TEGAR: Tempe Freshness Determination on Mobile Application

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Abstract. This research proposes Tempe Segar ‘TEGAR’ as mobile application for freshness determination of tempe based on tempe image on the Android operating system. Three kinds of freshness, including very good, good and not good were used to categorized tempe freshness. In this research, we used 50 tempe samples that were consisted of 25 tempe with plastic wrap and 25 tempe with leaf wrap. Tempe image was taken using mobile phone camera as digital tempe image then extracted using Local Binary Pattern (LBP). Detection accuracy and consumer satisfaction of TEGAR application were evaluated using questionnaire. The evaluation results show that TEGAR application is promising application to determine tempe freshness. TEGAR application will help consumer to determine tempe freshness as an important indicator of good quality tempe. The freshness of food directly or indirectly will affect the health of consumer.

1. Introduction
Tempe is a traditional soybean derivative food that is made through fermentation using mix cultures of Rhizopus spp. Production of tempe is mostly conducted in small household industries that spread out in all provinces of Indonesia. As the source of protein, tempe is widely consumed as a part of Indonesian food pattern [1].

Tempe freshness is one of important indicator in determining the quality of tempe. Generally, fresh tempe can last 1-2 days at room temperature then there will be physical, chemical, and biological changes so that tempe freshness decreases. These changes can modify its taste and lead to food poisoning. So that, tempe freshness are necessary to determine [2].

In the traditional detection method, the sensory method is commonly used to determine tempe freshness. It can be conducted through the sense of smell and touch by consumers. Though the sensory method is limited due to personal preferences and high risk of misinterpretation, therefore the instrumental method is needed to develop [3].

Many instrumental methodologies have been proposed to determine food freshness in automated fashion. Image processing-based technique is one of instrumental method that is noticeable to determine food freshness. Permana [4] detected tempe freshness level based on implementation of image processing and machine learning on desktop. Then, Permana et al. [5] determined tempe freshness level using automated application that is synchronized with the mobile phone based on Matlab and digital image.
This application detected tempe freshness and decided its quality whether good or bad through its freshness.

In this research, we propose a mobile application to determine tempe freshness. Tempe images were taken and extracted through image processing steps. Determination of tempe freshness is working automatically based on tempe image that runs on Android operating system. Local Binary Pattern (LBP) is used to extract tempe samples and categorized the level of tempe freshness. Subsequently, the application was tested for its performance evaluation regarding detection accuracy and consumer satisfaction.

2. Materials and Methods

2.1. Tempe Samples Collection

Tempe samples were collected from Kampung Tempe Kelurahan Koang Jaya Kecamatan Periuk Kota Tangerang. We used 50 tempe samples that were consisted of 25 tempe with plastic wrap and 25 tempe with leaf wrap. Tempe images were captured using mobile phone camera as digital tempe images.

2.2. Development of TEGAR: Tempe Freshness Determination on Mobile Application

The overall diagram of our proposed tempe freshness determination including training and testing phages are describing in Figure 1.

![Figure 1. The overall diagram of TEGAR.](image)

Tempe images in both training and testing phases were pre-proceed and extracted. The pre-processing step is to reduce computational complexity. Tempe images were segmented into desired part so that it will be easier to analyze. Segmented tempe images were converted into binary images that were represented by black and white. Several features were extracted from segmented tempe images known as feature extraction. These images entered the training processes. The trained models were used to categorize the input image into very good, good, or not good, then the performance test was also evaluated using questionnaire to obtain approval rate how is the performance of TEGAR regarding detection accuracy and consumer satisfaction.

3. Results and Discussion

We have been developed TEGAR: tempe freshness determination on mobile application. The application runs on Android operating system. The minimum specifications of smartphone to run TEGAR properly and smoothly are as follows:

- OS: Android OS, v.4.1.1 (Jelly Bean)
- RAM: 2 GB
- Processor: Quad-core 1.6 GHz Cortex-A9
- Camera: 8 MP
- Space Storage: 15.7 MB
The application is divided into two main functionalities, i.e., tempe freshness determination (Figure 2, Figure 3) and tempe information (Figure 4). For tempe freshness determination, tempe image can be captured from camera phone or gallery (Figure 2). The selected image will be displayed on the mobile screen, then users can decide whether to crop or directly use the selected image. To determine tempe freshness, users can press the checklist sign as the determination button. The results are shown in Figure 3 with several categorization: not tempe, not good tempe, good tempe or very good tempe. Figure 4 show interface of tempe information.

Figure 2. TEGAR: tempe freshness determination (a) main menu, (b) pop up menu.

Figure 3. TEGAR results menu (a) not tempe, (b) not good tempe, (c) good tempe, (d) very good tempe.
We evaluated performance of the application using questionnaire to the users. The performance test was applied to 20 respondents to obtain approval rate how is the performance of TEGAR regarding detection accuracy and consumer satisfaction. Respondents consisted of 5 males and 15 females aged between 20-60 years.

The results of the questionnaire show that the accuracy of TEGAR is excellent (75%) (Figure 5). The detection accuracy of an application was determined by the image quality of the samples. The quality of image whether good or bad was caused by the camera devices, so that every image has different illumination [6].

![Figure 4. TEGAR tempe information.](image)

![Figure 5. Detection accuracy of TEGAR.](image)

The evaluation of consumer satisfaction in determination of tempe freshness show that 85% consumers were satisfied, 10% quite satisfied and 5% not satisfied (Figure 6).
4. Conclusion

We have been developed TEGAR: tempe freshness determination on mobile application. The application runs on Android operating system that use image processing technology. The application is divided into two main functionalities: tempe freshness determination and tempe information. The accuracy of TEGAR is excellent (75%) and 85% consumers were satisfied. The evaluation results show that TEGAR application is promising application to determine tempe freshness. TEGAR application will help consumer to determine tempe freshness as an important indicator of good quality tempe.

5. References

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