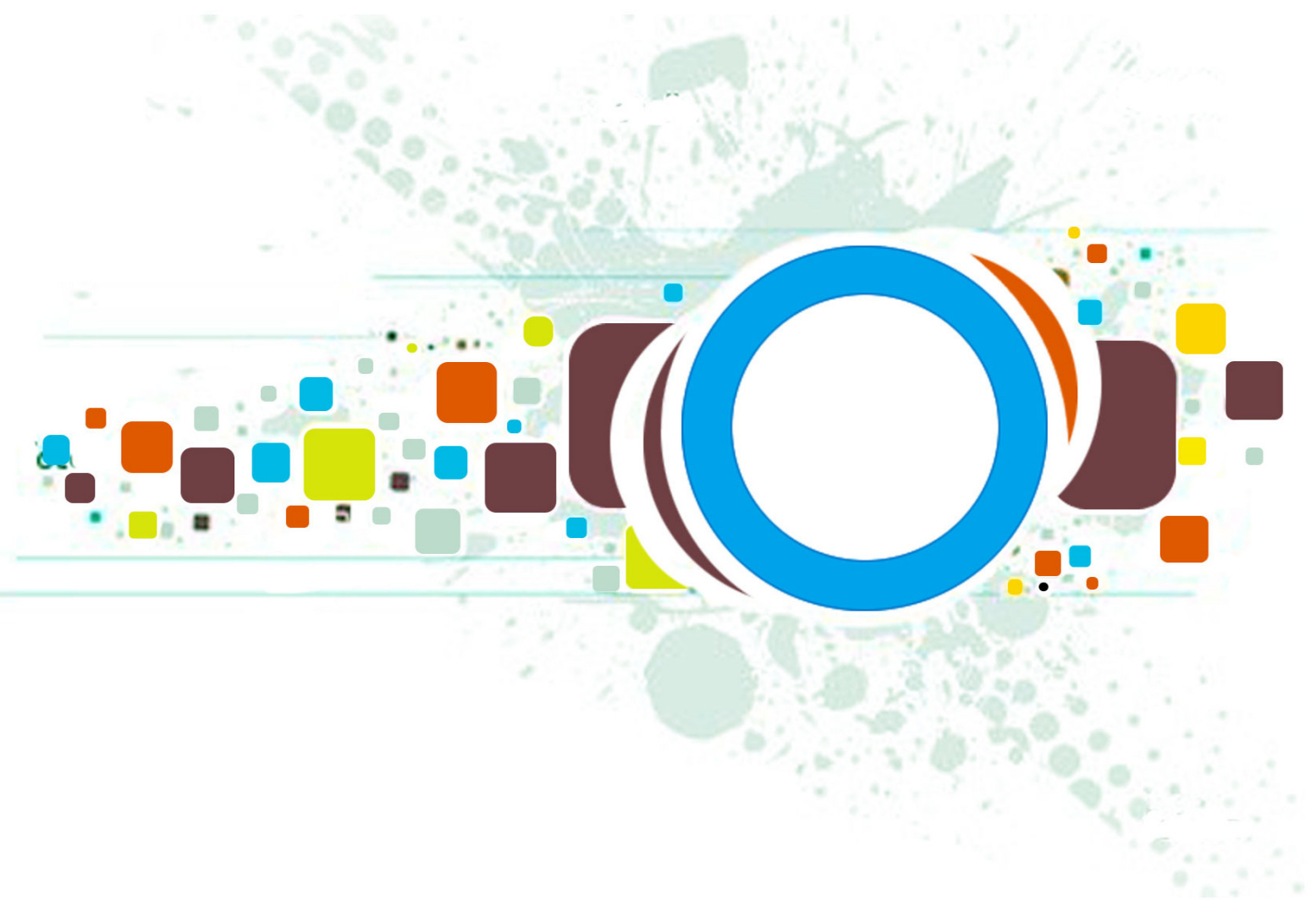


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## EDITORIAL PREFACE

The International Journal of Image Processing (IJIP) is an effective medium for interchange of high quality theoretical and applied research in the Image Processing domain from theoretical research to application development. This is the *Second Issue* of Volume *Fifteen* of IJIP. The Journal is published bi-monthly, with papers being peer reviewed to high international standards. IJIP emphasizes on efficient and effective image technologies, and provides a central for a deeper understanding in the discipline by encouraging the quantitative comparison and performance evaluation of the emerging components of image processing. IJIP comprehensively cover the system, processing and application aspects of image processing. Some of the important topics are architecture of imaging and vision systems, chemical and spectral sensitization, coding and transmission, generation and display, image processing: coding analysis and recognition, photopolymers, visual inspection etc.

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## Facial Expression Recognition System Based on SVM and HOG Techniques

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### Abstract

Facial expression is one of the most commonly used nonverbal means by humans to transmit internal emotional states and, therefore, it plays a fundamental role in interpersonal interactions. Although there is a wide range of possible facial expressions, psychologists have identified six fundamental ones (happiness, sadness, surprise, anger, fear and disgust) that are universally recognized. Automatic facial expression recognition (FER) is a topic of growing interest mainly due to the rapid spread of assistive technology applications, as human–robot interaction, where a robust emotional awareness is a key point to best accomplish the assistive task. The proposed work aims to design a robust facial expression recognition system (FER). FER system can be divided into three modules, namely facial registration, feature extraction and classification. The objective of this work is the recognition of facial expressions based the Histogram of Oriented Gradients (HOG) and support vector machine (SVM) algorithm.

Firstly, a comprehensive study on the application of histogram of oriented gradients HOG descriptor in the FER problem is presented, highlighting as this powerful technique could be effectively exploited for this purpose. Then, a multi SVM is then trained to perform the facial expression classification.

The proposed technique is applied to two public datasets, such as the JAFFE dataset and an extended Cohn-Kanade (CK+) dataset. Facial expression recognition from the proposed method are validated and the True Success Rate (TSR) for the test data available is evaluated, and then a comparative study versus existing techniques is presented. Face Recognition using HOG and SVM are better compared to existing state of the art methods.

**Keywords:** Component, Facial Expressions, Histogram of Oriented Gradients (HOG), Support Vector Machine (SVM), Facial Expression Recognition, HOG Features, Facial Component Detection.

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## 1. INTRODUCTION

Although humans are experts in facial recognition, it is not yet understood how to perform this recognition with high accuracy [1] [2] [3]. For many years, psychologists and neuroscientists have been looking at whether facial recognition is done holistically or by analyzing local features, i.e. facial recognition is done by looking at the face as a whole or by looking at local facial features independently to identify people.

The study of the face and its characteristics is an active search area and very increased in the past few decades. Many efforts have been made and many are still being made to develop a robust and accurate system in the field of information security and the security in general. It is mainly used in the fields of human-computer interaction, psychological behavior analysis, image understanding, e-learning, etc. Successfully recognized expressions can be used in many sectors of our lives for the betterment of everyday experience. It can be used for security purposes, robots can be given this ability to enhance their performance, automated machines can be articulated with expression analyzing feature, face expressions can be analyzed to determine the persons authorized to enter places that have security levels to allow or prohibit a person from doing crucial tasks and in many other sectors, this facial expression recognition (FER) can be used. As the world is heading towards automation, so the ultimate goal of the research is to recognize expressions flawlessly and spontaneously using machines, as humans can do in high accuracy. Usually, seven basic facial expressions are considered while dealing with FER problems and they are neutral, angry, fearful, happy, sad, surprise, disgust [5] [6] [7].

However, the proposed research took the form of a new research but on an existing research subject. In order to satisfy the objectives of this work, a quantitative research was held, is that it offers a complete description and analysis of a face recognition research subject [8] [9].

In this paper, we introduce an effective appearance-based method to handle the facial expression recognition problem. Given a face image, the system detects the face first and then, extracts the facial components from the face image. After that, the Histogram Oriented Gradient (HOG) [10] [11] is extracted to encode these facial components and concatenate them into a single feature vector. Once the feature vectors are determined for each image to be classified, the SVM rule and decision are applied to obtain the final classification.

Section 2 introduces the proposed method for face recognition. The experimental results are discussed in Section 3, and the conclusion is given in Section 4.

## 2. THE PROPOSED METHOD

The approach facial expression recognition can be seen as a three-stage process: face detection, feature extraction, and expression classification. In recent years, the extraction methods of expression feature mainly include Global feature extraction and Local Feature extraction [12] [13].

In order to extract facial expression features better and improve facial expression recognition rate, this paper proposes a face expression classification based on method Global Features extraction geometric features.

In the case of facial expression recognition [14] [15] [16], the determination of features is a crucial step of recognition [17] [18]. Whether the extraction of expression features is effective or not will directly affect the expression classification process [19] [20].

In this work, facial expression recognition is a combined effort of the feature extraction process and classifier. The HOG [18] are applied on the face images to determine the feature vectors and the classifier SVM is employed for the classification. The seven expressions used in our facial expression recognition system are: angry, sad, surprise, happy, fear, disgust, neutral [19].



## 2.1 Preprocessing

First, the input image is converted to grayscale if it is a color image. Otherwise, this step is ignored. Gray scaling is a method of transforming an RGB image into a grayscale image using the following equation:

$$Gray = \frac{R+G+B}{3} \quad (1)$$

Hence the input images are transformed to gray level images, the facial images are then transformed into a fixed sizes based on resampling method, where the image will be added by new pixels within the resized pixel mathematically and the color and new pixel will be predicted to be added within the pixels colors nearby.

## 2.2 Features Extraction Approach

Feature extraction [21] [22] [23] is a process that identifies important features or attributes of the data. Feature extraction is an important task in facial expression recognition. In our application, the Histogram of Oriented Gradient (HOG) is applied for extracting features of various facial expressions [24] [25].

Basically, HOG is a feature descriptor used for object detection and feature that represents shape change by excluding all other unnecessary information. Prominent areas are extracted from a face image by compute centered horizontal and vertical gradient with no smoothing and compute gradient orientation and magnitude.

In short, the gradient intensities of an image can reveal some useful local information that can lead to recognition of the image and then Show confusion and diagram to HOG.

In HOG (see Figure 1), a feature descriptor tries to capture the important information in an image and keeps all the not so important information behind the scenes. Then we can use the useful information from the feature descriptor for image recognition and object detection.

Therefore, we propose a HOG Feature Descriptor of the general form:

- 
- Computing the edge and Gradients.
  - Spatial / Orientation Binning
  - Block Normalization.
  - Get the HOG Feature Vector.
- 

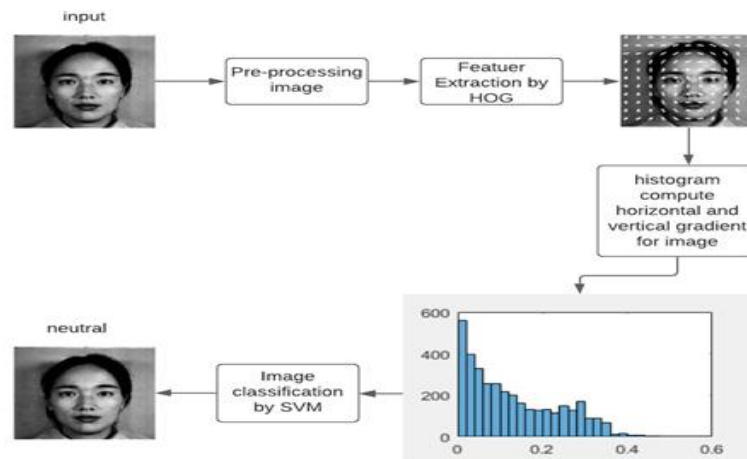


FIGURE 1: Histogram of Oriented Gradient (HOG).

### 2.3 Classification Approach

Support vector machines (SVMs) are a set of supervised learning methods used for classification, regression and outlier's detection. However, it is mostly used in classification problems.

In this paper, a novel learning method, Support Vector Machine (SVM), is applied on the features extracted from the input images, which have seven classes. SVM, a powerful machine method developed from statistical learning and has made significant achievement in some field. Introduced in the early 90's, they led to an explosion of interest in machine learning. In our experiment, HOG is used to obtain the support vectors, which are critical for classification. The proposed method can be described the flowchart given in Fig. 2.

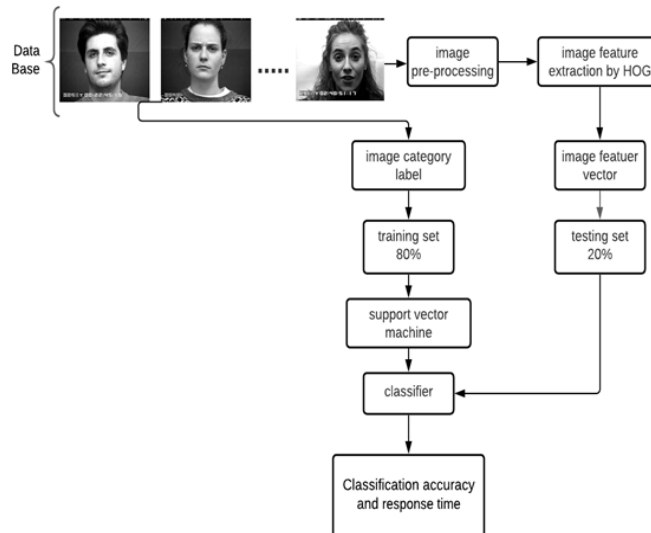


FIGURE 2: Flowchart of the Proposed Method.

### 3. RESULTS AND DISCUSSION

In this section, several simulation results on the facial expression recognition, which illustrate the ideas presented in the previous section, are given. In addition, the performance analysis of the proposed algorithm is discussed. The face databases: JAFFE dataset and an extended Cohn-Kanade (CK+) are considered for performance analysis. The results are compared with the existing techniques.

Traditionally, the most important problem that a researcher faces in an SVM algorithm the potential overlap of multiple classes, so the best solution was to use machine-learning technology to train the classifier on multi classes in the training group.

Recently, simpler and more rapid functions of multi classes SVM have been developed in training set followed by the test group in which classifier predicts the required output (labels).

The most obvious finding to emerge from the analysis is that results were impressive in the classification phase and there are several possible explanations for this finding.

In our application, we can noticed that the more the database was large and the content of the images in it was many, the better the results would be and the accuracy was very high, so the database accuracy rate JAFFE was less than Cohn-Kanade and the reason is due to the number of images in the two databases.

Regarding the accuracy, Tables 1, Table 2 and Table 3 list the accuracy of the different methods for the data set used in the experiment.

The Accuracy is determined as follows:

$$\text{Accuracy} = (\text{NCP} / \text{TNPM}) \times 100 \quad (2)$$

where:

NCP is the number of genuine persons recognized correctly and TNPM is the total number of persons inside the database.

Table 1 and Table 2 illustrate the accuracy and the response Time of the proposed method applied to the JAFFE dataset and an extended Cohn-Kanade (CK+) dataset, respectively.

	<i>JAFFE</i>	<i>CK+</i>
Accuracy	95.23	99.23

**TABLE 1:** Table Accuracy of Data Base.

	<i>JAFFE</i>	<i>CK+</i>
Response Time	0.51094	0.592032

**TABLE 2:** Table Response of Data Base.

Although the proposed method is accurate in terms of predicting the label of a test image, compared to previous studies, the results of our system showed that accuracy is high, and this means that our system supports previous studies by using an SVM and HOG algorithm to recognize facial expressions.

Also, let us compare the performance of our proposed algorithm to those in other published reports that have recently been applied to facial expression recognition. These include Bakchy et al. 2017, Islam et al. 2018, and Mehta et al. 2018. The results are illustrated in Table 3.

Study	Technique	Dataset	Accuracy
Our System 2020	System Based on SVM and HOG	JAFFE	95.23
		CK+	99.23
2017	2D Gabor Filter and MultiSVM	JAFFE	94.89
		CK+	99.57
2018	LBP and HOG	Mediu-S-DB	97.82
2018	Viola Jones, Gabor filter and SVM	JAFFE	94.42
		CK+	99.59
2018	HOG and LBP Features and Multiclass SVM	JAFFE	95.76
		CK+	99.15

**TABLE 3:** The Accuracy of Applied Techniques.

As seen on Table 3, the proposed method HOG with SVM for classification still gets the best performance on the JAFFE dataset and an extended Cohn-Kanade (CK+) dataset.

#### 4. CONCLUSION

In this paper, we have proposed a new method for facial expression recognition based on HOG and SVM techniques. In the first phase, The HOG is applied to the entire database to generate a final set of features. Then, SVM technique is employed for classification task.

The most obvious finding to emerge from this study is that a work HOG and SVM emerge as reliable predictors of facial recognition, where the relevance of SVM algorithm is clearly supported by the current findings for recognition systems as a model high security.

Therefore, the findings of this investigation complement those of earlier studies and supports it. These results provide more support and power for HOG and SVM in facial recognition systems.

Despite these promising results, there is still abundant room for further progress in determining facial recognition.

We obtained highest recognition rate as 99.23% with HOG–SVM method. Considering weighted means of recognition rates, the proposed Facial expression recognition method gave better results than some existing approaches.

The results obtained demonstrated the significant improved performance in Facial expression recognition. The proposed method can be useful for facial expression recognition.

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