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ANALYSING ID3 (A DECISION TREE BASED) ALGORITHM IN COMPARISON TO OTHER FACIAL EXPRESSION DETECTION METHODS

Dr A KANNAGI[1], Dr A N NANDAKUMAR[2], LINU PAULOSE[3], PREMA MANI [4]
Professor[1,2], Assistant Professor[3,4]
Department of Computer Science and Engineering, Indira Gandhi Institute Of Engineering And Technology, Nellikuzhi P.O ,Kothamangalam, Ernakulam (Dist) Pincode 686691

Abstract

Recognising the emotions of people is also crucial in establishing relationships and fostering emotional communication. Accurate recognition and explanation of facial expressions assist individuals in determining whether to display socially acceptable behaviours and provide guidance in selecting approaches or withdrawal methods in interpersonal interactions. Comprehending emotions throughout early adolescence is positively linked to the development of adaptable social behaviour. This study focuses on the ID3 classification algorithm. Essentially, ID3 algorithm constructs a decision tree from a predetermined collection of examples. The following tree is used to categorise future instances. The case contains a few attributes and belongs to a category (such as yes or no). The leaf nodes of the decision tree include the name of the class, whereas a non-leaf node is a decision node. The choice hub is a property test where each branch represents a possible measurement of the quality. This study presents a comprehensive comparison of all facial expression recognition (FER) approaches using the ID3 algorithm.

Keywords: Facial Expression Recognition, Principle Component Analysis (PCA), Recognition Rate, Singular Value Decomposition (SVD), and other related terms.

Introduction

This document provides a comprehensive explanation of the ID3 classification method. Essentially, ID3 constructs a decision tree using a predetermined collection of samples. The resultant tree is used to categorise next samples. The example has many properties and is classified as either "yes" or "no". The terminal nodes of the decision tree store the class name, whereas a non-terminal node is a decision node. The decision node is a node in a decision tree that represents an attribute test. Each branch of the decision node corresponds to a potential value of the attribute and leads to another decision tree. The ID3 algorithm uses the concept of information gain to choose the most suitable characteristic for a decision node. Learning a decision tree has the benefit of allowing a programme to extract information directly from an expert, rather than relying on a knowledge engineer. Facial expression identification by computers remains a formidable job, despite achieving a high recognition rate. Facial Expression Recognition typically involves three stages: face detection, feature extraction, and expression categorization. This article provides an overview of the current research conducted in the subject of facial expression recognition techniques. It discusses the many approaches used for face detection, feature extraction, and classification, as well as their respective performance.

The main need of a Face Expression Recognition system is Face Detection, which is used to identify and locate the presence of a human face. The subsequent stage is feature extraction, which entails the selection and extraction of important facial features, such as the eyes, eyebrows, nose, and mouth. It is crucial to extract just the elements from a picture that have a significant impact on identifying expressions.

Fig.1 Different facial expression

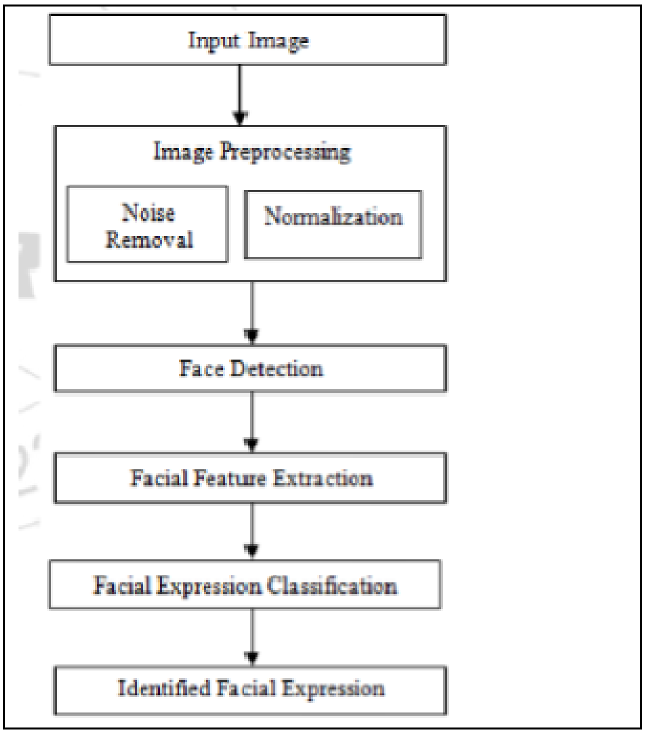

Fig. 2 Steps of facial expression recognition

The last stage is the categorization of facial expressions, which categorises the facial expressions according to the retrieved pertinent characteristics.

Various techniques can be employed for extracting features, including appearance-based methods, geometric-based methods, and methods that extract feature information based on the shape, distance, and position of facial components. Appearance-based methods specifically utilise information about the pixel intensity of the face image. Once the characteristics have been obtained, classification algorithms are used to identify face expressions. Nevertheless, the intricacy of face processing in both real-life situations and controlled laboratory settings extends beyond just observation or tasks involving comparison. The understanding of the mechanisms involved in face recognition is derived from behavioural studies that utilise more intricate testing methods compared to the relatively straightforward visual tasks that have identified activation patterns in the fusiform gyrus. This raises the question of whether the fusiform gyrus should be classified as a distinct area specialised for processing faces. Traditionally, the study of face recognition involves people first learning a group of faces and then identifying them at a later testing session. Moreover, as we have shown, becoming acquainted with faces is a crucial determinant in the process of recognising faces.

Various methods for detecting six facial expressions

Facial expression recognition using Principal Component Analysis (PCA) and Singular Value Decomposition (SVD) is discussed in this study.
Principal Component Analysis (PCA) is a statistical method used to reduce dimensions and identify patterns. It is extensively utilised in extracting and recognising face features. PCA, short for Principal Component Analysis, is a technique that involves projecting data onto a lower-dimensional space known as the Eigen space. This projection is achieved by linear transformations. The process of mapping the image space to a feature space with reduced dimensions is referred to as Eigen space projection. Several face-recognition algorithms based on Principal Component Analysis (PCA) have been developed in the last decade. Nevertheless, current face recognition systems that rely on Principal Component Analysis (PCA) encounter difficulties when it comes to expanding their capabilities due to the high computational expense and memory demands they impose. A two-dimensional face picture may be converted into a one-dimensional vector by concatenating each row or column into a single, elongated vector. Assume that we have M vectors, each of size N, which represents a collection of sampled photos. pj's correspond to the numerical values assigned to each pixel.
The vector xi is defined as [p1,pN]T, where i ranges from 1 to M.
The photos are normalised by removing the average image from each image vector. Let m denote the average image. The equation is written as m = 1/MΣ xi i=1. The variable wi is defined as the mean centred image, where wi = xi – m. Our objective is to identify a collection of ei's that have the greatest potential projection onto each of the wi's.
The algorithm is implemented as follows.
Step 1: The supplied images are subjected to pre-processing.
Step 2: The classifier receives and processes the retrieved features.
Step 3: Next, two photos are compared and the necessary expression is found or recognised.

Benefits: This strategy yields exceptional outcomes. The Singular Value Decomposition (SVD) approach is used for the purposes of image enhancement, localization, and feature extraction. This programme efficiently analyses many emotions. Having a larger dataset accessible and reducing calculation time are both advantageous.

Drawbacks: The primary drawback of this method is its inability to erase things such as spectacles or beards that may be present on the face. Consequently, it has difficulties in accurately detecting the right facial expression.

System for Automated Facial Expression Recognition:
Humans effortlessly see and comprehend faces and facial emotions in a given scenario. However, creating an automated system to do this job is rather challenging. There are many interconnected issues: identification of a specific part of a picture as a face, extraction of the data associated to the facial expression, and categorization of the expression into different emotional categories. An precise and real-time system capable of performing these activities would be a significant advancement towards developing a human-like interface between humans and machines. This article provides an overview of previous research conducted to address these issues. The discussion also includes the capacity of the human visual system in relation to these issues. The purpose of this is to act as a definitive objective and a reference point for deciding suggestions for the advancement of an automated facial expression analyzer.
An algorithm is a step-by-step procedure or set of rules for solving a problem or completing a task.
Step 1: Video Processing
Step 2: Form and Aesthetic Modelling
Step 3: Expression Classification
Step 4: Following the classification of expressions, the algorithm provides operators that provide many real-time outputs such as reports, trend analysis, snapshots, and indicators.

Advantages: This algorithm is designed to use the face Action Coding System, which is very successful in accurately identifying and interpreting different universal face expressions. It may also identify the existence of deceit throughout any interview procedure and assess the cognitive state of an individual.

Drawbacks: It lacks the ability to clearly identify the existence of deceit, which is a crucial aspect for doing future study.

Fuzzy rule-based face expression recognition algorithm:
Step 1: Video Input
Step 2: Frame Extraction
Step 3: Extraction of Feature Points
Step 4: FAP Extraction
Step 5: Fuzzification

Step 6: Facial Expression Recognition

Benefits:
The algorithm's favourable aspect lies in the resilience of the Fuzzy system. This method is very resilient to the many variations that may occur in the outcomes of image processing.

Facial expression recognition with neural network:
The FER approach employs a decision tree with nodes based on feed forward neural networks (NN). The first neural network-based node of the decision tree is assigned the task of distinguishing between a set of facial emotions consisting of "smile" and "surprise" and another group including "anger" and "sadness". This node has the ability to alleviate the ambiguity among the category members of the two groups. Two neural network-based nodes are created for each group to segregate its two members. Consequently, the initial issue of recognition, which included four categories, is now split into three smaller difficulties, each requiring the distinction of just two members.
Procedure:
Step 1: The input picture is acquired using a camera.
Step 2: The face detection procedure is performed using the optical flow approach.
Step 3: Image pre-processing
Step 4: Principal Component Analysis is conducted.
Step 5: involves the processing of categorization using a feed forward artificial neural network.

Advantages: This technique provides a feasible solution in a constrained setting.
Drawbacks: It will not function optimally in an uncontrolled setting.

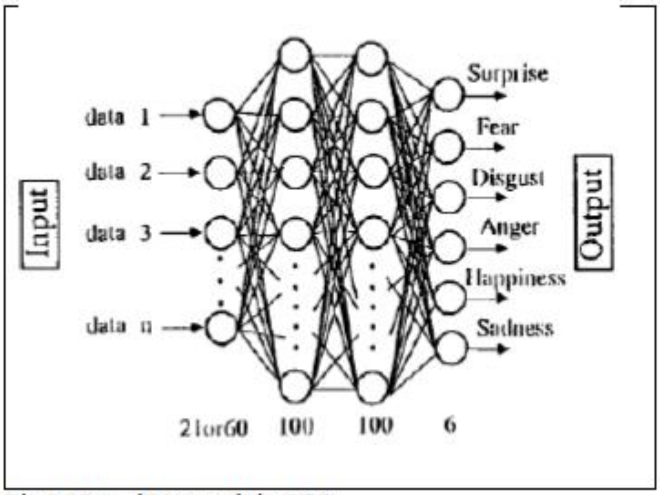

Fig.3 Neural Network in FER

Facial expression recognition is achieved by using the distances between 3-D facial features.

Algorithm
Step 1: Involves extracting the characteristic distance vector from a database that contains six characteristic distances.
Step 2: The distance vector is categorised using a neural network that has been trained using the back propagation approach.
Step 3: The first five distances are normalised using a sixth distance.

Benefits: This method will provide dependable and important data. This method has a superior recognition rate in comparison to 2D. Utilising a Neural Network as a classifier will enhance the performance of this technique.

Drawbacks: This algorithm suffers from misunderstanding between the anger class and neutral class, resulting in a lower recognition rate for the anger class.

Facial Expression Recognition Utilising the ID3 Algorithm
Essentially, ID3 constructs a decision tree using a predetermined collection of samples. The resultant tree is used to categorise subsequent samples. The example has many properties and is classified as either "yes" or "no". The terminal nodes of the decision tree store the class name, whereas a non-terminal node serves as a decision node. The decision node is a node in a decision tree that represents an attribute test. Each branch of the decision node corresponds to a potential value of the attribute and leads to another decision tree. The ID3 algorithm uses the concept of information gain to choose the most suitable characteristic for a decision node. Learning a decision tree offers the benefit of allowing a programme to extract information directly from an expert, without the need for a knowledge engineer. The recognition of human external

appearance, also known as Facial Expression Recognition (FER), has gained significant attention in recent times due to its importance in the development of highly intelligent human-machine interactions. The exterior appearance plays a crucial role in perceiving human emotions, and understanding emotions relies on the recognition of facial expressions.

Several FER approaches have been suggested. Examine the instances and the corresponding citations. The Facial Action Coding System (FACS), developed by Paul Ekman and Wallace V. Friesen, is the most widely used and accepted method for quantifying and describing facial behaviour. Ekman and Friesen identified six fundamental emotions: joy, sorrow, fear, disgust, surprise, and anger. Each of these six fundamental emotions corresponds to a unique facial expression. The researchers developed the Facial Activity Coding Framework (FACS) to facilitate the analysis of facial expressions by using standardised coding to identify changes in facial movement. FACS consists of 46 activity units (AU) that represent fundamental face movements. The portrayal of facial highlights relies on the precise movement of muscles, capturing the detailed effect of each Action Unit (AU).

Furthermore, out of the 46 Action Units (AU) that indicate the basic growth of facial muscles, 5 of them are related to the development of the cheek, jaw, and wrinkles, while the other 41 AUs are especially associated with the growth of the eyes, eyebrows, and mouth [10]. However, not all of the 41 anatomical units (AUs) are necessary for the calculation of facial characteristics points (FCP). Therefore, we have determined that there are 30 FCP's. In order to eliminate these 30 FCP's, we first use a template matching technique to align the positions of the eyes, eyebrows, and lips. At that juncture, we define these 30 Facial Control Points (FCPs) to record the location and condition of the various facial features, such as the eyes, eyebrows, and lips. Using these FCPs, we analyse the specific parameters to be entered into the decision tree algorithm for recognising various facial expressions. The ongoing project under consideration.

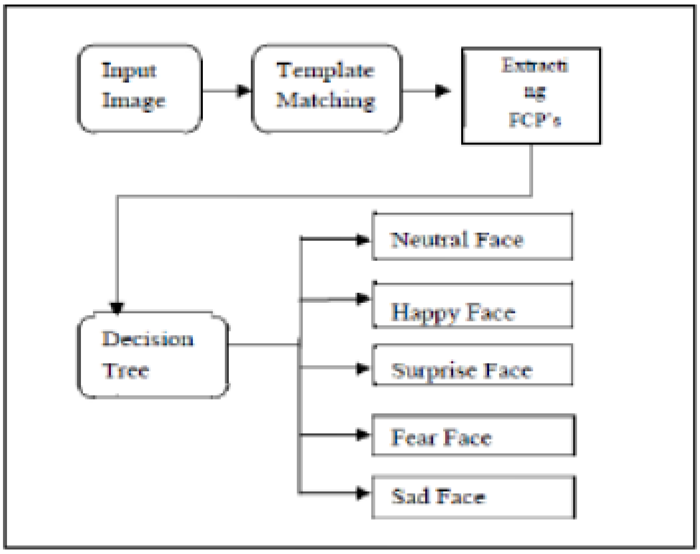

Fig. 4 ID3 Algorithm Processing in FER

Template matching

Template matching is a technique used to compare an image or pattern with a template in order to find similarities or matches. The process of layout coordinating involves using convolution and connection coefficients to get the highest level of accuracy and precision. The desirable features of the eyes, eyebrows, and lips are being extracted from the image.

Procedure:

Step 1: Provide the picture and its corresponding template as input to the template matching method.
Step 2: Transform the picture and template into grayscale by using the rgb2gray() function.
Step 3: Calculate the convolution of the original picture with the average of the template that has to be matched.
Step 4: Next, we calculate the correlation to determine the strongest match between the template and the whole picture.
Step 5: Next, we determine the four values required to draw the bounding rectangles, namely the maximum value among the rows, the maximum value among the columns, the height of the template, and the width of the template. The FCP's are recorded by determining the coordinates of the top left corner of each rectangle that defines their boundaries. In addition, the layout size may be determined by considering its width and height.

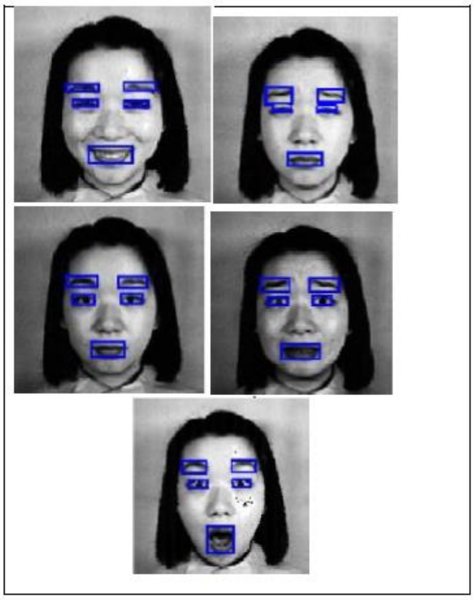

Fig. 5 Template matching of the Different components

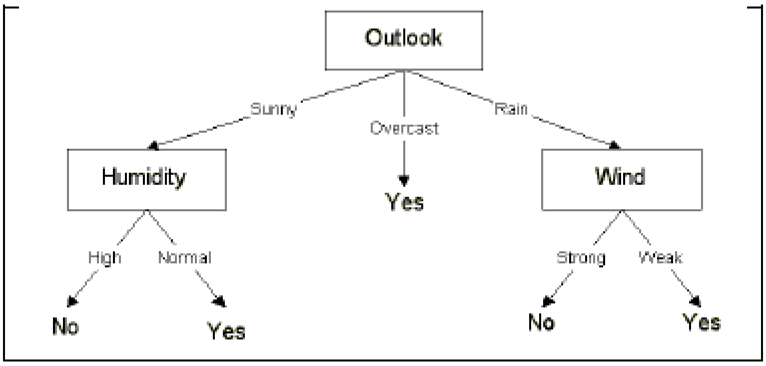

Fig. 6 Example of ID3

Example of the ID3 algorithm.
Let's assume that we need to use the ID3 algorithm to determine if the environment is suitable for playing baseball. Over a period of two weeks, data is collected in order to assist ID3 in constructing a decision tree.The first inquiry is whether or not we should engage in the activity of baseball.
The climatic features include the perspective, temperature, humidity, and wind speed. They may possess the following attributes:
The prognosis consists of three possible weather conditions: bright, cloudy, and rain.
The temperature may be classified into three categories: hot, moderate, and cold.
The humidity may be classified as either excessive or normal.
wind = {feeble, powerful}
Set S may be shown by referring to figure 6.

Benefits of the ID3 algorithm

This algorithm is resistant to noise. The system is capable of processing disjunctive expressions, sometimes known as OR's. The hypothesis space of ID3 is fully expressive. The information may be easily understood by a tree structure or a set of if-then rules. This technique has the capability to be expanded to include qualities that have actual numerical values. The target function in question has discrete output values. The algorithm described in the book presupposes the use of Boolean functions. ID3 This may be expanded to accommodate various output values.

Conclusion
The field of Facial Expression Detection has become more intriguing and valuable for ongoing research endeavours. The significance of this domain of computer vision will continue to grow on a daily basis. The aim of this research is to compare several approaches for detecting human expression, including their algorithms as well as their strengths and weaknesses. The explanations and examples provided demonstrate that ID3 is user-friendly. The main purpose of this tool

is to automate the process of creating a classification tree, eliminating the need for a human expert to do so manually. As shown by the industry, ID3 has proven to be beneficial.

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