Portable Smart Grading Fresh Fruit Bunches (FFB) Detector for Harvesting Oil Palm Fruit

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OBJECTIVE OF RESEARCH PROJECT

1. Efficiency Improvement: Develop a portable device that can quickly and accurately grade FFBs in the field, reducing the time and labor required for manual grading processes.

2. Quality Enhancement: Ensure that the portable smart grading detector can assess FFB quality parameters such as ripeness, size, and maturity with high precision, resulting in the selection of only high-quality fruits for processing.

3. Resource Optimization: Enable palm oil plantations to optimize resource allocation by providing real-time data on FFB quality, allowing for better planning of harvesting schedules, manpower allocation, and processing capacity utilization.

4. Cost Reduction: Introduce a cost-effective solution that minimizes the need for manual labor and reduces waste by ensuring that only ripe and high-quality FFBs are harvested and processed.

5. Sustainability Promotion: Promote sustainable practices in the palm oil industry by minimizing environmental impact through reduced fuel consumption, greenhouse gas emissions, and the preservation of biodiversity.

6. Technology Transfer and Adoption: Facilitate the adoption of advanced technology in agriculture by providing palm oil producers with user-friendly and accessible tools for improving their harvesting and grading processes.

7. Market Competitiveness: Enhance the competitiveness of palm oil producers in the global market by offering consistently high-quality products that meet consumer demands for sustainability and traceability.

8. Long-term Impact: Contribute to the long-term sustainability and profitability of oil palm plantations by improving efficiency, quality, and environmental stewardship practices.

Overall, the objective of the Portable Smart Grading FFB Detector project is to leverage technology to address key challenges in the oil palm industry, ultimately leading to increased productivity, profitability, and sustainability across the supply chain.

RESEARCH/PROJECT JUSTIFICATION

Method		Advantage	Disadvantage
Common FFB sorting and grading method	It is done manually viewed by eye of worker (https://www.techsains.com/cara-sortasi-dan-grading-buah-kelapa-sawit/20210429119)	- Low cost - It works for both sorting and grading	- Not accurate - Wasting time - High cost for the human resource need
AI technology	Thermal imaging technique (Zolfagharnassab, et all, 2022)	- Automatic classified FFB based on model only	- Some accuracy prediction is still less than 80% - There is no interface - Not applicable to user
	Grading System Using Smartphone and Modified YOLOv4 (Suharjito, et all, 2023)	- Accurate - There is user interface - Applicable for industry - Portable	- It works for post harvesting only - Detection model in oil palm plantation areas is limited - It works for grading FFB only
	Proposed technology: **Portable Smart Grading Fresh Fruit Bunches (FFB) Detector for Harvesting Oil Palm Fruit.** By integrating distance metric with ordinal neural network	- Accurate - There is A user interface - Automatic classified FFB based on AI model - Applicable for industry - Detection model in oil palm plantation areas is not limited - It works for both sorting and grading FFB - Portable device.	- It takes time to develop models and user interfaces

Source:

Suharjito, M. Asrol, D. N. Utama, F. A. Junior and Marimin, "Real-Time Oil Palm Fruit Grading System Using Smartphone and Modified YOLOv4," in IEEE Access, vol. 11, pp. 59758-59773, 2023, doi: 10.1109/ACCESS.2023.3285537.

Zolfagharnassab, S.; Shariff, A.R.B.M.; Ehsani, R.; Jaafar, H.Z.; Aris, I.B. Classification of Oil Palm Fresh Fruit Bunches Based on Their Maturity Using Thermal Imaging Technique. Agriculture 2022, 12, 1779. https://doi.org/10.3390/agriculture12111779

RESEARCH PROJECT JUSTIFICATION: THE PROPOSED IDEA

There are two stages of the FFB separation process in general:

1. **Sorting**: separating FFB from impurities such as twigs, sand, empty bunches.

2. **Grading**: determining the maturity level of oil palm FFB, fully ripe, semi-ripe, and unripe fruit.

First alternative based on location for grading FFB

Grading can be done in the production area

Camera and application

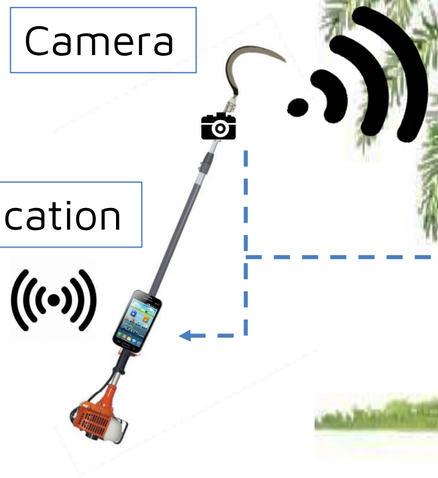
Loading ramp [Fungsi Stasiun Loading Ramp - Pabrik Kelapa Sawit Modern]

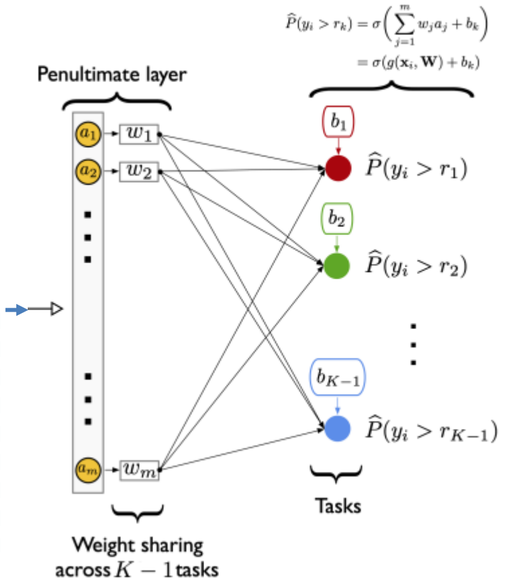
Second alternative based on location for grading FFB

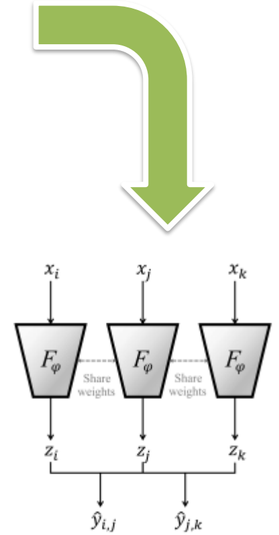
Both sorting and grading can be done in the plantation area

Camera

Application







Integrating distance metric with ordinal neural network

Wenzhi Cao, Vahid Mirjalili, Sebastian Raschka, Rank consistent ordinal regression for neural networks with application to age estimation, Patte Recognition Letters, Volume 140, 2020, Pages 325-331, ISSN 0167-8655, https://doi.org/10.1016/j.patrec.2020.11.008.

BIG PICTURE RISET/PROJECT

Project Initiation and AI method development:
- Define project objectives and scope.
- Establish project team and roles.
- Conduct initial research on existing technologies.
- Construct AI model
- Generate dataset

WP 1

(1st 4 months)

Conceptual Design:
- Develop conceptual design for the portable smart grading FFB detector.
- Identify key components and technologies required.
- Conduct feasibility studies and initial testing of prototype concepts.

WP 2

(2nd 4 months)

Prototype Development:
- Build the first prototype of the portable smart grading FFB detector.
- Integrate hardware and software components.
- Conduct iterative testing and refinement of the prototype.
- Test the proposed tech.

WP 3

(3rd 4 months)

1 year

Field Testing:
- Deploy the prototype in field trials at oil palm plantations.
- Identify any technical challenges or issues that need to be addressed.

WP 4

(4th 4 months)

Scaling and Expansion:
- Monitor industrial response and satisfaction.
- Scale up production to meet demand.
- Stable implementation to the oil palm industry.

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WP 5

(5th 4 months)

WP: Work Package

Further research

GANTT CHART

Activity	PIC	Output	Time (months)							
			1st -2nd	3rd – 4th	5th – 6th	7th -8th	9th -10th	11th -12th	13th – 16th	17th -20th
1. Preliminary/initiation research	Leader	Clear the job desk and output								
2. Construct proposed AI model	Leader and member 1	Develop new proposed AI method								
3. Observe the plantation of oil palm and generate the data in Kalimantan	Leader, member 1, & member 2	Generate dataset								
4. Test the proposed AI method and validate it	Leader and member 1	Finding the model accuracy and stability model performance								
5. Conceptual design including develop the design and conduct feasibility studies and initial testing	Leader and member 1	The proposed design of portable smart grading FFB detector								
6. Making the user interface and the hardware of portable smart detector of FFB (prototype development)	Member 2	Proposed the device and model are created								
7. Present the result of proposed method to a conference and prepare for patent	Leader, member 1, & member 2	Publication and patent draft								
8. Implement the proposed model and device (Field testing)	Leader, member 1, & member 2	The proposed model and device can work well								
9. Implement the proposed portable smart detector of FFB and develop more advance and then scaling it	Leader, member 1, & member 2	Develop more advanced technology based the previous research								

COST ESTIMATION

Cost category	Item	Cost (Rupiah)	Vol.	Total (Rupiah)
Equipment	Camera	5.000.000	4	20.000.000
	Existing motorized cutter	6.000.000	3	18.000.000
	Solder	800.000	3	2.400.000
	Device stand	3.000.000	3	9.000.000
	Toolbox	5.000.000	1	5.000.000
Consumable	Cable	500.000	2	1.000.000
	PCB	400.000	4	1.600.000
	Lead wire	500.000	4	2.000.000
Travel	Flight: Surabaya-Kalimantan (raound trip for 2 people X 3 times)	5.000.000	6	30.000.000
	Flight:Surabaya-Jakarta (round trip for 3 people)	4.000.000	3	12.000.000
Honorarium	Official travels cost (2 people, 3 days) in Kalimantan	1.500.000	6	9.000.000
	Official travels cost (3 people, 2 days) in Jakarta	1.000.000	6	6.000.000
	Official travels cost (2 people, 4 days) in Bali for conference	1.000.000	8	8.000.000
Accomodation	Hotel in Kalimantan (2 people, 3 days)	1.000.000	6	6.000.000
	Hotel in Jakarta (3 people, 2 days)	1.000.000	6	6.000.000
Services	User interface design creator	8.000.000	1	8.000.000
Publication	Conference submission	4.000.000	1	4.000.000
	International journal (IEEE Access Journal) fee	30.000.000	1	30.000.000
	Dissemination	8.000.000	1	8.000.000
Total:				178.000.000

IMPACT OF RESEARCH PROJECT

Portable smart grading FFB detector (PSGFD)

Improved Efficiency: Traditional FFB grading methods are often labor-intensive and time-consuming. Portable smart grading detectors can streamline this process, allowing for faster and more efficient grading of FFBs. This can lead to significant cost savings for palm oil plantations and processing facilities.

Optimized Resource Allocation: By accurately grading FFBs, plantations can better allocate resources such as manpower, equipment, and processing capacity.

Quality Control: Consistent and accurate grading of FFBs is essential for maintaining product quality standards.

Environmental Impact: Efficient grading and sorting of FFBs can help reduce unnecessary transportation of low-quality fruits, thereby lowering fuel consumption and greenhouse gas emissions associated with transportation.

Increased Accuracy: Smart grading detectors can utilize advanced technologies such as machine learning algorithms and computer vision to accurately assess the quality of FFBs. This can lead to more precise grading results compared to manual methods, reducing errors and improving overall product quality.

Data-driven Decision Making: Smart grading detectors can generate valuable data on FFB quality metrics such as ripeness, size, and maturity. This data can be analyzed to identify trends and patterns, enabling informed decision-making regarding harvesting schedules, plantation management practices, and processing strategies.

Labor Savings: Automating the grading process reduces the need for manual labor

Market Competitiveness: With improved efficiency, accuracy, and quality control, palm oil producers using smart grading technology can enhance their competitiveness in the global market by offering consistently high-quality products.

Bumitama Gunajaya Agro

THANK YOU