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Combination Of CNN And LSTM In Cat Breed Detection In Pet Stores

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Abstract
The research examines the utilization of the Long Short-Term Memory (LSTM) algorithm for identifying cat breeds in pet retail establishments. With numerous cat breeds globally, each with unique needs and behaviors, manually identifying them presents a challenge. This research aims to address this issue by implementing deep learning techniques for breed classification, which will assist pet owners and storekeepers in recognizing and caring for cats more efficiently. The dataset used consists of 9,755 images, spanning six distinct cat breeds: Siamese, Birman, Russian Blue, British Shorthair, Bengal, and Egyptian Mau. The methodology encompasses image preprocessing, partitioning the dataset into training, validation, and testing subsets, and training the LSTM model for cat breed classification. The model is included into an Android application created with the React Native framework, utilizing Python for backend model processing. This study's results are anticipated to yield a reliable and precise instrument for cat breed identification, with possible uses in pet store administration and individual pet care. The ultimate application is assessed according to accuracy, precision, recall, and F1-score, all of which are obtained from the confusion matrix.
Keywords: *LSTM, cat breed detection, deep learning, React Native, image classification.*

1. INTRODUCTION

Cats are popular pets and companion animals (Mikkola, Salonen, Hakanen, Sulkama, & Lohi, 2021). In addition, cats have also been very close to humans for thousands of years and have recently been deliberately bred to obtain new fur appearances and colors known as cat breeds (Alhaddad, Abdi, & Lyons, 2021). The Governing Council of Cat Fancy (GCCF) acknowledges 41 cat breeds, the Cat Fanciers' Association (CFA) acknowledges 45 cat breeds, and the International Cat Association (TICA) acknowledges 71 cat breeds (McGrath et al., 2021). Just like what happens in a pet store that has many types of cats with various breeds. Numerous cat breeds possess distinct requirements and varying habits. However, considering so many types of cats, it is not easy to distinguish them even manually using the human eye. In addition, there is no technology applied to detect cat breeds in pet stores, so recognizing cat breeds requires special knowledge to avoid mistakes in their care. This is supported by research conducted by Hadar, Bonnett, Poljak, & Bernardo (2023) analyzing data from Agria Pet Insurance to examine health risks in purebred and mixed-breed cats. A striking difference in disease rates was found between these groups, with purebreds generally more susceptible to certain health problems such as heart disease and complications from surgery, while mixed breeds had a higher incidence of endocrine and skin problems. The study underscores the importance of understanding and addressing breed-specific health risks to improve care and prevention strategies. Therefore, a way to identify cat breeds is needed to help many people. In identifying cat breeds, deep learning techniques will be used. Several studies on animal detection/classification have been carried out by several previous related studies, including research conducted by Mulyana, Zuhari, & Yel (2023) discussing the classification of Bali starling images. The problem underlying this research is that the many types of starlings that exist are sometimes still difficult to identify or recognize by humans. So in this study, image classification of Bali starlings was carried out using K-Nearest Neighbor (KNN). The results of this study were a training accuracy value of 98.95% and a test accuracy value of 98.50%. The second study conducted by Hussain et al. (2022) discussed the detection of dog activity. The background to this research is that it is difficult to obtain dog behavior patterns. So in this study, identification was carried out using deep learning technology. The deep learning technology used is Long Short-Term Memory (LSTM). The results of this study were successful in producing an accuracy of 94.25%. Based on the description above, this study will detect cat breeds. This study will use the LSTM algorithm to detect it. The use of LSTM in this study is because LSTM can classify images by learning important features while ignoring unimportant features (Salehin et al., 2023). LSTM is considered a dominant and lightweight network that has long-term dependencies compared to CNN, because the pattern is stored in a separate memory cell in it and used when needed (Amin et al., Brain tumor detection: a long short-term memory (LSTM)-based, 2020). In addition, this study introduces a novel approach to detecting cat breeds, utilizing an application built on the Android platform using the React Native framework, the Python programming language as the backend, and Kaggle as the dataset. By conducting this research, it is hoped that it can help pet shops detect cat breeds, so that they can be handled specifically or provided care according to their breed.

Based on the background of the problem, there are problem formulations used in this study, namely:

1. How to classify/detect cat breeds that can make it easier for adopters/owners to recognize their cat breeds?
2. What are the accuracy results obtained from cat breed classification using the LSTM algorithm?

From the problems that have been explained, there are research objectives, namely:

1. Classify/detect cat breeds that can make it easier for adopters/owners to recognize their cat breeds by utilizing deep learning models.
2. Determine the accuracy outcomes of cat breed categorization utilizing the LSTM algorithm to assist pet businesses in identifying cat breeds.

The scope of this study is as follows:

This study employs a dataset obtained from Kaggle's public repository, consisting of 9,755 instances across three pairs that represent six cat breed classes: Siamese (2,884), Birman (562), Russian Blue (2,071), British Shorthair (890), Bengal (2,712), and Egyptian Mau (636).

The study was conducted by Rajendran, Kumarasamy, Zarro, Divakarachari, & Ullo (2020), which examined the categorization of land use and land cover. This work is predicated on the significance of land use and land cover classification in environmental modeling. In this work, classification was conducted utilizing the LSTM algorithm and optimization methods. This study's results indicate that the maximum accuracy achieved with LSTM was 94.09% for the barren land class, while optimization utilizing HGO and PSO enhanced the highest LSTM accuracy to 97.40%.

The fourth study was conducted by Klosowski et al. (2021), which identified moisture in brick walls by electrical impedance tomography. The objective of this work is to employ LSTM for the detection of moisture in brick walls. This research employed 3D tomography scans including 11,297 elements. This study compared the LSTM approach with the ANN. The findings of this investigation indicated that LSTM outperformed ANN. This is demonstrated in instance 1, where the RMSE value generated by LSTM was 1,419, whereas ANN yielded 1,436.

The fifth study was conducted by Demir (2021), which addressed the identification of COVID-19 cases by chest X-ray pictures. The objective of this work was to employ an LSTM to identify COVID-19 instances from chest X-ray pictures. This research utilized 1,061 chest X-ray scans. This study yielded an accuracy of 100% for LSTM, representing the optimal results. The sixth study, conducted by Amin et al. in 2020, titled "Brain Tumor Detection: A Long Short-Term Memory (LSTM)-based Learning Model," focused on the detection of brain cancers. This study's background highlights that automatic tumor identification and treatment planning are intricate endeavors. The study employed deep learning methodologies, specifically the LSTM algorithm, for the detection of brain cancers. This study achieved an accuracy of 98%.

2. Method

2.1 Framework

The framework consists of a sequence of stages designed to accomplish research objectives. The utilized framework is illustrated in Figure 1.

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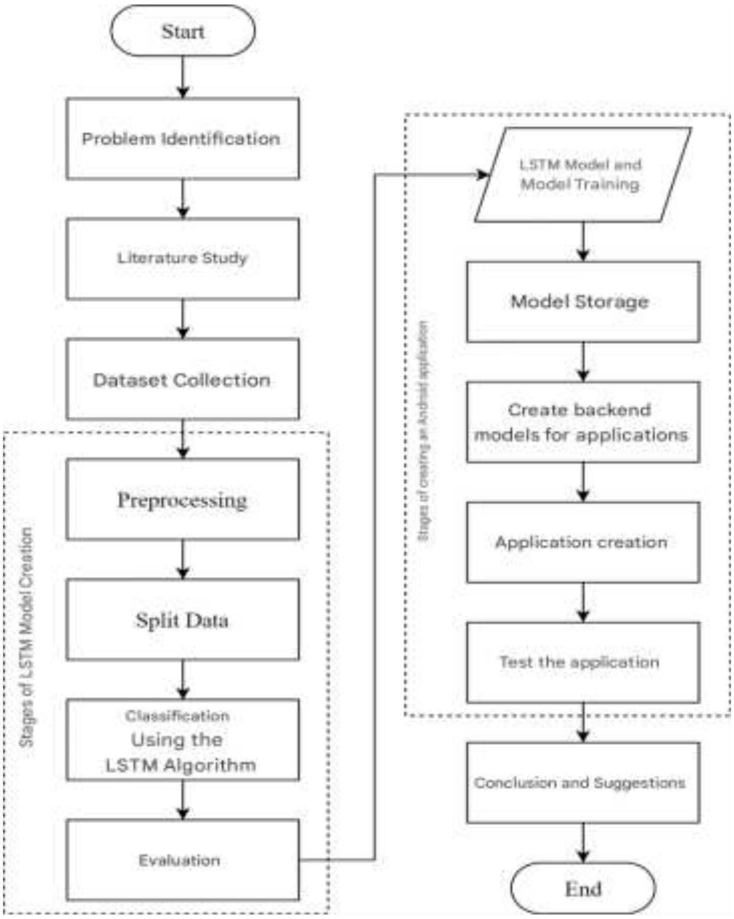


Figure 1 Framework

In this framework, it starts from identifying the problem in the form of the danger of errors in determining the cat breed, and has an impact on the health of cats, which is likely to occur in pet stores. Furthermore, conducting a literature study research to find problems related to the problems obtained and used as references. Then the dataset is collected in the form of photos of several similar cat breeds that are difficult to distinguish.

The procedure involves developing an LSTM model, commencing with preprocessing to enhance image quality beyond previous standards. Furthermore, the data is classified into three segments: training data, validation data, and testing data. Classification is executed via LSTM when the data has been segmented. This section also encompasses hyperparameter tuning configuration. This study will employ hyperparameters such as batch size, learning rate, epochs, and optimizer. An evaluation is performed using a confusion matrix, which will then be utilized to measure the effectiveness of the LSTM method.

If the LSTM model creation stage has been completed, it is continued by implementing it into the Android application. The first stage is carried out by inputting the LSTM model and the training model. Next, the best model is stored in Keras format and is continued with the creation of a backend model in the application. The application is created using the required user interface (UI) elements. When the application has been completed, it is tested. This testing is to ensure that the application's performance is appropriate.

2.2 Research Stages

The research stages are an explanation of the framework that has been described in Figure 3.1. The research method in this study is as follows:

1. Problem Identification

In the initial stage, a problem identification was carried out on the research to be carried out. The many types of cat breeds also occur in pet stores that have many types of cats with various breeds. Numerous cat breeds possess distinct requirements and varying habits. Nonetheless, given the multitude of cat breeds, distinguishing them manually with the human eye proves challenging. Moreover, pet retailers lack equipment for detecting cat breeds, necessitating specialized knowledge to avoid errors in their care.

2. Literature Study

The literature study stage is the stage of conducting a study of relevant theories in similar research that have been conducted by previous researchers as reference material in the current research, and the theories used. Some of the theories used are cat breeds, deep learning object detection, preprocessing, LSTM, Python, react native, and confusion matrix.

2.3 Dataset Collection

The dataset collection stage is the stage of collecting datasets used for cat breed detection. The data used is in the form of images from the Kaggle website.

The dataset to be used is 9755, consisting of 3 pairs consisting of 6 classes of cat breeds, namely Siamese, as many as 2884, Birman, as many as 562, Russian Blue as many as 2071, British Shorthair as many as 890, Bengal as many as 2712, Egyptian Mau as many as 636.

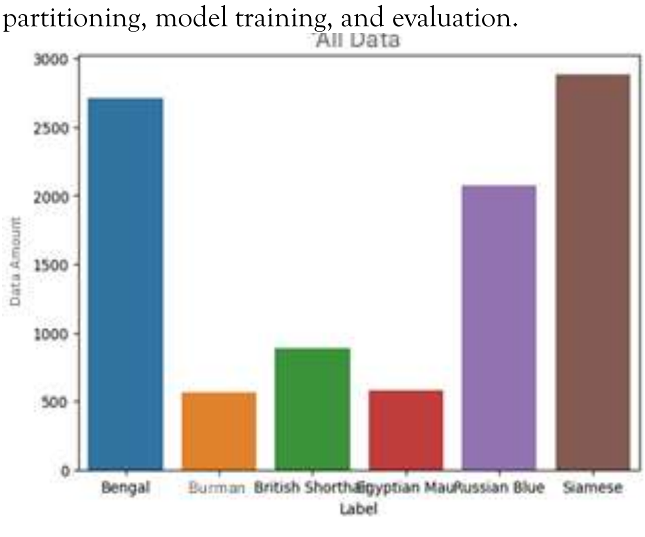
2.4 Preprocessing

Preprocessing is a stage to obtain better image quality than before. Preprocessing consists of resizing and normalization stages. Resizing is done to change the image size to suit the needs. In this study, images that have been resized to a size of 128 pixels x 128 pixels were used, because this size is small enough to reduce the computing power required, but large enough to maintain important details in many types of images (Dwi & Setiadi, 2023). Normalization is used to change the pixel values in the image so that they have a uniform scale and facilitate the training process. In performing normalization, the image pixel intensity is changed by dividing the array by 255.0 to change the image into the range 0-1 (Aprilia, Rohana, Al Mudzakir, & Wahiddin, 2024). The process is carried out so that the model's performance can be more optimal because it uses a fairly small data scale (Fathurrahman & Dwiyansaputra, 2021).

3. RESULTS AND DISCUSSION

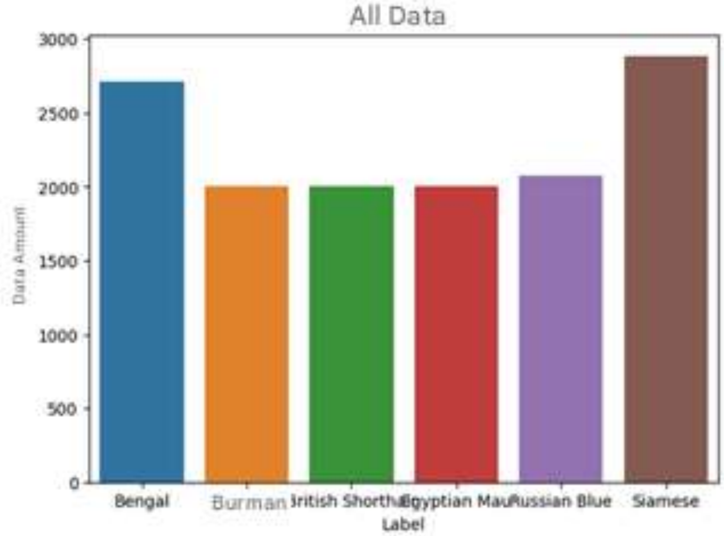
3.1 Data Processing Results

This research employs a hybrid approach of Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) algorithms to identify cat breeds at pet retail establishments. The dataset utilized comprises 9,755 photos representing six cat breeds: Siamese, Birman, Russian Blue, British Shorthair, Bengal, and Egyptian Mau. The data processing occurs in multiple stages: augmentation, dataset partitioning, model training, and evaluation.



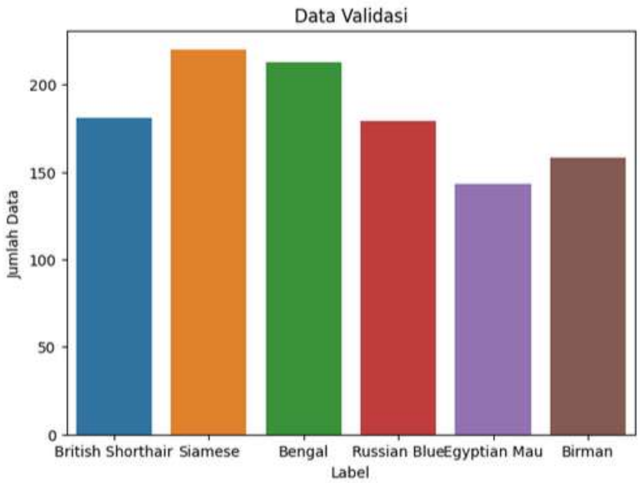
3.2 Augmentation

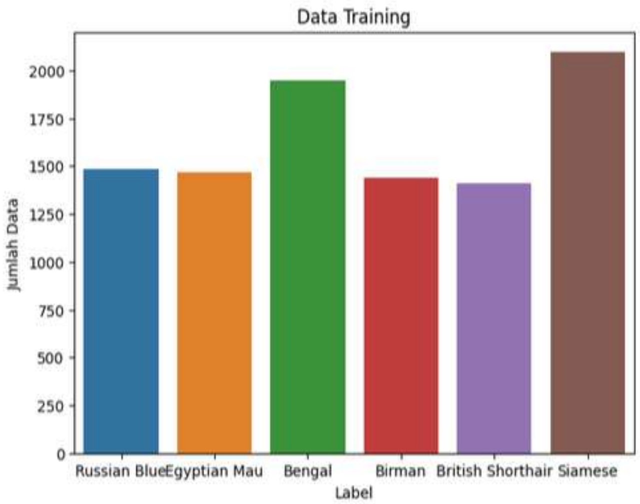
The data augmentation technique seeks to enhance the quantity and diversity of the dataset by introducing modifications to the photos, including rotation, flipping, and blurring. Augmentation was executed with the OpenCV and TensorFlow libraries. The augmentation procedure greatly enhanced the dataset's variety, especially for underrepresented breeds like Birman and Egyptian Mau.



3.3 Dataset Splitting

The dataset was partitioned into 80% for training, 10% for validation, and 10% for testing. This division guarantees that the model is proficiently trained and evaluated on novel data. The division was executed utilizing the train_test_split function from the sklearn library.





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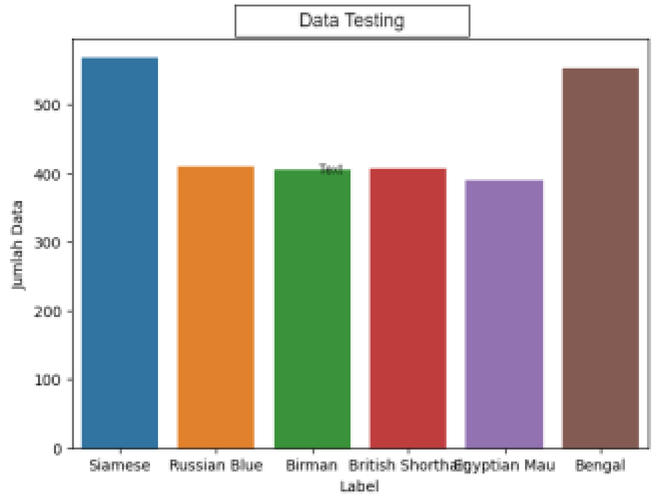


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Total data training : 9842
Total data validasi : 1094
Total data testing  : 2734
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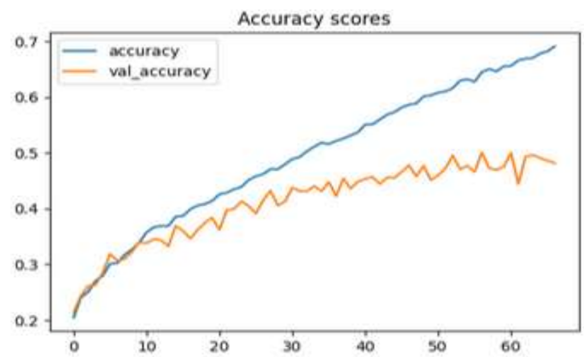
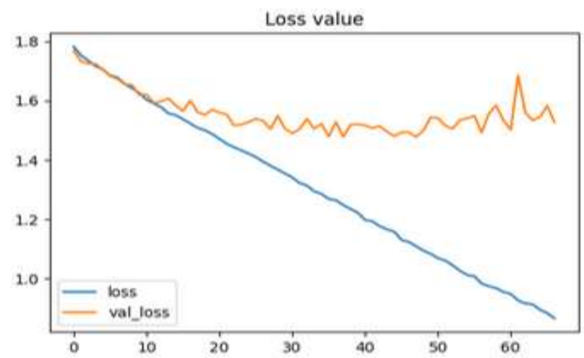
3.4 Classification Using C-LSTM

The classification technique employed a CNN to extract significant picture features and an LSTM to record sequential information from these features. Hyperparameter tuning was conducted via the Adam optimizer, incorporating an adaptive learning rate to enhance training outcomes. The model underwent training for 100 epochs, employing the ReLU activation function in the CNN layers and the Softmax function in the output layer.

3.5 Program Testing Results

The C-LSTM model attained an accuracy of 86.83%, a precision of 87.64%, a recall of 86.83%, and an F1-score of 86.9%, according to the testing findings. The evaluation findings, derived from a confusion matrix, indicate the model's efficacy in categorizing cat breeds.





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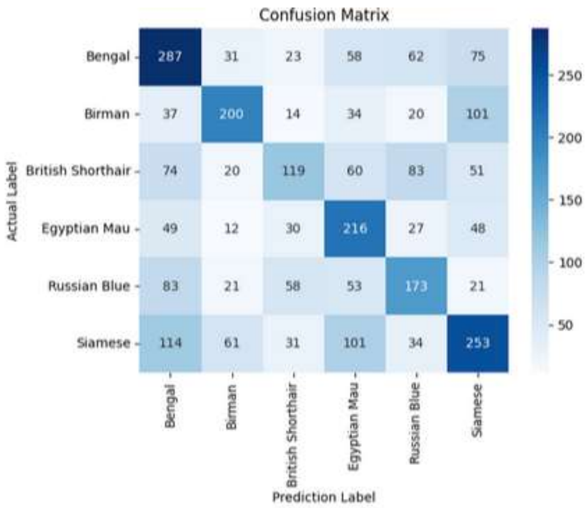
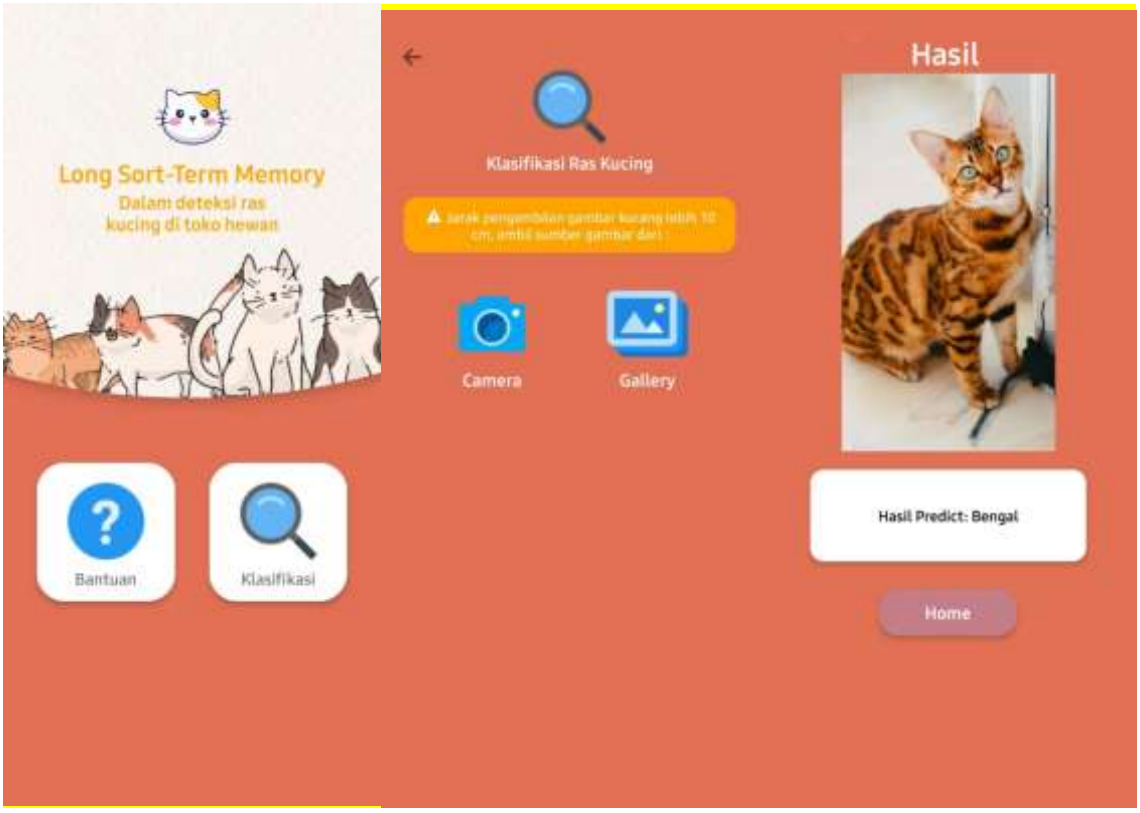


3.6 Application Testing

The cat breed detection application developed with the React Native framework underwent evaluation through the black box testing methodology. The assessment was performed to ascertain the application's functionality and confirm that all features operate as intended. The application enables users to capture images of cats using the camera or choose photos from the gallery, delivering instantaneous breed identification results.



4. CONCLUSION

This research effectively established a classification system for identifying cat breeds through the integration of Convolutional Long Short-Term Memory (C-LSTM) algorithms. The model utilizes CNN to extract visual features from cat photos and LSTM to preserve the sequential context of these features. Testing results indicate that the C-LSTM model attained an accuracy rate of 86.83%, markedly surpassing the LSTM, which achieved at 45.65%. This signifies that the C-LSTM model is efficient and dependable for recognizing cat breeds.

Suggestions

Subsequent advancements may investigate alternative combinations of deep learning algorithms to enhance detection and classification precision for feline breeds. Augmenting this study with more comprehensive visual data or a diverse array of datasets could improve the model's capacity to identify a larger spectrum of cat breeds.

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