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Design of Intelligent Tool for Learner Emotion Recognition in e-learning context

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Abstract: ***In E-learning context, the emotional state of the learner allows the tutor to undertake the appropriate pedagogical actions that can improve the teaching-learning interaction. In this paper we present the architecture of a Learner Emotion Recognition Tool in an e-learning context as contribution in the objective of having an automatic and intelligent tutor. This tool uses some facial and emotion recognition algorithms. the first step in face recognition system is face detection for this we are using the viola jones object detect algorithm that can provide the detection in real time. Features extraction and tracking is the base of emotion detection for that the KLT algorithm will be applied. The last step in our proposed method is the emotion recognition. In this step we have designed a three-layer connectionist model. The input layer which represents the reduced vector of the detected face image. The deep layer represents a set of adequate nodes whose role is the interpretation of emotion. The multi-node output layer one for each recognized emotion, whose role is the classification of emotions. To achieve the hidden layer of the designed neural network, we chose eigenfaces algorithm. In our system, algorithms will be performed in MATLAB as programming language focused in image processing and facial recognition. our system invaded by a data flow that progresses over time. Automatic tutor is pervasive system and must be able to process input data before a new generation cycle has begun, with the risk of losing much of the control of the process if it does not complete the processing of all the data entrance.***

Automatic Tutor using this methodology will be integrated on the e-learning environment which is MOODLE platform used by technical university of Sofia in Bulgaria.

Keywords: Face recognition, Emotional recognition, Connectionist approach, E-learning, Automatic tutor, Algorithm.

I. INTRODUCTION

E-learning is an environment achieving connection between two spaces (learner and tutor). Meanwhile, to determine the application is not sufficient, it is necessary to specify the best model of the susceptible network to solve the problem and its numerous parameters. As part of our current work, we focus on modelling an environment of distant educational follow-up of learner. Our main goal is to use facial recognition in the e-learning domain by creating an automatic tutor that can help and assist the Learner in learning process by guiding him depending of his emotion during the course. For that we are studying the facial features extracted and comparing it to the emotion database. Ekman and Friesen defined in [1], six basic emotions: happiness, sadness, fear, disgust, surprise, and anger. Each of these six basic emotions corresponds to a unique facial expression.

With the aim of making the tutor intelligent and automatic; our contribution is to create a tool that manages and gives meaning to the emotions expressed by the learner. With this educational tool we want to offer a more dynamic communication between the learner and the system. To achieve this goal we have opted for a layered architecture whose input is the video of the learner's face during his learning session and the exit is the emotion expressed by the learner's face. This emotion is the result of the analysis and recognition performed by the hidden layer of the neural network. Recognized emotion is classified in one of the predefined categories. The network output layer passes the call parameter to the 'decision-making' function activated by the automatic tutor to guide the learner to a specific point in the learning scenario.

II. Architecture of the Emotional Recognition Tool

The Emotional Recognition Tool, ORE, which we have designed combines two layers with an algorithmic approach of loop performing the functions of capture, extraction, facial and emotional analysis, recognition of emotions and interpretation of emotions recognized. Finally classification of emotion in appropriate category. Figure 1 shows the architecture of the ORE in an e-learning context.

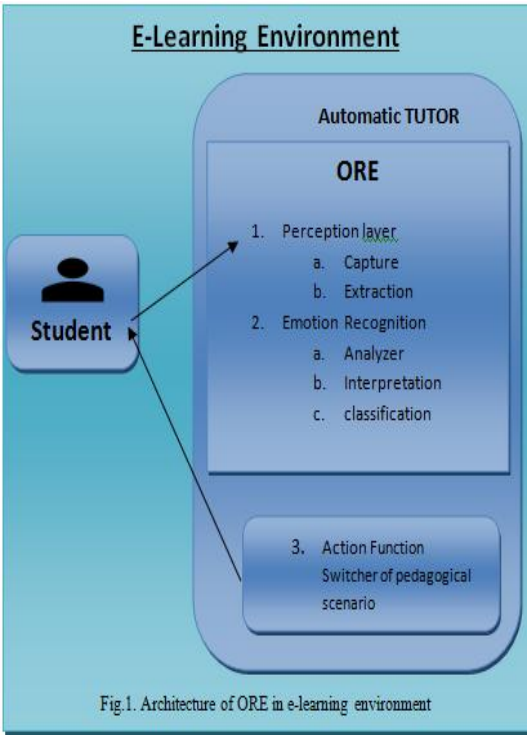

Figure 1. Architecture of the ORE in an e-learning context

A. Proposed approach to design emotion recognition tool

In this part of our research we are interested on algorithms of treatment and analysis of the facial expression in an e-learning context of which we quote some algorithms that we applied in our approach.

Our formal model is composed of two layers the first for the perception of the facial image of the learner. The objective of this layer is capture, extraction and facial analysis by applying algorithms like 'viola jones' and 'KLT'. The second layer of emotional recognition consists in analyzing the facial expression of the learner to recognize his / her emotional state then to interpret it and finally to classify it in one of the four categories already defined. To achieve the objectives of this second stage algorithms like PCA for Tracking and Eigenface for recognition are used. The output of the ORE will be a call parameter of the ACTION function which is a separate component of the Automatic Tutor whose purpose is to guide the learner to a specific point in the learning scenario.

1) Perception layer

- FACE PERCEPTION layer: the role of algorithms in this layer is locate the face from a still image from a recorded or live video of a learner in front of his camera. This technique is using the cascade Object detector that uses the viola jones algorithm to detect human face, eyes, nose…. In our system, this algorithm help separates the student face from any background noise [2].

Figure 2. Face detect result

- Crop face algorithm: which works only on the face detects by the first algorithm and whose main role is to crop and adjust the image quality of the face. In fact, knowing where the faces are in an image makes it possible to perform other operations, such as cropping or adjusting the quality of the facial image (rotation, red-eye correction, color correction of the face). skin, etc.). It is interesting at this stage to perform other interesting operations on the face.

Figure 3. Cropped image

2) Recognition layer

Once facial features are identified, and facial expression characteristics are determined, emotional recognition is achieved by the RECOGNATION layer algorithms.

- Emotion detect: this main algorithm groups several functions such as Eigenface and algorithms such as PCA witch uses a small set of image features to describe the variations between the face images. Several algorithms are used for the recognition of the emotions, we chose to use the decomposition by "Eigenfaces" [7,8, 9], simple to implement and with a rate of recognitions acceptable according to Donato [6] (79.3%). This method assumes that there is a correlation between the different pixels of an image, which makes it possible to define reduced information characterizing the entirety of this image.

- The interpretation phase consists first in giving meaning to the emotion recognized. The meaning given to this emotion also depends on the profile of the learner as well as his / her history drawn by GISMO during the learning session [13,14]. The given meaning defines the emotional state of the learner. Second, to classify emotions according to four of the six categories defined by Nkambou and Heritier [5], which are satisfaction, confidence, surprise, anguish, fear, sadness, anger and disgust. We grouped satisfaction and trust into the 'satisfied' category; fear, anguish and sadness in the 'anguished' category; anger and disgust in the 'surprised' category in addition to the 'happy' category. We found that these four categories summarize all emotional states that require intervention by the tutor to automatically guide the learner during their learning session. The result of this layer will allow the system to make a decision concerning the continuation of the pedagogical scenario to which the learner will be guided.

III. Connectionist Approach to Design the Recognition of Emotion Tool

According to Y. Lahmar& D. Souilem [11], the role of a connectionist approach is essentially in the design of a model for analyzing a large data flow and for predicting unknown behaviors expressed by the user of the system. In our case we have found that this approach best meets our needs to model an intelligent system that processes a large input data stream and

performs several levels of analysis and interpretation of this data. This approach applies the cognitive learning principle between these phases and finally presents a layer of nodes at the output, with relevant results, for decision-making by the tutor.

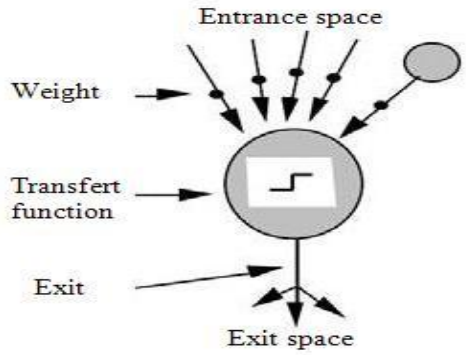

Figure 4. Structure of artificial neuron

We opted for a locally connected network structure. This structure is multi-layered where each node establishes relationships with a limited number of nodes in the next layer of the structure as shown in the following figure [12].

To develop the recognition layer in the ORE tool we chose to apply a connectionist approach based on the principle of learning the reactions previously recognized by the learner's monitoring process during the course session.

This tool is formally described by a neural network of three layers.

- The input layer of the designed neural network has essential information nodes on the learner such as the data collected by the GISMO system, which summarizes the traceability of the learner during the previous learning session. Also, we find in this layer the video of the face of the learner on which will apply the tracking algorithm.
- The hidden layer of the network groups together a set of appropriate neurons whose number is many inputs to the tracking function which gives a set of vector matrices which form the neurons of the hidden layer of the network. The connections between the neurons are the interpretation functions to be performed to give meaning to each emotion expressed by the learner. This function calculates the convergence between the vector matrices of the neighboring images of the tracking of the learner's face.
- The output layer of the network. Once the emotion is recognized, the information is passed to the classification layer to classify it in one of the four categories defined above. The output layer of the neural network is multi nodes one per category of emotions.

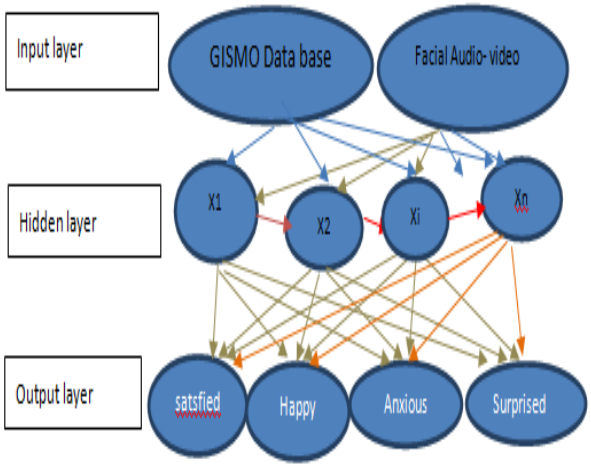

Figure 5. Structure of the local multilayer neural network

The hidden layer represents the black box of our neuron network. We want to show the contribution of the eigenface algorithm in the hidden layer of this network. Eigenface is used in the calculation of the difference between the vector matrices of facial images and consequently in the recognition of the emotion expressed by the face of the learner.

IV. EIGENFACE ALGORITHM IN NEURAL NETWORK PROPOSED

The eigenface algorithm is a Principal Component Analysis (PCA) approach, which uses a small set of image characteristics to describe variations between face images

In our case, this algorithm was applied to a set of images of the learner's face to extract a set of emotions at the exit. The previous analysis phases of the ORE tool represent a pre-treatment phase for the recognition of emotions. All images are represented as a vector matrix. For maximum efficiency in matrix operations, Thuseethan & Kuhanesan in [15], have shown that it is essential to work on a small square matrix. The system resizes all images at 260 * 260 pixel scales for all analysis and recognition processes.

At this stage of our research, the classifications are carried out on the following categories of emotions: satisfied, happy, anxious and surprised. The connections between the nodes are represented by arrows whose direction defines the dependence between the neurons of the network as well as the flow of information in the learning process.

A connection is information that has a weight (numerical value wj) associated with the sending node. The weight of the information passing through the connection will be used by the algorithm to calculate the state of the receiving node in the network. Here, weights are used for the recognition of emotions. One of the measurement metrics used in this approach is the Euclidean distance used to calculate the distance between the matrix vectors of the input face images.

The eigenface steps in the network are as follows:

- S is a vector that represents all of the final emotions, knowing that we chose to work on four emotions that we presented earlier:
- S= {S1, S2, S3, S4}.
- X is a vector that represents the set of emotional states of facial images. Each state of the face is represented by a vector matrix of data.
- X = {X1, X2, X3, …, Xn} where n is the number of images of the analyzed face.
- Associate a weight at each connection that represents the transition between the neurons of the treated image Xi with each neighborhood neuron of order j that we note Wj.
- Give a quantity of information to the state of the image Xi that we write Ai calculated according to the states of the neighboring neurons (X1, X2, ..., Xj, ..., Xn) and the weights of their connections (W1, W2, ..., Wj, ..., Wn)
- $Ai = \sum_{j=1}^{n} Wj\ Xj$.
- Define a transition function F that calculates a sense score of the emotion of the image Xi.
- $S(Xi) = F(Ai)$ avec $F= (1/n) \sum_{j=1}^{n} Wj\ Xj$.
- Update the set X of vector matrices by reducing Xi of the set X
    - X '= X – Xi, X = X '
- Repeat steps 5 and 6 until you recognize the emotion expressed by the face of the learner or finish all the pictures in X
- Classify the emotion recognized in S

The prototype of our system is tested with a database of facial images. The images used are 256 × 256 pixels in size for frontal views of the learner's face. These images are recorded in the database with the four basic emotional states that are satisfied, happy, anxious and surprised.

V. CONCLUSION

During a learning session, the life cycle of the system can generate a flow of data from several emotional states expressed by the learner's face. Thus, the system is invaded by a large amount of data. These data must be processed quickly as they arrive on the network. this real time will allow the system to make the pedagogical decision corresponding to the learner's emotional situation. In this research paper we have explained the contribution of the connectionist approach in the design of a facial recognition tool in an action system which is automatic tutor in e-learning context. This Tool Helpe to have an intelligent and automatic tutor. The system is based on a neural network whose output layer provides classification parameters of the emotion in the categories (satisfied, happy, anguished or surprised). These parameters are used by the tutor action layer to make the decision about the learner's orientation to a specific point in the course process.

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