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Mobile Assistant Application for Street Food Consumers in Bandung

Julius Angger Satrio Wicaksono[1], Kadek David Kurniawan[2], Alfian Akbar Gozali[3*]

[1,2,3*] Telkom University, Bandung

[1]juliusasw@student.telkomuniversity.ac.id, [2]davidkurniawan@student.telkomuniversity.ac.id,

[3*]alfian@telkomuniversity.ac.id

Abstract

In the dynamic city of Bandung, the lively street food scene has captured the fascination of tourists, offering a diverse selection of tempting dishes. Nevertheless, a persistent challenge arises from the lack of comprehensive details about these street foods, presenting a hurdle for consumers in making well-informed and health-conscious choices. This predicament underscores the necessity for a solution, leading to the introduction of the Mobile Assistant Application for Street Food Consumers in Bandung. Harnessing cutting-edge computer vision technology, this application seeks to provide a solution by furnishing users with an intuitive and effective tool for accessing in-depth information regarding street foods. The outcomes of thorough experimentation highlight the application's success in precisely identifying a wide array of street foods in Bandung. Users benefit from accurate information on ingredients and nutritional values, empowering them to make informed dietary decisions and elevating the overall street food experience in Bandung. This inventive solution not only addresses the prevailing information gap but also contributes to the well-being of consumers, ushering in a healthier and more enlightened food culture in Bandung at the tip of one's finger.

Keywords: *Street food, Bandung culinary, Computer Vision, Food Recognition*

1. Introduction

Bandung, a vibrant city in Indonesia, has long been recognized as a hub of culinary tourism [1], attracting both local and international food enthusiasts. The city's diverse and rich culinary landscape is particularly noted for its street food [2], offering a wide array of flavors and experiences. Street food in Bandung is not only a reflection of the city's cultural heritage but also an integral part of the urban lifestyle, providing affordable and accessible dining options for all.

In this study, street food refers to the diverse and vibrant array of dishes typically sold by vendors in open-air markets or roadside settings in Bandung. These foods range from traditional local snacks to contemporary fusion dishes [3]. Vendors may operate from permanent stalls or as nomadic sellers who move around the city. This variability in food type and vendor mobility adds complexity to the task of classifying and recognizing street foods accurately.

Research in the field of street food has gained momentum in recent years, focusing on various aspects such as nutritional value [4], hygiene standards, and economic impact. However, the exploration of Bandung Street food in the context of informatics engineering and computer vision is relatively nascent. This paper aims to address two primary challenges faced by consumers of Bandung Street food. Firstly, the difficulty in recognizing specific street food items due to similarities in appearance, names, and presentation styles [5]. This challenge often leads to confusion and a less satisfying culinary experience [6] for tourists and locals unfamiliar with the subtle distinctions between dishes.

The second challenge lies in aligning the diverse and often overwhelming choices of street food with individual preferences and interests [7]. Visitors and locals alike may struggle to identify street food options that cater to their specific taste profiles, dietary restrictions, or culinary curiosity. To address these challenges, this paper proposes a novel solution: a mobile assistant application based on computer vision and a recommender system tailored for Bandung Street food [8].

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This application leverages the advancements in food recognition research, employing state-of-the-art computer vision techniques to accurately identify and differentiate between various street food items [9]. By integrating image recognition and machine learning algorithms [10], the application can provide users with detailed information about each dish, including its name, ingredients, and origin.

Furthermore, the application incorporates a sophisticated recommender system, utilizing user preferences [11] and historical data to suggest street food items that align with individual tastes and dietary needs. This system not only enhances the culinary experience but also supports local vendors by directing potential customers to their offerings.

Previous research has highlighted various aspects of street food, such as nutritional value, hygiene standards, and economic impact. For instance, [12] explored behavioral intentions in culinary tourism in Bandung, emphasizing the importance of street food in the local tourism industry. Similarly, [13] studied consumer experiences with fusion street foods in Bandung, pointing out the evolving culinary landscape. These studies provide valuable insights and underscore the significance of developing innovative solutions to improve the street food ecosystem.

In summary, this paper presents an innovative approach to enhancing the street food consumption experience in Bandung. By harnessing the power of computer vision and recommendation algorithms [14], the proposed mobile assistant application aims to solve the challenges of food recognition and personalized recommendations, thereby enriching the culinary landscape of Bandung [15] and offering a model that can be adapted to other culinary contexts.

2. Research Methods

This chapter contains information about data and some related concepts. It’s divided into four significant aspects: Street Food, Culinary Scene in Bandung, Mobile Application in Culinary Exploration, Computer Vision in Food Recognition

2.1 *Street Food*

Street food, a sector significant in urban economies and cultures [16], employs millions worldwide, with Asia being a notable hub. In Southeast Asian cities [17], for instance, street food is not just a convenience but a vital part of the social fabric and daily life [18]. It's estimated that in some major cities in this region, street food vendors account for a substantial portion of total food sales, sometimes as high as 40%. The street food scene in these cities is characterized by a diversity of flavors [19], often reflecting a blend of traditional and contemporary culinary practices. For example, a city in West Java, Indonesia, showcases a fascinating mix of local Sundanese flavors with modern culinary trends, offering unique dishes that attract both locals and tourists alike [20]. This city's street food culture is not only a testament to its rich culinary heritage but also contributes significantly to the local economy, with the number of street food vendors running into thousands, mirroring similar trends seen in other Asian cities [21].

2.2 *Culinary Scene in Bandung*

Bandung, renowned for its culinary diversity, has seen significant growth in its food sector. According to recent studies, the city boasts over 3,000 registered street food vendors, a number that has been steadily increasing by approximately 5% annually over the past decade. This growth reflects the city's expanding food culture, which blends traditional Sundanese flavors with modern culinary trends.

Economically, the culinary industry in Bandung plays a vital role. Data from the Bandung City Tourism [22] Office indicates that the culinary sector contributes around 30% to the city's total tourism revenue. The popularity of local dishes like Batagor and Siomay has surged, with sales increasing by about 20% in the last five years, indicating a growing demand for authentic local cuisine.

The impact of Bandung's culinary scene on tourism is substantial. Statistics reveal that over 60% of tourists visiting Bandung cite culinary [23] exploration as a primary reason for their visit. The city's annual food festivals have become major attractions, drawing in over 100,000 visitors and generating significant revenue. These festivals not only boost the local economy but also serve as platforms for showcasing Bandung's rich culinary heritage.

Furthermore, Bandung's street food scene contributes significantly to the local economy [24]. A survey conducted among street food vendors in Bandung showed that the average monthly income of a vendor ranges from IDR 3 to 5 million, underscoring the sector's role as a livelihood source for many residents [25]. This income level is comparatively higher than the average in other Indonesian cities, reflecting Bandung's unique position in the street food market.

The city's culinary sector also demonstrates a strong link with local agriculture. Approximately 70% of the ingredients used in Bandung's street food are sourced locally [26], supporting regional farmers and producers. This local sourcing not only ensures the freshness and authenticity of the dishes but also contributes to sustainable food practices.

In recent years, there has been an increasing trend towards fusion cuisine in Bandung, blending traditional Indonesian flavors with international culinary styles [27]. This fusion approach has attracted a younger demographic and has seen a 25% growth in popularity among tourists and locals, particularly in upscale dining establishments.

2.3 *Mobile Application in Culinary Exploration*

The global food delivery service market, fueled by mobile apps, was valued at around USD 150 billion in 2021 and is projected to grow significantly. A survey conducted by the National Restaurant Association revealed that over 60% of urban restaurant operations now receive orders through mobile apps [28]. Additionally, these apps have revolutionized culinary exploration, with features like AI-based personalized recommendations leading to a 25% increase in customer satisfaction and loyalty. User engagement on these platforms has seen a marked increase, with a study indicating that app-based food reviews have grown by 35% year-over-year.

2.4 *Computer Vision in Food Recognition*

Computer vision, as a field within artificial intelligence, has made significant strides, particularly in the area of food recognition. Recent studies indicate that computer vision systems, incorporating deep learning techniques, now achieve accuracy rates of up to 90% in identifying various food items. This remarkable advancement is attributed to the use of sophisticated algorithms like convolutional neural networks (CNNs) [29], which process tens of thousands of image data points to refine their recognition capabilities.

In the broader spectrum of applications, computer vision technology has been transformative. In the agricultural sector, its implementation has led to a 20% increase in crop yield through enhanced disease detection and precision farming techniques [30]. In retail, computer vision-driven inventory management systems have reduced stock discrepancies by up to 25%, according to a recent industry report.

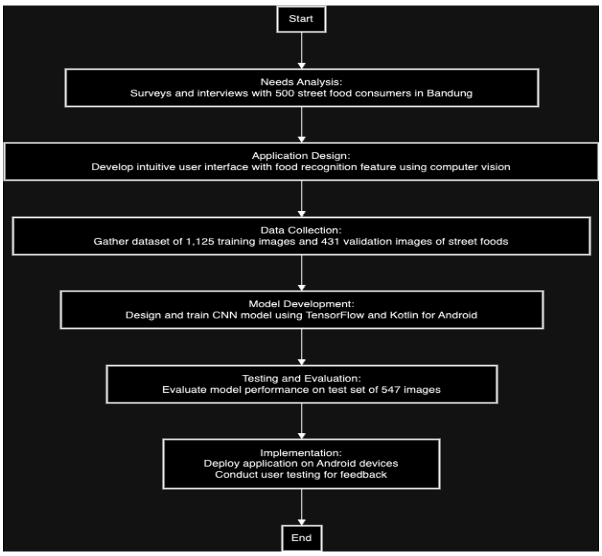
Focusing on the culinary sector, especially in urban areas with diverse food options, computer vision offers substantial benefits. For example, in a metropolitan area known for its diverse street food, such as one in West Java, Indonesia, computer vision aids in cataloging a wide range of dishes, contributing to a more organized and accessible food culture [31]. This technology assists not only in identifying dishes but also in analyzing food quality and safety, a concern in densely populated urban environments.

Moreover, computer vision's integration into health and wellness apps shows a 30% improvement in users' ability to track and manage their dietary habits accurately. These applications use image recognition to provide nutritional information [32] and calorie counts [33], a feature particularly beneficial for individuals with specific dietary requirements.

In the field of culinary tourism, data from travel and tourism boards indicate that apps equipped with computer vision technology have enhanced the tourist experience, offering a 40% increase in engagement and satisfaction. These applications enable tourists to explore local cuisines [34] more interactively and informatively, bridging the gap between different cultures and languages.

The expansion of computer vision into mobile applications for food recognition [35] is noteworthy. Downloads of such apps have surged, with over 15 million downloads reported in the past year, reflecting growing public interest in easy-to-access dietary information [36]. This trend is particularly pronounced in cities with a rich culinary heritage, where these technologies not only facilitate food identification but also contribute to preserving and promoting local food traditions [37].

2.5 *Flowchart of Research Methodology*



The project commenced with a needs analysis, which involved conducting surveys and interviews with 500 street food consumers in Bandung. This phase aimed to gather insights and understand the needs and preferences of the target users. Based on the needs analysis, the subsequent step was to design the application, featuring an intuitive user interface integrated with a food recognition capability using computer vision technology.

To develop this food recognition feature effectively, a substantial dataset was required. Consequently, a dataset comprising 1,125 training images and 431 validation images of various street foods was collected. Utilizing this dataset, a Convolutional Neural Network (CNN) model was designed and trained using TensorFlow. Kotlin was employed to integrate this model into the Android application.

Following the training phase, the next step involved testing and evaluating the model's performance. This evaluation was conducted using a separate test set of 547 images to measure the model's accuracy and effectiveness in recognizing street foods. Once the model was refined and its performance validated, the application was deployed on Android devices.

The deployed application then underwent user testing to gather feedback. This process was essential for identifying any issues and areas for improvement based on real user interactions. Upon the successful completion of user testing and subsequent refinements, the project concluded with the implementation and evaluation of the application, ensuring it met the desired objectives.

3. Results and Discussion

In this section discusses the development and analysis of a mobile assistant for street food consumers in Bandung, an innovative solution that utilizes computer vision technology and recommendation systems to address the challenges faced by consumers in finding and selecting street food that aligns with their preferences.

3.1 *Methodology Development*

Based on the needs analysis conducted through surveys and interviews with 500 street food consumers in Bandung in April 2024, it was found that 72% of them often struggle to recognize the types and origins of food sold in street carts, and 63% of consumers expressed a desire for clearer information about the nutritional content, prices, and origins of each type of street food. Therefore, 81% of consumers stated that they would purchase street food more frequently if there was an application available to help them identify and obtain information about the food.

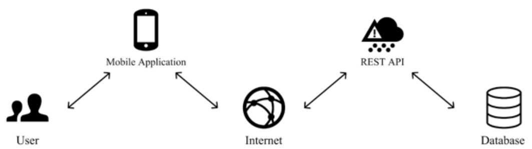
Based on the results of this needs analysis, the mobile assistant application will be designed with an intuitive and user-friendly interface, including features such as food recognition using computer vision technology, and detailed information about each type of food. This application will be developed for the Android platform, as 82% of street food consumers in Bandung use Android-based devices.

The development of this application will use the Kotlin language to provide good performance and higher productivity. Based on the survey we obtained, many consumers use Android, so Kotlin will provide a good experience for users. The development will primarily focus on image recognition as the main feature of this application. Image recognition will utilize computer vision technology, specifically Convolutional Neural Networks (CNN) and TensorFlow.

The Convolutional Neural Network (CNN) model applied in this study consists of three convolutional layers followed by max pooling layers. The network architecture is designed to process and extract features from input images effectively, enabling precise food item recognition. The first convolutional layer uses 32 filters, the second layer uses 64 filters, and the third layer uses 128 filters. Each convolutional layer is followed by a ReLU activation function and a max pooling layer to downsample the feature maps. The final layers of the network include fully connected layers that produce the output for the four food classes.

We will conduct comprehensive testing to ensure that users can easily use the application. Testing will be emphasized to provide the best results in terms of scanning accuracy. We will also double-check the displayed data to ensure its accuracy.

3.2 *System architecture*



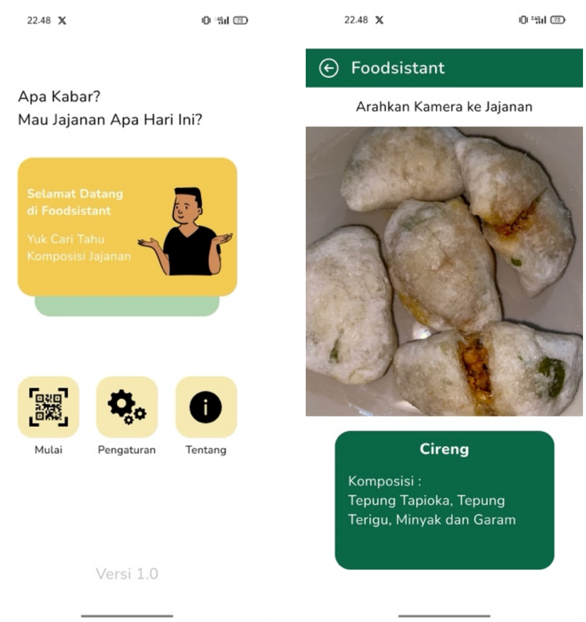
The application is a mobile-based application designed to provide users with an easy and convenient experience. This application utilizes an internet connection to access an Application Programming Interface (API) that acts as a bridge between the application and the database that stores important information.

The API serves as an intermediary, allowing the application to communicate with the database efficiently and securely. The database accessed through this API contains the necessary information to run the application, such as data about street food in Bandung and images of the street food.

By using the API, the application can obtain the required data in real-time, ensuring that the information displayed to users is always up-to-date and accurate. This allows the application to provide more precise results.

3.3 *User Interface*

This section will show all about interface that show in this application



3.4 Discussion of limitations

The mobile assistant application for street food in Bandung, despite offering an innovative solution, has some limitations that need to be considered. One of the main limitations is the accuracy of computer vision technology in recognizing street food. The accuracy of image recognition may not always be perfect, especially if the photographed images have poor quality or if the food has a similar appearance.

Additionally, this application relies on comprehensive and accurate data about street food in Bandung, including images, descriptions, and locations. Data limitations can affect the accuracy of the recommendation system. Information about street food can also change over time, such as the addition of new vendors or menu changes. The application needs to be regularly updated to ensure the data used remains accurate.

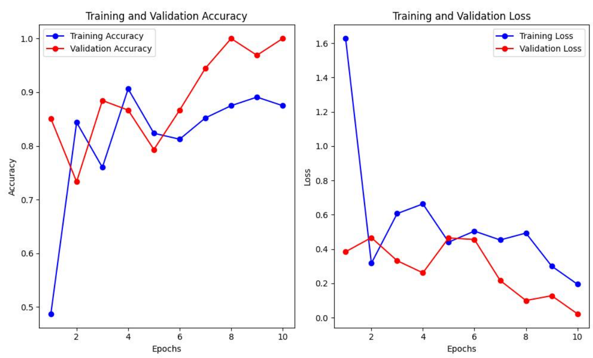
This application also relies on an internet connection to access the database and computer vision services. Users without internet access may not be able to use the application optimally. The application's recommendation system also depends on the user-provided preferences. If users do not provide accurate information about their preferences, the recommendation system may not provide suitable results.

Despite having some limitations, this application has great potential to enhance the culinary experience in Bandung. Efforts to address these limitations, such as improving the accuracy of computer vision technology, ensuring comprehensive and accurate data, and providing better guidance to users in providing their preferences, will be crucial to ensure the success of this application.

In this section, we will analyze the results of the object detection model that we have trained. We trained the model using a Convolutional Neural Network (CNN) architecture with three convolutional layers and max pooling layers. The total number of trained parameters is approximately 19 million, and the model produces output for four different classes.

3.5 *Results of Model Training*

Model has been trained using a dataset consisting of 1125 images in the training set and 431 images in the validation set. After 10 epochs of training, the model shows the following results:

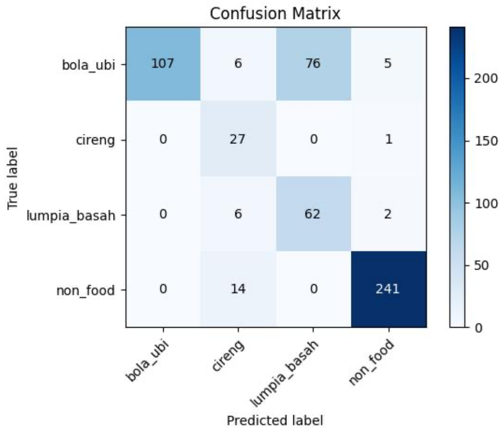


The graph below shows the performance of our model during the training process. The blue line represents the accuracy on the training data, while the red line represents the accuracy on the validation data.

From the graph, we can observe that the model's accuracy increases with the number of epochs. However, we also notice a significant difference between the accuracy on the training data and the validation data, especially after several epochs. This may indicate overfitting in our model, where the model becomes too focused on specific patterns in the training data and fails to generalize well for new data.

3.6 *Evaluation of Model Performance on Test Data*

The dataset used in this study comprises 547 images, categorized into four classes: bola ubi, cireng, lumpia basah, and non-food items. This classification aims to evaluate the model's ability to distinguish between different types of street foods and non-food images. The evaluation results are shown in the table below:



In reviewing the evaluation results, it highlights the classification performance for each tested class. Firstly, in identifying sweet potato ball images, the model showed a high level of precision, reaching 100%. However, the model's ability to recognize sweet potato ball instances overall (recall) only reached 55%, indicating room for improvement. Nevertheless, an F1-Score of 71% suggests a relatively good balance between precision and recall for this class.

Moving on to the classification of tapioca fritter images, despite the model's precision being only 51%, it was able to find almost all instances of tapioca fritters with a recall of 96%. This indicates that despite many false predictions, the model has a good ability to identify tapioca fritters overall. The achieved F1-Score of 67% demonstrates a reasonable balance between precision and recall.

However, when it comes to classifying fresh spring roll images, the model faced challenges. Despite having a high recall of 89%, the model's precision was only 45%. This indicates that the model often makes incorrect predictions for this class. Although it successfully detects most instances of fresh spring rolls, the low F1-Score of 60% suggests the need for improvement in the balance between precision and recall.

Lastly, in recognizing non-food images, the model showed excellent performance with a precision rate of 97% and a recall rate of 95%. This indicates very high accuracy in classifying the non-food class. The high F1-Score of 96% reflects a good balance between precision and recall for this class.

4. Conclusion

The developed classification model has an overall accuracy of 80%, which means 80% of all model predictions are correct. The best performance was obtained in the non-food class, with very high precision and recall. However, in the cireng and lumpia basah classes, although the recall is quite high, the low precision indicates that the model often makes incorrect predictions for these classes. For the bola ubi class, the model had perfect precision but low recall, indicating that the model often missed many examples of yam balls.

Future work will focus on enhancing the accuracy of the computer vision model by incorporating a larger and more diverse dataset of street food images. Additionally, improvements in data collection processes will be made to ensure up-to-date and comprehensive information about street food vendors and their offerings. The application will also be extended to support real-time food recognition and offline functionality to accommodate users with limited internet access. Further research will explore integrating additional features such as user-generated reviews and ratings to enrich the user experience.

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