DEVELOPMENT OF A NIGERIAN CULTURAL ATTIRE RECOGNITION SYSTEM

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Abstract: This paper presents the development of a system to automatically recognize Nigerian traditional attire worn by major ethnic groups. Samples of clothing images depicting the cultural groups were obtained from publicly available online sources and an architecture to classify the images classes was designed using the Convolutional Neural Network (CNN) model. Performance evaluation results from experiment show that the model can classify images accordingly, achieving a validation accuracy score of 86 %. A web application interface was also implemented to validate the model's accuracy which shows good potential when integrated in commercial clothing applications.

Keywords: recognition system, Nigerian attire, convolution neural network

1. INTRODUCTION

Nigeria is a country of rich culture and heritage. There are several ethnic groups in the country which have distinguishing traditional attires. These attires are a major way of identifying different cultures within the country [1]. Identifying ethnic groups by their attire can be easy for Nigerian citizens or individuals that are aware of the culture and practices which may be difficult for non-citizens to identify. Digital technologies and automated processes have made clothing/cultural fashion applications more accessible to a global reach with the increase in use of artificial intelligent techniques for computer vision and pattern recognition [2]. Research efforts have been made in the area of fashion/clothing style classification, providing, adopting and developing various methods. These methods have majorly been applied to specific cultural and contemporary classes using standard datasets and focusing on the use of convolutional neural network (CNN) in classification of clothing images. Furthermore, CNN have been widely applied by researchers in the fashion/clothing domain because the technique has proven to be effective in delivering high accuracies and expert level performances especially when used to analyze images [3].

In [4] an automatic classification of traditional clothing worn in Bangladesh using convolutional neural network (CNN) was proposed. Images depicting clothing worn in Bangladesh were collected from online sources and a CNN model that recognizes images and automatically categorizes the traditional attire into any five traditional clothing categories was implemented. Experimental results reported, showed an accuracy score of 89.22 % for the testing sets. [5] proposed an algorithm for the recognition of clothing styles. Image samples were categorized into five classes and experimental results showed that the proposed algorithm achieved better recognition accuracy and detection speed than existing learning algorithms. [6] proposed a model for the development of a recognition system for classification of e-commerce clothing images using CNN architectures. DeepFashion dataset was used to train the model and experimental results showed that the architectures used are efficient in classifying clothes.

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[7] presented an approach for clothing style classification considering contemporary clothing. Classification was carried out using a Deep CNN technique and transfer learning for deep feature extraction. Experiments on clothing datasets showed better results than several existing techniques. [8] utilized deep residual network and detection technology to extract clothing features to improve traditional residual network methods. [9] proposed a CNN based architecture to train CNN parameters on Fashion MNIST dataset. Results from their experiment show that the proposed model achieved an accuracy of 98 %. [10] classified apparel from images using CNN. They showed through experiments that the CNN model performed better when compared with baseline classification, Support Vector Machine (SVM), Random Forest, and Transfer Forest.

Studies that have used other machine learning techniques in clothing classification have also reported significant accuracy results. In [11] several classification techniques such as Decision Trees, Random Forest, Naïve Bayes and Bayesian Forest were used for the categorization of garments using Deep Fashion dataset. From the experiments, it showed that Random Forest performed better comparatively than the other classifiers. In [12], SVM was used to classify clothing brand styles which achieved 56.25 % success rate. [13] proposed a method for classification of fashion images focusing on improving classification accuracy and computation time, using random-forest based on genetic algorithm and Visual Geometry Group-Image Enhancement algorithm. Experimental results show that classification accuracy was improved as well as computational time.

Specifically in the context of the Nigerian clothing and style, research has been carried out focusing majorly on fabric patterns. [14] developed a model for recognizing Nigerian fabric patterns. Samples of fabric patterns were analyzed to extract features; artificial neural network was used for classification and fuzzy inference engine to extract subset of matching images. Experimental results showed that the recognition model obtained 100% for all fabrics considered. From reviewed literatures, computational recognition of attire styles for specific Nigerian culture has not been carried out, since features and patterns are distinguishable from those of other African and international cultures.

This work focused on the development of a Nigerian cultural attire recognition system with specific objectives to (i) collect and process varying image samples of cultural attire of four major ethnic groups in Nigeria (ii) classify the images using CNN model (iii) evaluate the classification performance and (iv) implement a prototype of the recognition system. The remaining sections of the paper are organized as follows: section 2 presents the experimental setup, section 3 presents the results and prototype implementation and section 4 concludes the paper.

2. EXPERIMENTAL SETUP

2.1. Data collection and preprocessing

Data in the form of images were collected from publicly available online sources such as Pinterest, Google image search, Instagram, as shown in Figure 1. A total of 1200 images were collected, 300 images each for four classes of ethnic groups (Yoruba, Igbo, Hausa and Edo). A total of 7200 were reproduced by image augmentation method with each image generating 6 more images with effects such as removing background, crop, zoom and flipping the images horizontally/vertically. For ease of computation, the images were resized to an input shape of 28 ×28×3 pixels which represents the width, height and number of channels for each input.

Fig. 1. Samples of images collected from publicly available sources.

2.2. CNN classification architecture

2.2.1. Architecture design

As illustrated in Figure 2, the resized input image is fed to the network which consists of two convolution layers with max pooling and a fully connected layer that uses the ReLU(rectified linear unit) activation function. The output layer has four units and uses the softmax activation function.

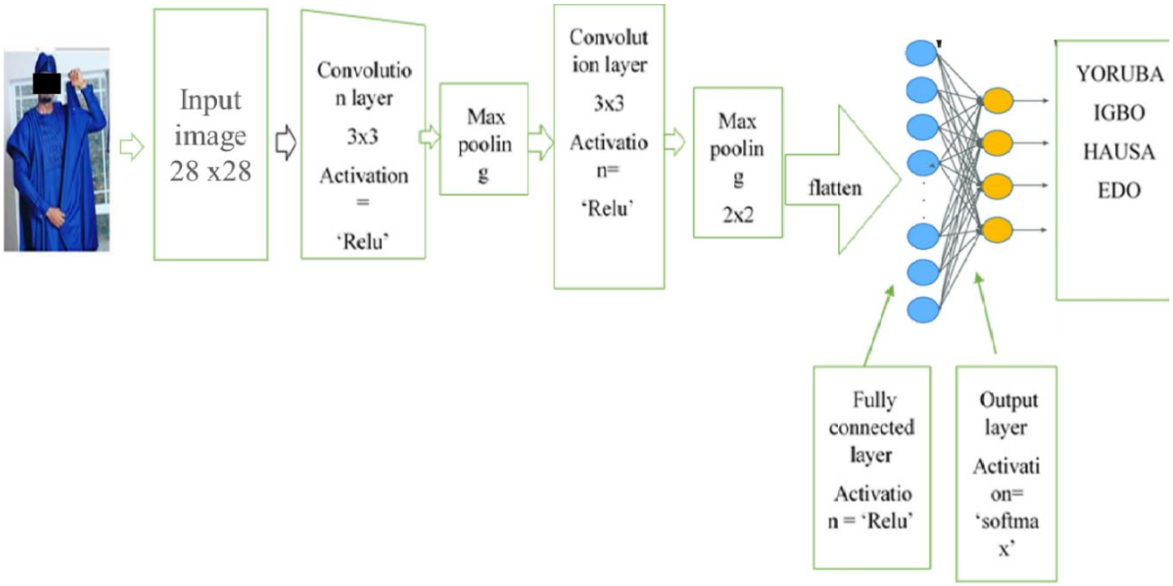

Fig. 2. CNN Architecture for traditional attire classification.

The convolution layer was used for the extraction of features such as lines, edges, corners, from the input image using the filter method. Two activation functions 'ReLU' and 'softmax' were used at different layers of the model. The ReLU function in equation 1 is applied to the hidden and fully connected layer while the softmax function in equation (2) is applied at the output layer.

$$f(x) = \max(0, x) \tag{1}$$

$$s(x) = \frac{e^{x_i}}{\sum_{j=1}^{n} e^{x_j}} \tag{2}$$

The ReLU function is better in handling the non-linearity of functions and the softmax's role is to convert the raw output to relative probability scores. The probability scores are then translated to the possible output class (Yoruba, Igbo, Hausa or Edo).

2.2.1. Training and testing

The preprocessed images were split for the purpose of training and testing the model. The images were split as 80 % for training and 20 % for testing which is 5760 images for training and 1440 images for testing. Tensorflow which is a widely used and highly computational machine learning library was used for experimenting the training and inference process of the model. Table 1 shows the number of images used in training and testing the model for each category of images.

Table 1. Number of images used for training and testing.

Category	Training Set	Testing Set
Yoruba	1440	360
Igbo	1440	360
Hausa	1440	360
Edo	1440	360
Total	5760	1440

3. RESULTS AND DISCUSSION

The recognition performance from the tested model was evaluated using the recall, precision, F1-score, and accuracy as defined by equation 3, 4, 5 and 6 respectively.

$$\text{Recall} = TP / TP + FN \tag{3}$$

$$\text{Precision} = TP / TP + FP \tag{4}$$

$$F1 = 2 * (\text{Precision} * \text{Recall}) / (\text{Precision} + \text{Recall}) \tag{5}$$

$$\text{Accuracy} = (TP + TN) / (TP + TN + FP + FN) \tag{6}$$

Where TP is True Positive, FP is False Positive, TN is True Negative and FN is False Negative. The Precision, Recall and F1-scores for the four classes are presented in Table 2 and Figure 3.

Table 2. Precision, Recall and F1-Score for each class.

Label	Class	Recall	Precision	F1-Score
0	Edo	0.91	0.79	0.85
1	Hausa	0.78	0.90	0.84
2	Igbo	0.82	0.92	0.86
3	Yoruba	0.93	0.84	0.88

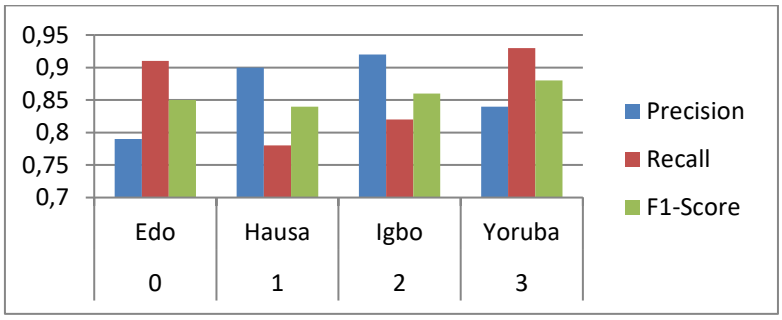

Fig. 3. Precision, Recall and F1-Score for each class.

Experimental results carried out using Tensorflow and Keras show that the model achieved an average accuracy of 86 %. The accuracy and loss were compared to determine the training and validation progress of the model. The training and validation accuracy increased by the number of epoch as shown in Figure 4. Likewise, Figure 5 shows the training loss and validation loss with no overfitting.

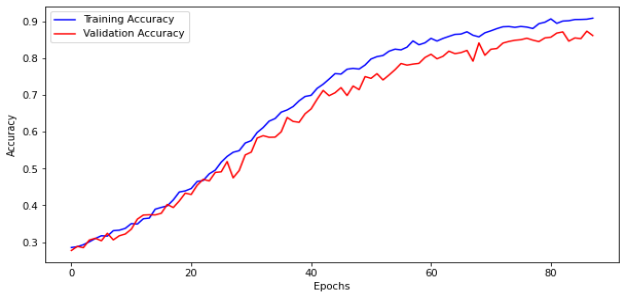

Fig. 4. Training accuracy against validation accuracy.

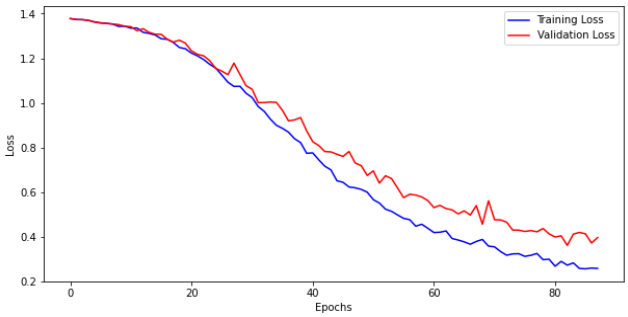

Fig. 5. Training loss against validation loss.

For the final stage of the development, a simple web based application interface of the model was implemented using Python and Flask framework. Figure 6 shows a sample of the classifications given by the application when a Yoruba and Edo image sample is uploaded. This shows that the model is able to predict accurately for varying instances.

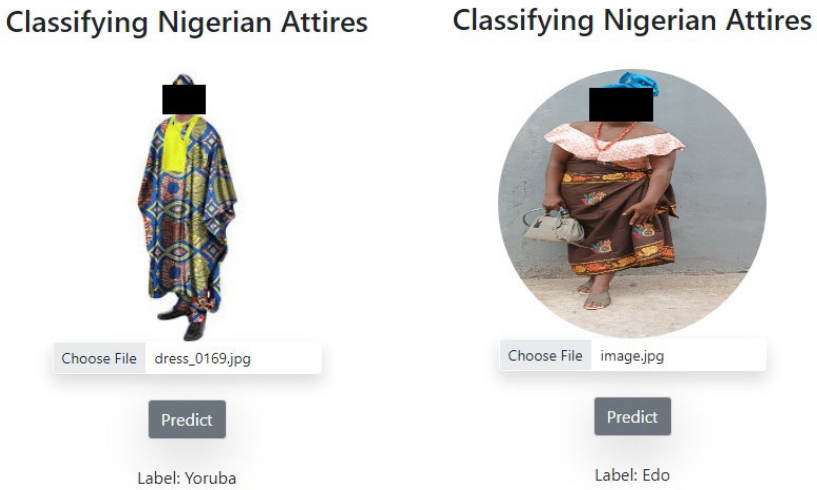

Fig. 6. Recognition of sample image.

4. CONCLUSIONS

This study presented the development of a recognition system for Nigerian traditional attire, classifying major ethnic groups with an attempt to integrate its implementation into recognition technologies that can determine the ethnic group an individual belongs automatically. Four ethnic groups (Yoruba, Igbo, Hausa and Edo) were considered and the CNN architecture was adopted in the classification of data samples. The study showed that CNN is effective in analyzing Nigerian attire patterns and classifying accordingly achieving high accuracy score. The resulting implementation would make a great impact in the Nigerian fashion and clothing industry and make it easier for online stores and shops to market and arrange their items for customers to view them. For future works, this study can be extended by including more ethnic groups for classification.

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