p–ISSN: 2723 - 6609 e-ISSN: 2745-5254
Vol. 4, No. 8, August 2023 http://jist.publikasiindonesia.id/

E-COMMERCE PRODUCT IMAGE-BASED RECOMMENDATION SYSTEM KALCARE.COM USING DEEP LEARNING

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ARTICLE INFO

Accepted : 04-08-2023
Revised : 08-08-2023
Approved : 09-08-2023

Keywords: recommendation system; e-commerce; picture; deep learning.

ABSTRACT

Recommendation systems have now become an important part of a digital service, one example is e-commerce. The facts show that the COVID-19 pandemic has had a significant impact on customers by making them spend more time surfing online to get daily necessities products by shopping on e-commerce sites. With the rapid development of deep learning technology today, of course, it can be used to help in terms of the process of producing a product image-based recommendation system that has a fairly high level of similarity. This study will discuss how to produce an image-based product recommendation system architecture by comparing the results of the application of algorithms 8 pre-trained models that are available and have also been widely used in various studies and the information technology industry. The dataset used is product images sourced from the kalcare.com website. After testing the pre-trained model, then an application prototype was made to be tested then in the final stage of this research a poll was conducted to determine the response and opinion of users to the protopine recommendation system made for e-commerce kalcare.com using deep learning.

Introduction

The massive development of internet technology today and also the COVID-19 pandemic has an impact on the fact that customers are increasingly spending more time surfing online to get their daily necessities products including healthy food, nutrition, and medicine (Bhatti et al., 2020). This was also explained by Orinaldi (Laming, 2020) that during the Covid-19 pandemic, the trend of using e-commerce increased quite drastically. Coupled with restrictions on the movement of people, the choice of shopping online is one of the main choices (Hanifah & Rahadi, 2020).

Kalcare.com is an online buying and selling site based in Indonesia that presents the best quality health products from various brands, making it easier for Indonesian people to be able to meet their needs in nutrition and medicine. Currently, kalcare.com websites have text-based product search features, but everyone's ability to describe the desired product in text form is certainly different, even often users do not get the appropriate search results. Image-based search has several potential advantages when compared to text-based (Goel, 2017). First, it can be faster and more intuitive, just by uploading or taking a photo of an image and then doing a search. Second, language

agnostic, which is becoming increasingly important as online shopping goes global, and also doesn't require customers to get acquainted with the terminology used by e-commerce sites for the type of merchandise they're looking for.

Based on the conditions mentioned above, this study made an architectural design of an image-based product recommendation system, with input queries in the form of images, which will search and display the most similar images, where users can use images of the products they want to buy or also to search for similar products visually, to find the products they want more quickly and interactively. Then to get a direct response from users, it is necessary to make a prototype recommendation system, and then conduct a poll.

A. Recommendation System

Recommender Systems, hereinafter abbreviated to RSS, is a subclass of information filtering systems that generally aim to predict the rating or preference that will be given to users of an item or product (Sulthana, Gupta, Subramanian, & Mirza, 2020).

B. Content-Based Image Retrieval

Content-Based Image Retrieval (Content-Based Image Retrieval) hereinafter can be called CBIR known as queries against image content and content-based visual information retrieval, namely the application of computer vision techniques to image capture problems, namely the problem of searching for digital images in large databases. CBIR is used to search in an image database to retrieve images of visual content similar to the specified query image (Jenni, Mandala, & Sunar, 2015).

C. Deep Learning

Deep learning, also known as deep structured learning, is part of a broader machine learning method based on artificial neural networks with representation learning (Appalaraju & Chaoji, 2017). Deep learning architectures such as deep neural networks, deep belief networks, deep reinforcement learning, recurrent neural networks, and convolutional neural networks have been applied to areas including computer vision, speech recognition, natural language processing, machine translation, bioinformatics, drug design, medical image analysis, material inspection, and board game programs, which can produce output comparable to and in some cases exceed performance human experts (Schmidhuber, 2015).

D. Cosine Similarity

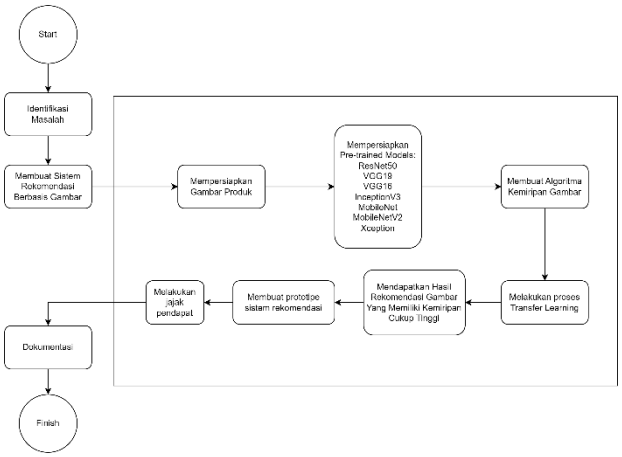
To produce the similarity value between one image and another, calculations are carried out using the cosine similarity formula, which is the size of the similarity between two nonzero vectors from the product space in the input image and the image dataset that has been prepared. It is defined as equal to the cosine of the angles between images, which is also equal to the inner product of the same vector normalized for both having a length of 1 (Patra et al., 2020), as described in Figure 1 below.

$$\text{cosine similarity} = S_C(A, B) := \cos(\theta) = \frac{\mathbf{A} \cdot \mathbf{B}}{\|\mathbf{A}\|\|\mathbf{B}\|} = \frac{\sum_{i=1}^{n} A_i B_i}{\sqrt{\sum_{i=1}^{n} A_i^2} \sqrt{\sum_{i=1}^{n} B_i^2}},$$

Picture. 1 Cosine Similarity Formula

Research Methods

The stages/steps and methods carried out in this study are as follows:



Picture. 2 Research Steps

Picture. 2 explain the steps taken in this study, starting from identifying problems, determining solutions to be carried out, preparing product drawings, and preparing pre-trained models (ResNet50, VGG19, VGG16, InceptionV3, NasnetMobile, MobileNet, MobileNet, MobileNetV2, Xception) that will be used, creating algorithms to generate image recommendations, conducting the Transfer Learning process, getting pre-trained models that produce image recommendations with The highest level of similarity, prototyping a web-based recommendation system, conducting polls to users, to documenting conclusions.

1. Dataset

This study used an image dataset sourced from the kalcare.com website with a product count of around 5,256 items (as of 2021). The dataset taken is an image of products that are still actively sold on the e-commerce with JPG/JPEG (Joint Photographic Experts Group) image format.

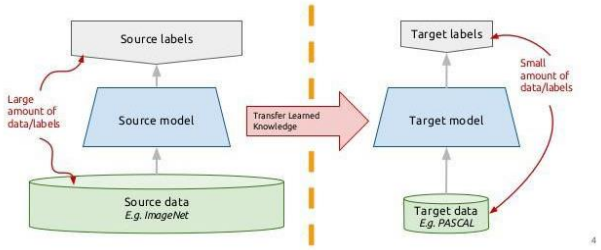
2. Pre-processing Dataset

Before processing calculations to produce the level of similarity to the image, an initial stage or commonly called pre-processing datasets is needed which aims to reduce the amount of work done by the machine, speed up time and increase accuracy. The initial stage is to create and implement a SQL (Structured Query Language) query against a database of e-commerce products kalcare.com that have an active status of sale and have product images to get the URL location (Uniform Resource Locator) of the

image. The query results obtained were then exported into CSV (Comma Separated Values) file format, then scripted using Python programming language which serves to download product images from the server to the local computer. In the script, in addition to functioning to download images, there is also a function to resize images to have the same pixel size, which is 240x240 pixels.

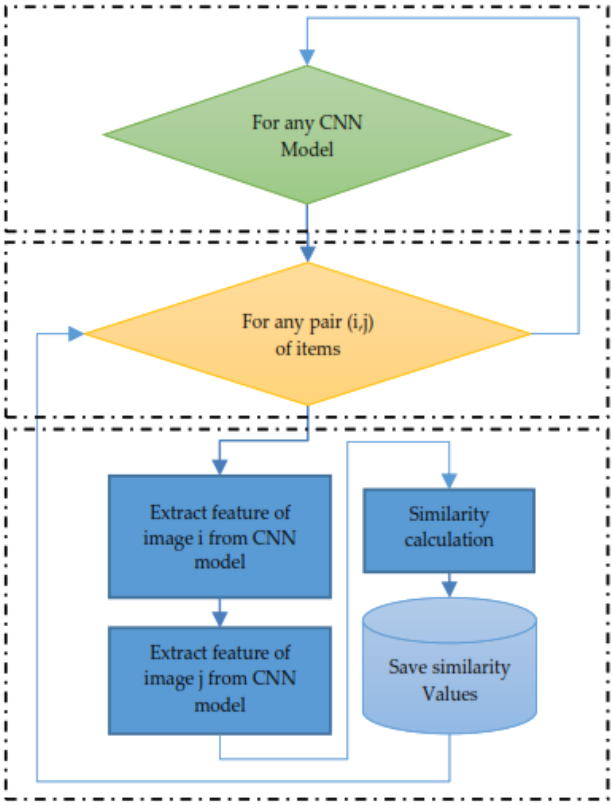
3. Training Process

The training process in this study uses eight (8) pre-trained models, then utilizes transfer learning (Transfer Learning) to adjust the model to the task given (Mira, Sembiring, & Purnomo, 2022).



Picture. 3 Ideas from Transfer Learning

Picture. 3 Explain the idea and process overview of Transfer Learning. To simplify and speed up this process, the Keras library is used, a Deep Learning Application Programming Interface (API) written in Python programming language that runs on a machine learning platform called TensorFlow (Sanchez, Romero, & Morales, 2020). It was developed with a focus on allowing experiments to be carried out quickly. To predict the final feature on the last layer of the predicted 1,000 labels, it is necessary to redesign the model to remove the prediction layer (Dagan, Guy, & Novgorodov, 2021).



Picture. 4 Cosine similarity calculation algorithm based on CNN feature extraction approach

Figure. 4 describes a cosine similarity calculation algorithm based on the CNN feature extraction approach for object recognition, freezes the initial convolution layer of the network and trains only the last few layers that make predictions. The idea is that convolution layers extract common low-level features that apply throughout the image (such as edges, patterns, gradients) and further layer identify specific features in the image such as eyes or wheels. Thus, we can use networks trained on unrelated categories in large data sets (for example: Imagenet) and apply them to the problems discussed in this study because there are low-level universal features shared among images, therefore the Imagenet data set and the knowledge that models learn in Imagenet can be easily transferred into the processing of product images kalcare.com (Alamdari, Navimipour, Hosseinzadeh, Safaei, &; Darwesh, 2022).

Results and Discussion

In this study, tests were carried out using pre-trained models that have been determined and prepared before, namely: resnet50, vgg19, vgg16, mobv2, nasnetmobile, mobile net, incepv3, and exception. The selection of images used in this test is random from a pre-prepared corpus. The test aims to display 5 images that have the highest degree of similarity. The testing process was run in an online Google Collab environment with considerations such as being able to harness the full power of popular Python libraries to analyze and visualize data, simply run in the browser without performing complex configurations, get free CPU access, and be easy to share code

with colleagues and colleagues. Picture. 5 Displays examples of products tested to produce the most similar product recommendations. Picture. The 6-13 displays product recommendations resulting from each pre-trained model.

Picture. 5 Examples of tested products

Picture. 6 Test results of pre-trained model incepv3

Picture. 7 Mobilenet model pre-trained test results

Picture. 8 Pre-trained test results of mobv2 model

Picture. 9 nasnetmobile model pre-trained test results

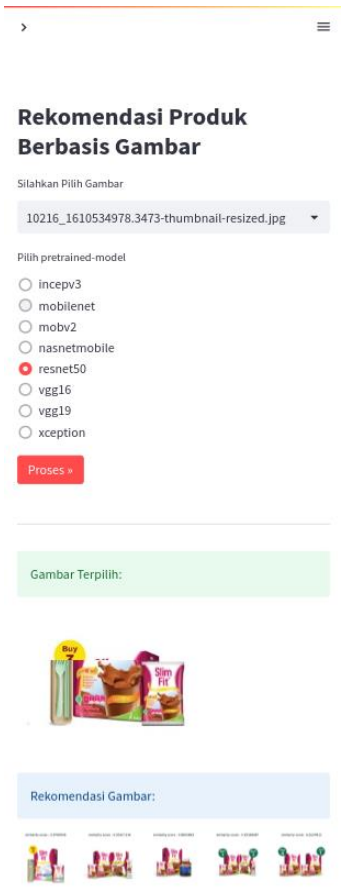
Picture. 10 Resnet50 model pre-trained test results

Picture. 11 vgg16 model pre-trained test results

Picture. 12 vgg19 model pre-trained test results

Picture. 13 Xception model pre-trained test results

From the test results, it can be seen and compared visually that the one that produces product recommendations with the best level of similarity is the resnet50 pre-trained model. Furthermore, to get responses and responses from users, a prototype image-based recommendation system was made that was applied to web browsers, as seen in the image. 14.



Picture. 14 Prototypes of Image-Based Recommendation Systems

The poll is conducted as a preliminary reference before the research results will be implemented in the production environment of the kalcare.com website. This was followed by 52 respondents, all of whom were employees working at kalcare.com. They fill out a poll through the Google form facility at https://forms.gle/J5LufG4Z1oKz11jg7 address with the condition that they must have tried the prototype of the recommendation system. The number of questions asked is 5, namely:

a. Prefer to search for products by typing text or image-based?
b. Is it easier to search for image-based products?
c. Is image-based product search more intuitive?
d. Is the image-based product search stage faster?
e. Does the existence of image-based product search make you come back to shop again?

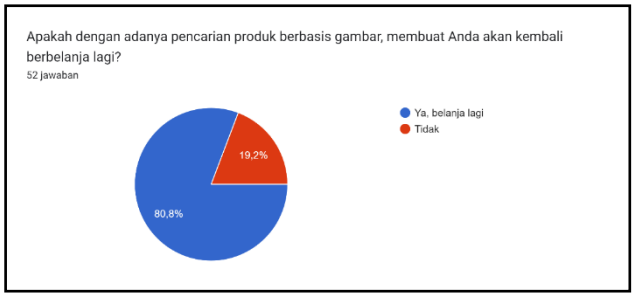
The results of the poll can be seen in the picture. The following 15-19:

Picture. 15 First-question survey results

Picture. 16 Second question survey results

Picture. 17 Third-question survey results

Picture. 18 Survey results fourth question



Picture. 19 Fifth question survey results

Conclusion

In this section, it can be concluded that from the results of trials on eight (8) pre-trained models that have been selected, subjectively ResNet50 is the one that can produce visual product image recommendations with the most relevant level of similarity. For the results of the poll on the prototype of the image-based recommendation system, the majority of respondents are still accustomed to searching for images by giving input in the form of text input rather than images (51.9%). Searching for image-based products is easier, so it is very helpful for respondents in the process of finding the product they want (75%). The majority of respondents feel that image-based product search is more intuitive (76.9%). According to respondents, image-based product searches are perceived to be faster than text-based (73.1%). Image-based product search is very positive, so it can make respondents want to return to shopping (80.8%).

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