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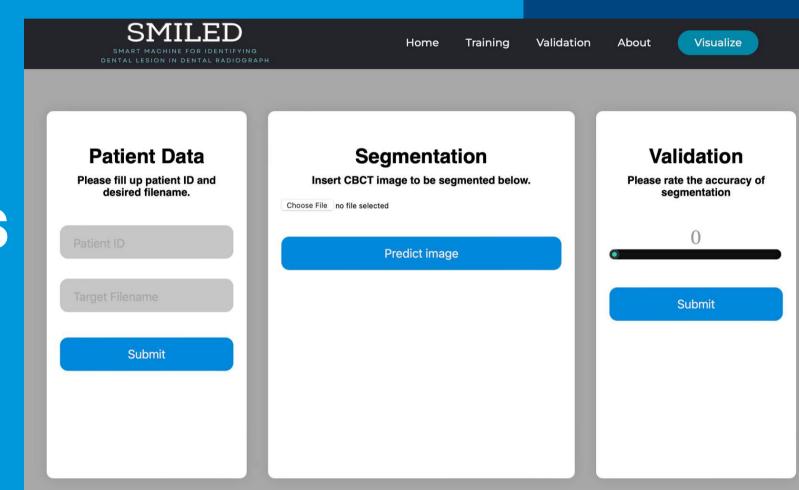






SMILED:

Smart Machine for Identifying dental Lesions with Efficient and accurate Detection











International Islamic University Malaysia















Assoc. Prof. Dr. Amelia Ritahani Ismail

- http://smiled.live

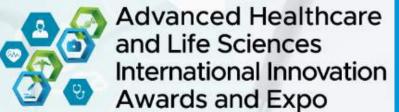
- amelia@iium.edu.my

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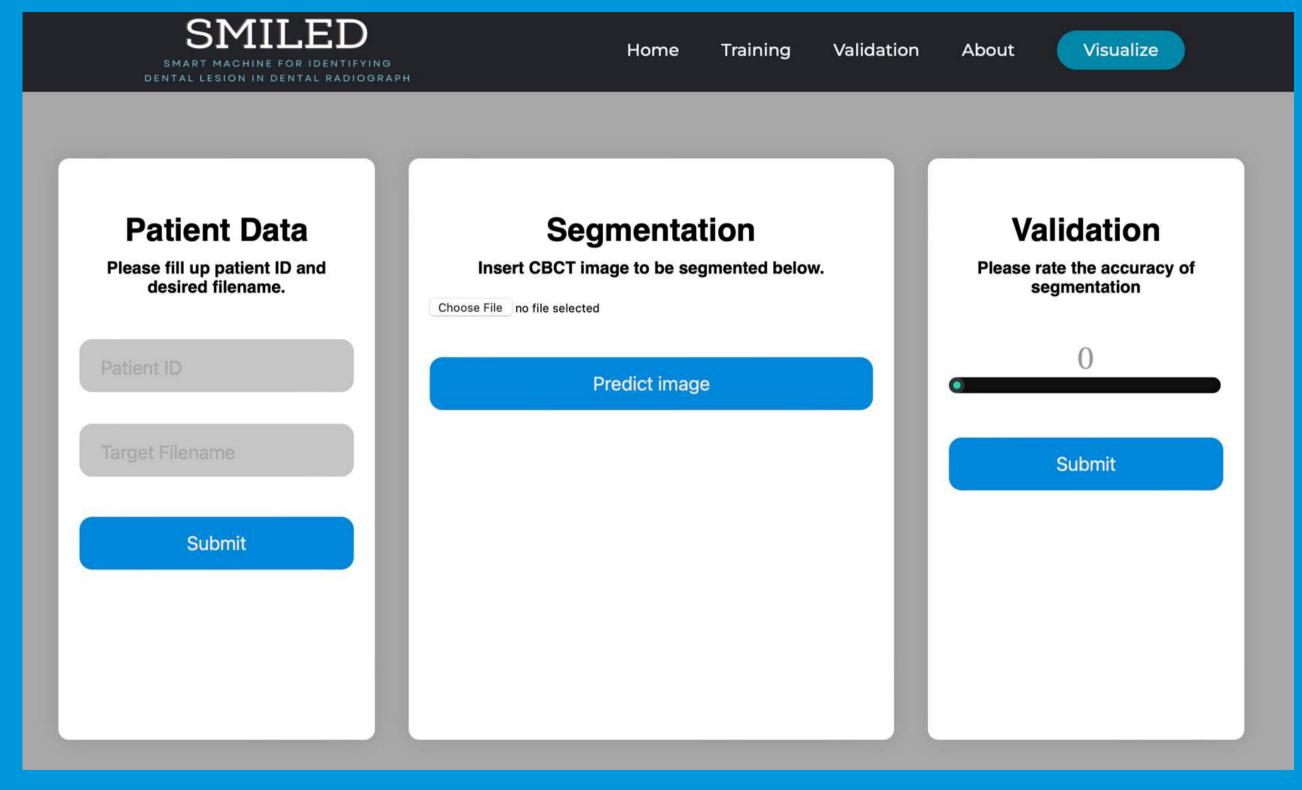






A Leading Global Innovation and Technology Event







Status of Invention : Prototype

INTRODUCTION

SMILED

SMART MACHINE FOR IDENTIFYING
DENTAL LESION IN DENTAL RADIOGRAPH



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

3 GOOD HEALTH AND WELL-BEING



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



ROLE OF Al in



Dental Lesion Classification & Segmentation

01

Among all the Al applications in dentistry, the most popular one is diagnosis. Al 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

Al 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 for dental treatment

Risto Tuominen

& Anna-Leena Eriksson

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

66 Download citation

https://doi.org/10.3109/00016357.2011.575079

Full Article

Figures & data

References 66 Citations

Metrics

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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.

PAIN



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

Mitali Pareek1*, Brahmansh Kaushik2

¹Mahatma Gandhi Dental College and Hospital, Jaipur, Rajasthan, India

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

²Department of Mechanical Engineering, Indian Institute of Technology Jammu, Jammu and Kashmir, India

NOVELTY



SMILED

DENTAL LESION IN DENTAL RADIOGRAPH

Home

Training

Validation /

About

Visualize

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

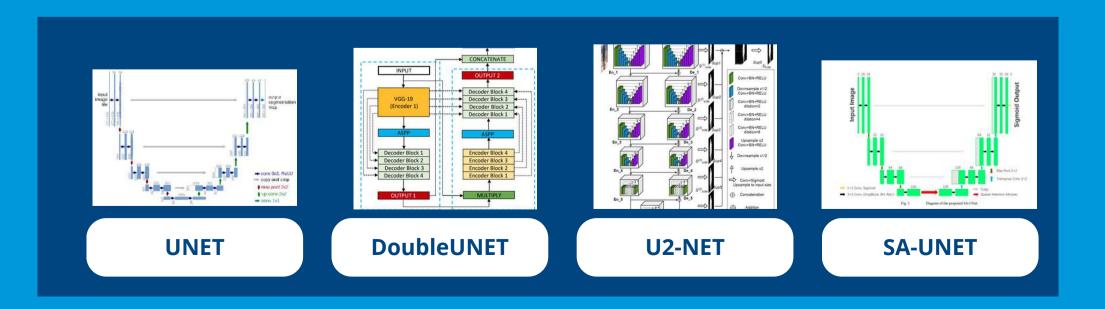


Cone Beam Computed Tomography (CBCT) images

advanced image processing

machine learning

UNET & hybrid U-Net architectures involved:



COMPARISON





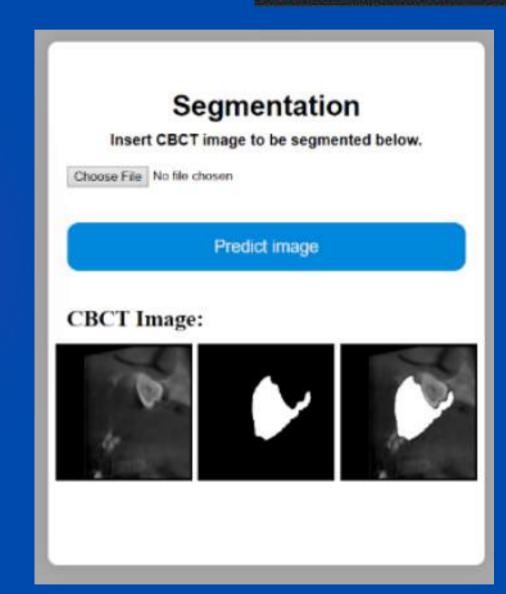


- Complex X-ray images
- Shows the potential segment in box
- Presence of noise due to lack or reliable saperation of between teeth
- Image is not secured



SMILED

SMART MACHINE FOR IDENTIFYING DENTAL LESION IN DENTAL RADIOGRAP

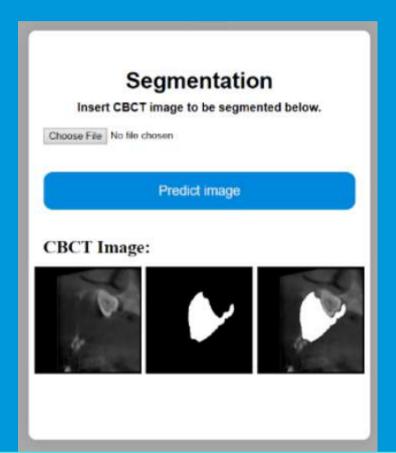


- CBCT Image
- Shows the actual segment of the lesion
- Secured Image (Privacypreserved)

VALUE PROPOSITION OF SMILE

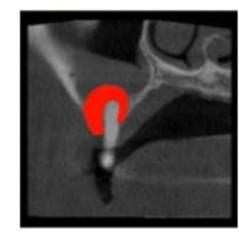


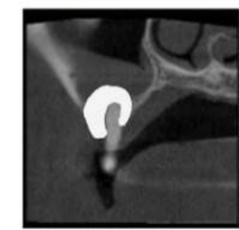




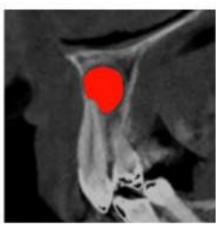
Model Validated Updated Model Segmentation Segmentation













- 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

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.

IMPACT OF SMILED



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

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 <u>Disclaimer</u>

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).

170%

decrease time taken to do lesion segmentation by using SMILED

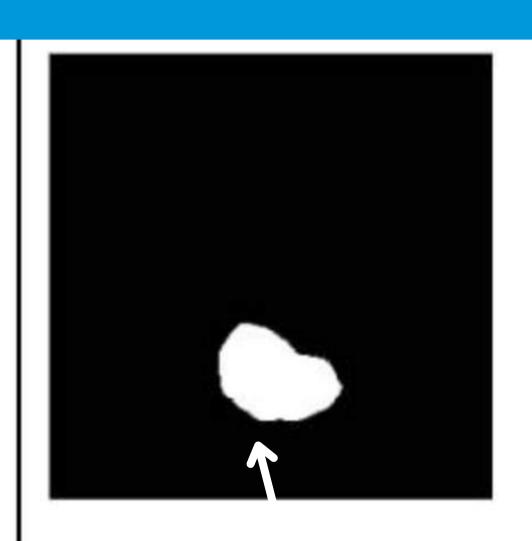
Expert manual segmentation

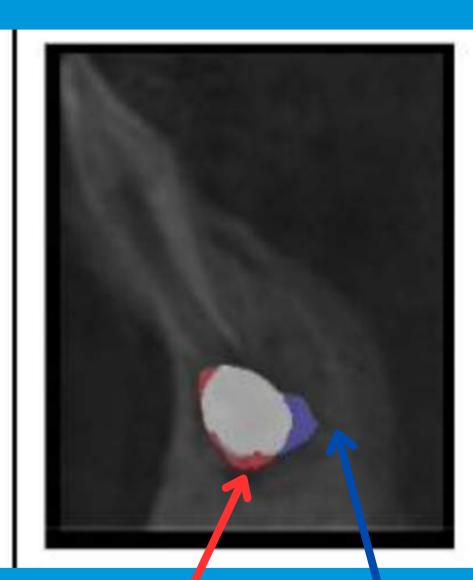
The average time spent on a single manual lesion segmentation was approximately 5 min for the total process (i.e., segmenting each slice where the lesion occurs). The radiomics model based on the expert manual segmentation (booster: gbtree, boosting rounds: 9, max depth: 3, features: 31) achieved a test 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

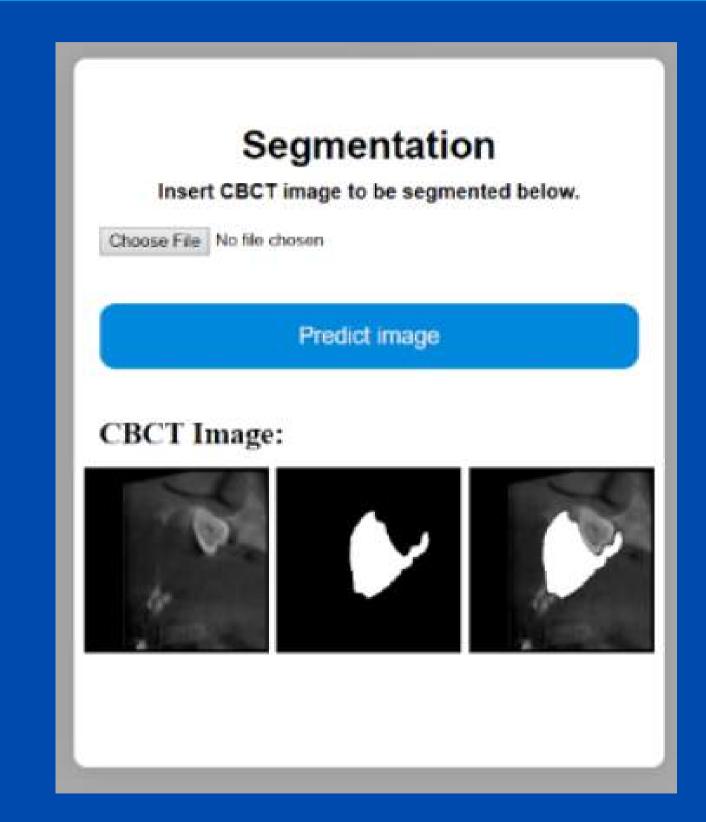
White: Intersection of Union (87%)

PROTOTYPE DEMO



SMILED

SMART MACHINE FOR IDENTIFYING
DENTAL LESION IN DENTAL RADIOGRAPH



MARKET SIZE



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.

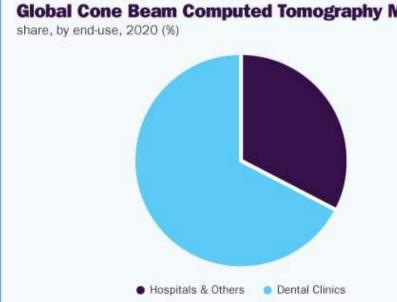


Revenue 2026

Total 284.20

231.80

217.70





PUBLICATIONS



HIGSA Manuscript Associated Manusch Common Systems and Applications and Alexander Associated States (A. No.) λ , λ (C. No.) λ

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

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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

1992 T. Improvisional Second of Improving Service, Projection & Technology, Vol. 5 Inter 4, April 2023 1985 (Oakley) 2548 - 7985 (Dept & English (2006) - 6.72

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

Syef Quarter Niscand, Amelia Ritchard Ismail

Department of Computer Salamos, Kirllysalt of Information and Communication Technology. International Islands University Malayeta, P.U. Box 10, 50728 Kaula Lampur, Malayeta swiggern research and con-

trage elementation is the recent challenging and emerging field reducing for medical integer analysis. Polyn integer segmentation is a official task here the variations in the appearance and other issued by the polyte in ordinarity image. In this paper, we use a dataset of germinatorized polyte image. So expressed in the opposition methods for parent interface polyte images for the paper are issued on free deep convolutional action interest, medical forcure P.N. U-N.U. and Joyce to the Joyce Data argumentation is applied to the dataset on the content of the Dataset P.N. U-N.U. and Joyce to the forcure P.N. U-N.U. and D.N. especifically, which corporations the other two madels PCN and U-Not in an strong testinal polyption to session trains Reprovide Image: Segmentation, Generalizational Palpy Images, Deep Consolutional Neural Network, 100, 1990.

Gustraintestinal polyps are the irregular development of cells in partic and cateria maccas. This irregular development is a gradual process and, in most cases, it does not cause symptoms until it maches a large scale. Nevertheless, if polyps could to identified early, soncer is preventable and transible [1]. Polyt segmentation is a difficult task due to differences in the orn and color intensity of polyps in colorascopy images [2]

Supportation is one of the officient and menular technique for many analysis. Which is the procedure of partitioning of digital troops into surface segments to memore the quality of the images. Segmentation in medical images is used to current the region of interest for medical image analysis [5]. Medical images have to go through several steps before the diagnosis. of the discuse, history, the images have to be acquired, and proposessing has to be done and the date has to be stored in marriary. It requires a hope answer of merrory and processing time. In made all applications, in order to find the datast of the

large analysis is a melasique of obtaining deformation by measuring objects within an image. For image analysis, there are various image processing techniques such as preprice sing of images, edge detection, and segmentation of images [5]

Medical images play as essential rule is dispossis and nonliving the condition of the patient's beath [6]. Medical images such as Magnetic Resonance Imaging (MRI), Computed Tomography (CT) sean, X-Roys, Ulmasound, and Positioncritation Tomography (PET) are used for a visual representation of the internal hady for clinical studies, diagnosis, and restment planning. Meditor' images contain rich features, these are the images with high resolution, massive amounts and complex features [7]. The medical images have been used and sweed continuously for diagnosis as well as research

Image analysis is the process to extract the information from images. Image analysis has become very usofil for industria purposes and in research because of its ability to process digital images and objectively, without disturbing the complex analyze permeters such as size, color, distance, and a number of perticles [8]. The various image processing techniques for mass analysis are image pro-processing, image compression, also detection, and image segmentation 193, Image maprocessing is used to nonexy background noise in orbanic data images prior to computational processing Image

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

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Medical Image Analysis using Deep Learning: A Review

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E. MEDICALIMATES.

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Segmentation is a wardy applicable undensiting in relient image applyeds. An exact regimentation of medical mages in a significant very in shaping during the course of to flor nearly research. The process of solitting hange evenly to Bornestry research. The process of soliding image eventy the section parts in order on fraging regressionate. Mather that measurement for notice image of the same time too draw will be areas in the image which do not commit any information. It is before no concentrate on a specific area in a related to region. The prime good of the image sequentialities to be terrified the use that of girling as the section part of the object too simpler analysis purpose; [7]. Segmentation of soliding the image may be segmented, for investigation proof-inging, consignors regions and object limitation. Image region, or inguists regions and opport problems. Image regionment and important bods which obtain the region of it must 100M in the image. The stream regioned to the complemental or medical image facilities. Future C-Maint, morphological emodeling on New Jerge of constant scription and miningum image, Only feed on command scription and miningum and formal net (15) in miningum mage [6].

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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





B7/1/1, One Ampang Avenue Business Centre, Jalan Ampang Utama 1/2, Taman Ampang Utama, 68000, Ampang, Selangor 03-4256 8444, 013-366 8444 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.

Dr Abu Razali Bin Sain 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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DEPARTMENT & KULLIYAH	Dept. of Computer Science, Kulliyyah of Information and Communication Technology, IIUM
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EMAIL	amelia@iium.edu.my
OFFICE TEL. NO. & H/P TEL. NO.	018-2765072 03-6421 5642

IMPORTANT REMINDER: -

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

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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

Copyright Submission: In Progress

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

PART A. 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

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

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

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-1		- 1
-1		- 1

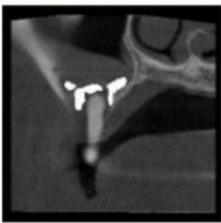
Detail backgrounds, description, and the document file.

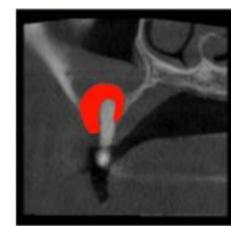
✓ The originality report by plagiarism software (TurnItIn) for manuscript (Only originality report with green range (1-24%) will be considered)

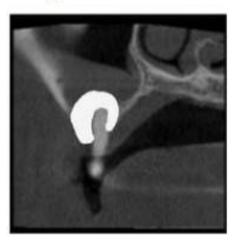
VALIDATION

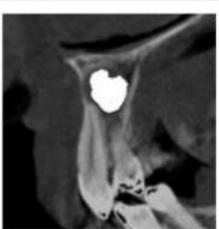


Model Validated Updated Model Segmentation Segmentation















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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.

- 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.
- 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) 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 cuttingedge approaches resulting in a solution with global application potential

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





Our Team ®



http://smiled.live



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