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Low Morale, Depressed and Sad State Recognition in Confined Spaces

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Abstract - *This paper presents a novel fusion method using infrared sensor based recognition of negative human emotion in closed spaces. Often prisoners or suspects are kept in closed confinements under observations. In such surroundings the individuals often experience sadness, loneliness, frustration, anger and get violent. The paper used multiple sensors (4) to detect the participant behavior and extracted features based on markers on the face, hand, body and legs. A total of 28 participants enacted actions representing sadness, boredom, loneliness, frustration, anger and fear. The data was trained using SVM classifier. The overall accuracy was 72% for sadness and 71% anger which was an improvement over full frontal recognition by over 5%.*

Key Words: Negative emotion detection, closed spaces, confined spaces, low lit lighting, sensor, multiple input fusion.

1.INTRODUCTION

Human activity recognition has gained research interest because of its application in safety systems, surveillance, robotics, emotion recognition and affective computing. One such application is counselling and preventive action for ensuring individuals in solitary confinements, patient care and living alone under the monitoring of authorities and care givers do not get depressed or enter in poor mental state. Additionally, such individuals may express their mental state through frustration, violence and anger.

Automated early recognition of such conditions is important and as a result this research examines the detection of these emotional states using sensors from 4 different viewpoints. Existing studies have used various methodologies such as motion analysis [1], time and dynamic motion based templates [2], graphical modelling [3], shape analysis [4], posture detection using probabilities [5], real time processing [6], using canonical mapping space [7], hidden markov models (HMM) [8], view independent extraction [9] and rule based matching [10].

Similarly, a series of studies have been done on emotion recognition, intensity recognition, multimodal recognition [11] to [29], software design strategies for the implementation of real time, automated systems [12] to [16] for emotion and human activity recognition. Various real life scenario based analysis [30] to [42] has been performed in research on human actions. These studies have evaluated recognition in group, individual, different lighting conditions and view angles.

2. METHOD

28 participants volunteered to enact various actions in front of 4 sensors (1 on each wall of a 4 wall room). 7 participants were between age 21 to 30, 15 participants were between age 31 to 45 and 6 participants were between age 46 to 55. Out of 28 participants 6 were females and 22 were male. 12 participants were Europeans, 11 were Americans, 2 South Americans and 3 Asians. As a result, the experiment contained a good variation of age group, gender and ethnicity and cultural background. The participants were asked to enact an emotion from a list of actions representing sadness, boredom, loneliness, frustration, anger and fear. The actions were performed in bright light, darker light and controlled lighting.

Each participant's face, hand, body and leg movement was captured using markers. This enabled us to extract the facial, hand, body and leg features without complex processing and focus on capturing the feature movement and location to represent each emotion. The facial features consisted of eye brows, nose, cheeks, chin, upper and lower lips to capture the facial expressions. Palms, wrist, elbow, shoulders were tracked for the hand. The neck, back, hip, waist was tracked from the body torso. The knees, ankles and left and right hips were tracked for the legs. The feature vector was constructed by combining these tracked points 3 dimensional co-ordinates. In addition to the co-ordinates, the movement of each feature was tracked for 3 seconds and the velocity, acceleration, displacement was measured as temporal features. The data from all for view-points was combined. The features were then used to train an SVM classifier. The annotated data was split into 80% training data and 20% test data. The SVM classifier was trained using 10-fold cross validation. The results of the classification process against the 20% test data are shown in next section.

A classifier was trained for each input channel (face, head, hand, body, leg). Additionally, the classifier was trained for each viewing angle. This resulted in a total of 5x4 = 20 classifiers. The result from each classifier was chained to form an ensemble of classifiers and the decision level fusion was implemented to predict the final emotional state. The various viewing angles from the 4 sensors compensated for occlusion. The various input channels provided a comprehensive emotion profile resulting in better emotion accuracy. The participants were asked to wear orange, white and grow beards to mimic realistic conditions in a prison confinement. Some participants were shown reference videos to assist in enacting the emotion. The participants were also asked to enact emotions while sitting in one spot as well as moving around in the room to depict feeling of frustration and restlessness.

3. RESULT

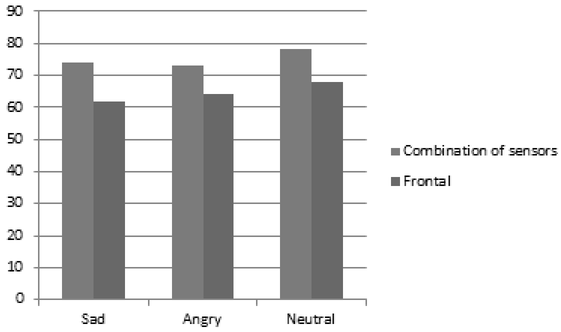

Chart -1: Recognition accuracy using multiple sensors vs 1 sensor and frontal view

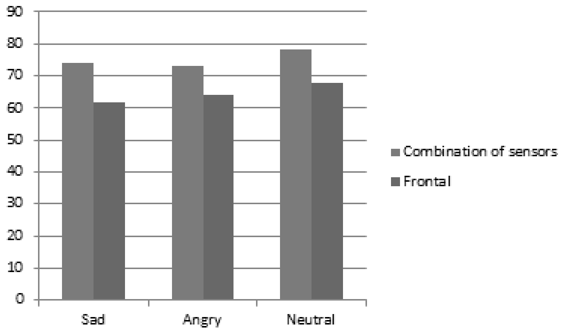

Chart -2: Recognition accuracy in different lighting conditions

The recognition accuracy using multiple sensors was greater than accuracy obtained using one sensor capturing the action and emotions from the frontal view, for all emotional states (anger, sad and neutral). The recognition accuracy under dim and bright light was lower compared to the accuracy obtained in controlled lighting. This was expected although there was no specific emotion (anger or sad) that did better under either (dim or bright) lighting conditions.

The study also found that the display of emotional expression was dependent on the cultural background of the participant. For instance, the manner in which south American participants expressed sadness and anger was different from the way Asians expressed it.

4. CONCLUSIONS

The study showed that multi-view tracking of human activity yields better results as compared to frontal only emotion recognition systems. As a future scope the experiments should be tested on spontaneous actions instead of enacted emotions. The study examined the feasibility of human emotion recognition in confined places with dim lighting. The research has potential applications in security, preventive measures in case of violent, self-destructive behavior from prisoners or people in isolated, and solitary confinements.

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