PRODUCT CLASSIFICATION AND EXPIRY DATE DETECTION USING DEEP LEARNING

1. Abstract

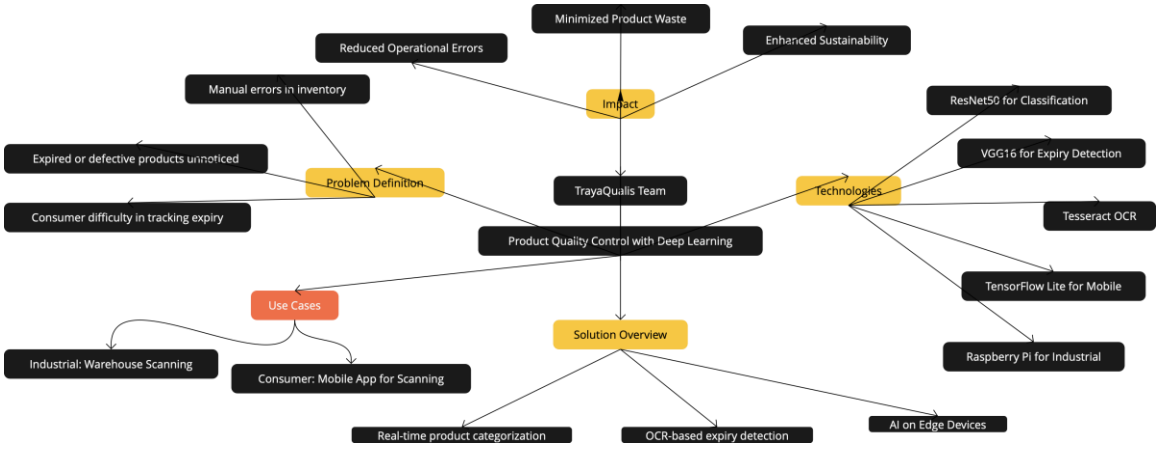
This project aims to transform inventory management and quality control by addressing challenges such as product classification, freshness analysis, and expiry date detection. By leveraging advanced deep architectures of neural network models like ResNet50 and VGG16, it employs edge computing for real-time industrial applications and lightweight AI for consumer devices. This dual-use framework is designed to enhance efficiency, accuracy, and sustainability in industries such as logistics, retail, and pharmaceuticals, while also helping individual consumers manage their inventory effectively.

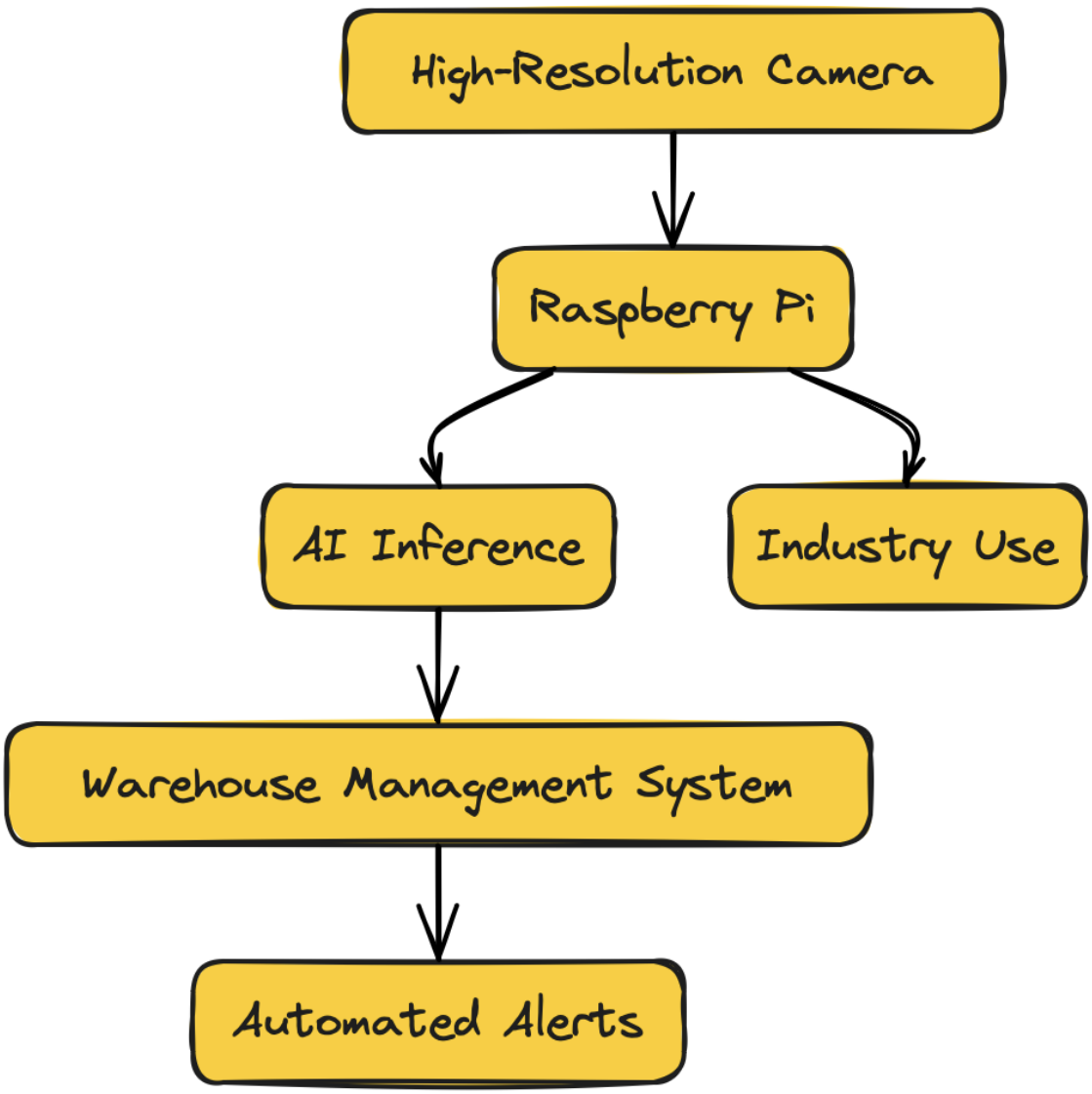
2. Introduction

The main issue faced by modern industries in inventory management happens because of the manual processes in industries. Due to this, errors are created in product classification, leading to financial loss. For consumers, it is very difficult to detect the freshness and expiry date of products. As a result, consumers often purchase unnecessary products, which creates a lot of waste. This project helps manage inventory for consumers and industries by using deep learning techniques. By detecting the freshness and expiry date of products, it also contributes to sustainability and waste reduction

3. Proposed Work

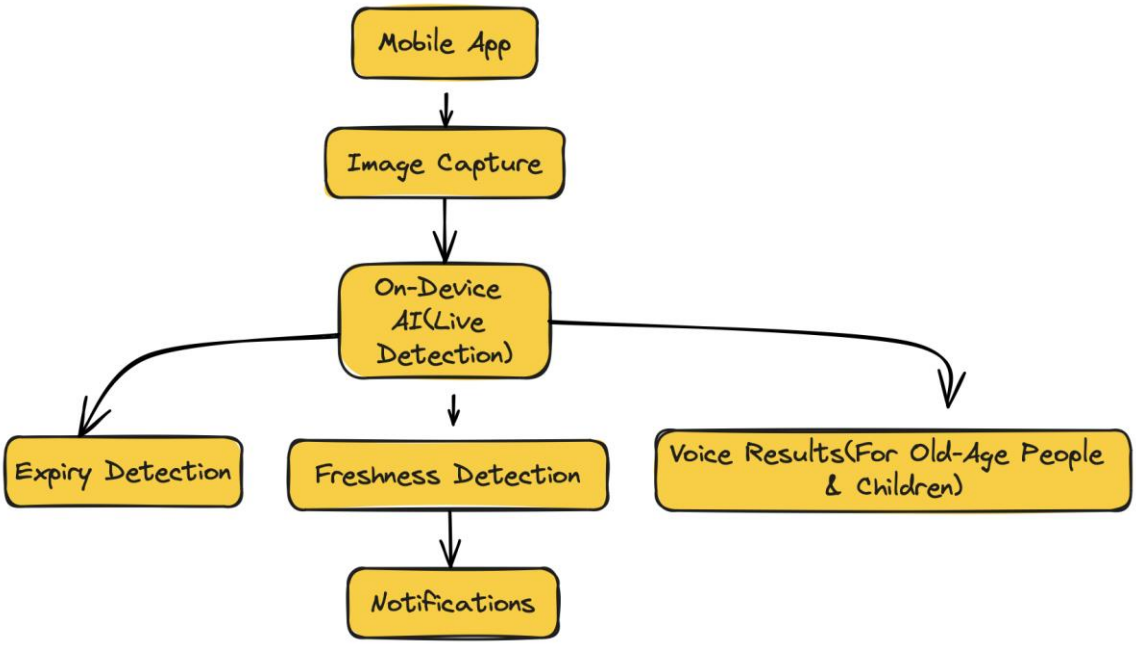
The project is designed to operate in two distinct environments:
- **Industrial Applications:** A robust framework is proposed to automatically track inventory in a warehouses using high-resolution cameras connected to end devices such as Raspberry Pi. The equipment stock is immediately checked for identification and continuous adulting purposes, thus reducing human intervention and operational errors.





- **Consumer Applications:** A mobile application is being developed to empower consumers to scan and track household products. The app will display product information, including freshness and expiry status, and send timely notifications, making inventory management accessible and efficient for individuals.

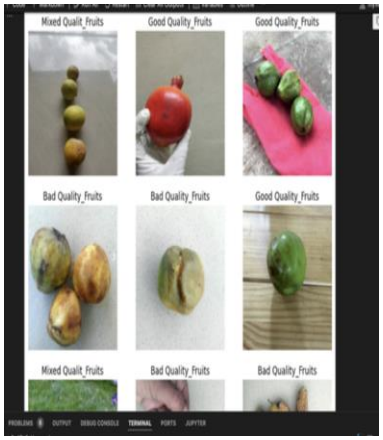
The proposed solution integrates advanced AI models with intuitive deployment strategies to address the diverse needs of industrial and consumer users.

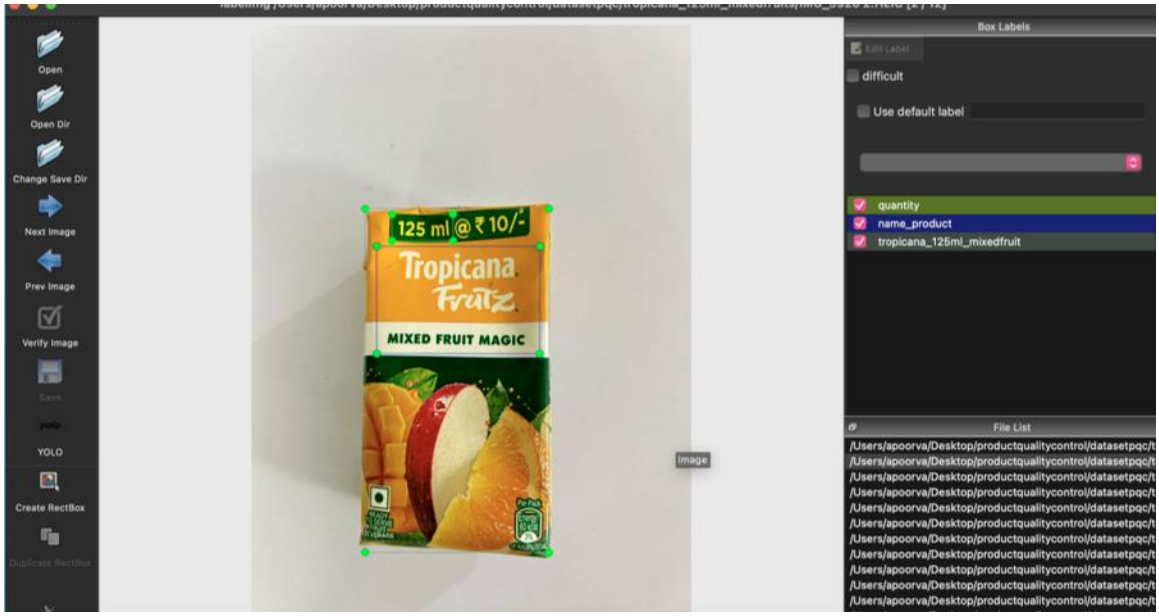


4. Methodologies

4.1 Dataset Preparation

- A diverse dataset comprising images in multiple formats (HEIC, JPEG, WebP) was curated for product classification.
- Fruit datasets were categorized into 'good,' 'bad,' and 'mixed' conditions for quality assessment.
- Annotation tools like LabelImg were used to label bounding boxes for expiry date detection.





4.2 Model Architecture
- **ResNet50** for product classification, enhanced with fine-tuned layers for optimal performance.
- **VGG16** for bounding box detection, extracting regions containing expiry date information.
- **Tesseract OCR** for reading text within detected regions, ensuring efficient expiry date recognition.

4.3 Deployment Strategies
- **Edge Computing:** AI models are optimized for Raspberry Pi, enabling real-time processing without cloud dependency.
- **Mobile AI Framework:** TensorFlow Lite is used to ensure lightweight model deployment for mobile devices, offering on-the-go product analysis.

4.4 Scalability
The solution is designed for seamless adaptation to diverse operational environments, from

industrial warehouses to consumer households, providing robust and efficient results.

5. Experimental Results

5.1 Industrial Applications

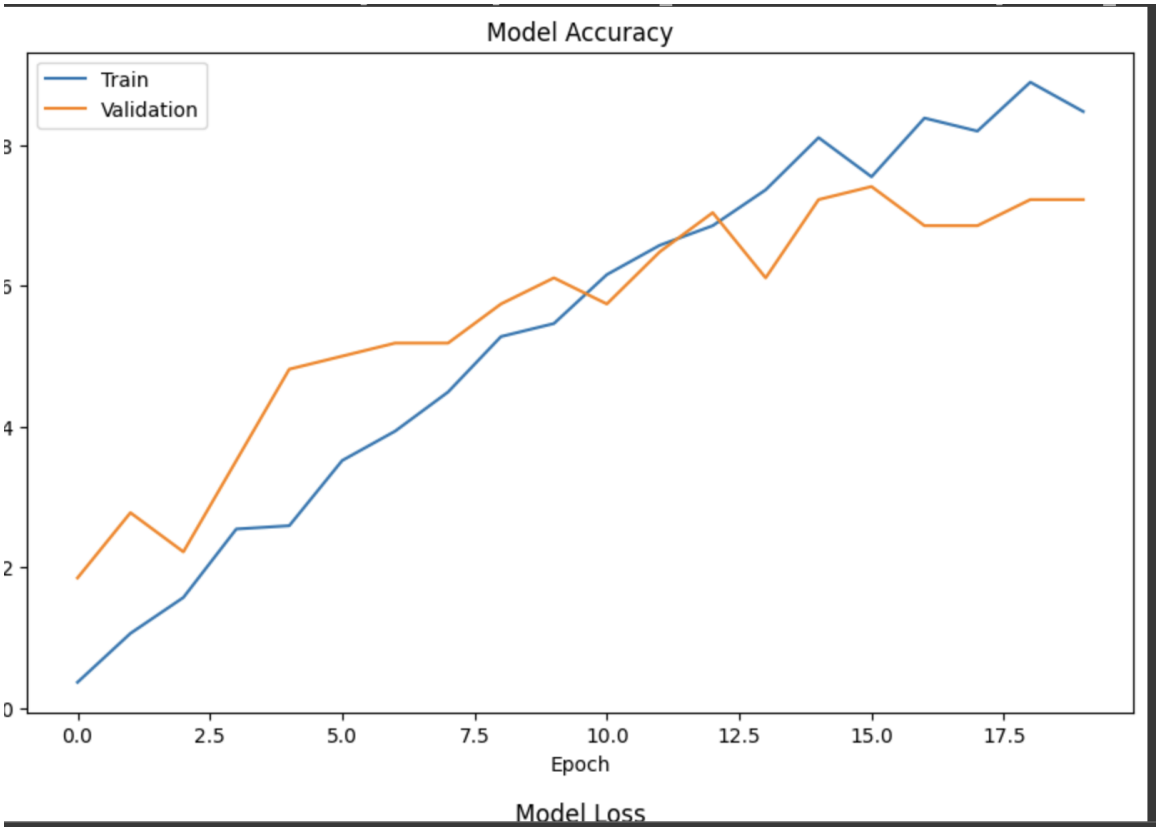
The implementation of area AI on Raspberry Pi enabled real-time product scanning and expiry detection on conveyor belts. initial tests indicated a reduction in operational mistakes through up to 80%, with automated indicators improving decision-making.

5.2 Consumer Applications

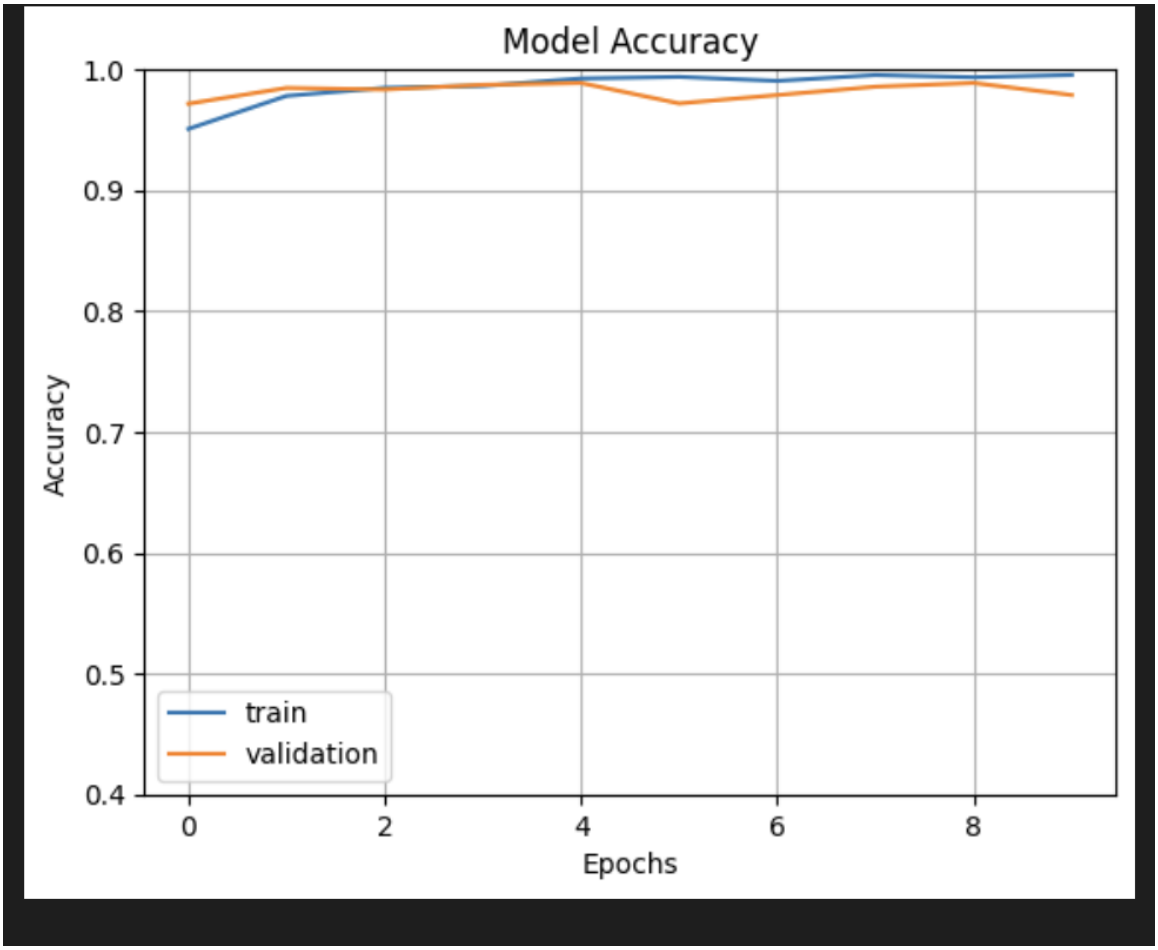
The mobile app prototype confirmed correct product scanning and expiry date detection. Simulated use cases confirmed a 25% reduction in family product waste due to timely notifications and advanced inventory tracking.

5.3 Model Performance

- **Product Classification Accuracy:** ~92% using ResNet50.



- **Freshness of Fruits Detection:** ~99% using ResNet50,



These results emphasize the system's potential for improving efficiency and sustainability.

6. Conclusion

This project provides an advanced solution for managing inventory by leveraging deep learning AI with practical deployment methodologies. It achieves significant efficiency in detecting freshness, product classification, and expiry date detection, benefiting both consumers and industries by reducing product waste. Through product classification and expiry date detection, it addresses critical challenges, improves workflows in industries, and promotes sustainable practices across various sectors.

7. Future Scope

7.1 Dataset Expansion

- Industrial Relevance: Curate an extensive dataset with diverse products, fruit types, and packaging formats to improve model generalization and robustness.

- Global Adaptability: Incorporate multilingual datasets for OCR to enhance usability across different languages and regions.

7.2 Advanced Technology Integration

- Edge Computing: Deploy models on devices like Raspberry Pi to enable real-time processing in industrial setups, such as warehouses and logistics centers.
- Mobile Accessibility: Utilize TensorFlow Lite for lightweight AI models, allowing seamless operation on Android and iOS platforms without requiring cloud services.

7.3 Enhanced Deployment Capabilities

- Dual-Environment Use: Offer solutions for industrial and consumer applications. For industrial use, integrate high-resolution cameras for real-time expiry detection and quality assessment on conveyor belts. For consumers, provide a mobile application for personal inventory management.
- Hybrid Frameworks: Explore hybrid AI approaches combining cloud and edge processing to achieve better scalability and efficiency.

7.4 Real-Time Analytics

- Dynamic Alerts: Integrate real-time notification systems for industrial settings to flag expired or defective products instantly, improving operational decision-making.
- Data Visualization: Provide dashboards for businesses to track inventory statistics, wastage patterns, and quality trends.

7.5 Sustainability and Environmental Impact

- Minimizing Waste: Focus on reducing product waste, particularly in food and pharmaceutical industries, through automated expiry tracking and quality control.
- Promoting Green Practices: Advocate for sustainable inventory management, aligning with global sustainability goals to reduce environmental footprints.

7.6 Enhanced User Experience

- Intuitive Interfaces: Build user-friendly mobile apps for consumers to manage household products, complete with expiry date tracking and purchase reminders.
- Interactive Features: Offer voice-based assistance and AR (Augmented Reality) integration to scan and analyze products in real-time.

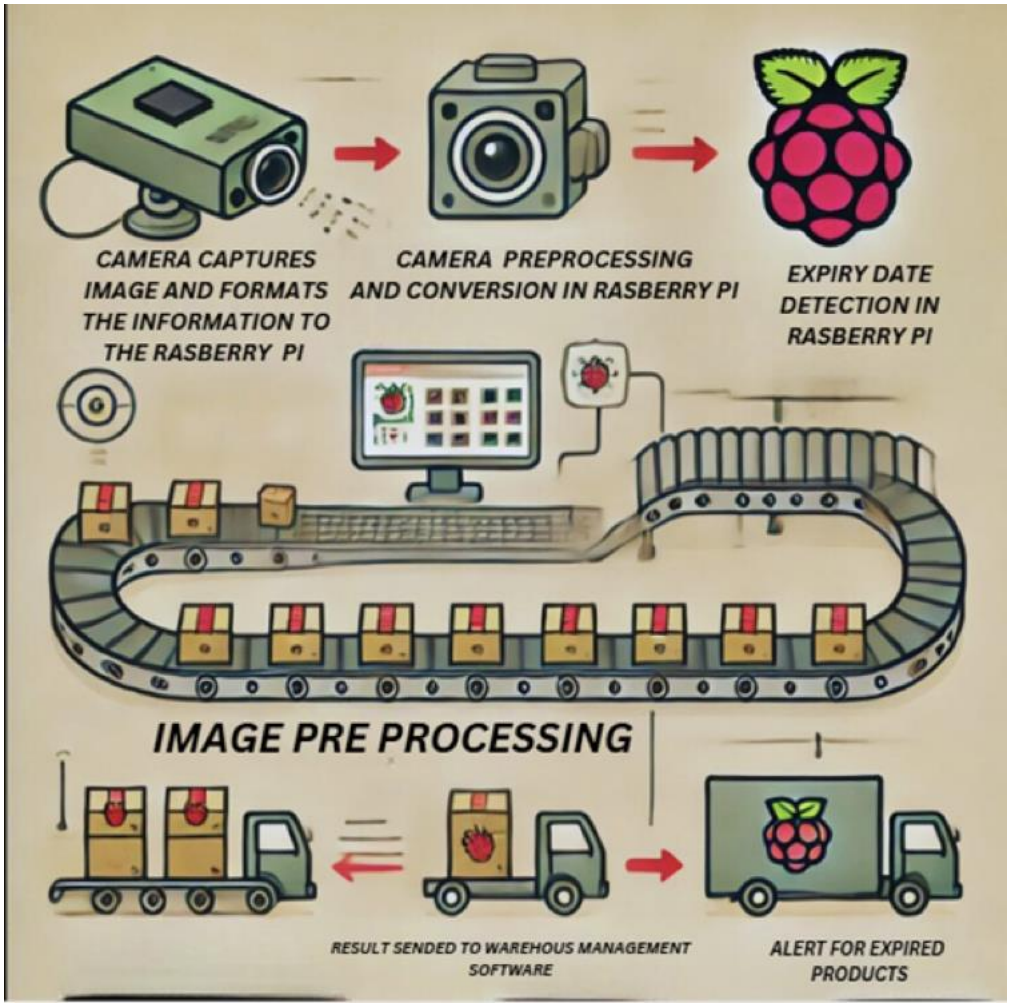

CAMERA CAPTURES IMAGE AND FORMATS THE INFORMATION TO THE RASBERRY PI
CAMERA PREPROCESSING AND CONVERSION IN RASBERRY PI
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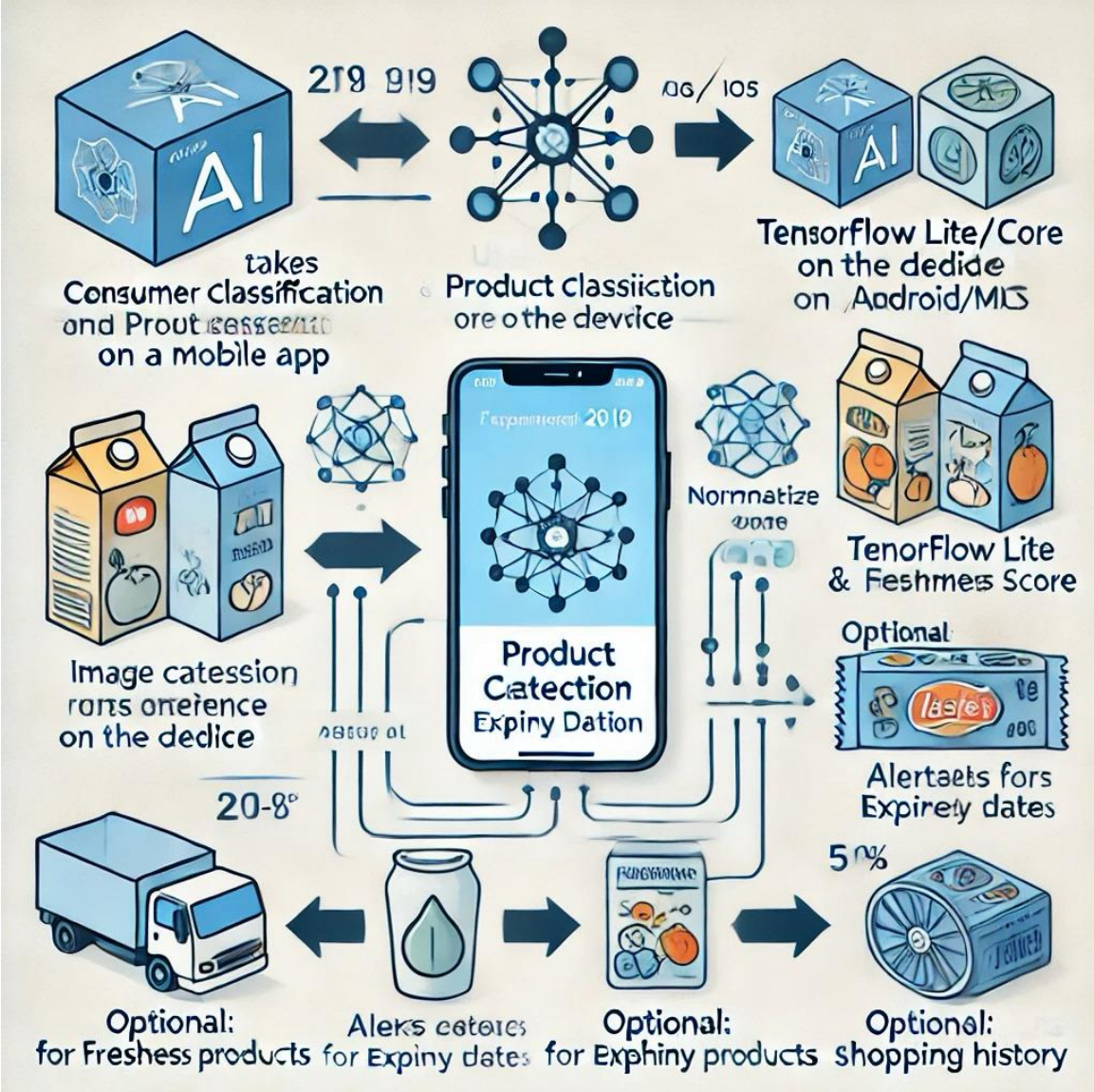
IMAGE PRE PROCESSING
RESULT SENDED TO WAREHOUS MANAGEMENT SOFTWARE
ALERT FOR EXPIRED PRODUCTS



7. Refrences

1.**DOI 10.1088/1755-1315/794/1/012110**

Author(s). (Year). Title. *IOP Conference Series: Earth and Environmental Science, 794*(1), 012110. https://doi.org/10.1088/1755-1315/794/1/012110

2.**DOI https://doi.org/10.1016/j.foodres.2023.113641**

Author(s). (2023). Title. *Food Research International, Volume(Issue), Article*. https://doi.org/10.1016/j.foodres.2023.113641

3.**DOI https://doi.org/10.1007/978-3-319-92007-8_12**

Author(s). (Year). Title. In Editor(s) (Eds.), *Book Title* (pp. Page Numbers). Springer. https://doi.org/10.1007/978-3-319-92007-8_12

4.**DOI: 10.37789/ijusi.2020.13.1.1**

Author(s). (2020). Title. *International Journal of Urban Science and Innovation, 13*(1), Article. https://doi.org/10.37789/ijusi.2020.13.1.1

5.**DOI: https://doi.org/10.1080/09540091.2023.2202363**

Author(s). (2023). Title. *Cognitive Neuropsychology, Volume(Issue), Pages*. https://doi.org/10.1080/09540091.2023.2202363

6. **DOI: https://doi.org/10.1109/ANTEM.2018.8572867**

Honari, M. M., Saghlatoon, H., Mirzavand, R., & Mousavi, P. (2018). An RFID sensor for early expiry detection of packaged foods. *2018 18th International Symposium on Antenna Technology and Applied Electromagnetics (ANTEM)*, 1–2. https://doi.org/10.1109/ANTEM.2018.8572867

7. **DOI: https://doi.org/10.1016/j.dss.2011.05.001**

Author(s). (2011). Title. *Decision Support Systems, Volume(Issue), Pages*. https://doi.org/10.1016/j.dss.2011.05.001

8. **DOI: https://doi.org/10.1007/BF02729448**

Author(s). (Year). Title. *Journal Name, Volume*(Issue), Pages. https://doi.org/10.1007/BF02729448

9. **DOI: https://doi.org/10.1016/j.foodchem.2020.127615**

Author(s). (2020). Title. *Food Chemistry, Volume(Issue), Pages*. https://doi.org/10.1016/j.foodchem.2020.127615

10. **DOI: https://doi.org/10.1016/j.eswa.2022.117310**

Author(s). (2022). Title. *Expert Systems with Applications, Volume(Issue), Pages*. https://doi.org/10.1016/j.eswa.2022.117310