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Fashion-MNIST Classification Based on HOG Feature Descriptor Using SVM

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Abstract*: Image recognition and classification plays an important role in many applications, like driverless cars and online shopping. We present the classification of Fashion-MNIST (F-MNIST) dataset using HOG (Histogram of Oriented Gradient) feature descriptor and multiclass SVM (Support Vector Machine). In this paper we explore the impact of one of the successful feature descriptor on Fashion products classification tasks. We have used one of the most simple and effective single feature descriptor HOG. The multiclass SVM which is one of the best machine learning classifier algorithms is used in this method to train the images. Selecting appropriate technique for feature extraction and choosing a best classifier algorithm remains a big challenging task for attaining good classification accuracy. However, the experimental results show that impressive results on this new benchmarking dataset F-MNIST.

***Index Terms*: Fashion-MNIST, HOG features, Image Classification, SVM Classifier.**

I. INTRODUCTION

In computer vision one of the most popular applications are Object Recognition or Object Classification. In object classification the main aim is to extract features from the images and classify it into right classes using any one of the classifiers or classification methods. Object classification is an important problem in various computer vision applications, such as image retrieval, driverless car, and surveillance. For example, in a driverless car, we have to classify nearby objects as vehicles or pedestrians. For classifications of images or patterns one of the best classification methods is multiclass SVM (Support Vector Machine). HOG (Histogram of Oriented Gradient) is an efficient gradient based feature descriptor for data discrimination and its performance is excellent comparing with other feature sets. This work classified the fashion products in Fashion-MNIST dataset using HOG features with multiclass SVM classifier. Fashion-MNIST (F-MNIST) is a dataset of 70000 fashion articles developed by Zalando Research Company. Figure 1 shows some images in F-MNIST.

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II. BACKGROUND AND RELATED WORK

In this work we propose to classify fashion products using HOG feature descriptors [5] and a multiclass SVM [6] classifier. In OCR (Optical Character Recognition) this type of classifications are used. HOG was first introduced by Dalal and Triggs (2005) [5] for the human detection and it is one of the most popular and successful feature descriptors in pattern recognition and computer vision. In one of the research paper presented by Ebrahimzadeh and Jampour [2] shows that they have achieved very high accuracy on HDR (Automatic Handwritten Digits Recognition) using this efficient HOG descriptor with multiclass SVM.

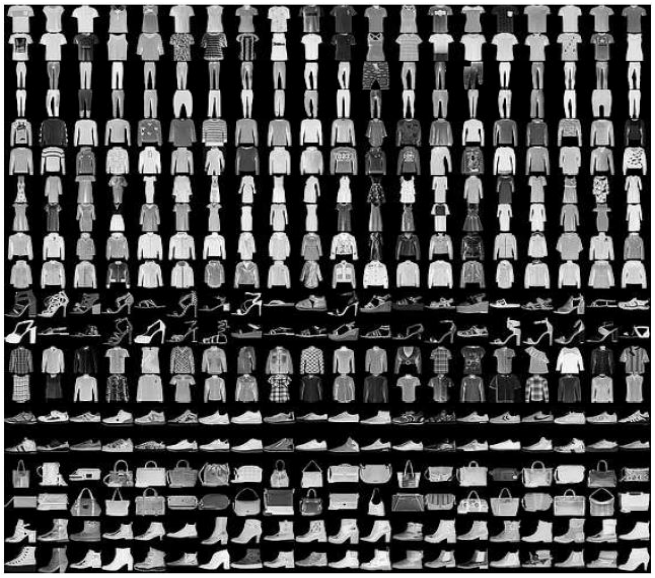

Fig. 1. **Fashion-MNIST Dataset Images**

One of the previous works suggested by Khan, H. A. (2017) [4], a new MCS (Multiple-Cell Size) method is being introduced for make use of HOG features and multiclass SVM for performing Handwritten Digits classification efficiently. By performing HOG analysis and computing the HOG features with MCS approach, it has achieved best classification accuracy. Improvements based on Chain Code Histogram (CCH) for recognition of handwritten digits was proposed by Qian, Y. and Xichang (2013) [7] improves the speed of training and recognition and this reduces the feature dimension.

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III. PROPOSED METHODOLOGY

A. Preprocessing and Feature Extraction

The various features of the images are extracted in this phase and then they have used with SVM for classification of fashion objects in F-MNIST dataset. In advance of training a classifier and evaluating the test, a preprocessing task is introduced to decrease noise artifacts produced while collecting samples of images. For training the classifiers by applying pre-processing, it provides better feature vectors. Preprocessing is very much important task because its efficient functioning reduces the misclassification and improves the recognition rate [8]. Herein HOG based feature extraction scheme for recognizing fashion products is used for the proposed work. Every fashion article image of dimension 28x28 is used to extract HOG feature.

B. Histogram of Oriented Gradients (HOG)

One of the simple and effective feature extraction methods is HOG feature descriptor. It is a fast and efficient feature descriptor in compare to the SIFT and LBP due to the simple computations, it has been also shown that HOG features are successful descriptor for detection. Mainly it is used for object detection in image processing and computer vision. Using HOG the shape and appearance of the image can be described. It divides the image into small cells like 4-by-4 which is used in this work and computes the edge directions. For improving the accuracy the histograms can be normalized.

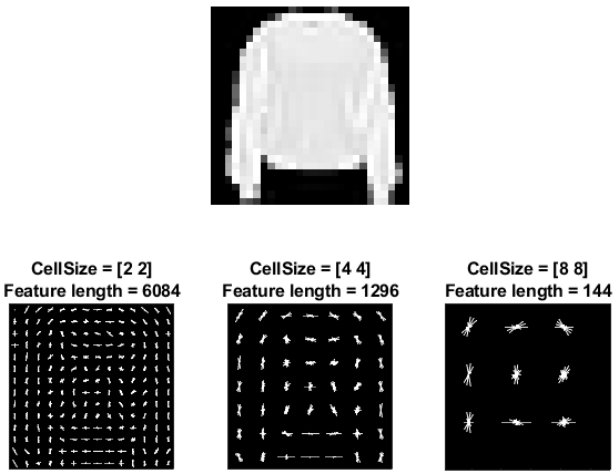

Fig. 2. *Extracted features of an image in Fashion-MNIST Dataset*

In Figure 2 extracted HOG features of one image using three different cell sizes are shown. In this figure the visualization of cell size [2 2], [4 4] and [8 8] are shown. From that it is clearly understood that the cell size [2 2] contains more shape information than the cell size of [8 8] in their visualization. But in the latter case the dimensionality of feature vector using HOG increases comparing with the former. A good choice is the [4 4] cell size. By using this size the numbers of dimensions are limited and this helps to speed up the training process. Also it contains enough information to visualize the fashion image shape. For identifying the suitable parameter setting configuration of HOG parameters more training and testing processes using the classifier has to be performed.

C. Support Vector Machine (SVM)

In machine learning one of the most common and successful classifier in supervised learning is SVM which can be used for classification and regression tasks [6]. Supporting Vector Machine has been successfully applied in the field of pattern recognitions, like face recognition, text recognition and so on. It shows good performance in applications [8]. So this part we utilize SVM to train and test. This paper employed a multiclass SVM classifier as a classification tool of HOG feature space developed for a complete dataset of fashion images from F-MNIST database. The HOG feature of dimension 1x1296 for each individual fashion object have been arranged in the row wise to prepare complete feature space.

IV. EXPERIMENTAL RESULTS

A. Fashion-MNIST Dataset

F-MNIST dataset is a collection of fashion objects in grayscale. It contains 4 files including the labels and images which are again subdivided into sets of training and test. The labels and images in training set consists of 60000 numbers and in the test set, it is 10000. F-MNIST contains 10 classes of images and the labels and description of each class is given in Table I.

TABLE I. CLASS NAMES AND LABELS OF F-MNIST DATASET

Labels	*Description*
0	T-shirt/top
1	Trouser
2	Pullover
3	Dress
4	Coat
5	Sandal
6	Shirt
7	Sneaker
8	Bag
9	Ankle boot

B. Experiment Results and Analysis

The presented work is implemented in MATLAB. HOG features of images are extracted from the 28 x 28 pixel training images of F-MNIST using the function in MATLAB. First of all in the training phase, extracting the features using HOG from the training images and then it will be used for making predictions using the classifier. These extracted HOG features are used to train the classifier. The results are evaluated using the test set images, and for measuring the accuracy of the classifier a confusion matrix is produced. Cell size used here for hog feature is [4 4].

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And then these features of 60000 images are given into multiclass SVM for training. Finally testing is conducted on 10000 images in test set. It achieves 86.53% accuracy on test images. Table II displays the confusion matrix of the classes in fashion image dataset where it is very clearly understood that the uncertainty took place in between the categories of '0', '6' and '4', '2' and '4',

'6' and '2', '6' which are make sense because t-shirts and shirts, coat and pullover and coat and shirts are looking same and little bit confusing.

TABLE II. CONFUSION MATRIX OF HOG FEATURE 4 x 4

Class	*Label*	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
T-shirt/ top	**0**	**835**	2	14	26	4	1	109	0	9	0
Trouser	**1**	2	**963**	2	27	1	0	5	0	0	0
Pullover	**2**	15	1	**765**	9	113	0	92	0	5	0
Dress	**3**	26	9	13	**871**	35	0	43	0	3	0
Coat	**4**	2	1	95	37	**796**	0	68	0	1	0
Sandal	**5**	0	1	0	0	0	**950**	0	38	1	10
Shirt	**6**	148	0	84	35	110	0	**612**	0	11	0
Sneaker	**7**	0	0	0	0	0	31	0	**952**	0	17
Bag	**8**	2	1	5	7	6	3	10	1	**965**	0
Ankle boot	**9**	0	0	0	0	0	13	1	42	0	**944**

TABLE III. ACCURACY RESULTS ON F-MNIST IN LITERATURES

Method	*Accuracy*
SGD Classifier [1]	81.9
Linear SVC [1]	83.6
HOG + SVM	**86.53**

SGD - Stochastic Gradient Descent; SVC – Support Vector Classifier;
HOG - Histogram of Oriented Gradient; SVM – Support Vector Machine

Comparing with the accuracy results on F-MNIST dataset test data results with various models in literature as shown in Table III, the HOG + SVM model shows better accuracy results of 86.53%. In Figure 3 it shows that the category-wise accuracy of images in F-MNIST dataset. From this figure it is very clear that the accuracy of class 'shirts', 'pullover' and 'coat' are very low compared with other classes.

V. CONCLUSION

In general, proposed work presents an efficient system for the effective and accurate classification and recognition of the fashion products images. After successful implementation of the proposed fashion articles classification system using HOG

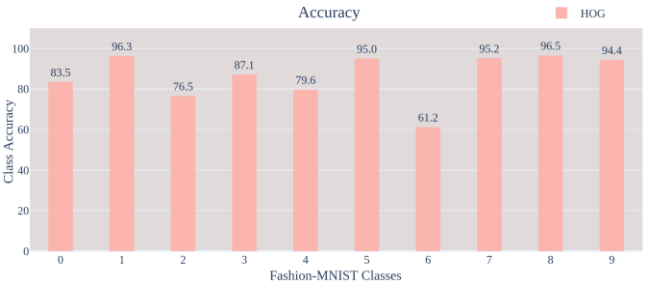

Fig. 3. ***Class-wise Accuracy of Fashion-MNIST Dataset***

feature space and multiclass SVM classifier, it has shown that the proposed system provides relatively good fashion object classification efficiency as compared to available literature works. In future, many modifications and improvements can be proposed on the preprocessing part and feature extraction and more combinations of features can be explored. We may modify the feature extraction and classification using many other techniques and can produce outstanding performance on fashion image classification. We can explore the other feature types for training the classifiers and analyze the effects of other machine learning algorithms for classifying fashion images.

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