Mantik Journal, 7 (4) (2024), ISSN 2685-4236 (Online)

Published by:Institute of Computer Science (IOCS)

Jurnal Mantik

Journal homepage: www.iocscience.org/ejournal/index.php/mantik

Design and development of skin disease detection application in humans using computer vision

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A R T I C L E I N F O

Article history:

Received Jan 05, 2024
Revised Jan 09, 2024
Accepted Feb 25, 2024

Keywords:

Artificial intelligence;
Deep learning;
MobileNet;
Skin diseases.

ABSTRACT

Skin diseases are abnormal conditions affecting the outer layer of the human body. The prevalence of skin infections worldwide reaches 300 million cases per year, with Indonesia contributing significantly, mainly due to the tropical climate and dense population. Factors such as air temperature, environmental cleanliness, personal hygiene, and the lack of public knowledge about skin hygiene can trigger various types of skin diseases. Skin diseases are often considered trivial as they do not cause death, yet if not promptly and accurately addressed, they can lead to spreading and difficulties in treatment. Analyzing skin diseases requires a high level of knowledge, and accurate diagnosis often presents a challenge. The success of diagnosis heavily relies on the experience of doctors, with some limitations involving subjective assessments and variations among experts. This research aims to design an artificial intelligence (AI)-based application that can quickly and accurately diagnose various types of skin diseases in humans. The application utilizes Deep Learning technology, employing the MobileNet model in Computer Vision to identify skin disease types based on images provided by the user. The system development method used is the AI Project Cycle, encompassing stages such as problem scoping, data acquisition, data exploration, modeling, evaluation, and deployment. Model evaluation results demonstrate good performance with an accuracy rate of 96%, precision of 96%, an f1 score of 95%, and a recall of 95%. The resulting application not only provides diagnoses but also offers information about symptoms, causes, and methods of handling the identified skin diseases.

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1. INTRODUCTION

Skin is a layer of tissue on the outer part that covers and protects the body surface (Srisantyorini & Cahyaningsih, 2019). Skin plays many vital roles, such as being a sensory organ, the outlet for sweat through sweat glands, regulating body temperature, and serving

as a storage place for fat (Rismanto et al., 2019). The skin consists of three main layers, namely the epidermis, dermis, and hypodermis. The epidermis, as the outermost layer of the skin, plays a role in protecting the body, creating a waterproof barrier, determining skin color, and having the ability to regenerate from wounds. The dermis functions to provide elasticity to the skin, while the hypodermis is the innermost layer that serves to store fat (Gulati & Bhogal, 2020).

Skin diseases are conditions where the outer layer of the human body experiences issues such as irritation or inflammation, leading to symptoms such as itching, scaling, burning, redness, and even numbness and deformities (W. Saputra, 2021). These diseases can be caused by various factors such as fungi, bacteria, allergic reactions, microbes, or pigmentation changes. Some skin diseases are chronic and, in certain cases, can develop into severe conditions (Srinivasu et al., 2021). The impact of skin diseases is not limited to physical damage but also involves psychological consequences, such as isolation, depression, and even the risk of suicide. Therefore, skin diseases are a primary focus in the field of medicine (L. F. Li et al., 2020).

The global prevalence of infectious skin diseases is reported to be around 300 million cases per year. In Indonesia, the prevalence of skin diseases ranges from 4.60% to 12.95%, ranking third among the top 10 prevalent diseases. Infectious skin diseases also fall within the top 10 prevalent diseases in West Sumatra, reaching approximately 5,995 cases or around 5.20% in 2019 (Lestari, 2022). Indonesia, with its tropical climate and dense population, especially in large cities, faces a diverse range of skin diseases. Various factors, including temperature, environmental and personal hygiene, contribute to the emergence of skin diseases. Other supporting factors for the prevalence of various skin diseases in Indonesia include infections, economic conditions, and a lack of public awareness regarding the importance of skin hygiene (T. O. Saputra & Alamsyah, 2023).

Skin diseases are often considered trivial as they do not lead to death. However, if left untreated, they can cause harm to the entire body and become challenging to treat. Skin diseases can affect anyone and any part of the body (T. O. Saputra & Alamsyah, 2023). Analyzing skin diseases requires a high level of knowledge due to the diversity of symptoms. Accurate diagnosis of skin diseases is challenging because various visual clues, such as individual lesion morphology, body site distribution, color scalability, and lesion arrangement, must be used to facilitate the process. Often, only experienced doctors can achieve precise diagnostic accuracy. Distinguishing skin diseases using dermoscopy images may not always be accurate and depends on the dermatological experience of the doctor. One limitation of expert diagnoses is their reliance on subjective assessments and variations among different experts (H. Li et al., 2021).

Artificial Intelligence (AI) is a branch of computer science that studies how to make computer machines perform tasks as well as or better than humans (Susatyono, 2021). AI aims to understand or model human thought processes and design machines capable of mimicking human behavior (Dompeipen & Sompie, 2020). In the development of AI applications, two main components are essential (Nufus et al., 2021): Knowledge Base: Contains facts, thoughts, and relationships between one another; Inference Engine: The system's ability to draw conclusions based on experience and information in the knowledge base.

Computer vision is an image processing system captured from a camera that mimics the concept of human vision (Desnanjaya et al., 2022). The goal of computer vision is to understand the contents of digital images. Essentially, computer vision attempts to mimic human visual performance, allowing a system to visually analyze objects after they have been represented in image form (Afni et al., 2021).

Deep learning is a new machine learning method based on neural networks that learn and become more accurate by providing more data to the model (Yudistira, 2021). Deep learning discovers complex structural patterns in a vast dataset using backpropagation algorithms to demonstrate how the machine should adjust weights on

each of its parameters. These weights are used to calculate representations at each layer from the representations in the previous layer (RAMADHAN, 2022). Deep learning differs from traditional machine learning techniques as it automatically represents data such as images, videos, or texts without introducing human-coded rules or domain knowledge. Essentially, deep learning is a neural network with three or more layers of ANNs. It can learn and adapt to large amounts of data and solve various problems that are challenging for other machine learning algorithms (Raup et al., 2022).

Convolutional Neural Network (CNN) is one type of artificial neural network commonly used in image data analysis. CNN is highly beneficial for analyzing and understanding complex patterns (Wijaya Kusuma et al., 2023). CNN is popular in the field of deep learning because it extracts features from input images and reduces the size of the image without altering its characteristics (Azmi et al., 2023). CNN typically consists of three layers: convolution layer, pooling layer, and fully connected layer (Novelinda Permata Wulandari, 2021). The convolution layer has a set of filters that can combine the entire input image and produce various types of feature maps. The pooling layer is used to reduce the spatial size of the feature map and reduce the computational load on the network. Average pooling and max pooling are two common nonlinear downsampling strategies used for translation invariance. The fully connected layer is usually placed at the end of the network to ensure that each neuron in that layer is fully connected to activations in the previous layer. This aims to activate 2D feature maps so that they can be transformed into 1D feature maps, necessary for further classification representation features (Gunawan et al., 2021).

MobileNet is a Convolutional Neural Network (CNN) architecture used to address excessive computing resources (Utami et al., 2023). MobileNet is built based on depthwise separable convolutions to reduce computation in the initial layers (Feriawan & Swanjaya, 2020). The fundamental difference between the MobileNet architecture and typical CNN architectures lies in the use of convolution layers or layers with filter thickness corresponding to the input image thickness (Listio, 2022).

Based on this background, this research aims to design an application based on Artificial Intelligence (AI) with deep learning algorithms in computer vision to accurately and rapidly diagnose skin diseases. This application is primarily intended to address the limitations of human diagnosis, often influenced by subjective factors. In addition to providing diagnoses, the application also offers information about explanations, symptoms, causes, and treatment methods for skin diseases. It is hoped that this application can positively contribute to improving public health in Indonesia, enhancing understanding of various skin diseases, and providing recommendations for appropriate care and prevention. Furthermore, the application is expected to be a tool for dermatologists and the general public in early detection of skin diseases, enabling prompt and accurate treatment. The significance of this research lies in its ability to provide fast and accurate diagnoses, overcome human limitations in diagnosing skin diseases, and contribute to improving public health. This application is expected to serve as an effective tool for dermatologists while also enhancing awareness of the importance of skin care within the community.

2. RESEARCH METHOD

In this study, the system development method employed is the AI Project Cycle. The AI Project Cycle is divided into 6 steps, namely problem scoping, data acquisition, data exploration, modeling, evaluation, and deployment.

Figure 1. AI Project Cycle (Sakti et al., 2023)

This research utilizes the MobileNet model as the primary model. The selection of the MobileNet model is based on considerations of performance efficiency, especially when implemented on devices with limited resources, such as mobile phones. Another advantage is the model's ability to operate quickly without requiring extensive computations.

a. Dataset

The dataset implemented in this study is obtained from various sources of human skin disease datasets available on Kaggle. This dataset consists of four types of skin diseases, namely Atopic Dermatitis, Herpes, Eczema, and Vitiligo. The total number of samples used is 3,808 image images. To enhance the effectiveness of the model learning, this dataset is divided into three main partitions: (a) Training Data: Encompassing 75% of the total dataset samples, with a quantity of 2,666 image images. This data is used to train the model to recognize patterns and characteristics of different skin diseases. (b) Test Data: Comprising 15% of the total dataset samples, consisting of 571 image images. This data is used to test the performance of the model trained on the training data. (c) Validation Data: Encompassing 15% of the total dataset samples, consisting of 571 image images. This data is used to adjust hyperparameters of the CNN model and compare changes in weights in the neural network to assess their impact on the accuracy of the model.

Table 1. Partition of Skin Disease Images

No	Skin Diseases	Number of Images	Images Partitions
1	Vitiligo	258	Train
2	Herpes	289	Train
3	Atopic Dermatitis	897	Train
4	Eczema	1222	Train
5	Vitiligo	55	Validation
6	Herpes	62	Validation
7	Atopic Dermatitis	192	Validation
8	Eczema	262	Validation
9	Vitiligo	55	Test
10	Herpes	62	Test
11	Atopic Dermatitis	192	Test
12	Eczema	262	Test

b. System Planning

The system design phase is the stage of creating the working mechanism of the system in the form of UML diagrams required in system development to design the system

that will be built later. Designing using diagrams will be easier to understand, more structured, and easily analyzed for errors and its functions (Handoyo & Anwar, 2023).

c. System Design

1) Use Case Diagram

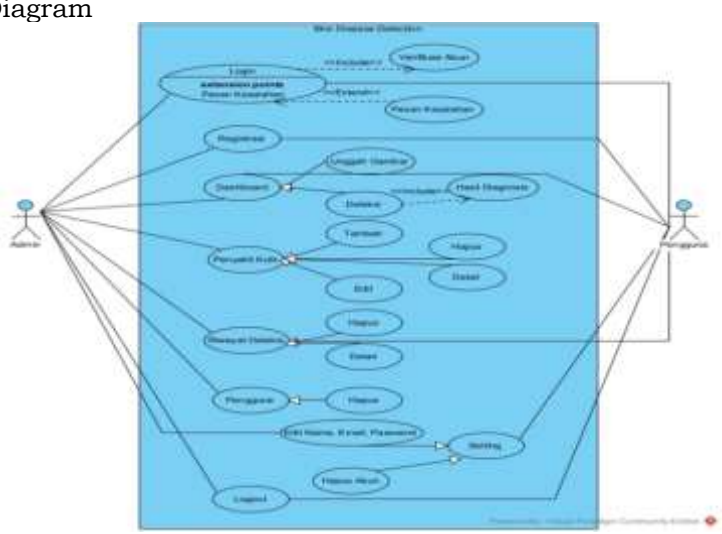

Figure 2. Use Case Diagram

2) Activity Diagram

Admin Activity Diagram

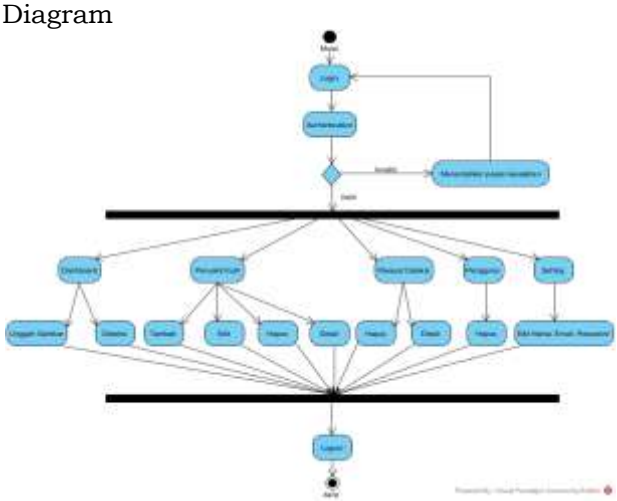

Figure 3. Admin Activity Diagram

User Activity Diagram

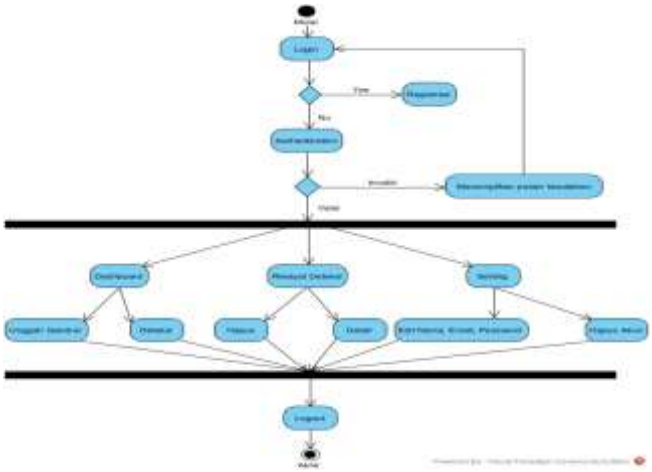

Figure 4. User Activity Diagram

3) Sequence Diagram

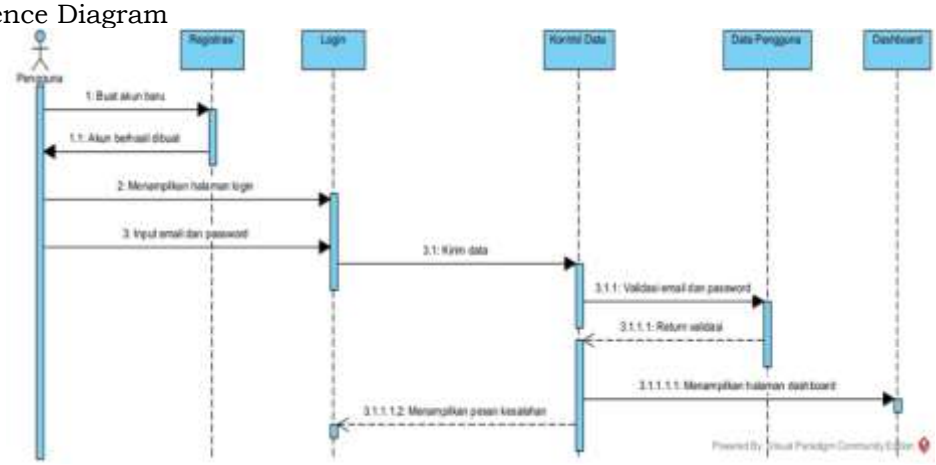

Figure 5. Sequence Diagram

d. System Requirements Analysis

System requirements analysis encompasses everything related to the characteristics present in the system and the needs for system development.

e. Hardware Requirements

Specifications for the hardware used in the development of the skin disease diagnosis application include: (a) Processor: AMD Ryzen 3 3250U with Radeon Graphics 2.60 GHz, (b) RAM: 8 GB (5.88 GB usable), (c) Operating System: 64-bit

f. Software Requirements

Applications or software used in the development of the skin disease diagnosis application include: (a) Google Collab, (b) Visual Studio Code, (c) Visual Paradigm, (d) MySQL, (e)React JS (f) Tailwind CSS, (g) Python, (h) Express JS

3. RESULTS AND DISCUSSIONS

3.1 Preliminary Research

The previous research conducted by Wilson Saputra, Alb. Joko Santoso, and Patricia Ardanari on the "Penerapan Metode K-Nearest Neigboar untuk Mendeteksi Penyakit Kulit"

has discussed the use of the KNN method in detecting skin diseases based on training data with the closest distances. This study diagnoses skin diseases based on symptoms inputted by users or patients, considering the provided symptoms. The KNN method is predicted based on the closest learning, which is then identified by users or patients using the total weight obtained from the similarity formula arranged from largest to smallest.

This research found that the use of deep learning algorithm with MobileNet architecture is more effective in detecting skin diseases based on images compared to the K-Nearest Neighbor (KNN) method. The main findings of this research include image-based detection capability, algorithm efficiency, and scalability. The image-based detection capability indicates that MobileNet can provide accurate results in detecting skin diseases, recognizing visual patterns that may be difficult to identify by the KNN method. The algorithm efficiency of MobileNet in processing images provides an advantage in computational time compared to KNN, which requires calculating the nearest distances in the training data. Additionally, the MobileNet method allows for broader and easier implementation in practical applications, especially when involving user-inputted images.

Comparison with previous research indicates an evolution in the approach to skin disease detection. While previous research focused on the KNN method based on symptoms, this study describes a shift to an image-based approach with MobileNet. The results show a significant improvement in accuracy and efficiency in detecting skin diseases. This discussion emphasizes that the implementation of MobileNet in this study opens up new potential in image-based skin disease diagnosis, making a positive contribution to the development of efficient and accurate skin disease detection technology.

3.2 Model Evaluation

The model evaluation process in this study is conducted by utilizing several metrics, including accuracy, precision, f1 score, and recall. This evaluation process aims to assess the performance of the model trained using training and validation data.

Table 2. MobileNet Model Evaluation Results

No	Metrics	Train	Validation
1	Accuracy	96%	88%
2	Precision	96%	87%
3	F1 Scores	95%	87%
4	Recall	95%	87%

3.3 Application Interface

The development process of this application utilizes several main technologies, such as React JS, Tailwind CSS, Express JS, MySQL, and Python. The application is designed with two main roles, namely Admin and User. Admin has full access and control over various provided features, while the user can only access and use the services provided by the application.

Figure 6. Login Page Display

On the login page, users and admins can enter their registered email and password to access the main page of the application.

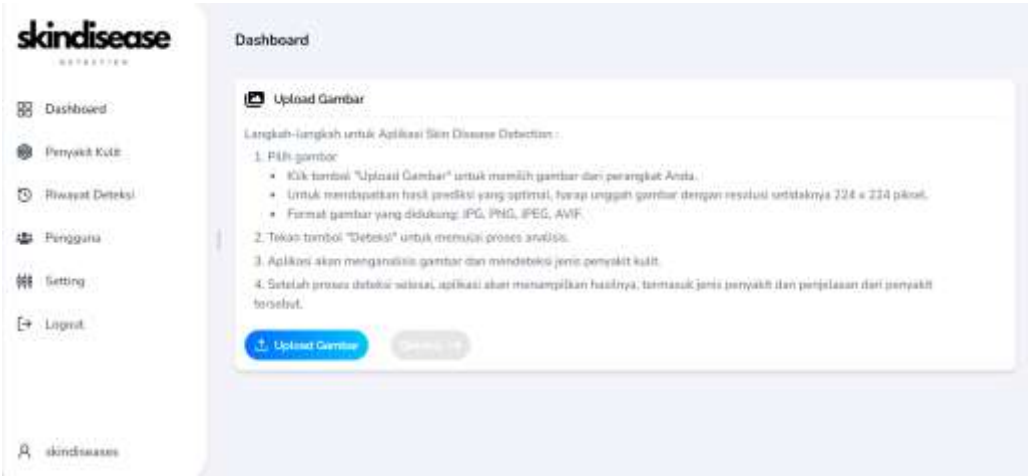

Figure 7. Dashboard Page Display

On this page, the steps for using the application are explained: upload a skin disease image with the 'Upload Image' button, then press 'Detect' for skin disease analysis and diagnosis.

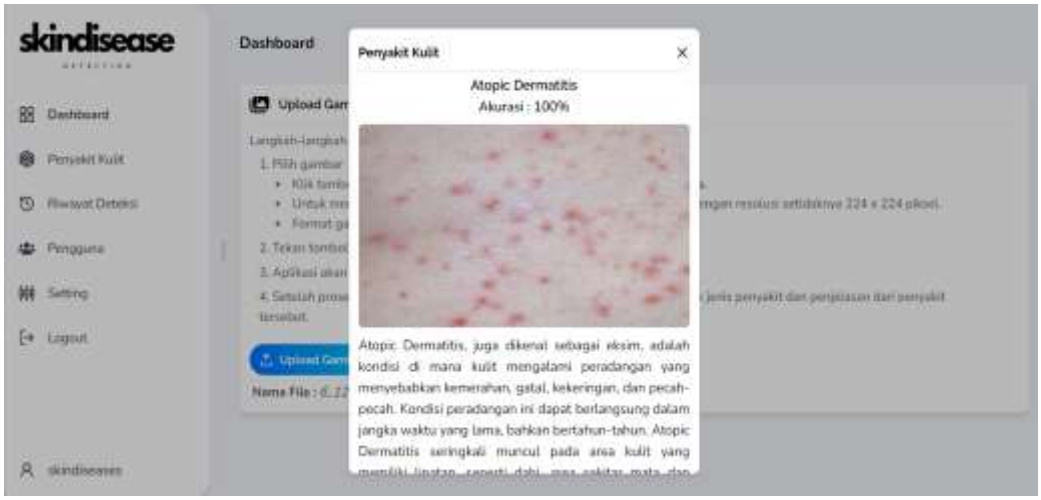

Figure 8. Display of Skin Disease Diagnosis Results Page

After pressing the 'Detect' button, the application will analyze the skin disease and then display the results.

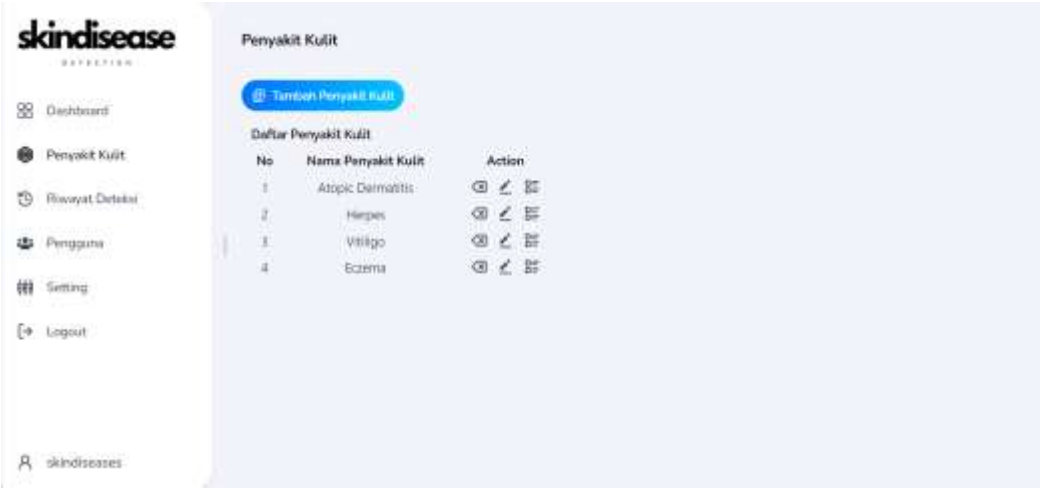

Figure 9. Display of Skin Disease Page

This page can only be accessed by the admin. Here, the admin can add, edit, and delete types of skin diseases.

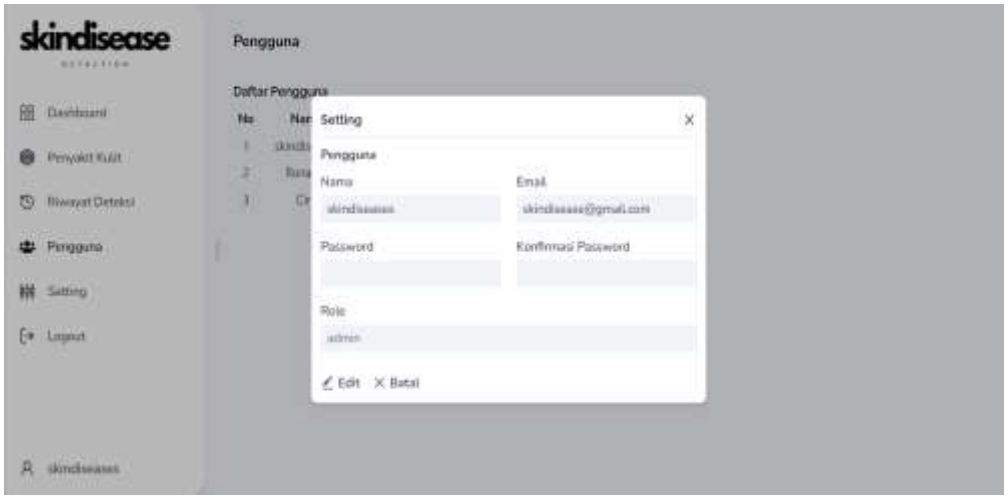

Figure 10. Display of Admin Settings Page

On this page, the admin can edit the name, email, and password

4. CONCLUSION

This study has successfully designed and developed an AI-based skin disease diagnosis application using computer vision technology with the utilization of the MobileNet deep learning algorithm. The model evaluation conducted shows excellent results with an accuracy rate of 96% for accuracy, 96% for precision, 95% for f1 score, and 95% for recall. This model demonstrates good performance in recognizing patterns and characteristics of skin diseases. With a high level of accuracy, this application can provide support in early detection of skin diseases for users, enabling prompt treatment.

This research has implications, both in theory and practice. From a theoretical standpoint, the use of artificial intelligence (AI) and deep learning in diagnosing skin diseases contributes to the advancement of medical science and information technology. This technology can serve as a foundation for further research in the application of artificial intelligence in diagnosing skin diseases. In practical terms, this application can be an effective tool for dermatologists in the diagnosis process. Moreover, the general public can also utilize it to detect early signs of skin diseases, enhance awareness of skin health, and take appropriate preventive measures.

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