Software design for the recognition of emotions through facial features

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ABSTRACT

Every day the demands on security systems are greater due to the constant increase in crime, facial recognition provides an efficient and hygienic solution because there is no contact with any device also with this technology can be made emotion recognition software that helps companies to detect specific feelings in customers or workers either to know their state of satisfaction or security. Emotion recognition of human faces is an interesting topic with a wide range of potential applications for security or learning such as human-computer interaction, automated tutorial systems, image retrieval, intelligent environments among others. To carry out the research, the image processing method and the conversion of color images to grayscale was chosen because it meets all the requirements to complete the project, facilitating the transformation of an image to a 2D matrix for later processing.

Key words: Grayscale; Facial Recognition; Emotion Recognition Software.

1. INTRODUCTION

Due to the constant increase in crime in Peru and in many parts of the world, the demands on security systems are greater [1]. Technologies such as facial recognition help in the prevention and detection of fraud, access control, passwords, and identification of clients in person, among many others [2], this technology provides an efficient and hygienic solution since there is no contact with any device**.**

In the present work, because we use images, we apply the image processing method and the conversion of color images to grayscale to decrease the computational load [3], and it also helps us to take into account the contrast values in the design of an image [4], but there are other methods to work with images such as signal processing which is used when working with real time image processing.

A DB with the images of the selected emotions was used, these images were processed and converted into 2D matrices [5], then organized into folders and further processed with the help of another algorithm that helped to identify the faces expressing these emotions, then the image is processed by the algorithm 10 times to ensure a high degree of prediction and finally showing the results in percentages. The specific objective of this study is to apply and use the methodologies and tools to create a software capable of detecting emotions from different images.

In this paper, in section 2, we provide a description of the image processing and grayscale method. Then, the case study is detailed in section 3, followed by the results and discussion in section 4. Finally, in section 5, the conclusions are presented.

2. METHODOLOGY

2.1 Image processing method

It consists of three basic steps as shown below.

A. Scanning the image
A raw image is acquired and must be processed. It can be expressed in the form of pixels. The aim of this step is to obtain and extract information that is suitable for computing [5].

B. Processing and realization
The extracted image is digitized using a tool that samples and quantifies the input signals. The sampling rate should be high for good resolution and a high level of quantification for human perception of different tones using grayscale [5].

C. Final
In the last step the result obtained describes the image property and the image is classified.

2.2 Color to Grayscale Image Conversion

There are basically two methods of converting a color image into a grayscale image:

A. *Average method*
In this method, the three colors are averaged, the primary colors of which are red, blue and green which are present in a color image. Therefore, we obtain:

Gray scale = (R + G + B) / 3;

But in this part a problem occurs, it happens that sometimes instead of a grayscale image, we get the black image. This happens because in the converted image we extract 33% of red, green and blue. Thus, in order to solve this inconvenience, the second method is used that is called the Weighted Method or the Luminosity Method [6].

B. *Weighted or brightness method*
To solve the problem of the Average Method, the Brightness Method is used. In this method, the presence of red color is decreased, green color is colored and blue color is increased. In equation.

Gray scale = ((0.3 * R) + (0.59 * G) + (0.11 * B))

We use this because of the wavelength patterns of these colors. Red has the longest wavelength, while blue has the shortest wavelength [7].

2.3 Involved in emotion detection

A. *OpenCv*
OpenCV is Open Computer Vision Library. It is a completely free library, OpenCV consists of more than 2500 algorithms specifically designed to carry out projects that are related to machine learning and artificial vision. These algorithms can be used to perform different tasks such as identification object, facial recognition, landscape recognition, camera tracking movement, etc. It has a large community with an estimated 47,000 active contributors to this library. Its use extends to various companies, both public and private [8].

B. *NumPy*
NumPy is a Python library used to evaluate complex techniques. It is used for the implementation of multidimensional arrays that have several mathematical formulas to be processed [5]. The matrix declared in a program has a dimension called axis and in a matrix the number of axes present is known as range.

C. *Glob*
Based on the guidelines specified by Unix Shell, it has functions to search a path for directory or file names that match a given pattern, the Glob module perceives the pattern and, with reference to it, generates a file. It generates the full path name [5].

D. *Scikit-learn*
Scikit-learn has many classification algorithms (classifiers), as well as a vast amount of algorithms for processing data into the vectors expected by classification algorithms. Classifiers include, for example, SVM, K-Neighbours and RF algorithms. These algorithms include things like Principal Component Analysis (PCA) and z-scaling of components (normalizer) [7].

3. CASE STUDY

Steps for the detection of emotions:

3.1 Image processing method
The data(images) must be processed to extract relevant information for the computer science is for it that in this point a method called imread is used, it is used to read images in any format and this way to be transformed later with help of libraries as NumPy that will convert the image to a matrix, this will help to detect facial points of reference in the image, these points are used to locate and to represent such prominent regions in the faces as: eyes, nose, eyebrows, mouth, etc [9], thanks to these facial reference points a series of techniques can be applied that will help identify the emotions in the face of the selected images.

After successfully installing all the necessary software and libraries, we must start by creating a data set, here we can create our own data set by analyzing a series or group of images so that our result is as accurate as possible and there is enough data to extract enough information, you can also use existing data (DB).

Once the image has been processed the data set or series is organized in directories. These directories are the ones that will contain all the images, then in another folder all the information about the different types of emotions will be placed as shown in Figure 1.

Figure 1: Architecture of the Enhanced Fuzzy Resolution Mechanism using ANFIS

Figure 1, we see that the folders are created with the name of the emotion to be detected. If you wanted to add a new emotion you would have to create a new folder with the name of the emotion which would contain images of that emotion. To make the detection of the faces faster and more precise the images should only be of the faces expressing that emotion as shown in Figure 2.

Figure 2: .bd emotions

Figure 2, images of faces expressing emotions, there are trained algorithms that help make the selection of faces. After running all the sample images with the help of Python code, all the output images are saved in another directory, organized in the order of the emotions and their subsequent coding. Several types of classes can be used in OpenCV to be able to recognize and detect emotions [10], but in the present work we will use an algorithm trained with the help of machine learning and facial marks. Face extraction: OpenCV provides sorters to detect as many faces as possible. The data set is divided into two parts, one set for training and the other for classification. The training set is used to teach the type of emotion by extracting the information from various images while the other classification set is used to estimate the performance of the classifier. For best results the preferred images should be the same size. Each image is analyzed, converted to grayscale, cropped, and then saved in a folder [11].

3.2 Conversion of color image to grayscale

For the correct functioning of the face detection algorithms used by the library it is necessary to convert the image to grey scale as shown in Figure 3.
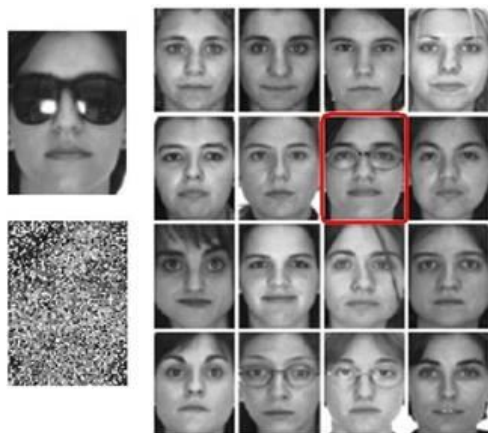

Figure 3: .grayscale

To carry out this conversion of a grayscale image as shown in Fig.3, the cvtColor function is available and used as follows.

CvtColor (image, picture, CV_BGR2GRAY);

Finally, we compiled the training set using 80% of the test data and classified the remaining 20% in the classification set. This process is repeated to improve efficiency and accuracy [7].

If you want to analyze and process a video instead of an image, you would analyze frame by frame the chosen video and perform the same processes and most methods, plus you would preferably have to run it on a high-end machine to get the results as fast as possible.

Any image (of the same size) can be placed and the code will process it and finally show the image with the percentage of each detected emotion. For a better compression, a flow chart representing all the processes that the image goes through before detection is shown in Figure 4.
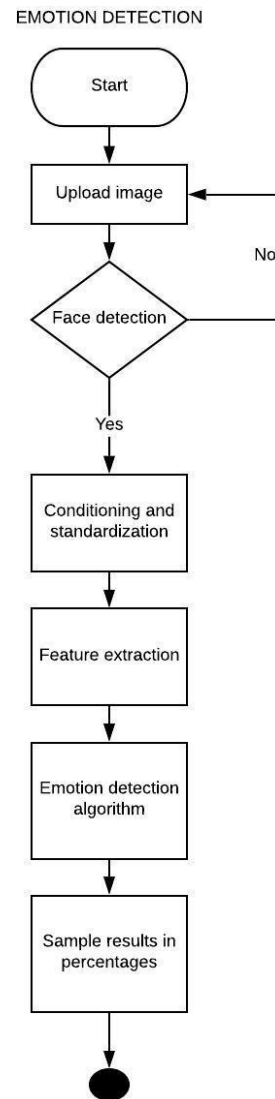

Figure 4: This flow chart shows the processes carried out

When it reaches the emotion detection algorithm the image is processed 10 times for a higher degree of accuracy in emotion detection, removing iterations increases the speed but loses accuracy.

3.3 Emotions that can be detected in an image:

To add a new emotion you must first have the images that express that emotion, then add it to the set of folders and retrain the algorithm with the help of machine learning. The emotions that the algorithm detects for now are

- Fear
- Neutral
- Happiness
- Sadness

Today, in the field of customer service, to cite one example, it is very important to know how comfortable a customer is at the time of being served. This type of information allows you to make decisions that will help build customer loyalty, and this can be done with your own code.

This technology would also bring benefits in airports as it would help detect certain feelings in people such as anguish, fear or for example a person who is nervous or upset.

4. RESULT AND DISCUSSION

4.1 About the Case Study

As a case study, programming in Python language was carried out with the help of the sublime text editor. Python was chosen because it facilitates the creation of understandable codes of fast learning such as those needed in machine learning projects and it has many libraries to develop projects of this style. Lucirdchart was also used to make the flow chart, this tool helped us to visualize graphically the processes involved in the program. Although the results over time are very accurate, the iterations make the process take longer, if you want to do this detection in real time, the ideal would be to use other tools such as those shown in the work "Face detection and recognition method based on skin color and depth information". [12] or we could also implement neural networks as they do in research [13] [14].

In Table 1, it is shown how in each iteration the algorithm adjusts the percentages and is more and more precise until the final result is obtained as shown in the following image.

Table 1: Iteration table

No.	Results of each iteration			
	Fear	Happy	Neutral	Sad
1	0.09	0.60	0.02	0.09
2	0.09	0.63	0.03	0.12
3	0.08	0.63	0.04	0.13
4	0.05	0.65	0.04	0.13
5	0.04	0.67	0.05	0.15
6	0.03	0.67	0.05	0.16
7	0.03	0.69	0.05	0.18
8	0.03	0.69	0.05	0.18
9	0.03	0.73	0.06	0.18
10	0.03	0.73	0.06	0.18

In the following Figure 5, we can see the results obtained in the process carried out of the four selected emotions.
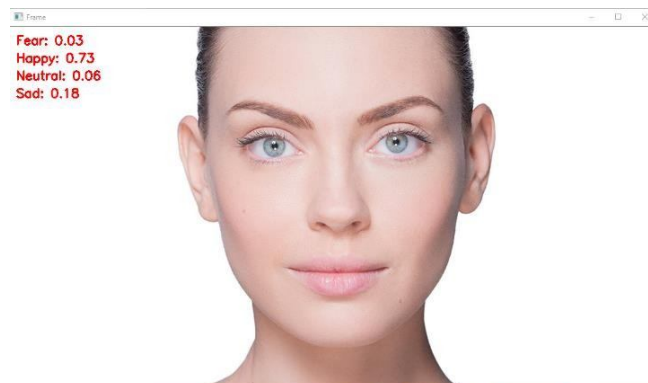

Figure 5: Processed image. The image is processed and the results are displayed in percentages

4.2 About the Case Methodology

The image processing method allowed us to obtain an improved image and extract useful information from it, in addition to classifying and detecting the facial marks of the selected images with high precision, this method is based on research and previous documents [9]. The method has an advantage over methods used in image processing such as signal processing. These methods focus not so much on accuracy as on processing speed.

4. CONCLUSION

In conclusion, we presented a prototype software with which it is possible to detect specific emotions in images with a high degree of accuracy, the accuracy and the amount of emotions increases depending on the BD, the algorithm was effectively applied to classify and predict the selected emotions of people, also was able to detect the facial marks of the selected faces so you can compare and calculate the percentages of each emotion, these types of software help large and small companies are safer due to better monitoring to customers and employees.

The methodology of image processing and conversion of a color image to grayscale was used for the development of this research work because we worked with images transformed

into 2D matrices and also with images converted to grayscale for easier detection of facial marks.

Finally, this technology could be implemented to analyze other types of shapes and objects making it easier to detect dangerous objects in airports, it could also be implemented in hospitals being able to detect diseases or symptoms

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