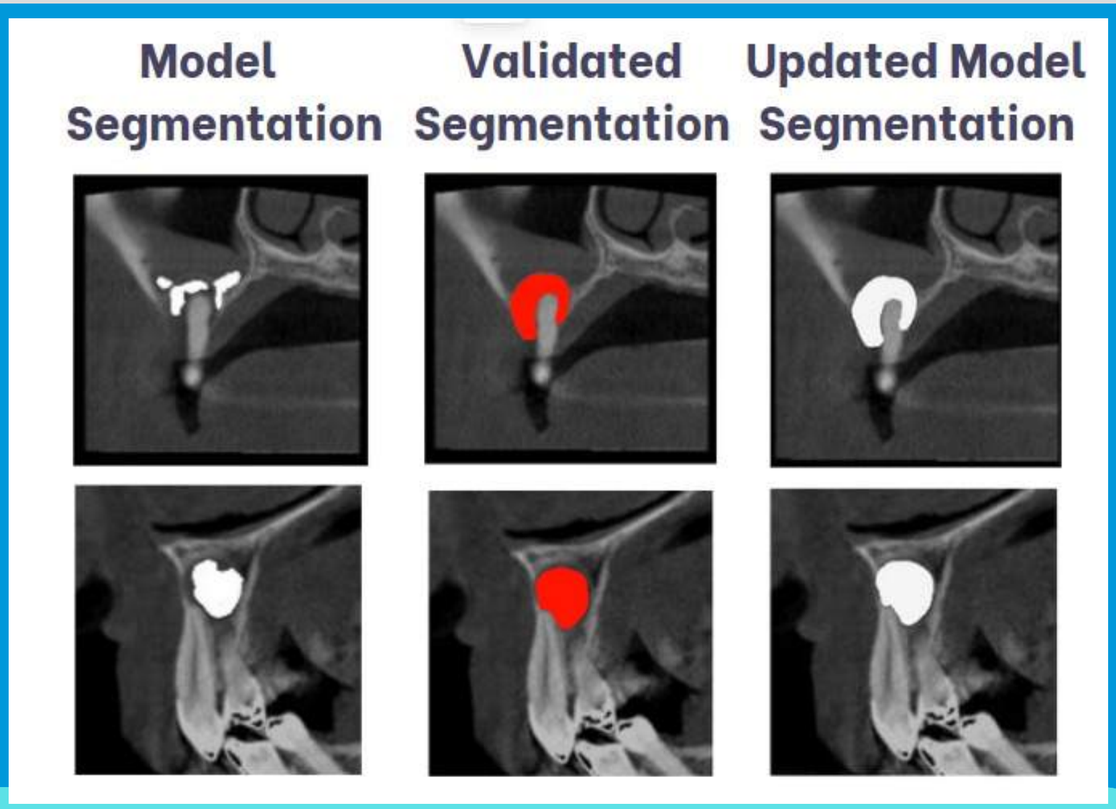
SMILED

SMART MACHINE FOR IDENTIFYING DENTAL LESION IN DENTAL RADIOGRAPH





- Accurate diagnosis,
- Fast result of diagnosis
- Validated by dental practitioners
- Patients image privacy
- Model improvement based on the validation
- Assist the dental practitioners in visualising the exact segment of the leison
- Increase patient understanding of dental diseases

VALUE PROPOSITION OF SMILED

Time & cost savings

Automatic segmentation will reduce time taken compared to manual segmentation and reduce the need for dedicated human resources for manual segmentation which can lead to cost savings by optimizing resource allocation and increasing overall operational efficiency.

Model Improved accuracy

With MLOps workflow applied, AI models will be improvised as 3 different methods of training will be applied to increase the model accuracy over time

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VALUE PROPOSITION OF SMILE

Enhanced Treatment Planning / Instant result

Dental professionals can quickly obtain accurate segmentation results, enabling faster decision-making and improved patient care. With SMILED, dental professionals can save valuable time, allowing them to focus on other critical tasks such as diagnosis and treatment planning.

Unet model as ML Model

UNet is able to receive an image as input and produce another image as output, which is convenient for generating segmentation images while having the ability to handle high-resolution images.

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IMPACT OF SMILED

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5.00
MINUTES

The average time taken for single manual lesion segmentation is 5 minutes

1.66
SECONDS

Smiled : Average time taken for lesion segmentation is 1.66seconds

170%

decrease time taken to do lesion segmentation by using SMILED

A deep learning masked segmentation alternative to manual segmentation in biparametric MRI prostate cancer radiomics

Jeroen Bleker,[✉1] Thomas C. Kwee,[1] Dennis Rouw,[2] Christian Roest,[1] Jaap Borstlap,[3] Igle Jan de Jong,[4] Rudi A. J. O. Dierckx,[1] Henkjan Huisman,[5] and Derya Yakar[1]

Author information ▸ Article notes ▸ Copyright and License information Disclaimer

Associated Data

▸ **Supplementary Materials**

Abstract Go to: ▸

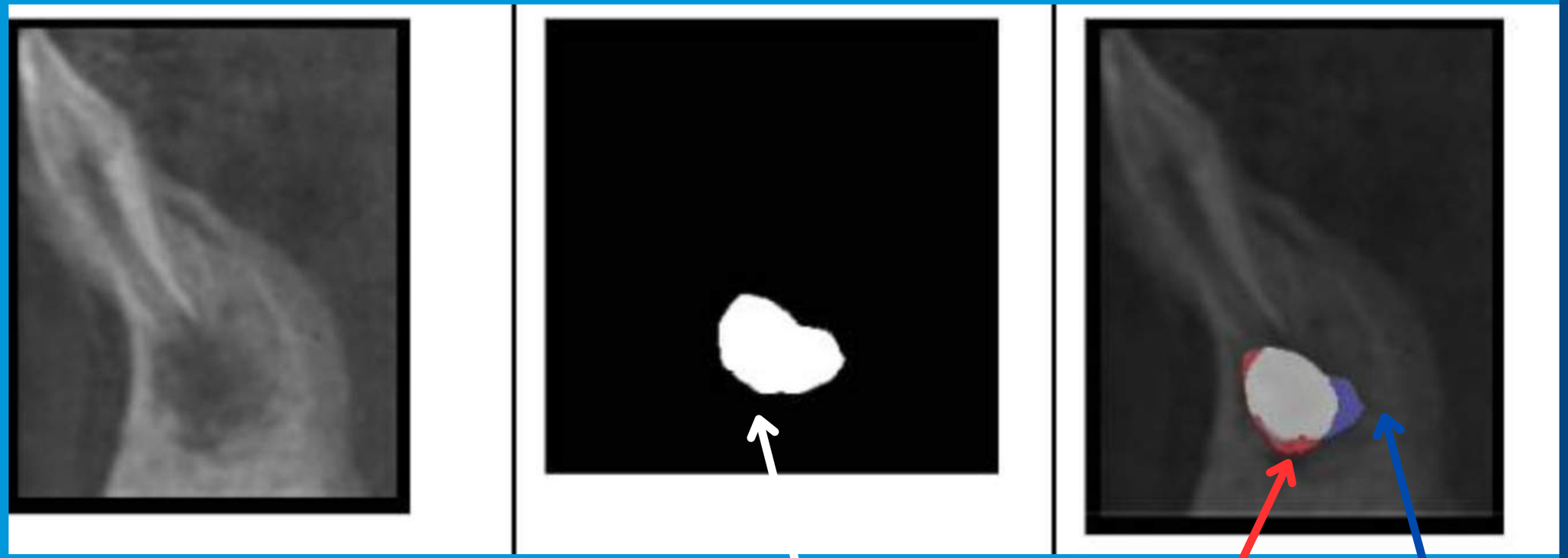
Objectives

To determine the value of a deep learning masked (DLM) auto-fixed volume of interest (VOI) segmentation method as an alternative to manual segmentation for radiomics-based diagnosis of clinically significant (CS) prostate cancer (PCa) on biparametric magnetic resonance imaging (bpMRI).

Expert manual segmentation

The average time spent on a single manual lesion segmentation was approximately 5 min for the total process (i.e., segmenting each slice where the lesion occurs). The radiomics model based on the expert manual segmentation (booster: gbtree, boosting rounds: 9, max depth: 3, features: 31) achieved a test AUC of 0.62 (95% CI: 0.52–0.73). Test sensitivity and specificity of the expert manual segmentation was 0.84 (95% CI: 0.73–0.94) and 0.45 (95% CI: 0.32–0.57) at an optimized threshold (0.181). The final model feature list can be found in Electronic supplementary material 3.

IMPACT OF SMILED



Red: Ground Truth
Blue :Segmentation by SMILED
White: Intersection of Union (87%)

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PROTOTYPE DEMO

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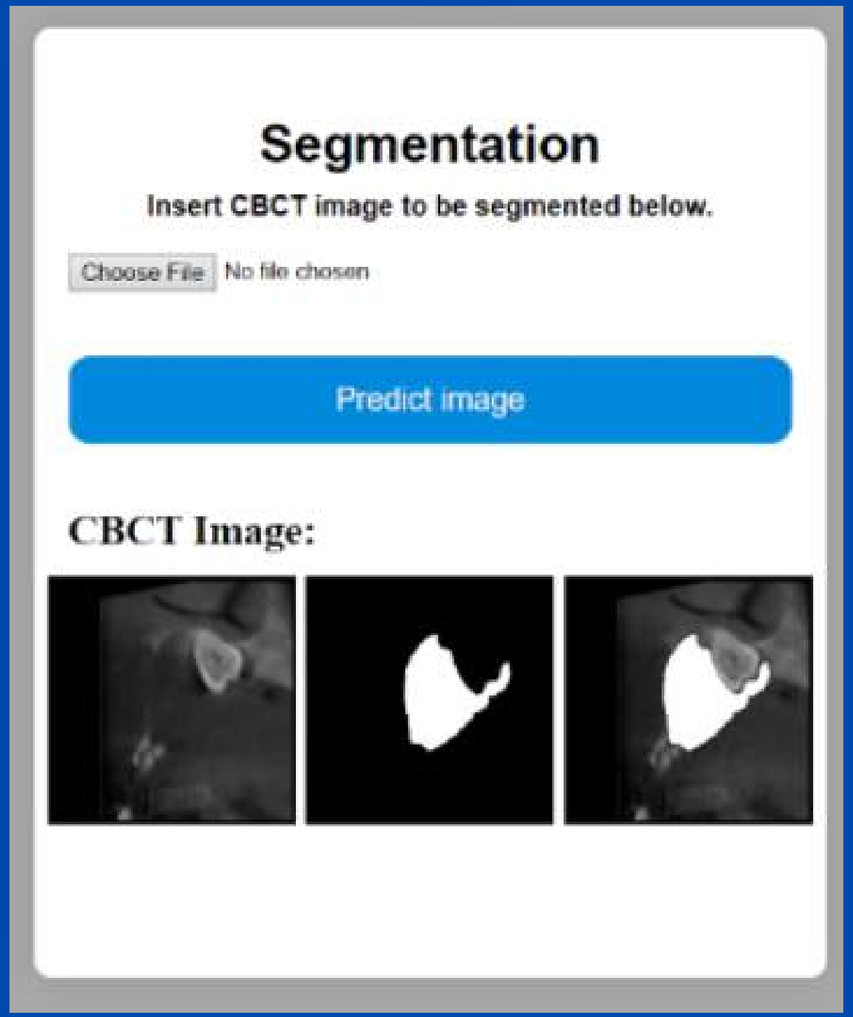
SMILED

SMART MACHINE FOR IDENTIFYING
DENTAL LESION IN DENTAL RADIOGRAPH



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MARKET SIZE

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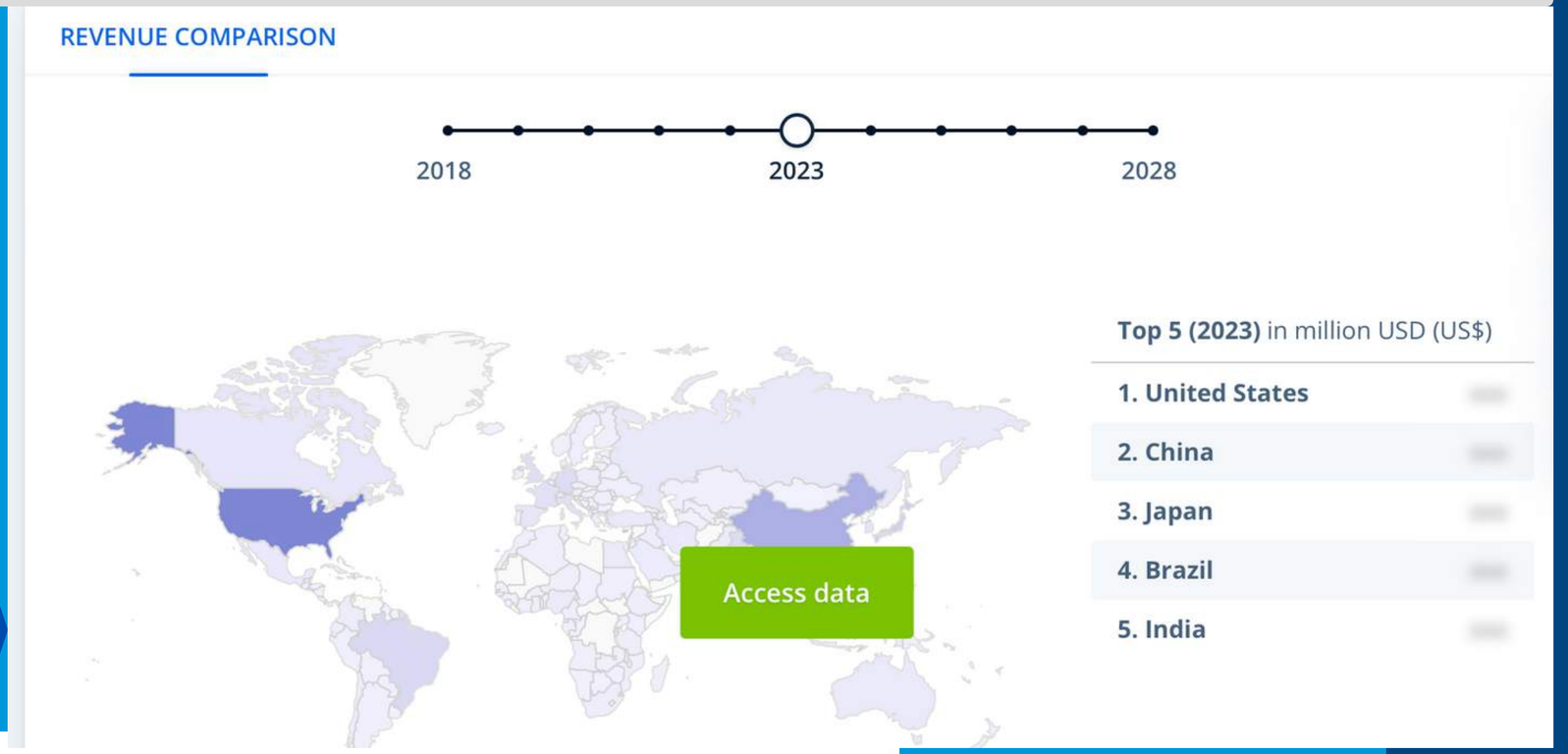
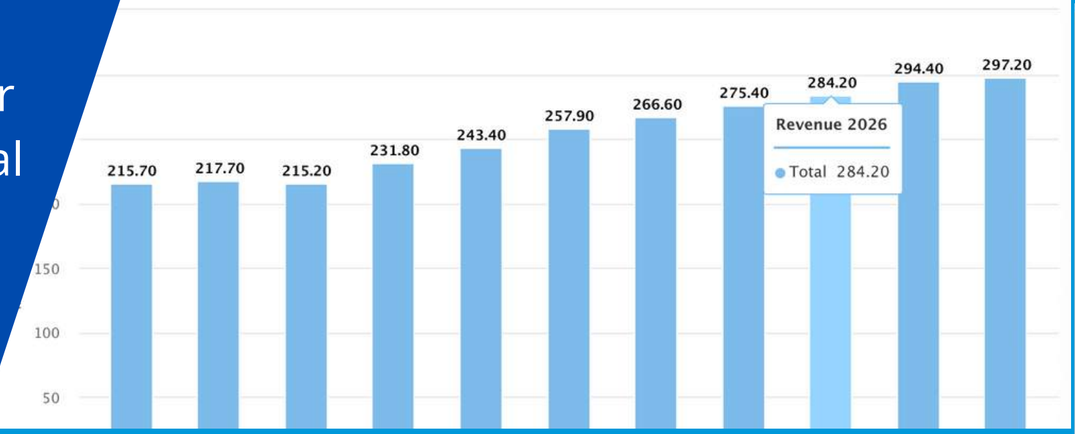
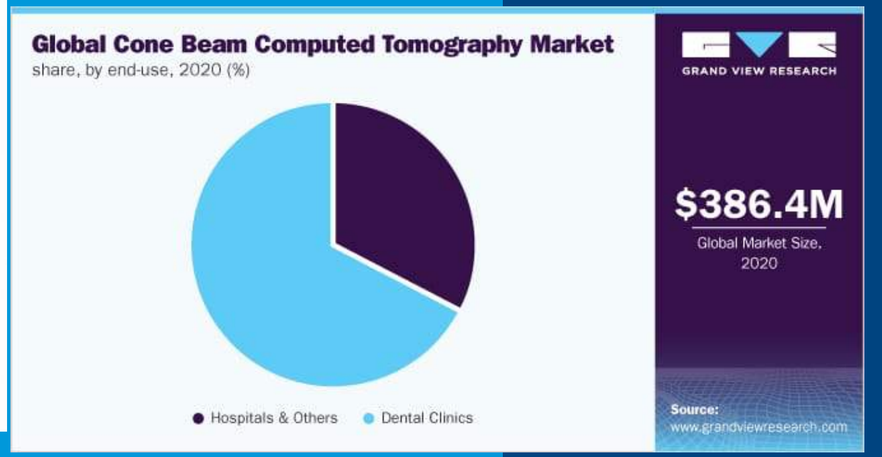
The overall global dental xray radiology market is expected to grow up to USD 5.3 Bilion in 2030.

The current CBCT market size value in 2021 is USD 477.1 million and expected to grow to USD 1.07 billion in 2028. CBCT offers 3D data visualization at much lower radiation than conventional CT scan at a significantly higher resolution.







PUBLICATIONS

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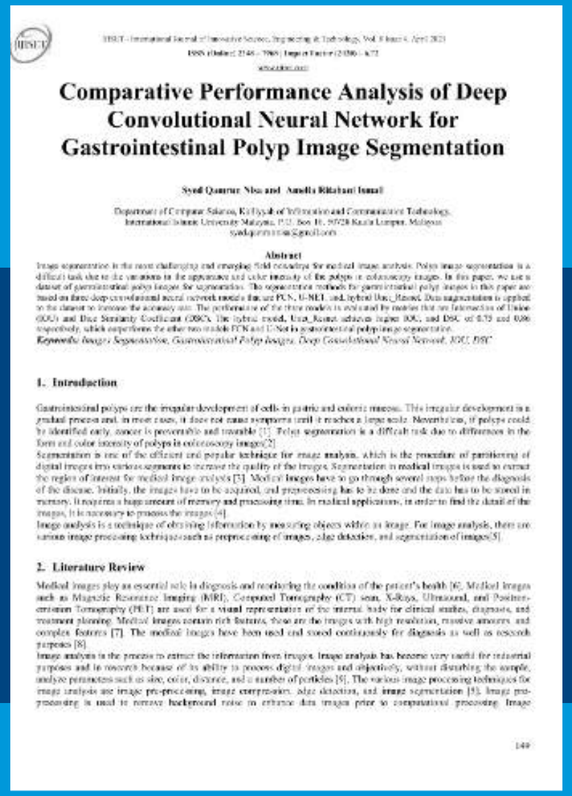
Dual U-Net with Resnet Encoder for Segmentation of Medical Images

Dual U-Net with Resnet Encoder for Segmentation of Medical Images
January 2022
International Journal of Advanced Computer Science and Applications
13(12) (Scopus)
DOI:10.14569/IJACSA.2022.0131265


Comparative Performance Analysis of Deep Convolutional Neural Network for Gastrointestinal Polyp Image Segmentation

Comparative Performance Analysis of Deep Convolutional Neural Network for Gastrointestinal Polyp Image Segmentation
April 2021
International Journal of Innovative Research in Science Engineering and Technology 8(4):8

Medical Image Analysis using Deep Learning: A Review

Medical Image Analysis using Deep Learning: A Review
December 2020
DOI:10.1109/ICETAS51660.2020.9484287
Conference: 2020 IEEE 7th International Conference on Engineering Technologies and Applied Sciences (ICETAS)

DOCUMENTS

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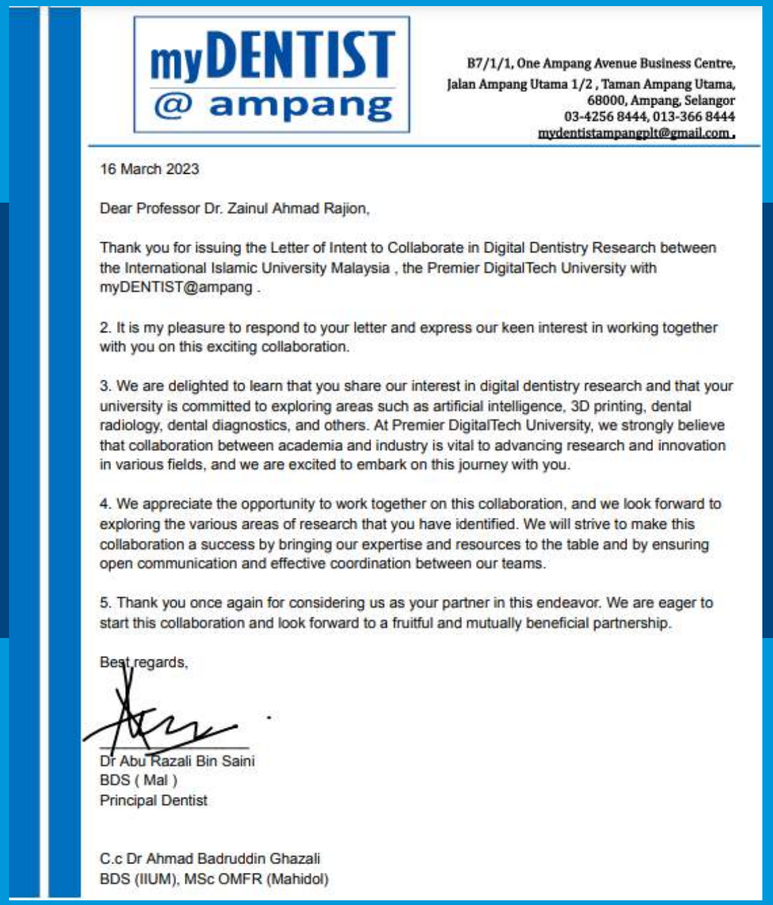

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mydentistampangplt@gmail.com ,

16 March 2023

Dear Professor Dr. Zainul Ahmad Rajion,

Thank you for issuing the Letter of Intent to Collaborate in Digital Dentistry Research between the International Islamic University Malaysia , the Premier DigitalTech University with myDENTIST@ampang .

2. It is my pleasure to respond to your letter and express our keen interest in working together with you on this exciting collaboration.

3. We are delighted to learn that you share our interest in digital dentistry research and that your university is committed to exploring areas such as artificial intelligence, 3D printing, dental radiology, dental diagnostics, and others. At Premier DigitalTech University, we strongly believe that collaboration between academia and industry is vital to advancing research and innovation in various fields, and we are excited to embark on this journey with you.

4. We appreciate the opportunity to work together on this collaboration, and we look forward to exploring the various areas of research that you have identified. We will strive to make this collaboration a success by bringing our expertise and resources to the table and by ensuring open communication and effective coordination between our teams.

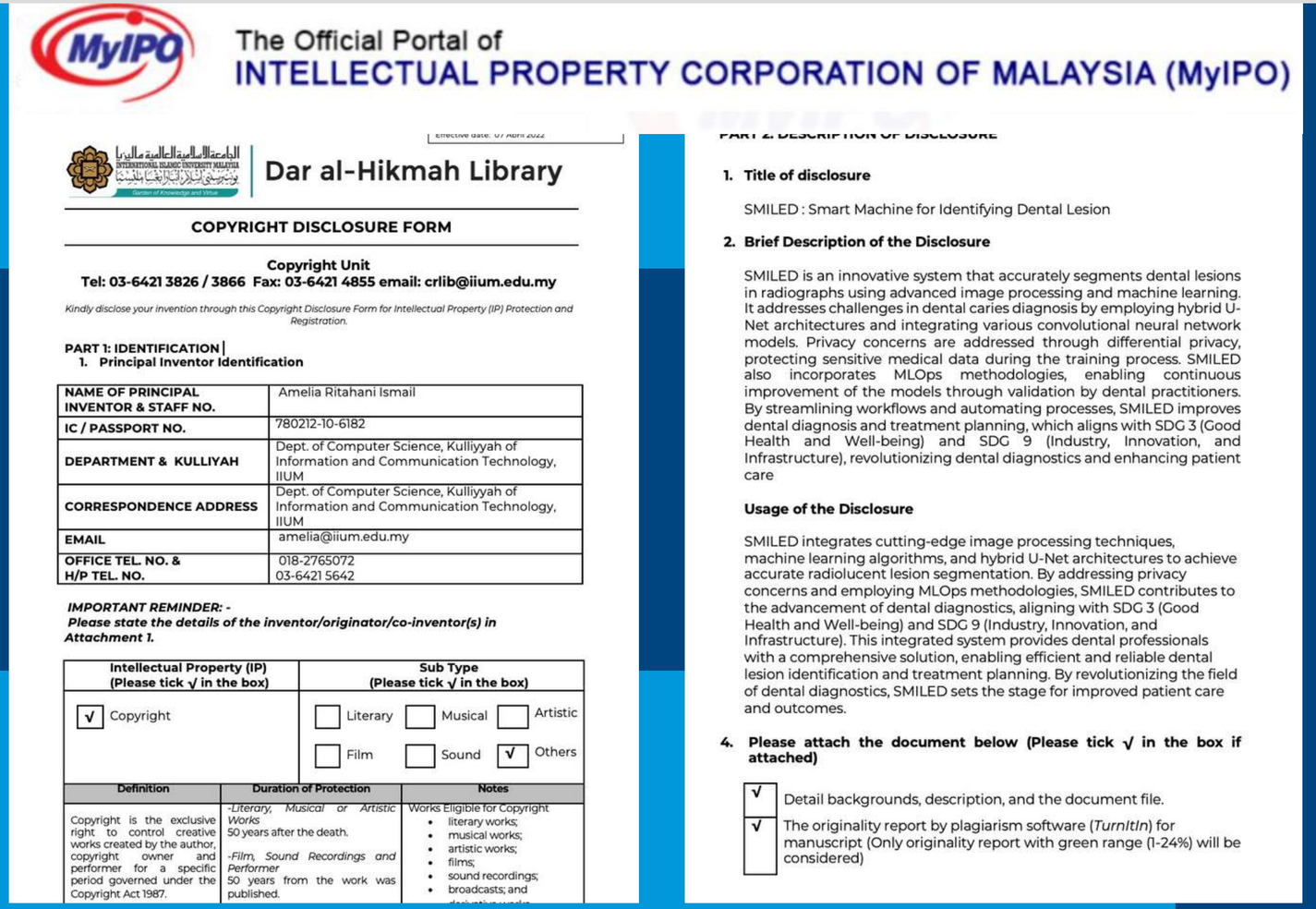
5. Thank you once again for considering us as your partner in this endeavor. We are eager to start this collaboration and look forward to a fruitful and mutually beneficial partnership.

Best regards,

Dr Abu Razali Bin Saini
BDS (Mal)
Principal Dentist

C.c Dr Ahmad Badruddin Ghazali
BDS (IIUM), MSc OMFR (Mahidol)

Letter of Intent : For Dental Practitioners Validation and future usage from myDentist Ampang Clinic



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PART 1: IDENTIFICATION
1. Principal Inventor Identification

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IMPORTANT REMINDER: -
Please state the details of the inventor/originator/co-inventor(s) in Attachment 1.

Intellectual Property (IP) (Please tick √ in the box)	Sub Type (Please tick √ in the box)
[√] Copyright	[ ] Literary [ ] Musical [ ] Artistic [ ] Film [ ] Sound [√] Others

Definition	Duration of Protection	Notes
Copyright is the exclusive right to control creative works created by the author, copyright owner and performer for a specific period governed under the Copyright Act 1987.	*-Literary, Musical or Artistic Works* 50 years after the death. *-Film, Sound Recordings and Performer* 50 years from the work was published.	Works Eligible for Copyright • literary works; • musical works; • artistic works; • films; • sound recordings; • broadcasts; and

PART 2: DESCRIPTION OF DISCLOSURE

1. Title of disclosure

SMILED : Smart Machine for Identifying Dental Lesion

2. Brief Description of the Disclosure

SMILED is an innovative system that accurately segments dental lesions in radiographs using advanced image processing and machine learning. It addresses challenges in dental caries diagnosis by employing hybrid U-Net architectures and integrating various convolutional neural network models. Privacy concerns are addressed through differential privacy, protecting sensitive medical data during the training process. SMILED also incorporates MLOps methodologies, enabling continuous improvement of the models through validation by dental practitioners. By streamlining workflows and automating processes, SMILED improves dental diagnosis and treatment planning, which aligns with SDG 3 (Good Health and Well-being) and SDG 9 (Industry, Innovation, and Infrastructure), revolutionizing dental diagnostics and enhancing patient care

Usage of the Disclosure

SMILED integrates cutting-edge image processing techniques, machine learning algorithms, and hybrid U-Net architectures to achieve accurate radiolucent lesion segmentation. By addressing privacy concerns and employing MLOps methodologies, SMILED contributes to the advancement of dental diagnostics, aligning with SDG 3 (Good Health and Well-being) and SDG 9 (Industry, Innovation, and Infrastructure). This integrated system provides dental professionals with a comprehensive solution, enabling efficient and reliable dental lesion identification and treatment planning. By revolutionizing the field of dental diagnostics, SMILED sets the stage for improved patient care and outcomes.

4. Please attach the document below (Please tick √ in the box if attached)

√	Detail backgrounds, description, and the document file.
√	The originality report by plagiarism software (*TurnItIn*) for manuscript (Only originality report with green range (1-24%) will be considered)

Copyright Submission: In Progress

1. **Smiled systems**
2. **Hybrid Model for Dental Leison Segmentation**

VALIDATION

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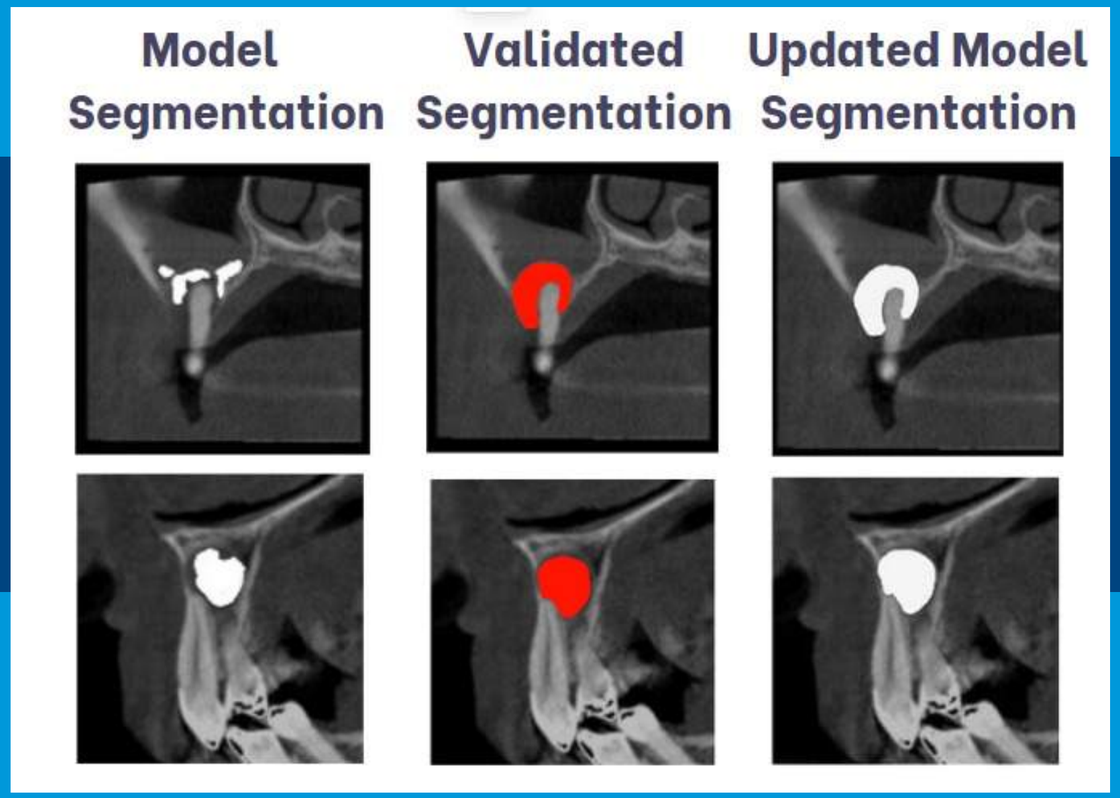

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Dr Abu Razali Bin Saini
BDS (Mal)
Principal Dentist

C.c Dr Ahmad Badruddin Ghazali
BDS (IIUM), MSc OMFR (Mahidol)

The study was approved by the International Islamic University Malaysia Research Ethics Commitee, approval no. **(IIUM IREC 2022-152)**

CONCLUSIONS --

SMILED integrates cutting-edge image processing techniques, machine learning algorithms, and hybrid U-Net architectures to achieve accurate radiolucent lesion segmentation

By addressing privacy concerns and employing MLOps methodologies

SMILED contributes to the advancement of dental diagnostics with comprehensive & effective lesion segmentation ensured by the combination of cutting-edge approaches resulting in a solution with global application potential

http://smiled.live

This integrated system provides dental professionals with a comprehensive solution, enabling efficient and reliable dental lesion identification and treatment planning.

By revolutionizing the field of dental diagnostics, SMILED sets the stage for improved patient care and outcomes

SMILED
SMART MACHINE FOR IDENTIFYING DENTAL LESION IN DENTAL RADIOGRAPH

Our Team

http://smiled.live

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