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Determining Emotions via Biometric Software

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Abstract **- Determining human emotion using computers is a constantly growing topic in the field of biometric and radio frequency. The focus of this study is to assess the validity of a device that synchronously uses the principles of iMotions - a biometric system which recognizes the physical interaction and behavior traits and EQ radio, a wireless remote system that measures heart rate and breathing. The main purpose of this research would be to combine radio frequency and biometric readings for improved accuracy. By using such a dual mechanism system will provide a better remote interface for detecting emotions. It can be used in medical facilities, police interrogation, geriatric care, and many others. In case of medical treatment, it will help to understand the mental state of severe brain damage or non-verbal patients and to provide appropriate therapy and management.**

Index Terms: Biometrics, EQ radio, Emotions, Facial Expressions, iMotions.

I. INTRODUCTION

From a psychological point of view, an emotion is a complex psychological state that involves three distinct components: a subjective experience, a physiological response, and a behavioral or expressive response. Emotion is divided into two parts. The early part of the emotion process is the interval between the perception of the stimulus and the triggering of the bodily response. The later part of the emotion process is a bodily response, for example, changes in heart rate, skin conductance, and facial expression [6]. Researchers have used basically two models of emotions - discreet and dimensional. The discreet model includes six emotions - happiness, sadness, fear, surprise, disgust and anger. These emotions are universally accepted emotions. Dimensional model basically talks about a graph plotting emotions against - valance and arousal. Valance denotes polarity of emotions, positive and negative. Arousal denotes the intensity of emotions [4]. The face serves as an important identifiable trait for these emotions. These emotional characteristics are considered to be specific to each individual, allowing them to be used as an identification method. Facial recognition is a technology that analyzes various features or characteristics of a face. This technology uses cameras, digital image processing, and algorithms to determine a myriad of emotions based on facial expressions.

Apart from the facial expressions, physiological measures like ECG, have been used to evaluate the state of emotions of a person. When a body undergoes any stress or for that matter feeling of joy, the brain triggers the flow of chemicals and hormones. This cascade of hormones accelerates the heart rate and breathing. These changes enable the body to respond to stress or happiness. The heart gives out the electric signals termed as electrical activity which is measured using an Electro Cardio Graham (ECG). QRS complex is graphical deflections seen on a typical electrocardiogram (EKG or ECG). The QRS complex corresponds to the depolarization of the ventricles of the heart. According to a study, this QRS System, which is an activity of ANS can be used to understand the emotions experienced by a person. [9]

This study examines the use of a software that provides first a preliminary response by examining facial expressions and then providing a confirmatory result by measuring heart activity. The iMotions was founded by iMotions Inc. in 2005 [1]. EQ radio is a device developed by Researchers from MIT's Computer Science and Artificial Intelligence Laboratory (CSAIL) that can detect a person's emotions using wireless signals [12].

II. Facial Features and Expressions

Research on facial expression dates back to 1872. Darwin's "The Expression of Emotions in Man and Animals" published in 1872, talks about general principles of expressions and modes of emotions in peculiar species especially man. To confirm his hypothesis that facial expressions are universal he obtained data from different sources from different parts of the world and analyzed the outcomes. In the year 1976. Paul Ekman published a cross - cultural study that established the fact that emotions are universal. With his colleagues he then developed a system known as FACS. to record and measure facial expressions. This system encodes movement of every anatomical facial muscle from momentary changes in facial expression [7].
FACS manually codes anatomically possible every facial expression. It does this by deconstructing facial expression into specific action units. Are defined as contraction or relaxation of one or more muscles. The use of FACS is mainly in the area of measuring negative emotions like depression and pain. FACS is one such technology which is defined to be self instructional. That is, it can be learnt from a number of resources including manual and workshops. However, FACS rating requires extensive training, and is time consuming and subjective thus prone to bias [3].

Face recognition technology was developed 1960's. It was the first semi automated system of face recognition. This technology required the researcher to take photographs and create data by calculating distances and ratio to a common reference point. This was a time consuming and challenging approach. In 1970's Goldstein, Harmon and Lesk used 21 anatomic markers to automate the recognition [5]. The problem with both these methods that they were hand measuring. In 1988 Kirby and Sirovich applied linear algebra technic to face recognition [10]. In 1991 Turk and Pentland discovered a technique that enabled real time automated face recognition systems. [12] The USA govt. has performed multiple projects to determine the advantages and limitations to face recognitions.

The FacE REcognition Technology (FERET) Evaluation, sponsored from 1993 to 1997 by Defense Advanced Research Products Agency(DARPA) was an effort to promotes innovations of face recognitions algorithms and technology.

The computer based face recognitions industry has made many useful advances in past decade, However the need for higher accuracy system still remains. A constrain in the facial recognition technology is that it deals with what is clearly visible on the face, ignoring invisible changes or also called physiological changes that occur inside the body.

III. Biometric systems

A biometric system is a technology that automatically uses personal information to recognize a person. It uses specific data and behavioral traits to work efficiently. There are various biometrics applications such as finger print scanner, retina scanner used to unlock latest mobile phones. Facial recognition software uses cameras for comparing facial characteristics of an individual.

iMotions is a scalable biometric research platform. It consists of biosensors, facial expression analysis, EEG, GSR, EMG, ECG. iMotions Inc. was founded in 2005, and headquartered at Copenhagen, Denmark.

It is a software that combines various biometric sensor device that performs various biometric sensors like facial expression, eye tracking, EEG, GSR and EMG. Eye tracking is concerned with the reaction of our pupils to various kind of visual events. Eye tracking systems uses corneal reflection to identify eye position and to evaluate visual attention. It is a non intrusive method used for identifying human emotions by tracking movement of eye ball.

Facial expression tracking by iMotion involves determining seven basic human emotions such as joy, anger, surprise, fear, contempt, sadness and disgust using facial features like eyes, eyebrows, lips and nostrils. There are myriad facial points to detect the human emotions. In these software it divides emotion into positive and negative. If emotion scale is on negative the person might be sad or angry. Else if the scale is on positive side then the emotions status of person might be happy or joy. Emotions such as surprise can be considering both negative or positive on scale. EEG integration with GSR ECG and facial recognition will improve the accuracy of software it monitors electrical activity generated in the brain.

IV. HEART ACTIVITY AND EMOTIONS\

Conventionally Electrocardiograms (ECG) are used to diagnose cardiovascular diseases and cardiac abnormalities ECG provide information's about the cardiac functions through graphical presentations. The use of ECG has now become more advance to include areas like the lie detection, emotions measurement and human identification.

In 1894 William James stated that afferent signals from our senses results in unique physiological responses that produce stimulus which in turn caused associated emotions [8]. The normal ECG is composed of a P wave, a QRS complex and a T wave the P wave is the first wave of electrocardiogram and represents spread of electrical impulse. The PR interval is measured from beginning of P wave to the beginning of QRS complex. It reflects the time taken by the impulse to travel the entire distance from SA node to ventricular muscle fiber. The QRS complex represents the spread of electrical impulse through the ventricular muscles (Depolarization).

The ECG records the electrical activity of the heart using electrodes and sensors. Heart rate variability which is also called as RR variability of the QRS complex is a physiological phenomenon which measures variations in the time interval between heartbeats. Heart rate variability is a physiological marker of how we experience and regulate emotions

[2].

In general, there are two types of HRV associated with emotions:

1) The jaggered and incoherent wave, which significantly belongs to the emotions of stress like anger, frustration and sadness.

2) The smooth and harmonious waves, observed when the subject experiences the feelings of joy care or love. This is called the coherent heart rhythm.

The ECG measures these variabilities' and thus help us to detect the emotions using the ECG readings.

The drawback of the existing ECG - emotion detection is that it requires the use of sensors and hence requires the patient to be connected to all sorts of wires and technology, thereby making a cumbersome process.

V. Eye tracking

Eye tracking can be a good way to detect stress in a subject. When the body encounters a stressful situation the pupils naturally dilate. The eye tracking module can also be used to detect where a person is focusing his/her attention which although not as useful in detecting emotion has other uses this type of technology could be used for many things for instance scrolling a page as you read.

VI. EQ-RADIO

EQ-Radio is a technology developed by MIT that uses RF signals to determine the heartbeat and respirations.

It transmits RF signals and then in return, reads the reflection back from the body of a patient. These reflections are then analyzed to determine the different emotions of the person.

It measures the heart activity as accurately as ECG monitor with 0.3% of marginal error. It sends the wireless signals and receive small variations of heartbeat intervals. This helps to determines the level of arousal and allows the EQ-radio to detect the emotions. [11]

EQ-radio operates on acceleration of RF signals to dampen the breathing signals and emphasize heartbeats. In contrast to the QRS complex which has a known expected shape. The shape of heartbeat in RF reflections is unknown and depends on person's body and exact posture [13].

EQ radio system has three components.

1. First component is a radio that transmits RF signals and receive the reflections.

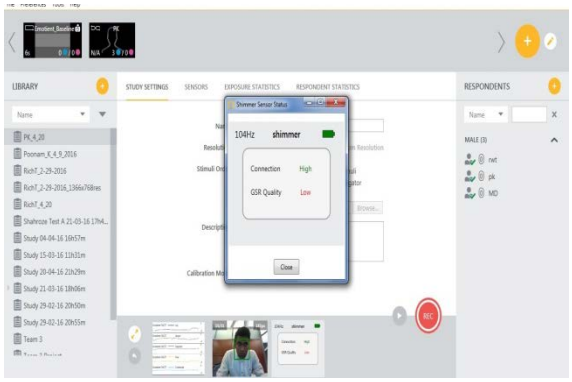
2. Next, the resulting RF signals is pass to beat extraction algorithm, the algorithm returns a series of signals that corresponds to individual heartbeats.

3. Finally, the heartbeats along with captured breathing patterns are past to an emotions classification system and produced on a monitor. The emotions classification system comprehends heartbeat and respiration based feature [12].

VII. Methodology

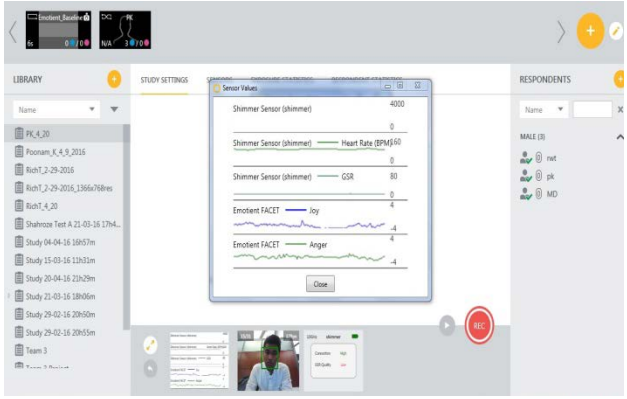
The Research methodology of this requires gathering and analyzing of data from questionnaires answered by participants to record the facial expressions and reactions. These were later analyzing by using iMotions software. To start the experiment, we exposed an individual to first a questionnaire followed by 2-3 incidental stories. We also captured live face recording iMotions software while he was answering and listening to our experimental questions and stories. The software created a graph which consisted of different emotions and reactions on his face. Throughout the experiment

the individual was expected to elicit an emotional reaction.



Data Analysis

Once the video was recorded the software analyzed the various expression the individual showed. For each reaction the individual gave a specific response was generated by the software. Once all the reactions were collected by the software it produced a bulk response in term of a graph. We compare the measured expressions and correlated them with true expressions. The system displays the raw scores which must be calibrated against a baseline neutral emotion for better accuracy, this corrected score accounts for natural features of the individual that might show them as happy or sad at a neutral state. Calculating the corrected score is as simple as subtracting the average baseline score from the new Raw score.



VIII. RESULTS

The Following finding have been discovered through the study iMotions only give the preliminary result to facial recognition and emotion detection to confirm these emotional results we need an ECG and respiratory rate confirmation. This confirmation can be achieved by incorporating the principle of radio frequency and electrocardiogram.

Though the iMotion software thus provide ECG rating cannot be used remotely. To enhance the technology, the wireless system needs to incorporated which can be done using EQ radio.

IX. LIMITATIONS

Because EQ radio is a property of MIT the exact working software could not be studied in this research paper. Hence we limited our research findings only to the aspects of the iMotions software.

X. CONCLUSIONS

The iMotions platform is a solid piece of software that could be used to perform a multitude of functions, by itself it provides a significant amount of data and with the ability to leverage it with its API into 3rd party applications I can see it becoming the standard in the industry. The uses of this technology are only bound by the imaginations of those who utilize it.

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