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Emotion detection based on user interaction with touch screen in E-Learning

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ABSTRACT

In recent years, there has been a growth in the use of touch input devices. So emotion detection of interactive system users without any extra hardware are a very attractive field. On the other hand, E-learning has become a popular paradigm. One of the most important situations in E-Learning is multiple-choice test. The level and quality of the user's tactile behavior in this situation is very different from others such as online games and we can't use the research results in this situation, so a special research is needed for this situation. A good system may not only recognize users' emotions, but also react accordingly to the detected emotions. In this research, we first propose an approach to detect three common emotions in learning process, we focuses on negative emotions: stress, frustration and boredom. we defines a features set and then NaiveBayes algorithm is used for classification. After that we use the detected emotions and personality type to react to the user. In this paper the Enneagram methodology, with the RHETI test is used to determine the user personality type. The results show that the combination of user emotion and personality type is very effective in improving user performance.

Keywords: emotion detection, E-Learning, touch screen, personality type, Enneagram

1. INTRODUCTION

One of the most important differences between humans and animals is learning. Technology and computer effect on many aspects of our life and it is generally acceptable that the use of computers and technology can improve the learning process [1]. E-learning provides an unprecedented flexibility and convenience for e-learners by breaking the limitations of space and time [2], so it has become a popular concept and its popularity will increase day by day. Except for its high flexibility, it has many other advantages. One of these advantages of e-learning is that we can get user behavior patterns in this environment [3]. Such data contains valuable information that can be used to analyze and improve the learning process. The purpose of such analyzes is adapting the learning process with the user's needs. However, they have some disadvantages as well. For example, during traditional communication, more than 65% of the information exchange happens through nonverbal communication. These include facial expressions, body posture, tone of voice etc. So the learner gets less information through e-learning system than through traditional interaction [4]. And one more thing is that the users of such learning come from varied socio-economic and cultural backgrounds [5] and if we don't care these individual differences (such as many current e-learning environments) we can't have efficient learning process.

Emotion plays a significant role in the cognitive process of humankind and they are an important factor in decision making, intelligence and even memory. They also promote creativity and flexibility in problem solving. The role of emotion is neglected in current e-learning systems [2].

There are many approaches in the field of emotion recognition. These mostly involve computer vision and image processing techniques, which are computationally very expensive methods. In addition, such methods also require

additional setups (hardware/software). In recent years, there has been a significant growth in the use of touch input devices, due to the availability of "smart phones" and "tabs" at affordable price. Detection of emotion of interactive system users is therefore important, as it can help design for improved user experience. [5]

In this research, we first propose an approach to detect three common emotions in learning process, we focuses on negative emotions: stress, frustration and boredom. We use users' touch behavior and does not require any extra hardware, hence, the proposed approach is more suitable for mobile touch input devices which has limited computational resources. We defines a features set and then NaiveBayes algorithm is used for classification. After that we use the detected emotion and personality type to react to the user. In this paper the Enneagram methodology, with the RHETI test is used to determine the user personality type. The results show that the combination of user emotion and personality type is very effective in improving user performance.

The rest of article is organized as follows. In section Π, we presents the related work, in section Ш the proposed method is explained, including the feature set, in section IV the results of evaluations are expressed, and the last section is a conclusion.

2. RELATED WORK

Authors in [1] claims that the motions of the user's hand and by extension the movements of the computer mouse have a direct relation with the psychological – sentimental condition of the user so they are proposed a new method of detection of the emotional state of a student who attends a lesson online. The detection method is based on information obtained from the movements of the user's computer mouse. Their method is occupied with the detection of boredom which can be caused by the presentation of a course through a distance learning environment. They suggested some metrics which are derived from this information and may be related to the emotional state of the user. They used the way by which the mouse is moved (orbit, speed, intervals of immobility, direction). The collected data after being processed were applied to the known classification algorithm C4.5 which classifies the values of the metrics according to the user's emotional state. the classifier managed to classify correctly more than 90% of the data

[6]has described a new approach to emotion recognition based on pressure sensor keyboards. Three methods (global features of pressure sequences, dynamic time warping and traditional keystroke dynamics) were proposed for the emotion recognition task; then they have combined the three methods together using a classifier fusion technique. They focused on six emotions: neutral, anger, fear, happiness, sadness and surprise and the best result were achieved utilizing all the method, obtaining an overall accuracy of 93.4%. Their technique of emotion recognition has been used for intelligent game controlling and several other applications.

[7]has described a method for user confusion detection by using mouse movements. A special computer game was designed to collect mouse logs. Users' self-reports and statistical measures were used in order to identify the states of confusion.to do this they have used Mouse movement's rate, full path length to shortest path length ratio, changes in directions and speed. Support Vector Machines, Logistic Regression, C4.5 and Random Forest were used to build classification models. Models generated by Support Vector Machine yield to best classification results with f_score 0.946.

Authors in [8] have used eight pressure sensors on a computer mouse and collect mouse pressure signals from subjects who fill out web forms containing usability bugs and then have trained a Bayes Point Machine in an attempt to classify two regions of each user's behavior: mouse pressure where the form-filling process is proceeding smoothly, and mouse pressure following a usability bug. The Bayes Point Machine has achieved a person-dependent classification accuracy rate of 88%.

[9] first has explained how emotion evolves during learning process and then how emotion feedback could be used to improve learning experiences. The results about emotion recognition from physiological signals have achieved a best-case accuracy (86.3%). And results have showed that engagement and confusion were the most important and frequently occurred emotions in learning. Experiments indicated the superiority of emotion aware over non-emotion-aware with a performance increase of 91%.

But all of these researches use extra hardware that has two disadvantage: 1) they are not always available and 2) they may be expensive. So it is better that we detect user emotion without any extra hardware, because it is more convenient and suitable. Now we describe such researches here.

In [5] has been proposed a model to detect the emotional state of the users of touch screen devices. They have assumed three emotional states of a user: positive, negative and neutral. The touch interaction is characterized by a set of seven

features, derived from the finger strokes and taps including average stroke length, average stroke speed, and deviation in number of strokes, deviation in number of taps, total delay, average delay, turnaround time. Their proposed model is a linear combination of these features. The validation study demonstrates a high prediction accuracy of 90.47%.

Authors in [10] have built a system to recognize four emotional states (Excited, Relaxed, Frustrated and Bored) and 2 levels of arousal and two of valence from finger stroke features during gameplay. Discriminant Analysis of the collected data shows that pressure features discriminate frustration states from the other three states. Stroke speed and directness features discriminate between different levels of arousal whilst stroke length features discriminate mainly boredom from a relaxed state. Three machine learning algorithms were used to build a person-independent automatic emotion recognition system based on touch behavior. All three algorithms have produced very interesting results in discriminating between 4 emotional states reaching between 69% and 77% of correct recognition. Higher results (~89%) were obtained for discriminating between two levels of arousal and between two levels of valence.

As already mentioned, personality type is very effective in learning strategy; there are many researches that imply this fact. Now we try to review some of these researches.

[11] has investigated the personality types as measured by the Myers-Briggs Type Indicator [MBTI] and the thinking skills of the students. This study seeks to ascertain if there is any significant difference in the domination of different critical and creative thinking skills among ES [Extravert-Sensing], EN [Extravert-Intuitive], IS [Introvert-Sensing] and IN [Introvert-Intuitive] students. The findings showed that there was significant difference among ES, EN, IS and IN students on the domination of certain critical and creative thinking skills.

[12] has introduced a computer-based grouping method that takes into account the student typologies and the neuro-linguistic programming(NLP) profile. Typologies are determined, according to the Enneagram methodology, with the RHETI test. Case studies show that groups created using this method show an increased communication among the members and better practical results. This is due to the members' compatibility.

3. THE PROPOSED METHOD

We assume three emotions, namely stress, frustration and boredom. First of all we need to define a features set, there are many features which can be extracted from touch behavior but we try to find the best set of them. Our proposed features set finally contains 21 features, they are listed below:

number of multiple touch, number of single touch, number of tap, sum of time of multiple touch, tap time, total time, sum of touch length, minimum touch length, maximum touch length, mean touch length, mid touch length, sum of speed, minimum speed, maximum speed, mean speed, mid speed, sum of time, minimum time, maximum time, mean time, mid time.

After defining the features set we apply the known classification algorithms NaiveBayes and c4.5 which classify the values of the metrics according to the user's emotional state. Finally, NaiveBayes had the best result with our feature set. The results will be explained in the next section.

A good system may not only recognize users' emotions, but also react accordingly to the detected emotions for improving the user performance; in order to do that we use the detected emotions and personality type. Each personality type has its own characteristics, so if we want to improve the user performance it is necessary to know the personality type. Imagine the benefits of understanding how our personality affects the way we teach. Conversely, imagine the benefits of knowing how the personality biases of our students affect how each learns and interacts with authority [13], but it is neglected in current e-learning system and it affects the performance of the systems and people. A number of personality type indicators have been used in the past. In this paper we use the Enneagram methodology, with the RHETI test as a tool to determine the user personality type. This kind of personality type indicator previously used in learning environment and it has had good results.

The Enneagram is one of the newest personality systems in use emphasizing psychological motivations; the word Enneagram stems from the Greek (ennea) meaning "nine" and (grammos) meaning "points" [13]. The Enneagram of personality is an application of the Enneagram figure in connection with personality features, including nine types (Fig 1).

1. Perfectionist, Reformer
2. Helper, Giver
3. Performer, Producer, Achiever
4. Tragic Romantic, Individualist, Connoisseur
5. Observer, Investigator, Sage
6. Devil's Advocate , Loyalist, Troubleshooter, Guardian
7. Epicure, Enthusiast, Visionary, Dreamer, Generalist
8. Boss, Top Dog, Challenger, Confronter
9. Mediator, Peacemaker, Preservationist

Fig 1: The Enneagram

The points on the Enneagram figure indicate a number of ways in which nine principle ego-archetypal forms or types of human personality, called Enneatypes, are psychologically connected. Enneatypes are referred to by different names or more general by numbers. Each Enneatypes corresponds to a distinctive and habitual pattern of thinking and emotions[12].

Our aim is to combine user emotion and personality type to improve user performance. For this purpose, stress, in particular is considered and then using psychological methods several tips are provided according to the personality type. Our goal is both to adjust user's negative emotion and also improve user efficiency. The results will be expressed in the next section.

4. EXPERIMENTAL RESULTS

In the empirical study, we collected touch usage data from 22 participants. Each of them participates in four exams. The data were collected with a Sony smart phone running the Android. We had developed an Android app for data collection. The app was developed using the Android Studio and includes four multiple-choice tests. They are listed below.

1: This part has very limited time with negative marking, the timer is displayed on the screen and the timer color changes with time, in order to give the user a sense of stress

3: This part is designed like the previous part in order to give the user a sense of stress.

4: This part is designed in such a way to mislead the user and these successive wrong answers make the user frustrated.

5: A long exam has been put in the end, in order to give the user a sense of boredom.

In order to identify users emotion, users' self-reports is used in the middle of each part. Simultaneously user touch behaviors are recorded through the AutoTouch application. AutoTouch can record and play back human touches in mobile devices. It is a macro making and playing app for Android and IOS. It can simulate human touches and run Lua scripts. In the beginning of the exam we run Auto Touch; at the end of the exam there will be a file with .Lua extension. These Lua file contains many information about user touch behavior and we must extract our features set among them, to do this we use a MATLAB code and extract our features set.

In the following, to find the relation between user emotions and his touch behavior, we apply the known classification algorithms NaiveBayes and c4.5 which classify the values of the metrics according to the user's emotional state. For this, we have used Weka software.60% of data was training data and 40% of data was testing data. Finally, NaiveBayes had the best result with our features set. The results are according to Table 1.

Now we want to adjust user's negative emotion. Between the first and second part, some tips are displayed to them. These tips are based on the user personality type and the level of user stress and it is different for each person. We divided the users into two groups, users in the first group in the beginning of the second exam, take these tips. And then two groups are compared based on stress level.

As already mentioned in order to identify users emotion, users' self-reports is used in the middle of each part. We asked the user to choose one of the numbers 1 to 5 for his stress level and then compared two groups. The result is shown in Table 2.

As you can see, the stress levels have increased in people in the second group while the level of stress in the first group has decreased after taking tips according to the personality type. This finding implies the importance of the personality types in learning environment

Table 1: The results of emotion detection

	Correctly Classified Instances	Precision	F-Measure
stress	75%	0.750	0.744
distraction	66.6%	0.667	0.658
frustration	75%	0.833	0.800

Table 2: The level of stress

	The average stress level for each person in the second exam	The average stress level for each person in the third exam
The first group(with tips)	4	2.4
The second group	2.6	3.6

5. CONCLUSION

Technology effects on many aspects of our life. On the other hand researches have shown that emotion has important role in our life so emotion detection is a need. One of the most important aspects of human life is learning process. Nowadays E-Learning has become a popular environment and it is expected to increase its popularity day by day. In this research, we first proposed an approach to detect three common emotions in exam, we focused on negative emotion: stress, frustration and boredom. To do this we defined a features set and then NaiveBayes algorithm is used for classification. After that we useed the detected emotions and personality type to react to the user. In this paper the Enneagram methodology, with the RHETI test as a tool to determine the user personality type is used. The results showed that the combination of user emotion and personality type is very effective in improving user performance.

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