UNIVERSITI TEKNIKAL MALAYSIA MELAKA
FAKULTI TEKNOLOGI DAN KEJURUTERAAN ELEKTRONIK DAN KOMPUTER

KERTAS CADANGAN PROJEK SARJANA MUDA (BERN 4972)
BACHELOR DEGREE PROJECT PROPOSAL (BERN 4972)

A. CADANGAN PROJEK
PROJECT PROPOSAL

I. Tajuk Projek : *Project Title*

Design and Implementation of a Deep Learning-Based Oil Palm Fruit Ripeness Classification System Using CNN

II. Nama Pelajar : *Student's Name*

YEO KHEONG JIE

III. No. Matrik: *Matrix No.*

B	0	2	2	2	2	0	0	7	4

IV. Kursus : *Course* **BERR**

Nama Penyelia Utama: **DR. FAKRULRADZI BIN IDRIS**
Main Supervisor's Name

Nama Penyelia ke-2 (Jika ada) :
Co-Supervisor's Name (If any)

....
(Tandatangan Pelajar)
Student's Signature

Nama / *Name* : YEO KHEONG JIE

Tarikh / *Date* : 1/12/2025

....
(Tandatangan Penyelia & Cop)
Supervisor's signature & Stamp

DR. FAKRULRADZI BIN IDRIS
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B. RINGKASAN PROJEK
PROJECT SUMMARY

Ringkasan projek yang dicadangkan tidak melebihi 200 patah perkataan (dalam SATU perenggan).
Project summary should not be more than 200 words (in ONE paragraph).

The classification of oil palm fruit ripeness is a crucial step in ensuring optimal oil yield and production quality in the palm oil industry. Traditional manual grading methods are often subjective, time-consuming, and inconsistent due to human error and varying lighting conditions. This project presents the design and implementation of a deep learning-based oil palm fruit ripeness classification system using Convolutional Neural Networks (CNNs) integrated with camera and smartphone platforms. A comprehensive dataset of oil palm fresh fruit bunch (FFB) images is collected under various outdoor lighting conditions and labelled according to the Malaysian Palm Oil Board (MPOB) ripeness standards. The CNN model is trained and optimized using TensorFlow to classify FFB images into ripeness categories such as unripe, under-ripe, ripe, and over-ripe. The trained model is then quantized and deployed for on-device inference on the microcontroller and Android smartphone using TensorFlow Lite. The system's performance is evaluated in terms of accuracy, latency, and energy efficiency. The proposed approach demonstrates the potential of lightweight deep learning models for real-time agricultural applications and provides a cost-effective, portable, and scalable solution for automated oil-palm fruit grading.

C. KAJIAN LATAR BELAKANG & PENYATAAN MASALAH
BACKGROUND STUDIES & PROBLEM STATEMENT

Sila membuat kajian latar belakang dan nyatakan dengan jelas masalah untuk projek yang dicadangkan.
Do a background studies and state clearly the related research problem for the proposed project.

<u>Fundamental Knowledge</u>

- **Oil Palm Tree & Palm Fruit**
  Oil pam tree is a tall, single-stemmed palm that produces bunches of palm fruit in tropical regions. The main products from the oil palm tree are palm oil from the fleshy fruit pulp, and palm kernel oil from the seed within the palm fruit.
  Palm fruit is the only fruit produced by the oil palm tree which has an outer skin and has different appearance according to its ripeness. For example, unripe with dark purple, underripe with red purple, ripe with orange red, and lastly overripe with orange color.

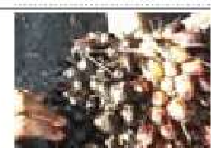
Ripeness	Colour	Loose fruits	Sample
Over ripe	Orange	>10	
Ripe	Orange-red	~10	
Under ripe	Red-purple	<10	
Unripe	Purple-black	<1	

Figure 1: Classification of Palm Fruit ripeness

In Malaysia, Malaysian Palm Oil Board (MPOB) is in charge with promotion and development of the palm oil industry. The duties involve implementation of policies, conducting research and development, market investigation, and fostering sustainable practices and innovation within the sector,

Figure 2: Malaysian Palm Oil Board (MPOB)

According to the information of MPOB, oil palm is simply the most productive crop for oil production, yielding the highest tonnage of oil per hectare if compared to soybean, sunflower and rapeseed etc. [13].

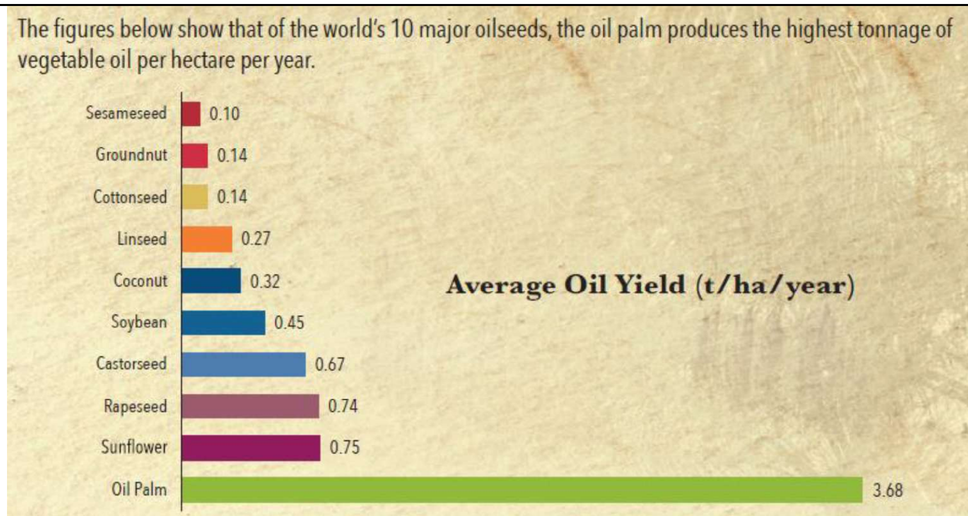


Figure 3: Comparison of Average Oil Yield among Major Oilseeds

Palm oil also required less production cost compared to other crops at international level. Oil palm is one of the main sources of oil yield and exceeds competitor with big lead. It brought huge economic value for Malaysia and created job opportunities for the workers involved. Another advantage of palm oil is the high output of palm oil with low amount of input. The statistics show that the energy input such as pesticides, fertilizers and fuel is the lowest for palm oil compared to soybean and rapeseed, which also yield highest amount of output.

Production Cost of Selected Vegetable Oils (USD/tonne)

Oil	Cost (USD/tonne)	Country/Region
Palm	228	Malaysia
Soybean	400	USA
Rapeseed	648	Canada
Rapeseed	900	Europe

Figure 4: Production Cost of Vegetable Oils

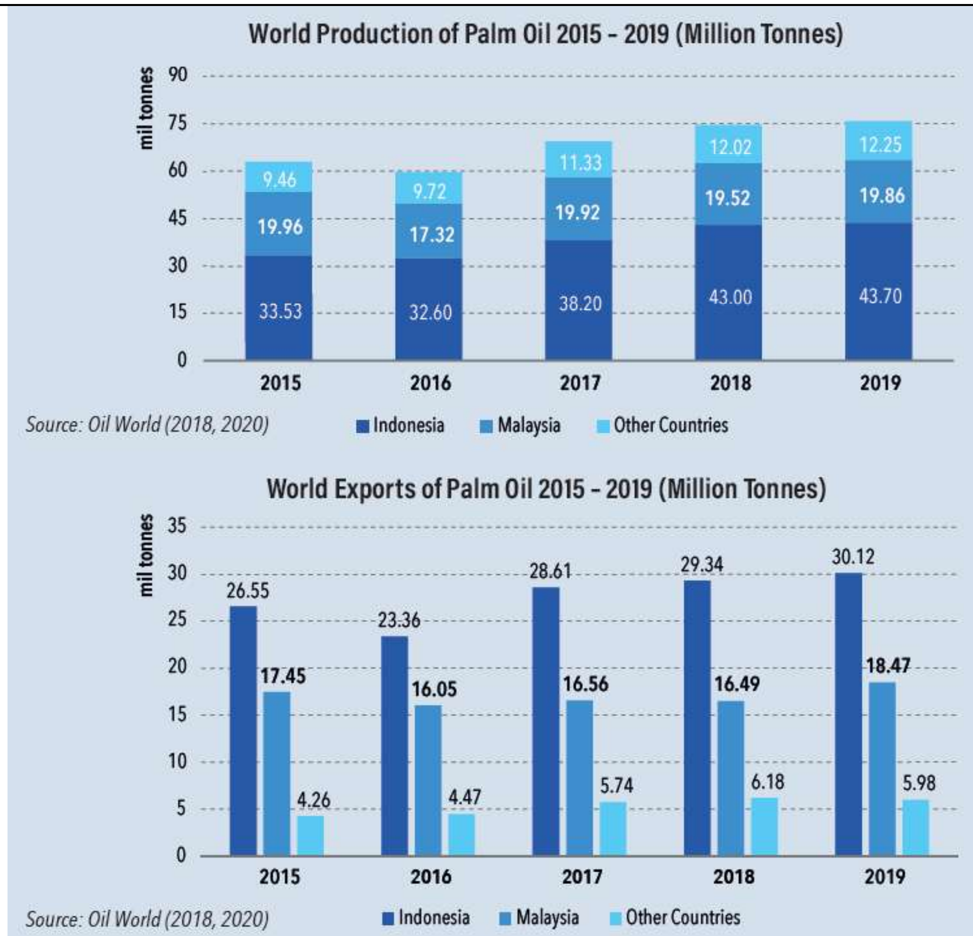


Figure 5: Profit of Palm Oil Production and Exportation

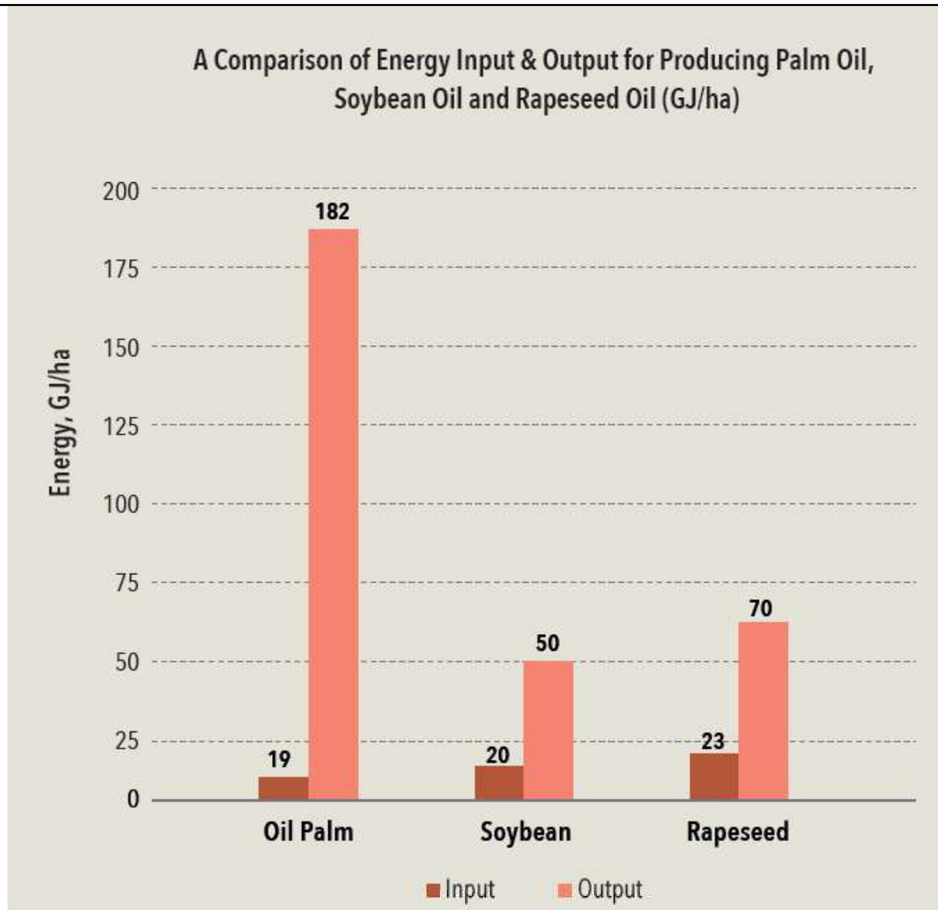


Figure 6: Energy Input & Output among Vegetable Oils

SUMMARY OF THE PERFORMANCE OF THE MALAYSIAN OIL PALM INDUSTRY,

2024 & 2023

INDICATOR	2024	2023	DIFFERENCE	
			VOLUME/ VALUE	(%)
PRICE (RM/TONNE)				
FFB (MILL GATE)	875.00	778.00	97.00	12.5
CPO (LOCAL DELIVERED)	4,179.50	3,809.50	370.00	9.7
PALM KERNEL (EX-MILL)	2,645.50	2,016.00	629.50	31.2
CPKO (LOCAL DELIVERED)	5,475.50	3,896.00	1,579.50	40.5
RBD PALM OIL (FOB)	4,400.00	3,945.00	455.00	11.5
RBD PALM OLEIN (FOB)	4,417.00	4,018.00	399.00	9.9
RBD PALM STEARIN (FOB)	4,425.50	3,781.00	644.50	17.0
PFAD (FOB)	3,802.00	3,424.00	378.00	11.0
OER (%)				
MALAYSIA	**19.67**	**19.86**	**(0.19)**	**(1.0)**
PENINSULAR MALAYSIA	19.46	19.64	(0.18)	(0.9)
SABAH	20.53	20.40	0.13	0.6
SARAWAK	19.37	19.83	(0.46)	(2.3)
FFB YIELD (TONNES/HECTARE)				
MALAYSIA	**16.70**	**15.79**	**0.91**	**5.8**
PENINSULAR MALAYSIA	18.42	16.09	2.33	14.5
SABAH	15.74	16.39	(0.65)	(4.0)
SARAWAK	14.89	14.75	0.14	0.9

Note : FOB - Free on Board
FFB - Fresh Fruit Bunches
RBD - Refined, Bleached, Deodourised
PFAD - Palm Fatty Acid Distillate
HRBD - Hydrogenated RBD
Source: MPOB

Figure 7: Summary of Malaysian Palm Oil Industry 2023 & 2024

SUMMARY OF THE MALAYSIAN PALM OIL INDUSTRY 2025

	Dec 24	Jan 25	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep (r)	Oct (p)	Nov	Dec
PRODUCTION (TONNES)													
Crude Palm Oil	1,486,942	1,239,895	1,188,443	1,387,616	1,686,379	1,771,621	1,692,370	1,812,467	1,854,756	1,840,983	2,043,886		
Palm Kernel	336,558	291,524	284,959	336,921	409,097	420,658	396,879	431,615	443,077	432,368	477,775		
Palm Kernel Oil	156,926	137,158	130,146	149,923	176,644	210,512	192,665	218,239	208,655	197,197	210,529		
Palm Kernel Cake	172,826	151,813	142,997	172,651	192,857	231,568	213,398	238,511	227,473	216,465	229,765		
CLOSING STOCK (TONNES)													
Palm Oil	1,708,756	1,580,934	1,509,942	1,563,831	1,865,536	1,982,895	2,031,249	2,113,881	2,201,618	2,359,572	2,464,452		
Palm Kernel	128,651	123,294	125,098	143,272	180,583	167,479	160,107	137,623	147,658	158,230	189,078		
Palm Kernel Oil	273,916	282,483	276,430	270,434	307,299	288,114	286,520	321,019	331,190	289,515	298,716		
Palm Kernel Cake	246,053	197,560	151,119	180,646	235,458	268,145	276,881	267,545	309,796	288,958	299,160		
EXPORT (TONNES)													
Palm Oil	1,341,936	1,179,874	996,463	1,005,664	1,104,351	1,407,603	1,260,957	1,328,547	1,325,672	1,427,609	1,692,895		
Palm Kernel Oil	95,919	57,554	58,144	56,315	99,017	119,020	86,814	90,028	110,363	117,520	100,491		
Palm Kernel Cake	177,553	177,396	194,894	122,977	140,833	193,328	189,774	254,239	175,874	256,412	217,177		
Oleochemical	223,447	231,829	198,221	209,449	217,516	233,252	203,621	249,128	231,079	235,024	254,265		
Biodiesel	15,231	33,795	42,052	14,947	23,589	32,848	2,809	49,195	30,833	34,958	11,318		
IMPORT (TONNES)													
Crude Palm Oil (CPO)		7,816	0	0	0								
Processed Palm Oil (PPO)	37,917	88,474	66,784	121,886	58,292	68,971	69,715	53,223	58,538	78,413	36,283		
Palm Oil (CPO+PPO)	37,917	88,474	66,784	121,886	58,292	68,971	69,715	61,039	58,538	78,413	36,283		
Palm Kernel Oil (PKO)	20,291	5,708	12,699	12,678	14,287	8,074	11,926	24,516	14,082	5,664	8,695		
PRICE (1% OER EQUIVALENT)													
FFB (RM)	56.71	51.88	52.75	52.50	47.96	43.20	42.63	44.79	47.35	48.36	48.68		

Figure 8: Summary of Malaysian Palm Oil Industry 2025

According to the summary of the Malaysian Palm Oil Industry form 2023 to 2025, few important parameters indicated the growth of Malaysian palm oil industry, which is Crude Palm Oil (CPO) is increased by 4.2%, and Fresh Fruit Bunch (FFB) with significant rise of 5.8%. However, the drop of Oil Extraction Rate (OER) by 1% indicated the processing of FFB is affected by adverse weather and require action taken to improve the quality of FFB with technology.

- **Deep Learning & CNN**
  Deep Learning is one of the many sections of machine learning that applies artificial neural networks with various layers to enable digital systems to learn and make decisions based on unstructured data.
  Convolutional Neural Network (CNN) is a type of deep learning algorithm that learns features by filtering optimization of the dataset given. It is a deep learning model designed to process data with a grid-like topology such as pictures. By using CNN, it enables most applications of computer vision to detect features within visual data. Nowadays, CNN is very common in industry due to its convenience to assist operation and process of the workplace. It is often related to image classification and object detection which is useful.

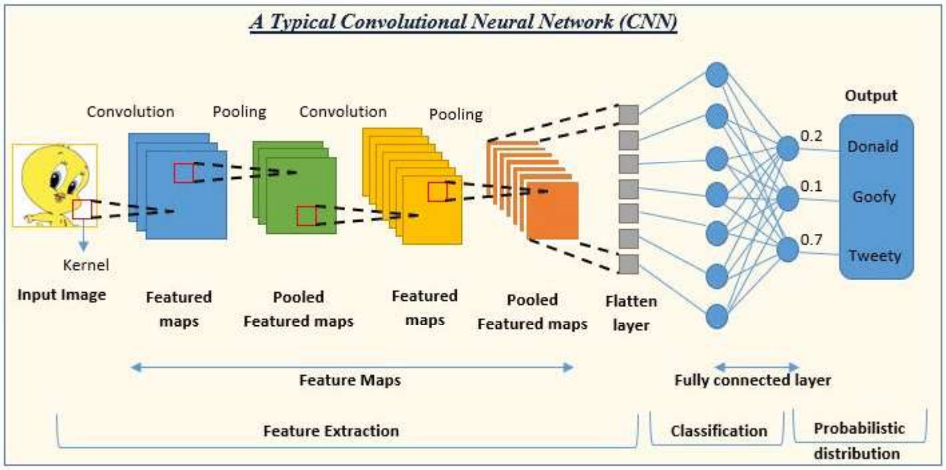


Figure 9: Typical Convolutional Neural Network

i. Background Studies/ Literature

No.	Author	Project Title	Finding	Limitation
1	Suharjito, Gregorius Natanael Elwirehardja, Jonathan Sebastian Prayoga (2021)	Oil palm fresh fruit bunch ripeness classification on mobile devices using deep learning approaches	Successfully implemented lightweight CNN models (SqueezeNet, MobileNet) with transfer learning for FFB ripeness classification, demonstrating the feasibility of using low-computational models for a mobile application	Although accuracy was high on the test set, the final performance metrics were not robustly benchmarked against the full spectrum of real-field environmental variations **<u>Research Gap</u>** Need for extensive real-world, on-device performance testing and optimization to guarantee maintained accuracy and speed in a true mobile operating environment
2	Suci Ashari, Gomal Juni Yanris, I. Purnama (2022)	Oil palm fruit ripeness detection using deep learning	Confirmed that the Convolutional Neural Network (CNN) algorithm is effective for image-based oil palm ripeness detection, classifying fruit into three fundamental categories: raw, ripe, and rotten	The study was limited to three basic ripeness classes, which is insufficient for commercial grading systems that require 4–6 detailed stages for optimal oil extraction and grading. **<u>Research Gap</u>** The model needs to be extended and re-trained to accurately distinguish the full spectrum of 4–6 industrial ripeness stages without sacrificing performance.
3	Rudi Kurniawan, Samsuryadi Samsuryadi,	Classification of palm oil fruit ripeness based on	Utilized the deep and established AlexNet CNN architecture to classify palm oil fruit	AlexNet is a large, historically complex network. This architecture is often

	Fatma Susilawati Mohamad, Harma Oktafia Lingga Wijaya, Budi Santoso (2025)	AlexNet deep Convolutional Neural Network	maturity, aiming to improve classification accuracy and reduce manual errors compared to traditional methods	too computationally heavy and slow for deployment by using low-power edge devices or standard mobile phones used by field workers **Research Gap** The trade-off between the high performance of deep architectures like AlexNet and the computational efficiency required for practical field implementation must be addressed
4	Yusuf Athallah Adriyansyah, Feri Adriyanto, Pringgo Widyo Laksono (2025)	Deep Learning Approach for Palm Oil Fresh Fruit Bunches Harvest Decision	Proposed an intelligent, hybrid harvest decision system that combines the feature extraction capabilities of YOLOv8 with the classification power of CNN and Support Vector Machines	The use of hybrid architecture (introduces sequential dependencies, which can lead to increased complexity, potential bottlenecks, and higher overall inference latency. **Research Gap** Need to investigate the development of a single, streamlined, end-to-end deep learning model to perform both detection and multi-class classification simultaneously, reducing latency and simplifying deployment
5	Jin Wern Lai, Hafiz Rashidi Ramli, L. I.	Oil palm fresh fruit bunch ripeness	A systematic review concluding that the most feasible method	The collective literature suffers from a lack of

		Ismail, Wan Zuha Wan Hasan (2023)	detection methods: A systematic review	for real-time, on-field FFB ripeness detection is the combination of computer vision and deep learning, noting its low-cost and high-accuracy potential	standardization in dataset collection, environmental testing, and performance metrics across the field **Research Gap** Call for the creation of standardized, publicly available datasets captured under diverse, challenging field conditions, and the establishment of uniform reporting metrics for comparative studies
	6	Dedy Setiawan, Pradita Eko Prasetyo Utomo, Muksin Alfalah (2025)	Detection of Oil Palm Fruit Ripeness through Image Feature Optimization using Convolutional Neural Network Algorithm	Applied CNN with image feature optimization to classify oil palm fruit into three classes (raw, ripe, rotten) using a dataset collected from internet sources and direct mobile photos	The dependence on a mixed-source dataset severely limits the model's generalization and robustness when deployed to a specific plantation with unique lighting, shadow, and background characteristics. **Research Gap** The model must be validated with an exclusive, large-scale, consistent dataset captured entirely under the challenging and heterogeneous conditions of a single target farm environment
	7	Ramesh Malyala (2024)	Development of a Convolutional Neural Network	Introduced a novel approach using CNNs to recognize complex visual patterns in FFB images for automated	The abstract is high-level and lacks specific quantitative results regarding accuracy, model

			Model for Automated Ripeness Classification of Palm Oil Fresh Fruit Bunches	ripeness classification, aiming to overcome the subjectivity and inconsistency of manual assessment	choice or inference speed, making it difficult to assess its technical contribution compared to existing benchmarks **<u>Research Gap</u>** The research must be substantiated with detailed performance metrics and an explicit demonstration of its ability to handle multiple, subtle ripeness stages effectively
	8	Herman Herman, Tjeng Wawan Cenggoro, Albert Susanto, Bens Pardamean (2021)	Oil Palm Fruit Image Ripeness Classification with Computer Vision using Deep Learning and Visual Attention	Proposed the ResAtt DenseNet model, which incorporates a residual-based visual attention mechanism to better recognize subtle differences across seven ripeness levels, resulting in a modest F1 Score improvement of 1.1%	The model's training relied on a small dataset (400 images) which was heavily augmented using the Ten Crop preprocessing method. This risks overfitting the augmented data and poor generalization to truly novel field images **<u>Research Gap</u>** Validation of the attention mechanism's efficacy must be performed on a significantly larger, non-synthetic, diverse dataset to confirm its generalized performance improvement
	9	Supattra Puttinaovarat, Supaporn	Oil palm bunch ripeness classification	Successfully developed an integrated platform for	The study evaluates both CNN and SVM, suggesting a

	Chai-Arayalert, Wanida Saetang (2024)	and plantation verification platform: Leveraging deep learning and geospatial analysis and visualization	oil palm management that combines Deep Learning for FFB ripeness classification with Geospatial Analysis and Visualization (GIS). This goes beyond simple classification, allowing for plantation verification and large-scale management decisions	hybrid or comparative approach. A key limitation of the study introduces the complexity of integrating two distinct technologies (Deep Learning + GIS). This type of platform often relies on expensive, complex, or infrequently updated high-resolution satellite/drone imagery for the geospatial data, making real-time, high-frequency updates across large areas cost-prohibitive for many plantations **<u>Research Gap</u>** The need for cost-effective, real-time data synchronization between the field-level deep learning classification and the geospatial platform. Future work should focus on developing methods to use low-cost drone/sensor data or highly efficient image sampling techniques to provide faster, cheaper, and more granular updates to the GIS layer
10	Achmad Alwi Hasibuan, Ali	Advanced Classification	Used ResNet50 to classify four ripeness	The use of the deep and large ResNet50

	Amran Nst, Aldi Antoni, Ray Handika, Budi Yanto, Akhmad Zulkifli (2024)	of Oil Palm Fruit Ripeness Using ResNet50 and Real-Time Image Analysis for Enhanced Agricultural Practices	stages (raw, under-ripe, ripe, overripe), achieving a remarkably high overall accuracy of 97%, demonstrating superior classification robustness	architecture, while accurate, makes the model computationally expensive and too slow, which is high inference latency for real-time mobile or edge device deployment in the field **Research Gap** The efficiency trade-off. Future work must focus on methods like model compression or knowledge distillation to maintain the 97% accuracy while drastically reducing the model's computational footprint and latency.

The reviewed studies focus on evaluating performance of CNN models in various environments and setups. With exploration on different research projects, specific tools and parameters are learnt and contributed to current project. Therefore, the research gap across the literature it to deploy trained CNN models into real-life farms which will help to evaluate the ripeness of palm fruit and return the result to user interface.

ii. Problem Statement

- Traditional manual grading methods are often subjective, inconsistent due to human error and varying lighting conditions
- The need for a lightweight deep learning model that provides a cost-effective, portable, and scalable solution for automated oil-palm fruit grading

D. OBJEKTIF & SKOP KERJA
OBJECTIVE & SCOPE OF WORK

Terangkan secara jelas skop kerja projek.
Explain clearly the scope of work for the Project.

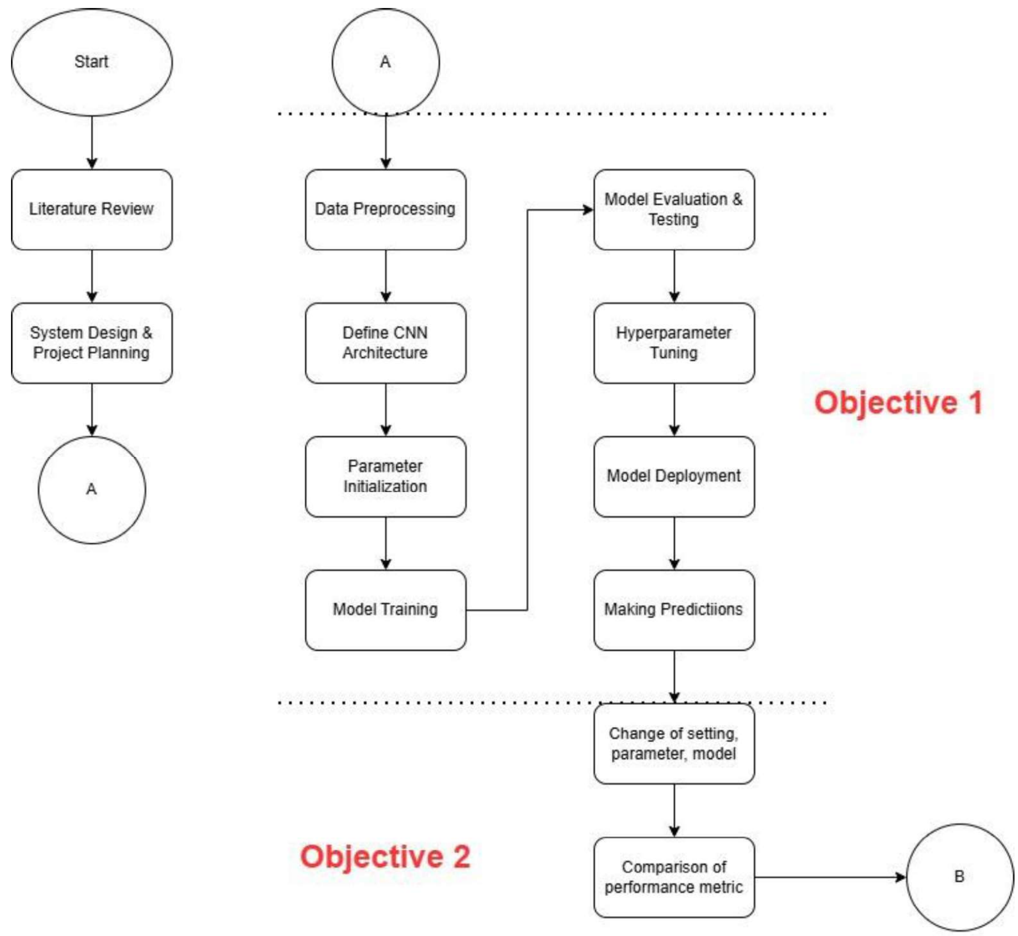
i. Objectives
- To develop and optimize a Lightweight CNN model for ripeness classification
- To compare the performance of developed classification system under different settings, parameters and models
- To deploy and evaluate performance of the developed system

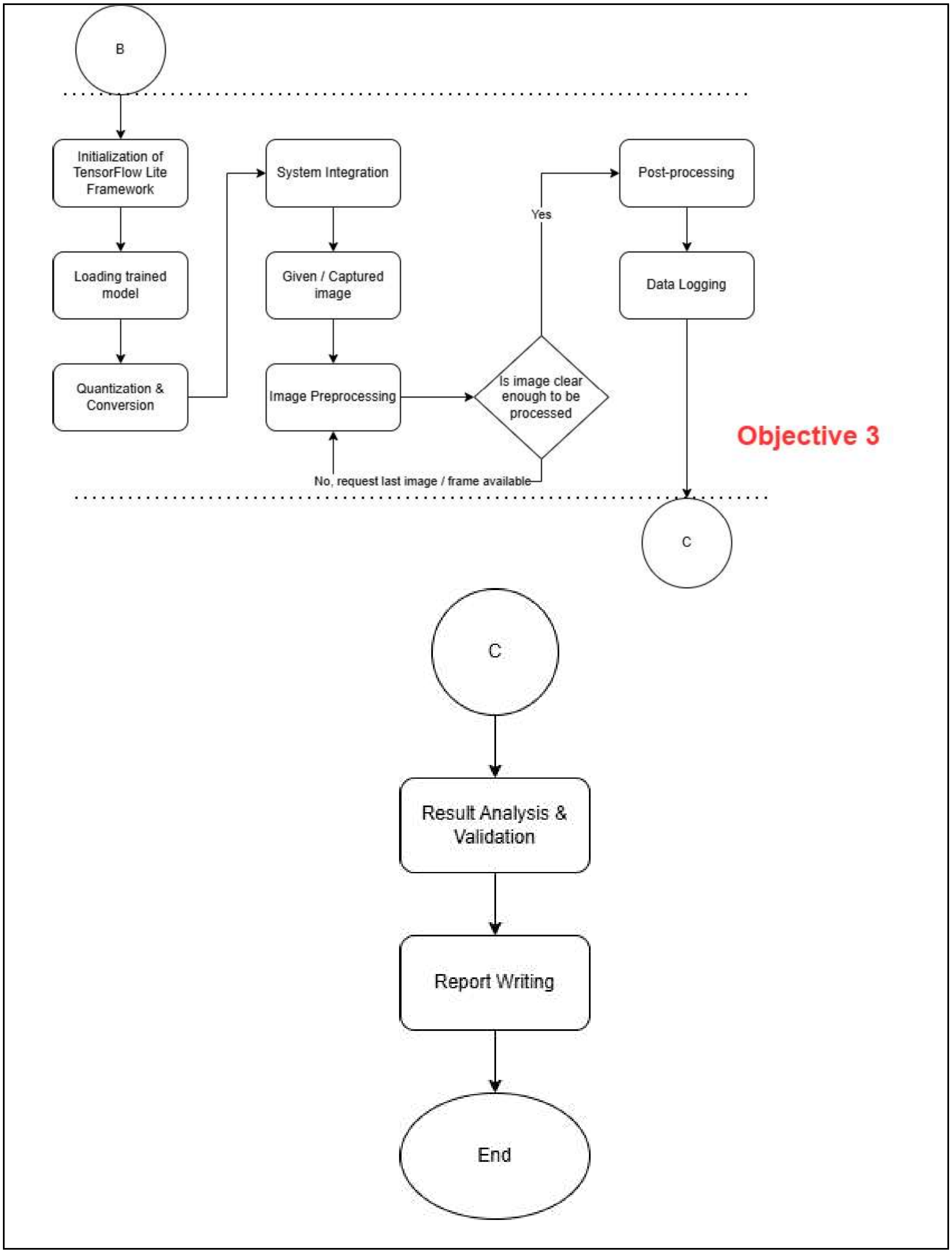
ii. Scope of Work
- 1 or 2 Deep Learning model that differentiates quality and ripeness of palm fruit (Unripe, Underripe, Ripe, Overripe) (AlexNet & ResNet50)
- Data required: Pictures of different kinds of palm fruits (For training & testing)
- System development and integration
- Prototype and software for field testing and performance validation

E. METODOLOGI PROJEK
PROJECT METHODOLOGY

Terangkan prosedur dan kaedah yang akan digunakan untuk mencapai objektif projek.
State clearly the procedure and method that will be used to achieve the project objectives.

i. Research Methodology Flow Chart




B
Initialization of TensorFlow Lite Framework
Loading trained model
Quantization & Conversion
System Integration
Given / Captured image
Image Preprocessing
Is image clear enough to be processed
Yes
No, request last image / frame available
Post-processing
Data Logging
Objective 3
C
C
Result Analysis & Validation
Report Writing
End

ii. Detail Description of The Research Methodology

- Literature Review
  Explore various research regarding ripeness of palm fruit and deep learning CNN model that related to this topic. It is to enhance understanding of this topic to provide smooth and accurate execution of this project.

- System Design & Project Planning
  Research and select suitable models and tools that fit the needs of project. Determine how the process of project is executed in real-life deployment and the parameters involved.

- Data Preprocessing
  Prepares the data for the model, which can involve cleaning, normalization, and augmentation.

- Define CNN Architecture
  Structures the layers of the CNN, such as convolutional, pooling, and fully connected layers. Planned to use AlexNet as the CNN model due to its excellent performance metrics.

- Parameter Initializaiton
  Sets the initial values for the model's weights and biases.

- Model Training
  Feeds the preprocessed data to the model to learn patterns and features.
- Model Evaluation & Testing
  Evaluate and test designed deep learning CNN model based on training and testing datasets. Compare and evaluate the performance metric of the CNN model.

- Hyperparameter Tuning
  Adjusts the model's external settings (e.g., learning rate, number of layers) to optimize performance.

- Model Deployment
  Integrates the trained model into a applicable environment for real-world use.

- Making Predictions
  Uses the deployed model to make predictions on new, unseen data.

- Change of setting, parameter, model
  Tuning of different settings, parameters and models to see the change of the result.

- Comparison of Performance Metric
  Compare the result in different scenario to validate each performance metric.

- Initialization of TensorFlow Lite Framework
  The system begins by initializing the TensorFlow Lite framework.

- Loading Trained model
  The process loads a pre-trained machine learning model into the framework.

- Quantization & Conversion
  The system quantizes and converts the model for efficient use on a device.

- System Integration
  The system integrates the prepared model into the overall application.

- Given / Captured Image
  The system receives a new image for processing.

- Image Preprocessing
  The system prepares the input image for the model by applying necessary transformations. If the image is clear, the system checks if the preprocessed image meets the quality standards for further analysis, otherwise the system requests the most recent available image or frame.

- Post-processing
  The system processes the output from the model to prepare the results.

- Data Logging
  The system records the results of image processing.

- Result Analysis & Validation
  The system will analyze and cross-validate the result to ensure the performance metric of the classification system.

- Report Writing
  Record the results and write the report.

F. JANGKAAN HASIL & KOS PROJEK
EXPECTED OUTCOME & COST OF PROJECT

Bincangkan jangkaan hasil untuk projek yang dicadangkan.
Discuss the expected outcome of the proposed project.

i. Description of Project Outcome (e.g prototype, solution, algorithm, new invention etc.)

With the designed system, the prototype will use raspberry pi as the controller and capture picture by using camera module. It would provide real-time data analysis for quality of palm fruit. The system with deep learning trained CNN will classify the ripeness of palm fruit and report the result to the user through digital interface.

ii. Cost of the Project

Component / Part	Quantity	Cost (RM)
Raspberry Pi (RP 4)	1	170.00
Camera Module (OV5647)	1	30.00
Power Supply (w/ regulator LT123A)	1	70.00
Total		270.00

iii. Applications & Commercialization Potential

This project would be attractive for palm fruit farmers which in need of real-time application with zero bias and avoid human error. It will ensure the yield of palm fruit remains optimum without wasting the palm fruit.

iv. How far the proposed project is relevant to sustainability & environmental friendly?

The proposed project will reduce wastage of palm fruit caused by incorrect identification of palm fruit ripeness. It will ensure reliability and sustainability of quality checking of palm fruit yield. The proposed object can work with low energy cost which is sustainable for project deployment in current era of industry. Overall, the proposed project will works towards sustainable development goals (SDG) by following few goals:

- Focuses on SDG12 Responsible consumption and production. This system will strengthen technological capacity for sustainable consumption and production by using CNN model to optimizae the yield of palm fruit and minimize waste of palm fruit
- Focuses on SDG8 Decent Work and Economic Growth. The system is capable to achieve higher level of economic productivity through technology. It boosts the productivity and profitability of palm fruit industry
- Focuses on SDG9 Industry & Innovation & Infrastructure. This system is aimed at enhancing scientific research and upgrading the technological capabilities within industrial sector. It will elevate the efficiency of palm fruit industry

G. RUJUKAN
REFERENCES

Senaraikan rujukan yang digunakan dalam projek yang dicadangkan.
List all the references that are being used for conducting this proposed project.

[1] "Grading of FFB for palm oil mills in Malaysia – PALM OIL ENGINEERING BULLETIN," *Malaysian Palm Oil Board (MPOB)*. http://poeb.mpob.gov.my/grading-of-ffb-for-palm-oil-mills-in-malaysia/

[2] N. Klingler, "AlexNet: A Revolutionary Deep Learning Architecture," *viso.ai*, Apr. 29, 2024. https://viso.ai/deep-learning/alexnet/

[3] Suharjito, G. N. Elwirehardja, and J. S. Prayoga, "Oil palm fresh fruit bunch ripeness classification on mobile devices using deep learning approaches," *Computers and Electronics in Agriculture*, vol. 188, p. 106359, Sep. 2021, doi: https://doi.org/10.1016/j.compag.2021.106359.

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H. PERANCANGAN PROJEK
PROJECT PLANNING (GANTT CHART)

Senaraikan aktiviti-aktiviti yang berkaitan bagi projek yang dicadangkan dan nyatakan jangka masa yang diperlukan bagi setiap aktiviti.
List all the relevant activities of the proposed project and mark the period of time that is needed for each of the activities.

	SEM I																			**SEM BREAK**					**SEM II**															
Aktiviti Projek *Project Activities*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Literature Review											**SEMINAR PSM I**																											**SEMINAR PSM II**		
Project Planning																																								
Data Collection & Logging																																								
Data Processing & Analysis																																								
CNN Development X																																								
Evaluation & Comparison																																								
CNN Model Deployment X																																								
TensorFlow Deployment																																								
Results Validation and Analysis X																																								
Final Report Preparation																																								

Mark “X” on the Gantt chart for the expected milestones (Hint: Completion of major activities)