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

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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-ST010 - B-ST152

B-ST024: SOLAR PANEL HOTSPOT DETECTOR

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ABSTRACT

The solar industry that continues to grow bigger is facing a huge obstacle in maintaining solar panel lifespan and efficiency due to normal occurrence of hotspots and cracks on solar panel surface. These defects not only shorten the panels' lifespan and limit their energy output but also accelerate their disintegration, resulting in substantial financial losses. Traditional detection techniques are largely manual, time-consuming and prone to errors making it difficult to implement effective preventive maintenance strategies. To address this issue, this mobile solar panel hotspot detector is designed to ease the detection process by making the detection in real-time on mobile smartphone with practical application of a FOMO (Faster Object, More Object)-based machine learning model for the detection of defects on solar panels. The significance of this product lies in improving the efficiency of solar panels defect detection and no longer uses human's eyes capabilities only during human inspection. In addition, by ensuring that solar panels are well maintained and working optimally will guarantee a steady supply of solar energy. In the end, this simple product has the potential to yield important breakthroughs in renewable energy technology, promoting worldwide economic savings and energy security.

Keywords: Solar Panel Hotspot Detector, Faster Object More Object (FOMO), Edge Impulse

1. Product Description

The solar panel hotspot detector is designed to be able to differentiate between the normal working solar panel and a defective solar panel with hotspot using FOMO based algorithm on Edge Impulse platform. This solar panel hotspot detector aims to enhance the accuracy and ease the detection process by deploying the object detection model on smartphone for real-time defect detection. This proposed system is developed by collecting sample images with few hotspots in solar panel from Kaggle website. Next, data pre-processing is done to resize images to 416x416 pixels. The images is uploaded to Edge Impulse for data acquisition and labelling. The collected data is then split in ratio of 80:20 for model training dataset and testing dataset. Next, model training is carried out using FOMO algorithm on model training dataset. Next, data validation is done to validate the model with testing dataset and to analyze performance metrics. The model achieved an F1 Score of 80.5%, indicating that model is proficient at both identifying true positives and minimizing false negatives which is important for effective hotspot detection in solar panels. Then, real-time defect detection can be done by deploying the model to edge devices on smartphones to detect defects hotspot.

2. Pictures and Flow Charts

The overall step in developing this product is shown in **Figure 1**. The initial phase is to collect the dataset of the solar panel images with hotspot and without hotspot. **Figure 2** shown some samples of collected dataset of solar panel images. Next the selected dataset is uploaded into Edge Impluse IDE platform as illustrated in **Figure 3**. The second step is the data prepossessing, where the dataset is then undergone data images sizing. Then the next step is doing the data labeling as shown in **Figure 4**. The fourth step is designed suitable on edge computing object detection using machine learning, the FOMO algorithm is selected for feature extraction and objection detection of solar panel hotspot detection. Then in fifth steps, the model training of hotspot detection is then carried out, along with the testing and validation of dataset is also done to determine the model performance. After the model is optimized then the final step in this project involves deploying the trained model on a smartphone, fully utilize the device's camera to capture real-time images of the solar panels. The final step is important for transitioning from a theoretical model to practical which involve real-world application. Once deployed, the smartphone camera continuously captures frames of the solar panels. This real-time image acquisition is essential for monitoring the panels without interruption, providing a steady stream of visual data for analysis. The constant feed of images ensures that any changes or anomalies in the solar panel conditions are detected promptly.

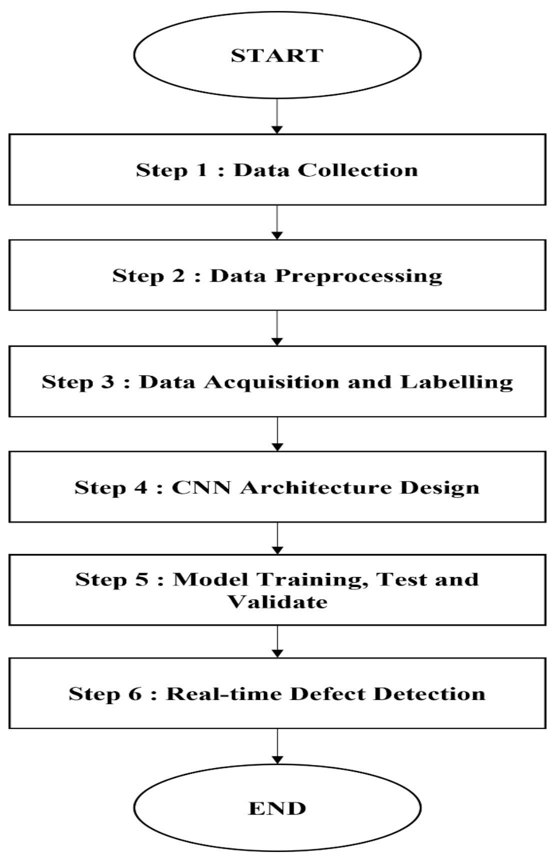

Figure 1. Overall step in developing a Solar Panel Hotspot Detector.

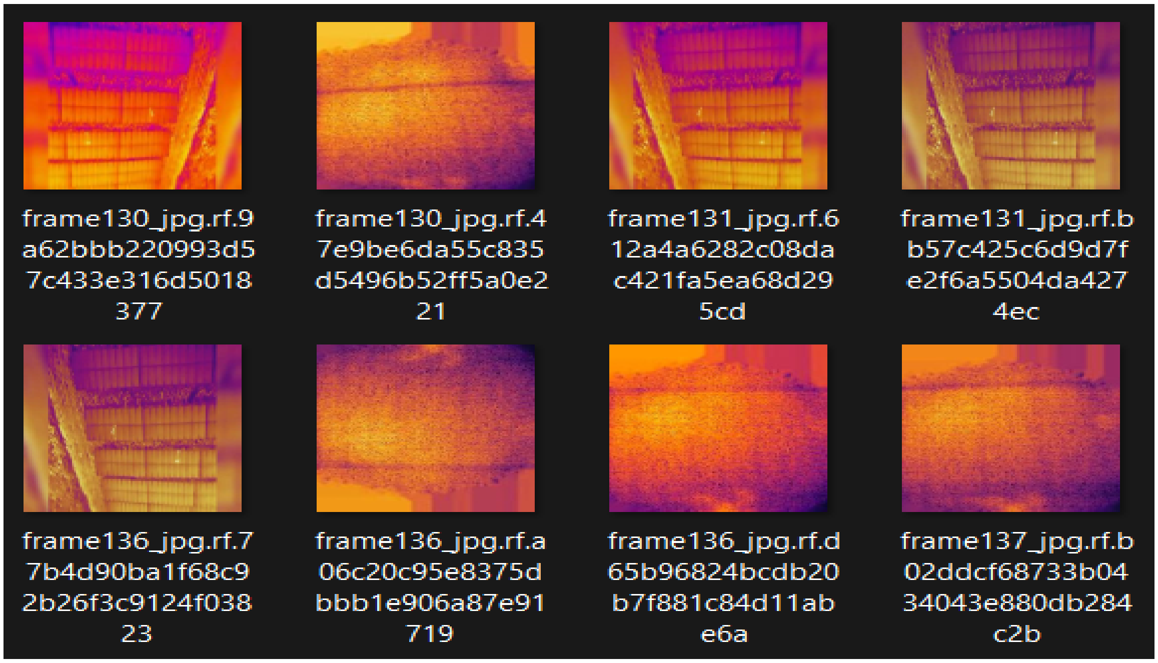

Figure 2. Samples of dataset Images used for Solar Panel Defect Detection.

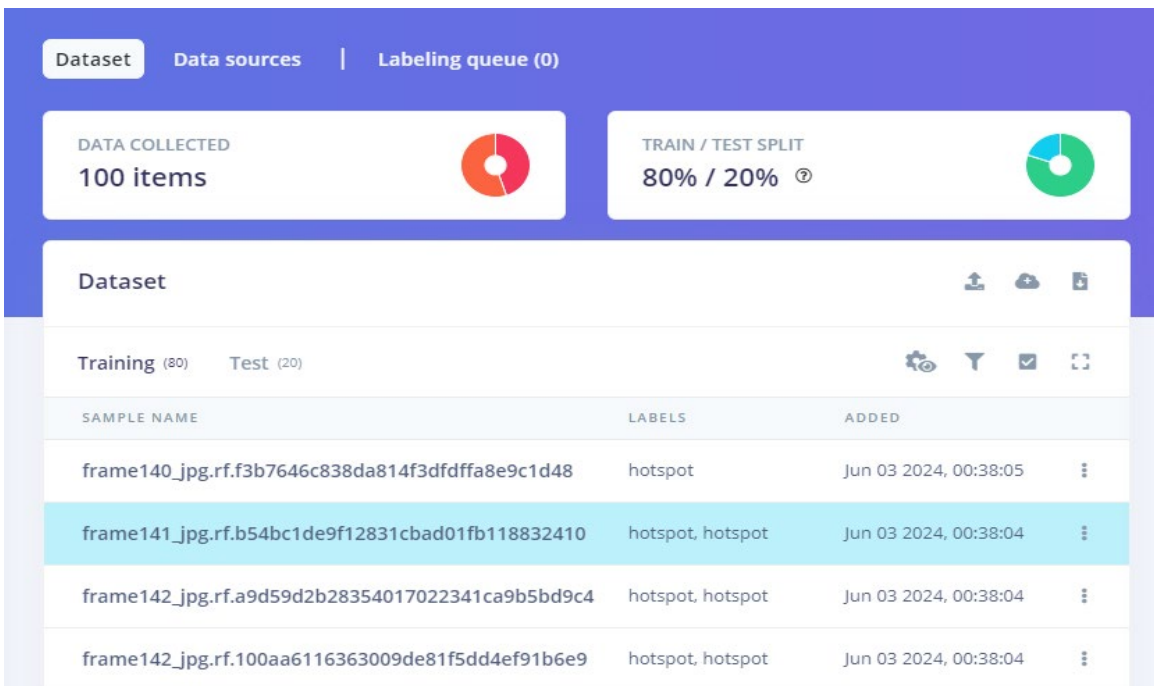

Figure 3. List of Dataset and its Sources in Edge Impulse.

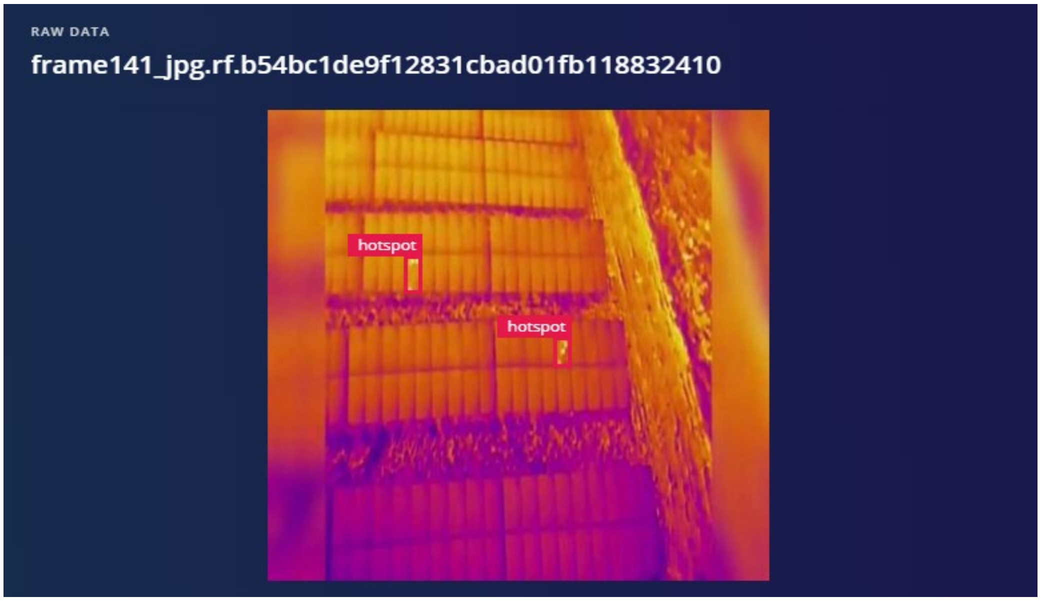

Figure 4. Labelling of Sample Images using Bounding Box.

Each captured frame is processed by the deployed model which performs inference to detect and classify any hotspots or defects. Inference is the process where the trained model applies its learned features to new data to make predictions. Having lower inference time indicate the model performance have significantly improve to the point where user can obtain better real-time detection. The Edge Impulse platform facilitates this by optimizing the model for efficient real-time processing even on devices with limited computational power like smartphones. In the experiment completed, the time inference is only ranging from 10 – 20 milliseconds. In order to run the model, user must be able to scan QR code provided on Deployment tab in the platform. During inference, the model analyses each frame to identify features indicative of hotspots or defects. The model's training allows it to accurately distinguish between normal conditions and potential issues on the solar panels. The results of the inference including the location of detected defects are overlaid on the live camera feed like in **Figure 5**.

3. Novelty and uniqueness

The uniqueness of this product is its ability to classify and locate defects in real-time is a critical feature enabling immediate detection of problems. The results of the inference including the location of detected defects are overlaid on the live camera feed. This overlay provides visual markers on the smartphone screen, highlighting areas of concern directly on the captured image. This real-time visual feedback is invaluable for inspectors or technicians as it allows them to see exactly where the defects are located without needing to manually analyse the data.

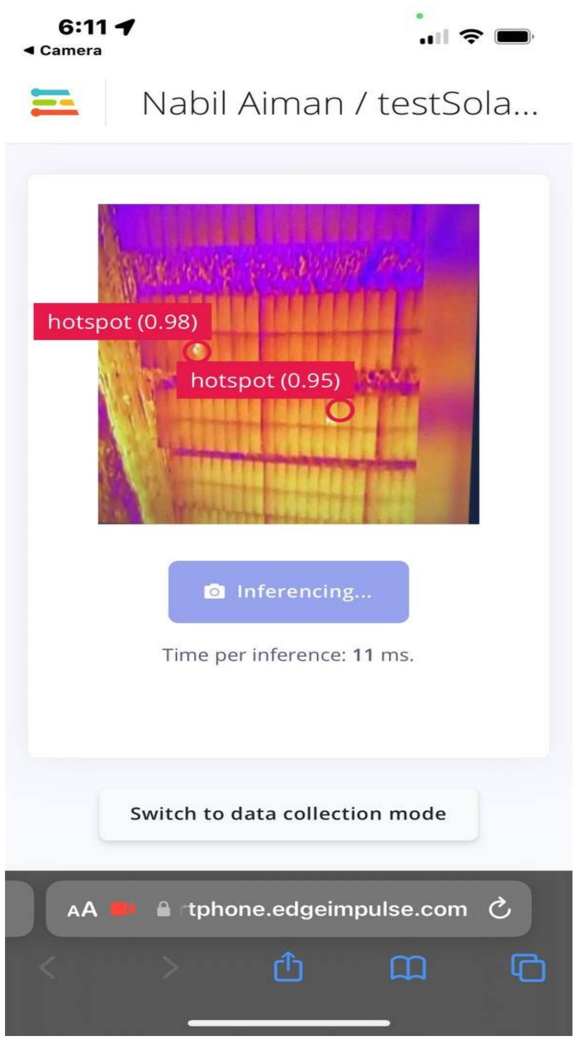

Figure 5. Solar Panel Defect Detection on Website using Mobile Phone.

4. Benefit to mankind

With the visual feedback displayed on the smartphone screen, users can immediately inspect the identified hotspots or defects. This rapid detection and visualization enable quick decision-making and action such as scheduling maintenance or repairs in real life scenario. The ability to address issues promptly helps in maintaining the efficiency and longevity of the solar panels, preventing minor defects from escalating into major problems. In addition, by ensuring that solar panels are maintained on schedule, the project contributes to sustainable energy initiatives by reducing resource waste and guaranteeing a steady supply of solar energy. In the end, this project has the potential to yield important breakthroughs in renewable energy technology, promoting worldwide economic savings and energy security.

5. Innovation and Entrepreneurial Impact

In pervasive world today, deploying the model on a smartphone with a camera for real-time detection of solar panel defects integrates Artificial intelligence (AI) machine learning promote new innovation with practical usability. The continuous capture of frames, efficient model inference and real-time visual feedback ensure that any hotspots or defects are detected and addressed promptly. This deployment strategy not only demonstrates the effectiveness of the Edge Impulse platform and MobileNetV2-based model but also showcases the practical application of machine learning in maintaining solar panel efficiency and performance.

6. Potential commercialization

The system of solar panel hotspot detectors has a great potential to be commercialized in community. This technology can be implemented especially in solar industry such as private houses and factories that equipped with solar energy system. This product also can be used by professionals that maintenance the solar energy farm. It can be commercialized in a form of a mobile apps for downladed into the smartphone.

7. Acknowledgment

The authors are grateful to Electrical Engineering Studies, College of Engineering, Universiti Teknologi MARA, Cawangan Pulau Pinang, Malaysia for their faclilities that led to the completion of this innovation. This research is funded by FRGS research grant – "Formulation of a New Density-Adaptive Classifier Framework based on Radiomics & U-Net Convolutional Neural Network (CNN) fused Features in Breast Lesion Mammogram" (File No: FRGS/1/2022/SKK06/UITM/02/3) from Ministry of Higher Education (MOHE), Malaysia.

8. Authors' Biography

Muhammad Nabil Aiman Baderul Hisham joined Universiti Teknologi MARA in 2018 as a student in Diploma of Electrical Engineering (Electronic). In year 2021 he then further his bachelor degree study by enrolling as an undergraduate student in Bachelor of Electrical and Electronic Engineering in Universiti Technology MARA Pulau Pinang branch at Permatang Pauh campus. He now undergoing his final year study and doing internship at Unit Facility that also located in same campus.

Ir. Dr. Iza Sazanita Isa received her bachelor's in electrical engineering from the Universiti Teknologi MARA, Malaysia in 2004 and the M.Sc. degree from the Universiti Sains Malaysia, Malaysia in 2008. Since 2009, she joined the School of Electrical Engineering, College of Engineering, Universiti Teknologi MARA (UiTM), Penang branch, in 2013. She pursues her PhD in Electrical Engineering under the SLAB/SLAI scholarship and graduated in 2018. Currently she is joining Universiti Sains Malaysia (USM), Malaysia as postdoctoral fellowship under School of Computer Sciences. She is attached to department of Control System Engineering at the faculty. She is also the members of AREDiM research group, the head of research group RIDyLT and actively involved in teaching and learning research. Her research interest includes the model development using image processing and artificial intelligence.

Dr. Zuraidi Saad is a Senior Lecturer at the Department of Control and System Engineering, School of Electrical Engineering, Universiti Teknologi MARA (UiTM), Pulau Pinang, Malaysia. He holds a Ph.D. in Mechatronics from Universiti Malaysia Perlis (UniMAP) and specializes in Artificial Neural Networks, Convolutional Neural Networks, Control Systems, and Medical Image Processing. Dr. Zuraidi has led numerous research projects, including the development of adaptive classifier frameworks for COVID-19 pneumonia detection. His work has been recognized through national and international publications and grants, and his contributions span various fields such as automotive control systems and industrial automation.

Assoc. Prof. Ir. Ts. Dr. Zainal Hisham Che Soh is a is PhD holder in Electrical and Electronic from USM. His research interest in Image Processing, Computer Vision, Artificial Intelligence, Embedded System and Internet of Things. He works in UiTM Pulau Pinang under Faculty of Electrical Engineering, UiTM, Pulau Pinang. He is head of a special interest group in Embedded System and Intelligent Computing (ESIC) research group. He is recognized as Professional Engineer (Ir) in Electronic Engineering by BEM and Professional Technologist by MBOT. He is also a Chartered Engineer and member of IET, UK and member of IEEE and BEM.