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E-COMMERCE SYSTEM WITH OBJECT RECOGNITION USING NEURAL NETWORK

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Abstract

Recently, as a result of the COVID-19 pandemic, many players in the retail industry had changed their conventional business operations to online business operations through various e-commerce platforms. The shift is due to the pressure of the current situation which limits the shop's operating hours, hinders many customers to shop at one time and the precaution of the virus spreading was still a concern. This phenomenon has given a lot of attention to the development and enhancement of e-commerce features in order to provide the best and most convenient online shopping experience as compared to traditional shopping. Despite the prominent features offered by most e-commerce platforms such as good user interface and customer service, exploring and searching on e-commerce websites takes time, especially searching using keywords when the name of the product could not be recalled or is unknown, leaving the customers unhappy and affecting the seller's sales and profit. Thus, we propose an alternative solution to the e-commerce website by allowing customers to perform an image search for items using captured images from phones and uploading them to the website. This solution applies the implementation of object recognition embedded in the website's search mechanism. On top of that, our proposed system allows sellers to adjust supply and price based on season, product kind, and demand. Subsequently, sellers will be able to print sales reports for a different store. Following the data collection process, the software will recognize products from pictures and analyse them using a trained neural network that utilizes a product image dataset and TensorFlow library functions for machine learning.

Keywords: Consumer behaviour, Convolutional neural networks (CNN), COVID-19, E-Commerce, Object recognition, Machine learning.

1. Introduction

Nowadays, as consequence of the COVID-19 pandemic, the primary issue while dealing with traditional shop would be that it typically has the constraint on the opening hours in which the consumers have to come to the shop on the particular operation hours where traditional shop may increase the risk of spreading the virus. Therefore, due to geographical constraints, the offline business cannot be managed from anywhere where the conventional shop does have its particular location. Moreover, it is time-consuming to explore and search on e-commerce websites, especially when they need to purchase an item but have forgotten the product's name or have goods without a label which leads the customers to be unable to find the product, which makes them disappointed and has a negative influence on the seller's sales and profit, resulting in numerous issues [1].

Due to this situation, the website-based system provides a flexible solution to the mentioned problem by providing a platform for people to buy and sell products via the internet. The technology will enable customers to search for products by name or image by taking photos with their phones or uploading them to the website, and the system will display similar available products. It includes the ability to print sales reports for a specified period for a shop in the form of PDF.

Furthermore, it will aid sellers' production processes by adjusting quantity and pricing based on season, product type, and demand. The system will be developed using Web Technology and Prototyping Methodology. It will utilize PyCharm and various programming languages like Python and JavaScript, following a data collection process where the software recognizes products from pictures and analyses them using a trained neural network and TensorFlow library functions for machine learning.

The shape of a projectile is generally selected based on combined aerodynamic, guidance, and structural considerations. The choice of seeker, at supersonic speeds, careful selection of the nose and tail shapes is mandatory to ensure performance and operation of the over-all system.

2. Problem Statement

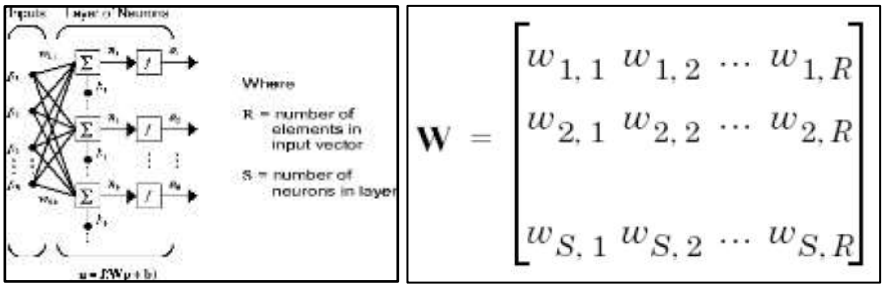
Recently, e-commerce has become world-famous application. People like to purchase or sell items online since the e-commerce platform are easy to use, and faster responses are highly handy [2]. Conventional physical shops difficulty arises because the sellers need a lot of time and work to sell and advertise their products in the business market. Furthermore, the customers may find that it is not convenient to only shop during normal business hours since most of them are still at the workplace. The situation becomes more inconvenience during COVID-19 pandemic where more people are afraid of crowds. This situation influence their preferences in online shop as this new way of shopping offers multiple benefits such as no time constraints, and consumers may buy at any time and from any location at their own convenience [3]. As a result, the online shop, provides a better shopping experience due to the wide variety of items, infinite time to shop, and accessibility at any time and from any location.

Effective on-site search is regarded as the primary point of interaction and also the core of an e-commerce website. When users are looking for the exact product, where up to 30% of them would use the site search bar, indicating a

likely desire to purchase by typing product names or codes [4], based on that, some consumers have forgotten the product's name or have goods without a label. In that regard, the customers are unable to find the product, which leads the customer to be disappointed and negative influence on the seller's sales and profit, resulting in numerous issues. Therefore, the website-based system provides a flexible solution to the mentioned problem by providing a platform for people to buy and sell products via the internet. The technology will enable customers to search for products by name or image by taking photos with their phones or uploading them to the website, and the system will display similar available products. Therefore, that means the more on-site search is used, the more opportunities there are to bring products closer to prospective buyers while also raising the website's purchase rate efficiency [5].

3. Literature Review on Neural Network Architecture

The architecture of an artificial neural network describes how neurons are linked to create a network, wherein the following Fig. 1, each element of the input line P is linked to every neuron via a weight matrix W, as shown in the following picture:



(a) Neural network architecture. **(b) Weight of each neuron.**

Fig. 1. Neural network architecture and weight of each neuron.

Each neuron has a collector connection that collects the weighted input and relocation to form the neuron's numerical outcome. Therefore, the neuron layer's outcome element forms the output line, where is a one-column array. The network receives the input line elements via the weight matrix.

The elements of this matrix are represented by lines, which identify the target neuron, as well as by columns, which represent the source input elements. The indications in the (W1,2) element show that this weight is linked with the first neuron and that the second element represents its input component [6].

Every layer of a neural network contains a weight matrix W, a relocation line b, and an output line a. To facilitate identification, the layer number is appended as an upper index to every one of the parameters utilized by the specified network of an input element, a neuron in the first layer, a neuron inside the second layer, and so on for subsequent layers. Every layer inside this network is called a single-layer network. The output layer is the layer that contains the outcome. Input is not recognized as a layer, and the other levels are referred to as hidden layers [7].

4. Methodology

4.1. Interviews

There are two interviewee who are both online sellers with more than 5 years of experience using e-commerce platform involved in this session. Every program must be user-centred because it is ultimately created for a user. As a result, the programmer must comprehend the users who are using the program and interest in e-commerce so collect their requirements and provide a useful program. Therefore, having conversations with people of various educational backgrounds and ages in order to achieve the ideal needs, particularly with people who are interested in e-commerce. The qualitative interview data also with the target market will be obtained using fact-finding approaches. Users' perspectives of the program and its demands are discovered through interviews.

4.2. Questionnaire

The total number of responses that participated was 25, and the majority of responses who responded to the questionnaire were students, contributing for 72 percent of the total, meaning 18 customers. Participants are followed by four customers who are employed, with a rate of 16% in the questionnaire. Two other occupations were unemployed with a rate of 8% (2 respondents) and self-employed with 4%. (1 respondent).

4.3. Prototyping methodology

Prototyping the proposed project concept is critical and one of the primary research techniques for gathering users' suggestions. This approach of fact-finding would be used to develop a prototype of the suggested system, which will represent the overall image of the project and how it would operate. The prototype will be designed primarily for checking and identifying issues based on user needs.

5. Proposed System

The proposed system combines two object identification techniques, neural networks, and pre-processing after doing a study on how the machine comprehends objects and the challenges that happened. This study will result in the development of a computer-based system. Through the use of artificial intelligence, methods reduce consumers' disappointment with the e-commerce web's search of products and allow a smooth and complete procedure for uploading images throughout the digital world of e-commerce that is seen during the Corona pandemic.

5.1. Input and pre-processing phase

The majority of pre-processing techniques consider the image as a two-dimensional signal that is then processed using traditional signal-processing techniques. In this case, image processing refers to a set of procedures that aid in improving the appearance of the input and assisting later phases, such as recognition. Geometric modifications such as expansion, reduction, and rotation, colour corrections such as brightness and contrast modifications, quantization or conversion to a different colour space, and digital or visual compositing are all examples of image

processing procedures. Conversion to grayscale, removing noise, and enhancing are among the pre-processing procedures performed here [8].

5.2. Feature extraction

A specialized type of dimensionality reduction is called feature extraction. The input content should be converted into a decreased representation set if it is too huge to be processed and contains duplicate content with so little value. This is known as features (also known as features vector), and it represents a unique description of the input pattern. Features extraction is the process of converting raw data into a set of features. Feature extraction is the process of reducing the number of resources needed to accurately describe a huge set of data [9].

5.3. Artificial neural network (ANN) phase

An artificial neural network (ANN) is made up of a network of artificial neurons that work together to process data using a connectionist approach to computation. During the learning phase, an ANN is an adaptable system that modifies its architecture based on external or internal data that passes through the network. In more functional aspects. The batch training method is used because it speeds up the training process and the rate at which the network converges to the desired value. Each epoch is comprised of a single cycle across the whole training set. Repeating the above procedure until the network satisfies the performance requirements, keeping track of the epochs passed. The MLP under consideration here contains two hidden layers, each of which is one and a half times as long as the input vector. The input and output layers are activated using log-sigmoid functions, whilst the hidden levels are activated using tan-sigmoid functions [10]. In addition, after Artificial Neural Network (ANN) phase finish, it will classifier be used to forecast the product's category.

5.4. Features of the system

The scope of this project is e-commerce. As a result, it is critical to make sure the project contains the essential capabilities to suit the demands of consumers and sellers. So, object recognition systems are often classified into two types, based on the technique used to acquire the data: online and offline object recognition systems.

Offline object recognition systems utilize a scanner or camera to collect product data, whereas online object recognition systems utilize digitizers that immediately capture the item. The application is restricted to an offline mode in order to serve customers' situations by assessing a scanned version of their product.

The software will have three parts each part has its unique features:

Product creation, editing: The proposed system enables sellers to add or edit product data such as type, amount, and unit pricing.

Add to cart: The proposed system allows users to add products to their cart or their favourites list on which items they want to buy.

Search and viewing products: The proposed system allows the user to perform in the search bar to search by the image of product where it will work by the opening camera if the user using the phone and for the computer users it gives them the

ability to upload a picture. Also, view products by filtering them based on their preferences, and browse the product's information.

5.5. Comparison with existing system

This section will understand similar systems for the proposed project and compare them to the proposed system. We compared our proposed system with another two selected e-commerce platform which is based in United Kingdom (UK). The comparisons are shown in Table 1.

Table 1. Comparison between Proposed System and The Others.

	ASOS	Boohoo	Proposed System
Artificial intelligence	□	□	□
Normal search	□	□	□
Smartphone image	□	□	□
Website upload image			□
Object Search image	□	□	□
Variety of categories			□
Crop image	□		□
Object Pattern Recognition	□		□

As indicated in the preceding table, all systems have artificial intelligence capabilities for analysing photographs, including an object. However, the ASOS and Boohoo applications were not specifically developed to analyse images containing pattern objects so that the findings may include inaccuracies. Additionally, the two apps do not have an option for uploading photographs to their website since they are not focused on computer users. On the other hand, the proposed system is capable of analysing a vast number of categories, not only fashion, and providing findings for more amiable items. Additionally, the suggested system and ASOS give a user interface that differentiates them as a copping service for the digital content.

5.6. Machine learning implementation

We used Coco dataset which comprises of 80 classes ranging from various different objects downloaded with annotations into training folder. However, authors only selected 31 classes that are related to the products that are commonly available in the e-commerce platform. Images in the selected classes was saved in a newly created train folder. The size of images was fixed to 128×128×3.

Several libraries that need to start machine learning where Numpy is used to make the process faster, Padas for reading CSV files that are created preciously, Keras for preprocessing with layers of Neural Networks, TensorFlow for machine learning and Sklearn for split train folder to train and test. Also, Matplotlib shows images in the Jupyter notebook and other libraries that are needed for machine learning.

The authors used ResNet50 model to train the Coco dataset. ResNet is one of distinguish convolutional neural network model that uses an identity block, or also known as a residual block. Batch Normalization is used to normalizes the batch of every layers in ResNet50 identity blocks.

The 2D Convolution block is a layer that is used to detect spatial features in an image by working either directly on the image data or the output of previous convolution blocks. Convolutional neural networks learn the appropriate filter forms for the task at hand, whereas standard computer vision and image processing depended on fixed shape feature detectors. As the function above, the convolution layer and the pooling Layer make up this layer. This layer is an important part of the feature extraction process.

Callbacks codes were used to prevent model from wrong learning and over fitting which will stop the learning after 10 epochs and val_loss value not decreased. While learning_rate_reduction is for reducing the learning rate when then accuracy does not increase for 2 steps.

The next step is to prepare data for generator where it needs to convert column category into string where it was digit since the author used image generator with class_mode="categorical". After that image generator will convert it one-hot encoding which is great for our classification. In addition, train split where train 70 percentages and validate 30 percentages with reset index to drop true and shape index number 0 for both then batch_size equal 30.

Following the above step, Training and Validation Generator is used to rescale images by 1./255 to make pictures smaller which make machine learning faster and used flow from datafame by passing train_df, train_data and other data as shown above.

After completing the preparation of the structural structure of the neural network that will be used in training the machine in artificial intelligence, the writer started training the artificial intelligence and was able to reach the accuracy at 50 epoch of training to 93% of the accuracy as shown in Fig. 2 to find the products after many attempts.

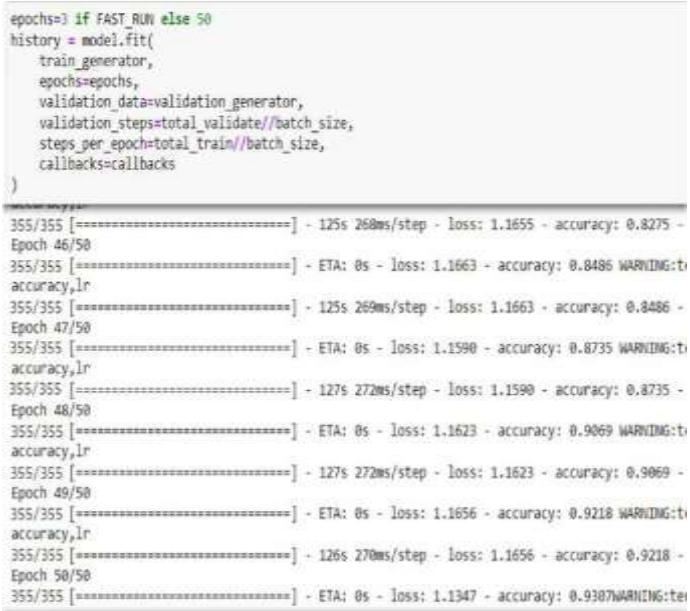


Fig. 2. The training models.

After completing the training, the model containing the training result was saved in the artificial intelligence to be used to find the product in the image that the customer will upload.

Figure 3 demonstrates how the preparation of the names associated with the IDs that the artificial intelligence will extract from the image and make sure that its number is correct, which is 31 products.

```
# COCO Class names
# Index of the class in the list is its ID.
my_class_names = [(25, 'backpack'), (26, 'umbrella'), (27, 'handbag'), (28, 'tie'),
                  (29, 'suitcase'), (42, 'cup'), (43, 'fork'), (44, 'knife'), (45, 'spoon'),
                  (46, 'bowl'), (57, 'chair'), (58, 'couch'), (60, 'bed'), (61, 'dining table'),
                  (63, 'tv'), (64, 'laptop'), (65, 'mouse'), (66, 'remote'), (67, 'keyboard'),
                  (68, 'cell phone'), (69, 'microwave'), (70, 'oven'), (71, 'toaster'), (72, 'sink'),
                  (73, 'refrigerator'), (74, 'book'), (75, 'clock'), (76, 'vase'), (77, 'scissors'),
                  (79, 'hair drier'), (80, 'toothbrush')]
```

Fig. 3. COCO class names.

Figure 4(a) shows the previous look, which is intended to make the model work perfectly when using a laptop with books in the background. As we can see, artificial intelligence works perfectly to take shape data, mask it, and detect the score of the laptop compared to the rest of the books as shown in Fig. 4(b).

(a) Object detection. **(b) Object segment.**

Fig. 4. Object detection and segment.

Referring to Fig. 5, we can see when the “class_id” is printed, we find that the word "laptop" for the product has been successfully extracted, which is found to have the same meaning as the image. This function made a mask on the product that was found in the image based on the data produced by artificial intelligence.

```
[n for i,n in class_names if i == r['class_ids'][0]]

['laptop']
```

Fig. 5. Object detection result.

6. Conclusion

Neural network has been widely used in many areas in different industries and has proof its outstanding contributions. In e-commerce system, embedded neural networks namely in object recognition task has given a new paradigm to the trending online shopping experience to both customers and sellers. This project has successfully incorporated the object recognition features as part of the image search channel which able to provide the customers with advance and refine search using images.

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