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FACE EXPRESSION RECOGNITION USING ELECTROMYOGRAPHY

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Abstract: Facial Expressions are very important to social communication between humans. Everyday actions are increasingly being handled electronically. This growth in electronic transactions results in great demand for fast and accurate user identification and authentication. Humans can adopt face expressions freely and parsimoniously. Human machine interface technology uses the human neural behaviors as input controllers for the device. Electromyography (EMG) is a basis technique for estimating and tracing the electrical activities generated by muscles. EMG signals are captured from body muscles such as arm or facial muscles and are translated and converted into machine input control commands. These captured signals are passed through band pass filter with 30 to 450 Hz bandwidth. The filtered signals are segmented into time sections and the Root Mean Square (RMS) value is computed for each section. Using these RMS values feature extraction is performed. After feature extraction, the extracted features are sieved and reduced by using the dimensionality reduction scheme. Finally these are trained and classified by using neural classifier. This paper discusses the use of nanotechnology in various face expression recognition applications.
Keywords: Electromyography, root mean square, signal recording, muscles activity, neural classifier

I. INTRODUCTION

Facial Expressions is the movements of muscles on the face and these muscles are innervated by the facial nerves. The several brain areas are giving the impulses to the facial nerves [1]. The micro expressionsare facial movements which are distinguished with squat time. The micro expression recognition uses Main Directional Mean Optical-flow (MDMO) features Region of Interest (ROI) based methods and Support Vector Machine (SVM) for classification [2].

The polarimeter is an imager based on the division of time spinning achromatic retarder (SAR) design. The polarimeter has the spectral response range using Stirling-cooled mercury telluride focal plane array[3]. The wearable human activity recognition system uses the System on Chip (SoC) approach. Here the signals are processed for feature extraction and the activities are classified by using neural network classifier [4].The hand gestures are detected by using the Artificial Neural Network (ANN) which is specially used for difficult pattern recognition and classification [5].EMG is a practice of electrophysological which can be used for detecting electrical movements through their reduction formed within the skeletal muscles [6].

For detecting gestures, the back propagation network with the training algorithm namely Levenberg-Marquardt is used. Biorthogonal wavelet entropy method with fuzzy multiclass SVM used for the extraction of multi-scale features and classification. Also it classifies the seven different expressions such as sad, anger, fear, happy, neutral and surprise [7]. One dimensional Local Binary Pattern (LBP) is used for extracting features for one dimensional signal. Smoothing algorithm is used with activity and inactivity markers [8].

The stretchable and sensitive strain sensors are attached to the elected location of the face skin which monitors the muscle movements at real time. The invention processof nanoparticle array curve is based on these stair sensors [9].The stretchable, transparent, ultrasensitive strain sensors are attached to the specified regions such as forehead, on the neck, close to mouth and beneath the eye for observing muscle movements through the expressions [10]. EMG is a new basis of signal information for designing human machine interface or human computer interfaces[11].

The rest of the paper is structured as follows: Section II provides the details of electromyography and their functions. SectionIII provides the description of proposed methodology. Section IV elaborates the conclusion of the proposed scheme.

II. ELECTROMYOGRAPHY

In Electromyography, ‘electro’ means electrical, ‘myo’ means muscle, ‘graphy’ means record. So it involves recording electrical activity of muscle.EMG signal is a measure of muscles electrical activity and which can be represented as a function of time and in terms of amplitude, phase and frequency. Atool called an electromyograph that can beperformed with EMG to generate a record called an electromyogram.An electromyograph senses the electric potential generated by muscle cellswhen these cells are electrically or neurologically activated.

Facial electromyography is also anEMG technique that quantifies the muscle activity by sensing and magnifying the tiny electrical impulses that are generated by muscle fibers when they contract. EMG signals find its applications in several areas

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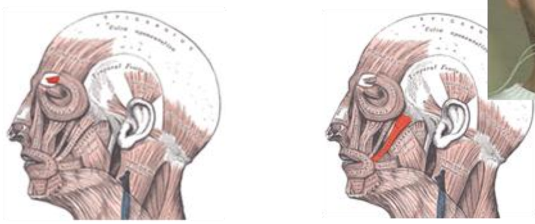
like diagnosis of neuromuscular diseases, human machine interfaces, virtual reality games, etc.

controlling of prosthetic or orthotic devices, development of muscle oriented excise equipment



(a) (b)

Fig1. Facial Muscle Groups

The Facial EMG primarily focuses on two major muscle groups in the face. They are corrugator supercilii muscle group and zygomaticus muscle group. Figure 1(a) shows the corrugator supercilii muscle group which is related with frowning it denotes the face expression of sadness or confusion. Figure 1(b) shows the zygomaticus major muscle groupwhich is related with smiling it denotes the face expression of happiness or joy.

The corrugator supercilli muscle is located at the medial end of the eyebrow and close to the eye. The zygomaticus major muscle is a facial expression muscle which depicts the angle of mouth. Facial EMG is perceptive scheme to estimate the emotional expressions. It is a technique to discriminate and track positive and negative emotional reactions.

III. PROPOSED METHODOLOGY

The Face expression recognition using EMG, which contains the stages are electrode placement on the face, EMG signal recoding and filtering, data segmentation and feature extraction, active feature selection and classification [11]. EMG contains two types, surface EMG and intramuscular EMG. Intramuscular EMG can be performed using a variety of different types of recording electrodes. The simplest approach is a monopolar needle electrode.

Fig .2 Electrode placements on face

First stage is electrode placement on the face, here surface EMG is used. The step before electrode placement is skin preparation which is typically involves simply cleaning the skin with an alcohol pad.Figure 2 shows how the electrodes are placed on the face. The electrodes must be placed where all considered expressions could be covered. The electrodes are placed in the location of corrugator superciliiand zygomaticus muscle groups. After the placement of electrodes on face, all wires are taped to the face to reduce the number of artifacts and to reduce any wire movement.More than one electrode is needed because EMG recordings display the potential (voltage) difference between two separate electrodes.

Second stage is EMG signal recording and filtering. The surface EMG signals are recorded with BioRadio 150 which has the sampling frequency is regulated at 1000Hz. All volunteers are relaxed for 1minute before recoding of EMG signals. Each participant has 30 seconds to record face expressions. Then these signals are saved to a computer for next step. All the recorded signals are passed through the band pass filter with 30 - 450 Hz bandwidth.

Third stage is data segmentation and feature extraction which can be performed with RMS computation. Here the filtered signals are segmented into non overlapping sections which can be 256 ms time sections. Then the RMS value is calculated using the following Equation 1.

$$Rms = \sqrt{\frac{1}{A}\sum_{a=1}^{A} X_a^2} \qquad (1)$$

Where X_a is the raw signal, A is the length of X_a. Therefore features for expressions are extracted.

Fourth stage is active feature selection which can be performed as follows. After extraction of features these are filtered to gather active ones. For this purpose, three threshold (TH_x) lines are designed using the following Equation 2.

$$Th_x = Mean(Rms(X_{normal})) + (3 \times std(X_{normal})) \qquad (2)$$

Thus three Th_1, Th_2, Th_3 threshold lines are compared with the *Rms* channels. The features which are greater than the threshold values they are selected as active features.
Final stage is the classification stage and it can be achieved with neural classifier [4]. It is a *pc-nn* ANN, where *pc* is the number of principal components after the active feature detection, *nn* is the number of nodes in the hidden layer. The neural classifier is used for training the active features and also classifies these into 6 different expressions.

IV. CONCLUSION

This paper uses the EMG signals to measure the face muscle activities, which is also used for measuring other activities in the human body. The surface EMG evaluates the muscle function by recoding muscle activity from a surface above the muscle on the skin. It uses the pair of electrodes for recording signals. Then these signals are recorded and they are filtered based on the activities. The filtered signals are fed into the stage of segmentation and feature extraction which can be performed by using RMS values. Next, the active features are selected and they are trained and classified with ANN neural classifier.

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