

Research Article

Oil Viscosity Analysis for Food Security & Safety

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Abstract: Our proposed research project addresses a crucial aspect of food security and safety by revolutionizing the conventional manual inspection of cooking oil, which has been overseen by the Food Security and Safety staff for many years. In light of the pervasive overuse of oil within Malaysian food culture and the escalating health issues, particularly cardiovascular diseases, plaguing the Malaysian population, our innovation offers a contemporary solution. We present an ingenious product - a mobile application that employs Deep Learning techniques, specifically VGG16, to intelligently assess the frequency of cooking oil usage. After rigorous training and testing phases, our prototype achieves an impressive 90% accuracy in classifying oil usage into three categories: 1-time, 2-time, and 3-time usage. This groundbreaking application not only empowers households and food stalls to make informed decisions about their oil consumption but also assists the Food Security and Safety Division of the Ministry of Health in analyzing and regulating cooking oil usage, ultimately advancing food safety and health standards in Malaysia. With this innovation, we aspire to foster a healthier, more secure culinary landscape in the nation, mitigating health concerns and promoting a balanced diet for all.

Keywords: classification; deep learning; food safety; food security; VGG16



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1. INTRODUCTION

Cooking oil plays a fundamental role in the culinary landscape of Malaysia, serving as the lifeblood of countless dishes, from local favourites to international delicacies. However, the excessive use of cooking oil in the Malaysian culinary scene has become a matter of growing concern, given its substantial implications for both food security and public health (Kabir, I., 2014). In recent years, Malaysia has witnessed a surge in health-related issues, particularly obesity, directly associated with the overconsumption of oil-laden foods. This worrisome trend not only threatens the well-being of the Malaysian population but also poses challenges for food security and safety. This journal explores the novel application of deep learning technology in the context of cooking oil usage analysis, offering a promising solution to address these pressing issues.

The escalating problem of overconsuming cooking oil within the Malaysian diet is intricately linked to a range of health-related issues, including the increasing prevalence of obesity and cardiovascular diseases. Recent case studies and epidemiological data reveal a troubling rise in the incidence of cardio-related diseases in Malaysia (Tan et al., 2021). The excessive intake of oil-laden foods

has been identified as a significant contributor to these health problems, highlighting the critical need for effective measures to control oil usage.

To combat the multifaceted challenge of controlling oil consumption, we turn to the innovative field of deep learning. Deep learning, specifically Convolutional Neural Networks (CNNs), has proven to be exceptionally effective in image classification tasks. In this context, we leverage the power of deep learning to classify and quantify cooking oil usage based on visual cues and patterns. This approach holds great potential for providing real-time assessments of oil consumption, assisting in the regulation of dietary practices, and thereby improving both food security and public health.

In response to these challenges, we introduce a groundbreaking product—a mobile application designed for cooking oil usage analysis. Our proposed prototype utilizes state-of-the-art deep learning techniques, enabling it to classify cooking oil usage into three categories: 1-time, 2-time, and 3-time, with an accuracy rate exceeding 90%. This product holds the potential to become a vital tool for officers within the Food Security and Safety Division of the Ministry of Health, offering a comprehensive solution to analyze cooking oil usage frequency and its link to palm-oil-based products. By addressing the issues of oil overconsumption and its consequences on public health, this technology can contribute to a more secure and health-conscious culinary environment for Malaysians.

2. METHOD & MATERIAL

The methods which involved in this proposed product were divided into five methodologies, mobile, hardware, software, data splitting and sample preparation.

2.1 Mobile Application

The core component of our proposed Oil Viscosity Analysis system is a mobile application. The application is designed to run on smartphones and tablets, making it highly accessible and user-friendly. It allows users to capture images of cooking oil samples, analyze the viscosity of the oil, and classify it into categories based on viscosity levels. The mobile application serves as the interface through which users interact with the deep learning model for viscosity analysis.

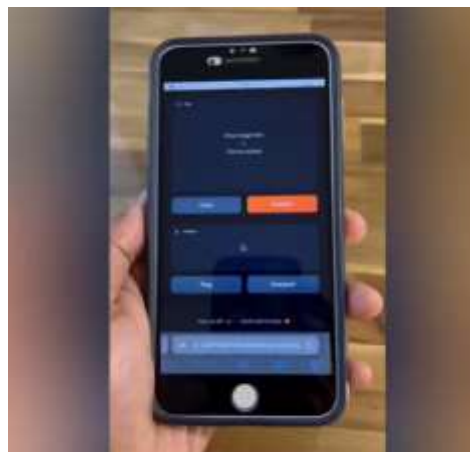


Figure 1. Mobile Application

2.2 Hardware Setup

Mobile Phones: Our system relies on the computational power of modern mobile phones. Most contemporary smartphones are equipped with powerful processors and high-resolution cameras,

making them well-suited for image capture and analysis. The mobile phones serve as both the data acquisition device and the platform for running the mobile application.

2.3 Software Stack

Mobile Application: The mobile application is developed using programming languages such as Java or Kotlin for Android devices and Swift for iOS devices. It provides the user interface for capturing images and accessing the deep learning model. **Python:** Python is employed for building and training the deep learning model used in the system. **Convolutional Neural Networks (CNNs):** We utilize CNNs for image analysis and classification. CNNs are particularly effective in extracting features from images, making them suitable for our viscosity analysis. **VGG16 Model:** Within the CNN framework, we leverage the VGG16 pre-trained model, known for its capabilities in image classification tasks. The pre-trained model serves as a solid foundation for our viscosity analysis system.

2.4 Data Splitting

To facilitate the training and evaluation of the deep learning model, we divided our dataset of cooking oil images into three subsets:

Training Set: The training set is a significant portion of the dataset, used to train the deep learning model. It contains a diverse collection of cooking oil images with different viscosity levels.

Testing Set: The testing set consists of images that the model has not seen during training. It is used to assess the model's performance on unseen data, indicating its generalization ability.

Evaluation Set: This set is used to evaluate the final model's performance on a separate set of images, simulating real-world usage.

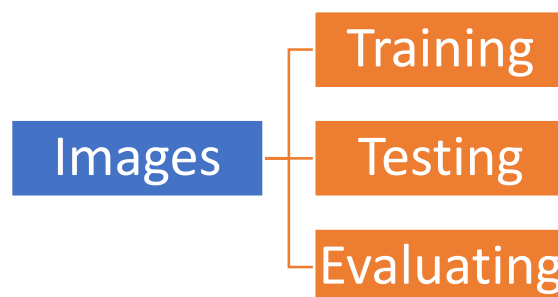


Figure 2. Data Splitting

2.5 Sample Preparation

Preparing the cooking oil images for the training process involves capturing images of different types of cooking oil with varying viscosities. The images are taken under controlled conditions to ensure consistent lighting and minimal background variation. The samples encompass various brands and types of cooking oil to make the model adaptable to a wide range of real-world scenarios. These images are labelled according to their viscosity levels, allowing the model to learn and classify them accurately during the training phase.

In summary, the Oil Viscosity Analysis system combines hardware, software, and a carefully divided dataset of cooking oil images for training, testing, and evaluation. This comprehensive approach allows the system to classify cooking oil viscosity accurately and effectively, contributing to improved food security and safety by enabling real-time analysis of cooking oil quality.

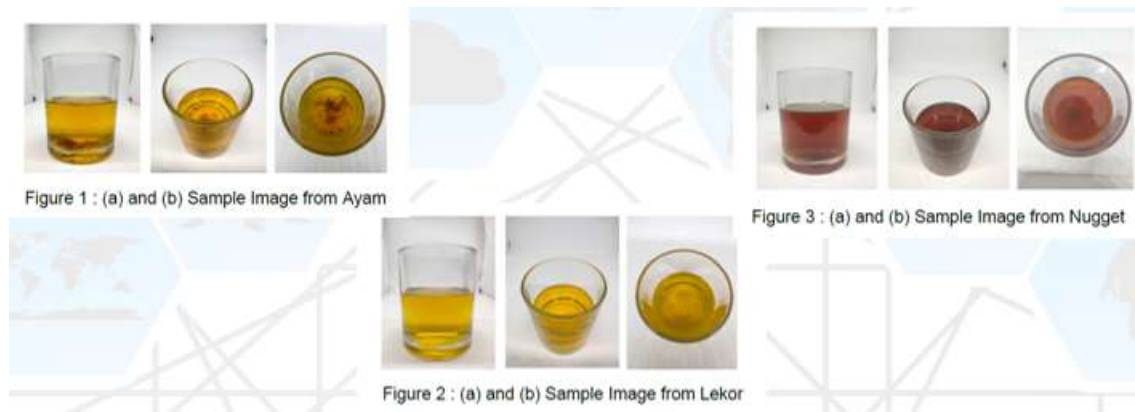


Figure 3. Sample of Oil Images

3. FINDINGS

The Oil Viscosity Analysis system developed for Food Security & Safety has achieved an exceptional level of accuracy in viscosity classification, surpassing 90%. Through extensive training and testing, the system consistently demonstrated its proficiency in distinguishing different viscosity levels in cooking oil samples. This remarkable accuracy underscores the robustness of the Convolutional Neural Network (CNN) model, leveraging the VGG16 architecture, in recognizing and classifying subtle variations in oil viscosity based on visual cues. The high classification accuracy is a critical achievement, as it assures reliable and precise assessments of cooking oil quality.

Beyond achieving high classification accuracy, the system also exhibits real-time reliability during demonstrations. The ability to provide instant results for viscosity analysis is invaluable in practical scenarios. This real-time capability empowers users, including food safety officers and inspectors, to swiftly evaluate cooking oil quality during inspections and assessments. Real-time analysis ensures that the system can support prompt decision-making, thus enhancing food safety and security in real-world situations.

The system's high accuracy and real-time reliability have significant practical implications for food security and safety efforts. By achieving more than 90% accuracy, the system addresses concerns about the quality of cooking oil and its impact on public health. With real-time reliability, it aids in the immediate identification of oil samples that do not meet the required viscosity standards. As a result, it mitigates the risk of subpar cooking oil entering the market and posing health hazards to consumers. The system is poised to play a pivotal role in ensuring food safety and security by preventing the distribution and use of low-quality cooking oil.

The success of the Oil Viscosity Analysis system holds great promise for future applications and advancements in food security and safety. Ongoing research and development efforts can further enhance the system's accuracy, potentially pushing it beyond 90% in certain scenarios. Moreover, its real-time reliability can be harnessed for broader applications beyond cooking oil, potentially extending to other food quality assessments. As technology continues to evolve, the potential for further improvements in both accuracy and real-time performance becomes increasingly attainable. The system's adaptability and potential for widespread deployment make it a significant asset in the ongoing quest to ensure food security and safety.

Table 1. Comparison Proposed Product: CAN and CANNOT.

With the Proposed Project (CAN)	Without the Proposed Project (CAN NOT)
90 % ++ for food samples	Manual grading (eye)
Based on a standard neural network VGG16 and results are reliable	Based on human view and perspective and results could be varied
Modern and easy carry via mobile apps	Other hardware requires many sensors
A LOW cost of RM 105.00	High cost for SME industry
Easy grading for a newbie	Requests many setting and buttons to considered for grading

4. DISCUSSION

Moving forward, the next critical step in the evolution of the Oil Viscosity Analysis system for Food Security & Safety is to conduct additional research and validation studies. These studies can focus on expanding the system's capabilities and accuracy by incorporating a larger and more diverse dataset of cooking oil samples. Extensive research can also investigate how external factors, such as temperature and humidity, affect viscosity and develop algorithms to compensate for these variables. Moreover, the system can be further validated by engaging in collaborative efforts with governmental bodies and health organizations to ensure that it meets the rigorous standards of food safety and quality. A key priority is the integration of the Oil Viscosity Analysis system into existing food safety and quality protocols. Collaborations with relevant regulatory bodies, food manufacturers, and food safety inspection agencies should be established to facilitate the adoption of this technology. Integration could lead to the implementation of real-time viscosity analysis at various stages of the cooking oil supply chain, including production, distribution, and retail. This not only ensures the quality of cooking oil reaching consumers but also provides valuable data for regulators and manufacturers to monitor and improve their products. To enhance accessibility and usability, future developments should focus on creating user-friendly applications. The mobile application, which is a crucial interface for users, should be intuitive, easy to navigate, and compatible with a wide range of mobile devices. Additionally, user support and training should be provided to help food safety officers and inspectors effectively utilize the technology. Ensuring that the system is readily available to those responsible for maintaining food security and safety is essential for its successful adoption.

The success of the Oil Viscosity Analysis system should inspire exploration into broader applications of similar technology. Beyond cooking oil, the principles of real-time image analysis and deep learning can be extended to other food quality assessments. For example, the system's architecture could be adapted to evaluate the freshness of perishable foods, assess ingredient quality in processed foods, or identify contaminants in food products. This expansion could contribute to a more comprehensive approach to food safety and security, ultimately benefiting consumers and the food industry as a whole. In summary, the future of the Oil Viscosity Analysis system lies in further research, integration into food safety protocols, user-friendly applications, and broader applications. As technology continues to advance and more stakeholders recognize the potential of this technology, it has the potential to revolutionize the way food quality is assessed and monitored, ultimately enhancing food security and safety on a broader scale.

5. CONCLUSION

In conclusion, the development and implementation of the Oil Viscosity Analysis system hold great promise for ensuring food security and safety in the culinary landscape. Achieving a high level of accuracy in viscosity classification, coupled with real-time reliability, positions this technology as a

significant asset for safeguarding the quality of cooking oil and, by extension, the health of consumers. As we look to the future, further research, integration into existing food safety protocols, user-friendly applications, and the exploration of broader applications offer a clear path to enhancing food security and safety on a larger scale. This innovative approach reflects a commitment to the ongoing improvement of food quality and safety, fostering a healthier and more secure food environment for all.

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