A FACIAL EXPRESSION MONITORING SYSTEM USING SUPPORT VECTOR MACHINE FOR IMPROVING HEALTHCARE IN SMART CITIES

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ABSTRACT: **Facial expression recognition (FER) plays a major role in pattern recognition and image processing. It is used to detect human emotion based on expression. This system is proposed to improve the service of the healthcare in smart cities. In this novel approach, the three phases are detection of face, feature extraction and Classifier. First, to get the input image and applies a Discrete Cosine Transform (DCT) to a face image to extract sub-bands. Then, a weighted, Bi-orthogonal Wavelet transform is applied to each sub-band block by block. The Wavelet filter histograms of the blocks are concatenated to produce a feature vector of the face image. An optional feature selection technique selects the most dominant features, which are fed into Support Vector Machine classifier.In the classifier, classify whether the expression is happy, sad, anger, anxiety, neutral and disgust.**

I -INTRODUCTION:

Facial expressions are the facial changes indicating a person's internal affective states, intentions or social communications. Based on the shown facial expressions, human face is the predominant mode of expressing and interpreting affective states of human beings. Automatic facial expression recognition impacts important applications in many areas such as natural human computer interactions, image retrieval, talking heads and human emotion analysis. Over the last decade, automatic facial expression recognition has been increasingly attracting attention and has become an important issue in the scientific community, since facial expressions are one of the most powerful, nature and immediate means for human beings to communicate their emotions and intentions.

A basic automatic facial expression recognition system generally consists of three steps: face acquisition, facial feature extraction and representation, and facial expression classification. Face acquisition is a preprocessing stage to detect or locate the face region in input images or sequences. The identification of a person by their facial images can be done in a number of different ways such as by capturing an image of the face in the visible spectrum using an inexpensive camera or by using the infrared patterns of facial heat emission. Several approaches to model facial images in the visible spectrum are Principal Component Analysis (PCA), local feature analysis, Neural Network; multi-resolution analysisetc.The challenges of facial recognition in the visible spectrum include reducing the impact of variable lightning and detecting a mask or photograph.

Some facial recognition systems may require a stationary or posed user in order to capture image through many systems, though many systems use a real time process to detect a person's head and locate the face automatically. Major benefits of facial recognition are that it is non-intrusive, hand free, continuous and accepted by most users. Such features generally include the eyes, nose, and mouth. The detection of faces and their features prior to performing verification or recognition makes these approaches robust to positional variations of the faces in the input image. Holistic or global approaches to face recognition, on the other hand, involve encoding the entire facial image and treating the

resulting facial "code" as a point in a high-dimensional space. Thus, they assume that all faces are constrained to particular positions, orientations, and scales. Even though holistic methods such as neural networks are more complex to implement than their geometric counter parts, their application is much more straight forward, where by an entire image segment can be reduced to a few key values for comparison with other stored key values and no exact measures or knowledge such as eye locations or the presence of moustaches needs to be known.

Facial expression recognition is the most important goal to improve efficiency and citizen's quality of life. The contributions of our present work are as follows: (i) Image acquisition- to get the input image. (ii) Feature extraction stage is one of the most important stages in the recognition system because FER system is to find an efficient facial feature representation from the face. The proposed system applies a discrete cosine transform is used to extract features from facial image and the facial expressions is preserved by using a block by block of each sub-band is based on Bi-orthogonal wavelet filter. (iii)The scores of these classifiers, Support Vector Machine. SVM is a supervised learning method and to determine the algorithm in which a new data point belongs in it.

II- METHODS

OBJECTIVE

` To apply Support Vector Machine learning in the context of emotion classification through facial expression by designing, implementing and evaluating an application to recognize emotions expressed in face images using MATLAB.

SCOPE OF PROJECT

Human beings naturally use facial expression as an important and powerful modality to communicate their emotions and to interact socially. There has been continued research interest in enabling computer systems to recognize expressions.This project presents an application of the machine learning system of support vector machines to the automatic recognition and classification of facial expressions in real time images.

STRUCTURE OF FACIAL EXPRESSION

Face expression recognition system has three phases are used:

Face detection,
Feature extraction,
Classification.

The first task of the face recognition system is capturing image by Charge Coupled Devices (CCD) Camera and this image is given to the further step of face recognition system that is discuss in this section.

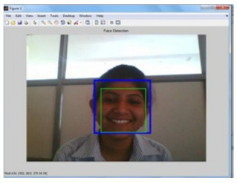
DESCRIPTION

INPUT IMAGE

A digital colour image is a input image that includes colour information for each pixel for visually acceptable results, it is necessary and almost sufficient to provided.

FACE DETECTION

Face detection is a computer technology that determines the locations and sizes of human faces indigital images. It detects face and ignores anything else, such as buildings, trees and bodies. Face detection can be regarded as a more general case of face localization. In face localization, the task isto find the locations and sizes of a known number of faces usually ones face detection, face is processed and matched bitwise with the underlying face image in the database.



FEATURE EXTRACTION

In pattern recognition and in processing, feature extraction is a special form of reduction. When the input data to an algorithm is too large to be processed and it is suspected to be notoriously redundant, then the input data will be transformed into a reduced representation set of features also named features vector.Transforming the input data into the set of feature is called feature extraction.

In this step features of face can be extracted using feature extraction algorithm. Extractions are performed to do information packing, dimension reduction, salience extraction, and noise cleaning. After this step, a face patch is usually transformed into a vector with fixed dimension or a set of fiducial points and their corresponding locations.

TRAINING AND CLASSIFICATION

The vector of displacements of each example expression together with a user-supplied label is used as input to the SVM training stage. The classifier is re-trained each time a new example expression is added. The SVM subsequently assigns unseen expressions the label of the target expression that has the most similar displacement pattern.

SUPPORT VECTOR MACHINES (SVM)

SVM is a learning procedure based on the statistical learning theory and it is one of the best machine learning techniques used in data mining. For solving a two-class classification problem, the main objective of SVM is to find an optimal separating hyper plane that correctly classifies data points as much as possible and separates the points of the two classes as far as possible by minimizing the risk of mis classifying the training samples and unseen test samples.

For binary classification SVM is used. SVM is a machine learning technique which is used as a classification tool. It uses kernel function, which acts upon the input data; final summation with an activation function gives the final classification result. Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification.

The set of input data and the given input predicts which of two classes forms the input, making it a non-probabilistic binary linear classifier. From given set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other. A threshold of 0.5 was used as significance level for a true positive detection during learning and 0.2 for evaluation.

Support Vector Machine (SVM) is a new machine learning method based on statistical learning theory. It overcomes many short comings such as over learning, the local extreme points, and dimensionality disaster that the neural network and traditional classifiers have. SVM has strong generalization ability and has now become a new hotspot in the field of machine learning. However, in a conventional SVM classifier, a highly unbalanced distribution of data usually brings about poor classification accuracy for the minority class, because the classifier may be strongly biased toward the majority class.

SVMs tend to learn how to predict the majority class in particular, although they can get higher predictive accuracies without considering the minority class.

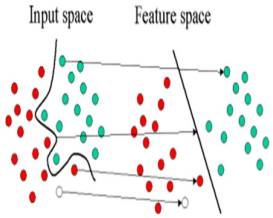


FIG: VISUALIZED SVM

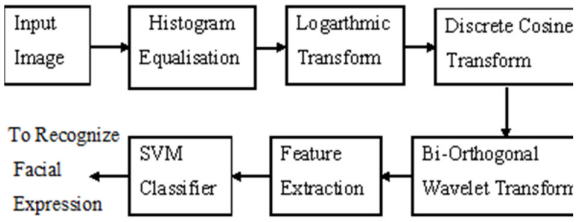
It uses kernel function, which acts upon the input data, final summation with an activation function gives the final classification result. Support vector machines are supervised learning models with associated learning algorithms that analyze data and recognize patterns, used for classification. In order to correctly classify training data and make better decision for unseen data, the objective of SVM is to find the optimal Separating hyperplane. To achieve this goal, a helper called the margin is a useful tool to assist finding Separating hyperplane. Given a particular hyperplane, the distance between the hyperplane and the closest data point can be calculated.

Margin is the double of this value. Basically, margin is the empty space, where there is no data point

inside the margin. The set of input data and the given input predicts which of two classes forms the input, making it a non-probabilistic binary linear classifier. From given set of training examples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other. A threshold of 0.5 was used as significance level for a true positive detection during learning and 0.2 for evaluation.

BLOCK DIAGRAM OF THE FACIAL EXPRESSION RECOGNITION

The block diagrams of facial expression recognition are given below:



INPUT IMAGE

Input image means display image object. Image creates an image graphics object by interpreting each element in a matrix as an index into the figure's color map or directly as RGB values, depending on the data specified. Images used for facial expression recognition are static images or image sequences. The image function has two forms:

1. A high level function that calls newplot to determine where to draw the graphics object and sets the following axes properties.
2. A low level function that adds the image to the current axes without calling newplot. The low level function argument list can contain only property name / property value pairs.

PRE-PROCESSING

Image pre-processing often takes the form of signal conditioning such as noise removal, and normalisation against the variation of pixel position or brightness, together with segmentation, location, or tracking of the face or its parts. Expression representation can be sensitive to translation, scaling, and rotation of the head in an image. To combat the effect of these unwanted transformations, the facial image may be geometrically standardised prior to classification. This normalisation is usually based on references provided by the eyes or nostrils. Segmentation is concerned with the demarcation of image portions conveying relevant facial information.

HISTOGRAM EQUALISATION

Histogram equalization is used to enhance contrast. It is not necessary that contrast will always be increase in this. There may be some cases were histogram equalization can be worse. In that case the contrast is decreased. The histogram in the context of image processing is the operation by which the occurrences of each intensity value in the image. The number of pixels in an image at each different intensity value found in that image. For an 8-bit grayscale image there are 256 different possible intensities, and so the histogram will graphically display 256 numbers showing the distribution of pixels amongst those grayscale values.

LOGARITHMICTRANSFORMATION

Log transformations are one of the elementary image enhancement techniques of the spatial domain that can be effectively used for contrast enhancements of dark images. The log transform is essentially a gray level transform which means that the gray levels of image pixels are altered. This transformation maps a narrow range of low gray level values in the input image to a wider range of output levels. The opposite is true for higher input gray levels. Thus the dark input values are spread out into the higher gray level values which improve the overall contrast and brightness of the image. The general form of the log transformation can be mathematically represented as,

$$s = c \log (1 + r)$$

DISCRETE COSINE TRANSFORM

DCT is a well-known signal analysis tool used in compression due to its compact representation power. It is known that the KLT is the optimal transform in terms of information packing, however, its data dependent nature makes it infeasible to implement in some practical tasks. Moreover, DCT closely approximates the compact representation ability of the KLT, which makes it a very useful tool for signal representation both in terms of information packing and in terms of computational complexity due to its data independent nature. DCT helps separate the image into parts or spectral sub-bands of differing importance with respect to the image's visual quality. DCT is conceptually similar to Discrete Fourier Transform (DFT), in the way that it transforms a signal or an image from the spatial domain to the frequency domain.

BI-ORTHOGONAL WAVELET TRANSFORM

Two shortcomings exist for using DWT to extract features from face expression images. First, the traditional wavelet suffers from complicated calculation.

Two advantages exist for OWT:

(i) Its associated wavelet transform is orthogonal; its inverse wavelet transform is the adjoint of the wavelet transform.

(ii) OWT can be defined merely on the basis of the scaling filter,that is the low pass filter. BWT inherits the first advantage of OWT, but its definition is based on both low-

pass filter and high-pass filter. It has another advantage that it allows more degrees of freedom than OWT.

FEATURE EXTRACTION

Feature extraction stage is one of the most important satges in the recognition system, because facial expression recognition system is to find an efficient facial feature represntation from the face.Then, feature extraction is done for extracting features from face images. In this paper feature extraction is done for extracting features like eyes, eyebrows and lips. Here GLCM algorithm is used to detect features.

GLCM (Gray Level Co-Occurrence Matrix) ALGORITHM

GLCM is defined as the gray level co-occurrence matrix. Here the texture features of images are extracted and stored in a matrix. GLCM is one of the simplest matrix methods to extract the texture features. GLCM features are extracted for all the images in the database and the input image are stored for performing affine moments. The four commonly used properties such as Energy, Entropy, Contrast and Inverse difference moment are used to reduce the computational complexity.

The co-occurrence matrix is a statistical model and is useful in a variety of image analysis applications such as in biomedical, remote sensing, industrial defect detection systems, etc. Gray Level Matrix is used to extract features based on the gray level value of pixels. The features are important for every classification algorithms. Here texture features of images are extracted. The GLCMs features are stored in a matrix, where the number of GLCM is calculated.

MEAN: The average intensity values of the pixels are denoted by this feature in the image.

STANDARD DEVIATION: The variance between the pixels in the input image is represented by this feature.

ENTROPY: The randomness of a gray level distribution is represented by the entropy feature. The entropy is high if the gray levels are distributed randomly throughout the image.

CONTRAST: Measure the local variation in Gray Level Co-occurance Matrix.

CORRELATION: Measure the joint probability occurrence of the specified pixel pairs.

ENERGY: To provide the sum of squared elements in the GLCM.

HOMOGENEITY: Measure the doseness of the distribution elements in GLCM to GLCM diagonal.

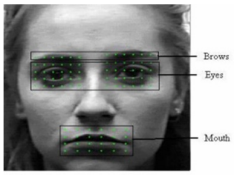
SUPPORT VECTOR MACHINE BASED CLASSIFIERS

Classification of data is important in machine learning where data points are spread in high dimensional space. Each data point belongs to one of the two classes, and the goal is to decide which class a new data point will be in. Gender classification is a binary classification problem, therefore Support vector machine is used for gender classification. SVM are supervised learning systems which can analyze and recognize the data very well. Support vector machine is a computer algorithm that learns by example to assign labels to object. SVM was developed by Vpnik to reduce error on training data set and finds its implementation in the fields of breast cancer diagnosis, Bioinformatics, hand written digit recognition and image based gender classification.

SVM is an algorithm for maximizing a particular mathematical function with respect to a given collection of data. The basic SVM takes a set of input data's and predicts, for each given input, which of two possible classes forms the output, making it a non-probabilistic binary linear classifier. A support vector machine constructs a hyper plane in a high dimensional space, which can be used for classification and regression. A good separation is achieved by the hyper plane that has the largest distance to the nearest training data set.
SVM separates the dataset into training and testing data sets, where each sample in the training set contains one target value and observed features. SVM classifiers generate a decision boundary based on the training data set, which helps in predicting the target value of the testing dataset.

To Recognize Facial Expression

There are two main schemes according to which emotions are classified in expression analysis systems in the literature. The most widely used scheme was originally proposed by Ekman. He positsthat there are six basic emotions, namely anger, disgust, fear, joy, sorrow and surprise, from whichmore complex combinations can be constructed and which are easily identified in facialexpressions.



To identify a face with the help of a Support Vector Machine (SVM) from an image using MATLAB. Face detection is one of the most relevant applications of image processing and biometric systems. Support Vector Machine has been used in the field of image processing and pattern recognition. In the classifier, whether the expression is happy, sad, anger, anxiety, neutral and disgust is identified.

CONCLUSION: Facial expression recognition (FER) is the most natural wayof human emotion expression. In this paper the identification facial expression recognition based on image processing using MATLAB is done successfully with 95% accuracy. The proposed facial-expression recognition system can be used in a smart healthcare framework.With this system, registered doctors and caregivers can constantly monitor patient's feelings remotely and take appropriate actions as required. We can use the experiments on this method for facial expression recognition to provide a real time, fast, spontaneous emotional human computer interaction system.

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