E-PROCEEDINGS

INTERNATIONAL TINKER INNOVATION & ENTREPRENEURSHIP CHALLENGE (i-TIEC 2025)

"Fostering a Culture of Innovation and Entrepreneurial Excellence"

23 January 2025
PTDI, UiTM Cawangan Johor
Kampus Pasir Gudang

ORGANIZED BY:

Electrical Engineering Studies, College of Engineering
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Editors

Aznilinda Zainuddin

Maisarah Noorezam

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CONTENTS

PREFACE

It is with great pleasure that we present the e-proceedings of International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), which compiles the extended abstracts submitted to the International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), held on 23 January 2025 at **PTDI, Universiti Teknologi MARA (UiTM) Cawangan Johor, Kampus Pasir Gudang.** This publication serves as a valuable resource, showcasing the intellectual contributions on the invention and innovation among students, academics, researchers, and professionals.

The International Tinker Innovation & Entrepreneurship Challenge (i-TIEC 2025), organized under the theme "Fostering a Culture of Innovation and Entrepreneurial Excellence," is designed to inspire participants at various academic levels, from secondary students to higher education students and professionals. The competition emphasizes both innovation and entrepreneurship, encouraging the development of product prototypes that address real-world problems and have clear commercialization potential. By focusing on technological and social innovations, i-TIEC 2025 highlights the importance of turning creative ideas into viable, market-ready solutions that can benefit users and society. The extended abstracts in this e-proceedings book showcase the diverse perspectives and depth of research presented during the event, reflecting the strong entrepreneurial element at its core.

We extend our sincere gratitude to the contributors for their dedication in sharing their innovation and the organizing committee for their hard work in ensuring the success of the event and this publication. We also appreciate the support of our collaborators; Mass Rapid Transit Corporation Sdn. Bhd. (MRT Corp), Universitas Labuhanbatu, Indonesia (ULB), Universitas Riau Kepulauan, Indonesia (UNRIKA) and IEEE Young Professionals Malaysia, whose contributions have been instrumental in making this event and publication possible.

We hope that this e-proceedings book will serve as a valuable reference for researchers, educators, and practitioners, inspiring further studies and collaborations in both innovation and entrepreneurship. May the knowledge shared here continue to spark new ideas and market-ready solutions, advancing our collective expertise and fostering the growth of entrepreneurial ventures.

B-ST132: MEDMATHEMATICA: ADVANCING CANCER SEGMENTATION THROUGH MATHEMATICAL MODELING

Akmal Shafiq Badarul Azam[1], Abdul Kadir Jumaat[2,5], Shafaf Ibrahim[3], and Mohd Hafizz Wondi[4]
[1]School of Mathematical Sciences, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA, Sarawak Branch, Mukah Campus, Mukah, Sarawak, Malaysia
[2]School of Mathematical Sciences, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA Shah Alam, Selangor, Malaysia
[3]School of Computing Sciences, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA Shah Alam, Selangor, Malaysia
[4]Faculty of Plantation and Agrotechnology, Universiti Teknologi MARA Cawangan Sarawak, Kampus Mukah, Mukah, Sarawak, Malaysia
[5]Institute for Big Data Analytics and Artificial Intelligence (IBDAAI), Universiti Teknologi MARA Shah Alam, Selangor, Malaysia

Corresponding author: Akmal Shafiq Badarul Azam, akmalshafiq@uitm.edu.my

ABSTRACT

MedMathematica is an innovative computer-aided detection (CAD) system designed to improve the accuracy and efficiency of cancer segmentation in medical imaging. This system employs the novel Selective Local Image Fitting (SLIF) model, a mathematical approach that addresses common challenges in cancer imaging, such as intensity inhomogeneity and low contrast. Unlike traditional methods, MedMathematica segments cancer abnormalities in both color and grayscale images without converting them to grayscale, preserving critical data and enhancing accuracy. Developed to meet the demands of radiologists and healthcare professionals, MedMathematica achieves a high Dice accuracy of 93.32% and a rapid processing time of 0.9483 seconds. Its user-friendly interface ensures accessibility, even for resource-limited healthcare settings. MedMathematica's impact extends beyond healthcare. By enabling early and precise cancer detection, it improves patient outcomes and reduces healthcare costs associated with late-stage treatment. Its commercialization potential includes partnerships with healthcare institutions, medical device companies, and academic research centers, offering scalability and adaptability across global markets. This innovation not only exemplifies the power of mathematical modeling in medicine but also contributes to socioeconomic goals by fostering healthcare innovation, improving public health, and supporting national initiatives like Malaysia's Shared Prosperity Vision 2030.

Keywords: Cancer Detection, Image Segmentation, Mathematical Modeling, Medical Images, Variational Model.

1. Product Description

MedMathematica is a revolutionary cancer segmentation tool designed to address key challenges in medical imaging, such as intensity inhomogeneity, low contrast, and the subtle nature of abnormalities. Its user-friendly interface, as shown in **Figure 1**, simplifies the

process of segmentation. Users can input medical images, initialize segmentation markers, and compare results with expert-validated benchmarks. The GUI displays essential outputs, including binary and boundary segmentation results, and provides metrics such as Dice Similarity Coefficient, Hausdorff Distance, and processing time, ensuring comprehensive analysis.

The system's performance is demonstrated in **Table 1**, which showcases segmentation results for various types of cancer images, including grayscale mammograms, ultrasounds, and MRIs, as well as color melanoma and brain images. The segmentation aligns closely with expert benchmarks, emphasizing the precision of the Selective Local Image Fitting (SLIF) model.

Moreover, **Table 2** highlights the system's exceptional performance metrics. With a Dice accuracy of 93.32%, an average Hausdorff Distance of 3.0810, and a rapid processing time of 0.9483 seconds, MedMathematica stands out as a highly efficient and accurate tool. These capabilities position it as a transformative innovation in cancer detection, bridging computational advances and real-world medical applications.

2. Figure of MedMathematica System

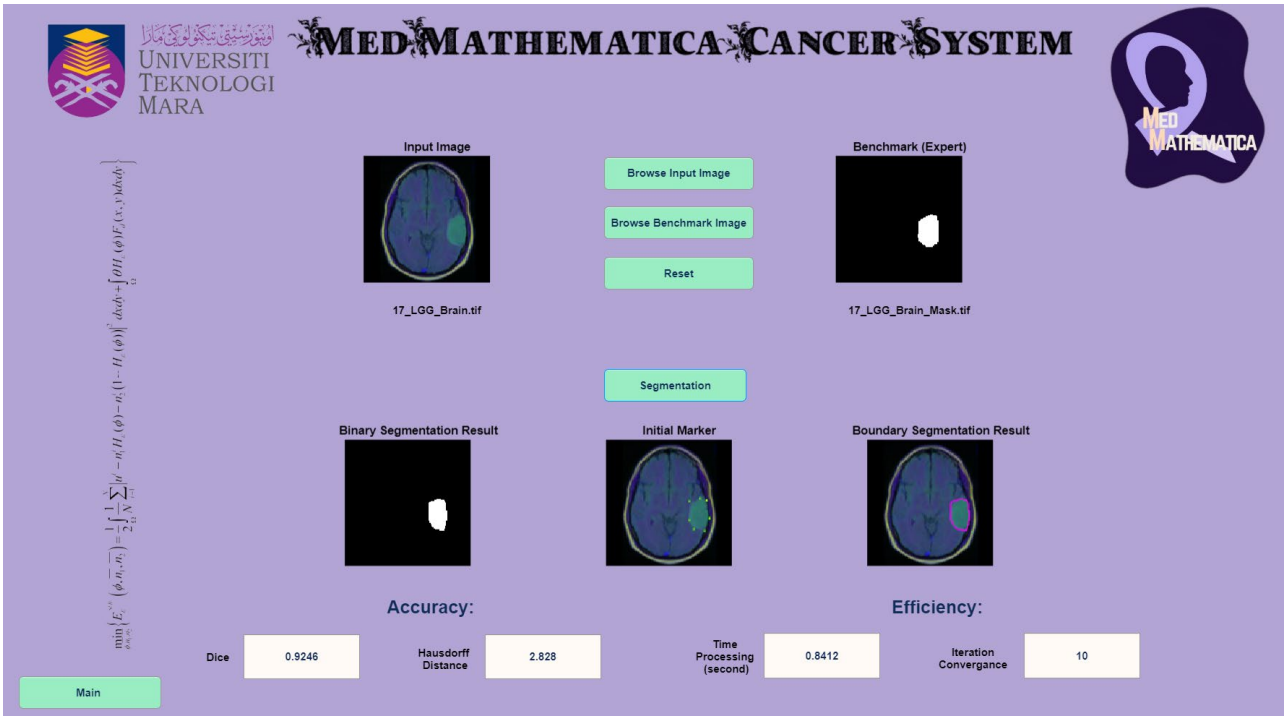


Figure 1. Graphical User Interface (GUI) of MedMathematica

Table 1. Segmentation Results of Cancer Images

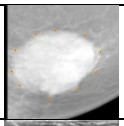
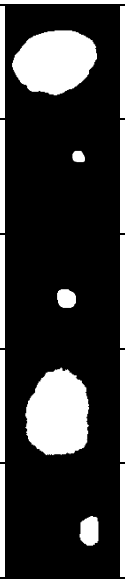
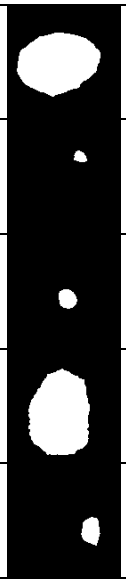
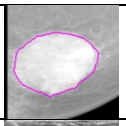
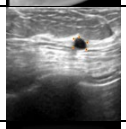
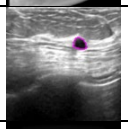
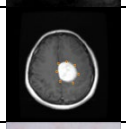
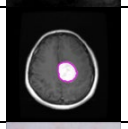
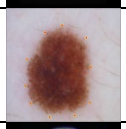
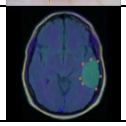
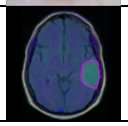
Type of Cancer Images	Medical Image with Initial Markers	Benchmark (Validated by Expert)	Binary Segmentation Result	Boundary Segmentation Result
Grayscale Breast Cancer Mammogram				
Grayscale Breast Cancer Ultrasound				
Grayscale Brain Meningioma MRI				
Color Melanoma Skin Cancer Dermoscopic				
Color Brain LGG MRI				

Table 2. Average Performance Evaluation

Average Dice Similarity Coefficient	Average Hausdorff Distance	Average Time Processing	Average Number of Iterations
0.9332	3.0810	0.9483	22

3. Novelty and uniqueness

MedMathematica redefines cancer segmentation with its Selective Local Image Fitting (SLIF) model, offering a groundbreaking approach to address longstanding challenges in medical imaging. Unlike traditional CAD systems that rely on grayscale conversions, MedMathematica retains critical image data by directly processing both color and grayscale images. This capability enhances segmentation accuracy, especially for abnormalities with intensity inhomogeneity and subtle boundaries. Its GUI simplifies the user experience, enabling radiologists and healthcare professionals to achieve precise segmentation with minimal technical expertise. With high Dice accuracy (93.32%) and rapid processing time (0.9483 seconds), MedMathematica ensures reliable and efficient results, outperforming many existing systems. The system's novel mathematical formulation allows localized segmentation, making it more versatile for diverse cancer types and imaging modalities. By bridging mathematics and medicine, MedMathematica stands out as a transformative tool that raises the standard for cancer detection and medical imaging technologies globally.

4. Benefit to mankind

MedMathematica enhances public health by enabling precise, early cancer detection. Its high accuracy and efficiency ensure better diagnosis, leading to improved treatment outcomes and reduced mortality rates. By addressing challenges like low contrast and intensity inhomogeneity, it provides reliable results for diverse cancer types and imaging modalities.

The system reduces the burden on healthcare professionals, offering a time-saving, user-friendly solution for segmentation tasks. Its accessibility ensures deployment in resource-limited settings, democratizing access to advanced diagnostic tools. This directly benefits underserved populations, contributing to global health equity. By promoting early intervention, MedMathematica reduces the financial burden of late-stage cancer treatments on patients and healthcare systems. Its alignment with societal goals, such as Malaysia's Shared Prosperity Vision 2030, underscores its broader impact on public health and human capital development.

5. Innovation and Entrepreneurial Impact

MedMathematica fosters a culture of innovation by demonstrating the transformative potential of mathematical modeling in medicine. Its novel SLIF model inspires further advancements in medical imaging, encouraging collaboration between mathematicians, healthcare professionals, and industry stakeholders. The project highlights the power of user-centered design, enabling seamless integration of advanced tools into healthcare workflows. This approach encourages other innovators to prioritize accessibility and functionality in technological solutions. From an entrepreneurial perspective, MedMathematica provides opportunities for commercialization, research, and development. By addressing a critical healthcare challenge with a scalable and adaptable solution, it paves the way for partnerships with healthcare institutions, medical device companies, and academic research centers. The project serves as a model for leveraging innovation to create social and economic impact within the community and beyond.

6. Potential commercialization

MedMathematica is primed for commercialization due to its versatile and cost-effective design. Its primary target markets include hospitals, diagnostic centers, and research institutions, where its precise segmentation capabilities can enhance cancer diagnosis and treatment planning. The system's PC-compatible software ensures easy deployment without requiring specialized hardware, making it suitable for diverse healthcare environments. Collaborations with medical device companies and distributors can expand its reach, leveraging established networks to penetrate global markets. Additionally, MedMathematica's adaptability to different imaging modalities and cancer types broadens its applicability, appealing to a wide audience of healthcare professionals. Its high accuracy and rapid processing time position it as a competitive tool in the growing medical imaging sector. These features, combined with its ability to reduce costs and improve patient outcomes, ensure strong market demand and long-term scalability.

7. Acknowledgment

Special thanks were extended to the School of Computing, Informatics and Mathematics, Universiti Teknologi MARA.

8. Authors' Biography

Akmal Shafiq Badarul Azam is currently a lecturer in mathematics at Universiti Teknologi MARA (UiTM), Mukah Campus, Sarawak. He earned his B.Sc. in Computational Mathematics and M.Sc. in Applied Mathematics (Financial and Management Mathematics) from Universiti Teknologi MARA (UiTM), Malaysia, in 2021 and 2022, respectively. He is now pursuing a Ph.D. in Mathematics at UiTM. His research interests include mathematical image analysis, medical image processing, computer vision, applied mathematics and mathematics education.

Abdul Kadir Jumat received his B.Sc. and M.Sc. in Mathematics from the Universiti Teknologi MARA (UiTM) in Shah Alam, Malaysia, as well as his Ph.D. in Applied Mathematics (Mathematical Imaging Methods) from the University of Liverpool in the United Kingdom. He is currently employed by UiTM Shah Alam in Malaysia as a research fellow at the Institute for Big Data Analytics and Artificial Intelligence (IBDAAI) and a senior lecturer in the School of Mathematical Sciences, College of Computing, Informatics, and Mathematics. His research interests include image/signal processing, artificial intelligence, computer vision, biometrics, medical image and analysis, and pattern recognition.

Shafaf Ibrahim is an Associate Professor at the College of Computing, Informatics, and Mathematics, Universiti Teknologi MARA Shah Alam, Malaysia. She holds a Diploma, Bachelor's degree Masters, and Ph.D. in Computer Science. Her research interests include artificial intelligence, evolutionary algorithms, deep learning, machine learning, and image processing.

Mohd Hafizz Wondi is a lecturer at Universiti Teknologi MARA (UiTM's) Faculty of Plantation and Agrotechnology, with an M.Eng. in Agricultural Process Engineering from Universiti Putra Malaysia (UPM). With 4 years of industry experience in edible oil, his research focuses on agricultural mechanization, smart agriculture, sustainable farming, green energy solutions, and thermal imaging.