Skinophile: The Art Of Skincare Selection With Haar Wavelet

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Abstract.

In this study, a mobile application has been developed with the primary objective of classifying facial skin types to facilitate the selection of appropriate skincare products tailored to individual skin needs. The motivation behind this research stems from the widespread issue of individuals being unaware of their specific skin types, which often leads to suboptimal skincare routines and, in some cases, adverse effects such as skin dullness and damage. To address this challenge, a comprehensive problem-solving approach has been adopted. The methodology encompasses the utilization of the Haar Wavelets method for facial image feature extraction, complemented by the application of the Support Vector Machine (SVM) algorithm for precise skin type classification. Face Recognition technology has also been integrated to enhance the accuracy and reliability of the classification process.In terms of system development, an Agile methodology has been employed, facilitating swift and cost-effective project completion. This agile approach ensures the development process is efficient, reducing both time and financial resources.The mobile application developed for this purpose utilizes the Python programming language, specifically incorporating the PyWavelets library. The culmination of this research effort is a user-friendly mobile application that enables users to capture their facial images. Subsequently, the application employs advanced algorithms to identify their specific skin type, providing personalized recommendations for suitable skincare products and routines. This innovative solution aims to empower individuals with the knowledge and tools necessary to enhance the effectiveness of their skincare regimen, ultimately promoting healthier and more radiant skin.

Keywords: *Agile Method, Face Recognition, Haar Wavelet, Mobile Application, and Skincare.*

I. INTRODUCTION

The skincare industry is experiencing significant growth, particularly in Indonesia, where skincare production increased by approximately 6% in 2017 [1]. This industry's evolution has led to innovative products tailored to specific facial skincare needs. For many individuals, skincare routines have expanded beyond a single step, encompassing multiple products and steps. The growing variety of skincare products available in the market offers consumers a wide range of choices. However, even with the benefits of skincare, users may not always achieve the desired results due to their lack of knowledge about their specific skin type. Research conducted by [2] revealed that approximately 80% of individuals have insufficient knowledge about skincare suitable for their skin type. Considering that each person has a unique facial skin type, there is a need for an application that can facilitate the identification of one's skin type.In this study, a mobile-based application [3], accessible through smartphones and gadgets, is proposed to address this issue. This application has been named “Skinophile”, which means a person who loves skin very much.

The application incorporates the Haar Wavelet method and utilizes face recognition technology to assist users in determining their specific facial skin type, consequently enabling more informed skincare product selections. While previous research has employed the Haar Wavelet method to determine skin types, the novelty of this study lies in its classification of four skin types: normal, oily, dry, and combination, as opposed to the previous two classifications of normal and oily skin types. The adoption of face recognition technology is deemed advantageous due to its high accuracy in identifying facial features and skin types. Face recognition, a subfield of computer vision, enables personalized identification for various human-computer interactions, achieved through the processing of visually rich image data [2]. It is expected that the combination of the Haar Wavelet method and face recognition technology in this application will effectively recognize and classify different skin types.By developing and implementing this innovative mobile application, this research aims to empower users with a convenient tool for identifying their unique facial skin type accurately. Ultimately, this technology-driven approach strives to enhance the effectiveness of skincare routines and product choices, contributing to improved skincare outcomes and customer satisfaction.

II. METHODS

Overview of the Research Object

This research is centred upon a comprehensive examination of the diverse facial skin types exhibited by individuals, coupled with the assessment of application users who employ the system to make informed decisions regarding skincare products and routines aligned with their specific skin characteristics. The accumulation of data pertaining to these multifaceted skin types is an integral aspect of this study, culminating in the synthesis of information aimed at elucidating the appropriateness of distinct skincare regimens. As delineated by [4], the discerned skin categories encompass dry skin, normal skin, oily skin, and combination skin. This investigation assumes significance in light of the growing awareness of skincare as a pivotal element of personal grooming and health, with a profound impact on one's overall well-being.

Selection Rationale for the Methodology

The software development method used in this research is called Agile [5]. The choice of this methodology is driven by several key considerations. Firstly, the software being developed falls within the realm of relatively modest complexity, categorizing it as a small-scale application. Furthermore, the development timeline for this software is not overly protracted. The adoption of the Agile methodology is as follows:

- Planning: At this initial stage, meticulous planning is undertaken for the creation of the skincare type determination application, customized to the various facial skin types at hand.
- Design: In this phase, the design of the User Interface (UI) is meticulously crafted, accompanied by a comprehensive analysis of the system's blueprint. System analysis is conducted using UML Tools, comprising flowchart diagrams, use case diagrams, activity diagrams, and class diagrams.
- Coding: The coding phase constitutes the actual construction of the system for skin type-based skincare determination. This entails crafting source code in alignment with the designated algorithm. The algorithm chosen for this research is the Haar Wavelets algorithm, and it is implemented using the Python programming language, specifically leveraging the PyWavelets library.
- Testing: Following the coding phase, the mobile-based skincare determination application is subjected to rigorous testing to assess its functionality and alignment with predetermined specifications. This assessment is carried out with randomly selected respondents. Any shortcomings or errors identified during this phase prompt necessary revisions.
- Implementation: Once successfully traversing the testing phase, the mobile-based skincare determination application proceeds to its implementation phase, becoming accessible to end-users.

In summary, the selection of the Agile methodology stems from its suitability for the development of a relatively uncomplicated, small-scale software application within a constrained development timeframe. This methodical approach, comprising planning, design, coding, testing, and implementation phases, ensures the efficient and effective realization of the skincare type determination application, ultimately facilitating its deployment and accessibility to users.

Problem-Solving

The objective of this research is to ascertain an individual's skin type, thereby facilitating the identification of suitable skincare products for their use. In pursuit of this goal, the chosen algorithm for image extraction is the Haar Wavelet algorithm due to its high accuracy rate and minimal error propensity in image detection [6]. This algorithm represents a relatively recent refinement of the Fourier Transform and is esteemed for its efficacy and superiority over Fourier techniques. Notably, Wavelet-based algorithms excel in addressing localized issues that Fourier Transform methods struggle to resolve, owing to the adaptive nature of wavelet bases, which are determined by both position and scale considerations [4].To facilitate the classification process, the Support Vector Machine (SVM) method will be employed [7]. To comprehend these methodologies in greater detail, the following steps must be undertaken [8]:

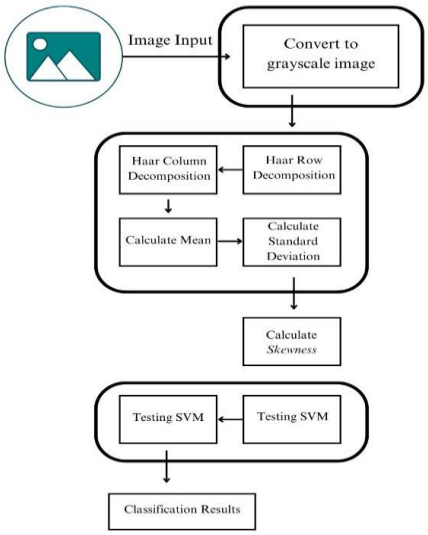

Fig 1. Stages of Research Methodology

In this research, the objective is to determine an individual's skin type to recommend suitable skincare products. The process involves converting colour images to grayscale using a formula, followed by Haar wavelet decomposition for feature extraction. Mean, standard deviation and skewness are calculated to characterize the skin. Classification is done using a Support Vector Machine (SVM) [9], involving margin calculation, quadratic programming, Lagrange Multiplier duality, and weight vector determination. The results yield the individual's skin type, allowing for tailored skincare recommendations.

The Data Collection Methods

In this research, several data collection techniques were employed to gather information pertaining to skin types, face recognition technology, and related algorithms such as Haar Wavelets and Fourier Transformation [10].

- Literature Review: Data collection through a comprehensive literature review involved studying relevant journals that addressed issues related to skin types, face recognition, and the algorithms associated with face recognition technology. This method provided a foundational understanding of the subject matter and served as a valuable source of secondary data.
- Questionnaire: Data was collected through the distribution of a questionnaire via Google Forms to individuals who served as respondents in this study. A total of 69 individuals responded to the questionnaire, although some questions were skipped.

Sampling Technique

In this study, primary data was collected by capturing images of human skin. The data collection involved a random sampling method where individuals willingly provided self-portraits (selfies) of their facial skin as data. Mobile phone cameras were used to capture these images, and a total of 100 selfies were collected. The collected photo samples were subsequently processed using the tools employed in this research, specifically the face recognition technology.These data collection techniques, encompassing literature review, questionnaires, and image sampling, allowed for a comprehensive and multifaceted approach to gathering information necessary for the research on skin types, face recognition, and their relevance to skincare product selection.

III. RESULT AND DISCUSSION

Planning Phase

The planning phase marks the initial stage in the development of an application utilizing the Agile system development methodology. This planning phase encompasses three key components: data analysis, user requirements, and system requirements. These components serve the purpose of understanding the precise requirements of the users and the nature of the desired application.

Data Analysis

The data analysis phase is a critical process within the data collection phase that underpins the creation of an application. Data collection is conducted through the review of relevant journals pertaining to the research topic, as well as the distribution of questionnaires via Google Forms, resulting in a total of 71 respondents. However, it's important to note that the valid responses amounted to 69. From these questionnaires, valuable insights were gleaned regarding the user's needs and preferences in utilizing the application as a means to determine suitable skincare products tailored to their specific skin type.

The outcomes derived from the questionnaire distributed to 69 respondents are as follows:

Table 1. Questionnaire and Response

No	Questionnaire Questions	Answer	
1	Do you believe that skincare, especially for the face, is crucial?	Yes	92.8%
		No	1.4%
		Maybe	5.8%
2	Are you aware of your facial skin type?	Yes	72.5%
		No	5.8%
		Just Guessing	21.7%
3	If yes, what is your facial skin type?	Normal skin	11.8%
		Oily skin	27.9%
		Dry skin	11.8%
		Combination skin	48.5%
4	Do you use skincare products on a daily basis?	Everyday	52.2%
		Seldom	26.1%
		If I remember	11.6%
		Never	10.1%
5	Do you consider your skin type before purchasing skincare products?	Yes	79.7%
		No	20.3%
6	In your opinion, is it necessary to know your skin type before buying skincare products?	Necessary	86.9%
		Neutral	13.1%
		No need	0%
7	Do you think there is a need for an application that can help detect skin type?	Yes	72.5%
		Neutral	26.1%
		No need	1.4%

For the first questionnaire, a substantial 92.80% of respondents considered facial skincare to be of utmost importance, while the remaining respondents provided varying degrees of uncertainty or considered it less significant. This observation underscores a notably high level of awareness among individuals regarding the importance of skincare, particularly for facial skin.Results from the second questionnaire show a significant 72.50% of the 69 respondents have a clear understanding of their skin type. However, a noteworthy 21.70% rely on approximate assessments, while a minor proportion of 5.80% remain completely unaware of their skin type. This substantiates the fact that not everyone possesses a definite knowledge of their skin type before purchasing skincare products, potentially leading to significant errors if products are acquired haphazardly or based solely on guesswork.From the third questionnaire, it can be deduced that the most prevalent skin type among respondents is combination skin. However, it's essential to acknowledge that this conclusion may not be definitive, as respondents might rely on approximate assessments without concrete evidence regarding their facial skin type.

From the fourth questionnaire, a conclusion that can be drawn is that the respondents exhibit a predominant inclination towards engaging in facial skincare routines. From the fifth questionnaire, it can be concluded that respondents generally purchase skincare products that align with their skin type (79.7%). However, there are still respondents who either do not engage in skincare routines or do so infrequently, without prior consideration of their skin type before making product purchases.From the sixth and seventh questionnaires, the majority of respondents recognised the importance of identifying their skin type before purchasing skincare products. This enables them to make informed decisions about which skincare products are suitable for their specific skin type. However, because some respondents remain uncertain about their facial skin type, there is a perceived need for an application that can assist in skin type detection.

User Requirements

User requirements are conducted in terms of functional requirements to test the functional needs of the application under development. Subsequently, the requirement phase for the application is divided into two categories: functional and non-functional.

- Functional Requirements: The system should be able to detect skin types by either taking a selfie or selecting a facial photo from the gallery. The system should provide recommendations for skincare products suitable for the detected skin type.
- Non-functional Requirements: The system is compatible exclusively with Android-based applications with a minimum operating system requirement of Nougat. The data contained within the application should encompass only the following skin types: normal, dry, oily, and combination.

System Requirement

The hardware and software components employed in this research encompass:

- Hardware: Macbook Air equipped with 8 GB of RAM and a 1.6 GHz Intel Core i5 processor. Android-based smartphone with a minimum OS version of Nougat.
- Software: Android Studio version 11. Android SDK with a minimum SDK version of 30.

Design Phase

In the design phase, an architectural blueprint of the system will be crafted using the UML (Unified Modeling Language) methodology. This will encompass the presentation of the application's underlying database structure.

Figure 2 shows a flowchart depicting the sequence of operations within this application. The flow begins with the Login process. If a user does not have an account, they must first register by providing their full name, email, password, and profile picture. Once registration is complete, users can log in by entering their registered email and password. Upon successful login, users are directed to the home page. Within the home page, users can initiate the skin type detection process by either taking a selfie or selecting a photo from their gallery. Once the user's skin type is identified, they can access skincare ingredient recommendations on the recommendation page.

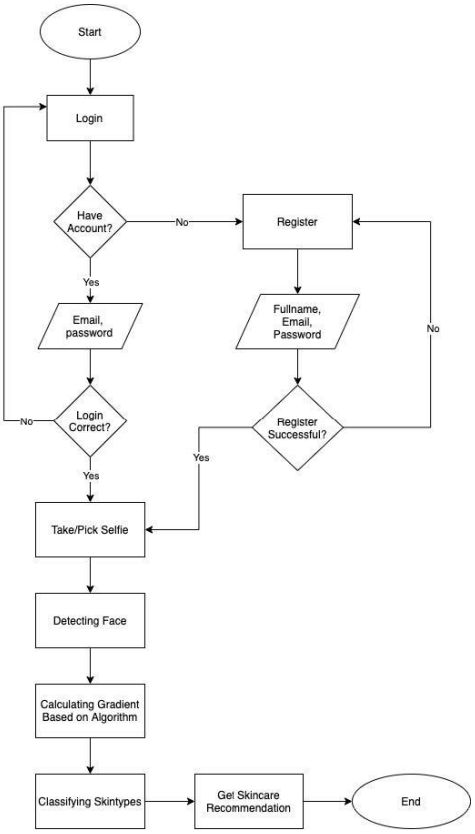

Fig 2. Flowchart

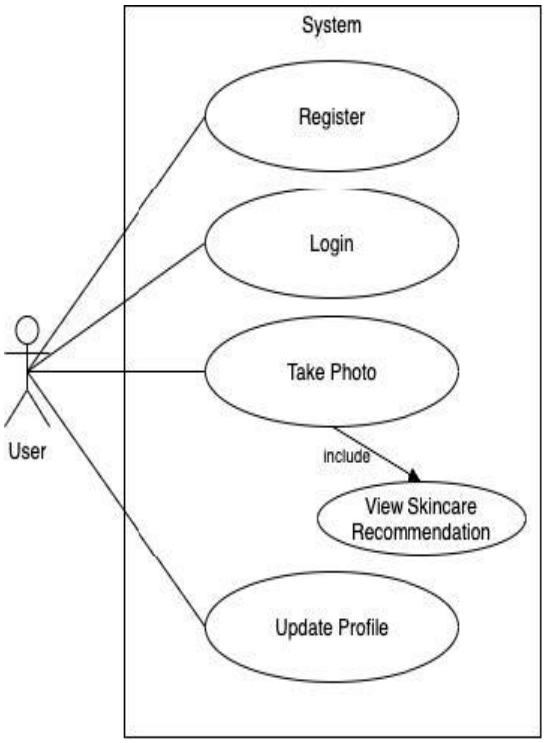

Fig 3. Use Case

In **Figure 3** The Use Case Diagram illustrates the primary system functions involving the actors within the Skinophile application, it can be observed that the Skinophile application encompasses five essential functionalities that serve as interactions between the user and the system:

1. Register: This function allows users to create an account within the application. Users must register if they do not already have an account to access the application.
2. Login: For users who already have an account, this function facilitates direct login into the application.
3. Take Photo: Users can capture a selfie or select a photo from their gallery to enable the detection and determination of their skin type.
4. View Skincare Recommendation (includes Take Photo): Once the user's facial skin type is detected, this function enables users to access skincare ingredient recommendations provided by the application.
5. Update Profile: Users have the option to update the data they provided during the initial account registration process.

Table 2. Before and After the Research

Case	Before	After
Facial Skin Type Detection	Before the existence of the Skinophile application, facial skin type detection was done roughly, and the results were not necessarily accurate.	After the existence of the Skinophile application, users can accurately detect their facial skin type, obtaining results in line with their actual skin type.
Skincare Purchases Aligned with Skin Type	Before the existence of the Skinophile application, skincare purchases were based solely on approximate skin type assessments, without consideration for suitable ingredients.	After the existence of the Skinophile application, users can identify skincare ingredients suitable for their skin type, leading to more precise skincare product purchases.

Table 2 represents scenarios where, before and after the introduction of the Skinophile application, users can detect their facial skin type and receive recommendations for skincare products tailored to their specific skin type, resulting in more accurate skincare product purchases. When compared to previous research, differences are evident. Previous research could only identify two skin types: oily and non-oily. In contrast, this study identifies four skin types: normal, dry, oily, and combination skin.

IV. CONCLUSION AND RECOMMENDATIONS

Conclusion

The following conclusions can be drawn from the conducted research:

1. The Skinophile application effectively assists users in detecting their skin type, with the capability to identify four types: normal, dry, oily, and combination skin.
2. Skinophile utilizes the Haar Wavelets algorithm for facial image extraction and Support Vector Machine (SVM) methodology for skin type classification, complemented by face recognition technology.
3. Facial skin type detection in the Skinophile application is achieved through user-generated facial selfies or by selecting photos from the user's gallery.
4. The Skinophile application provides recommendations for skincare ingredients that align with the detected skin type of the user.
5. The Skinophile application underwent testing by 70 users, and the User Acceptance Test (UAT) results indicated a highly positive response, with a satisfaction rate of 92.54% (Very Good).

Recommendations

To further advance this research, the following recommendations are proposed:

1. It is advisable to enhance the provision of detailed information regarding skin types and recommended skincare ingredients within the application. This will empower users with more comprehensive knowledge about their skin type and skincare components when using the application.
2. Consider extending the range of skin types covered, including sensitive skin, which was not included in this study. This expansion would enable the application to cater to a broader user base.

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