Depression and Sadness Recognition in Closed Spaces

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Abstract

This paper presents recognition of 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 x%.

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 markow 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.

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 were 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 were 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.

Results

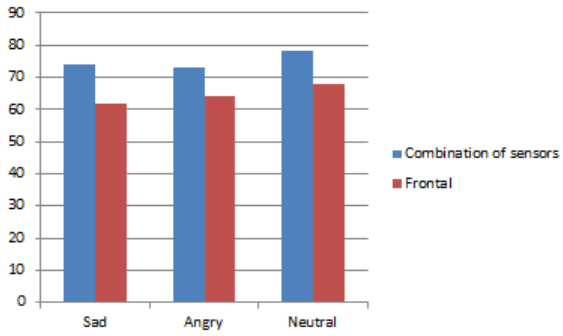

Fig. 1. Recognition accuracy using multiple sensors vs 1 sensor and frontal view

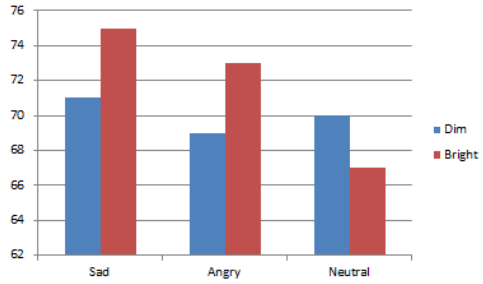

Fig. 2. Recognition accuracy in different lighting conditions.

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.

Conclusion

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.

References

[1] R. Poppe, “Vision-based human motion analysis: an overview,” Comput. Vision and Image Understan., vol. 108, pp. 4–18, 2007.

[2] A. F. Bobick and J. W. Davis, “The recognition of human movement using temporal templates,” IEEE Trans. Pattern Anal. Machine Intell., vol. 23, no. 3, 2001.

[3] R. Hamid, Y. Huang, and I. Essa, “ARGMode–Activity recognition using graphical models”, in Proc. Conf. Comput. Vision Pattern Recog., vol. 4, pp. 38–45, Madison, Wisconsin, 2003.

[4] S. Carlsson and J. Sullivan, “Action recognition by shape matching to key frames,”in Proc. IEEE Comput. Soc. Workshop Models versus Exemplars in Comput. Vision, pp. 263–270, Miami, Florida, 2002.

[5] R. Cucchiara, C. Grana, A. Prati, and R. Vezzani, “Probabilistic posture classification for human-behavior analysis,” IEEE Trans. Syst. Man, and Cybern. A, vol. 35, no. 1, pp. 42–54, 2005.

[6] I. Haritaoglu, D. Harwood, and L. S. Davis, “W4: Real-time surveillance of people and their activities,” IEEE Trans. Pattern Anal. Machine Intell., vol. 22, no. 8, pp. 809–830, August 2000.

[7] P. S. Huang, C. J. Harris, and M. S. Nixon, “Canonical space representation for recognizing humans by gait or face,” in Proc. IEEE Southwest Symp. Image Anal. Interpretation, pp. 180–185, 1998.

[8] J. Yamato, J. Ohya, and K. Ishii, “Recognizing human action in time-sequential images using hidden Markov model,” in Proc. IEEE CVPR, pp. 379–385, 1992.

[9] F. Niu and M. Abdel-Mottaleb, “View-invariant human activity recognition based on shape and motion features,” in Proc. IEEE Sixth Int. Symposium Multimedia Softw. Eng., pp. 546–556, 2004.

[10] L. X. Wang and J. M. Mendel, “Generating fuzzy rules by learning from examples,” IEEE Trans. Syst., Man Cybern., vol. 22, no. 6, pp. 1414–1427, 1992.

[11] A. S. Patwardhan, Jacob Badeaux, Siavash, G. M. Knapp, “Automated Prediction of Temporal Relations”, Technical Report. 2014.

[12] A. S. Patwardhan, 2016. “Structured Unit Testable Templated Code for Efficient Code Review Process”, PeerJ Computer Science (in review), 2016.

[13] A. S. Patwardhan, and R. S. Patwardhan, “XML Entity Architecture for Efficient Software Integration”, International Journal for Research in Applied Science and Engineering Technology (IJRASET), vol. 4, no. 6, June 2016.

[14] A. S. Patwardhan and G. M. Knapp, “Affect Intensity Estimation Using Multiple Modalities,” Florida Artificial Intelligence Research Society Conference, May. 2014.

[15] A. S. Patwardhan, R. S. Patwardhan, and S. S. Vartak, “Self-Contained Cross-Cutting Pipeline Software Architecture,” International Research Journal of Engineering and Technology (IRJET), vol. 3, no. 5, May. 2016.

[16] A. S. Patwardhan, “An Architecture for Adaptive Real Time Communication with Embedded Devices,” LSU, 2006.

[17] A. S. Patwardhan and G. M. Knapp, “Multimodal Affect Analysis for Product Feedback Assessment,” IIE Annual Conference. Proceedings. Institute of Industrial Engineers-Publisher, 2013.

[18] A. S. Patwardhan and G. M. Knapp, “Aggressive Action and Anger Detection from Multiple Modalities using Kinect”, submitted to ACM Transactions on Intelligent Systems and Technology (ACM TIST) (in review).

[19] A. S. Patwardhan and G. M. Knapp, “EmoFit: Affect Monitoring System for Sedentary Jobs,” preprint, arXiv.org, 2016.

[20] A. S. Patwardhan, J. Kidd, T. Urena and A. Rajagopalan, “Embracing Agile methodology during DevOps Developer Internship Program”, IEEE Software (in review), 2016.

[21] A. S. Patwardhan, “Analysis of Software Delivery Process Shortcomings and Architectural Pitfalls”, PeerJ Computer Science (in review), 2016.

[22] A. S. Patwardhan, “Multimodal Affect Recognition using Kinect”, ACM TIST (in review), 2016.

[23] A. S. Patwardhan, “Augmenting Supervised Emotion Recognition with Rule-Based Decision Model”, IEEE TAC (in review), 2016.

[24] S. D’Mello and A. Graesser, “Multimodal Semi-Automated Affect Detection from Conversational Cues, Gross Body Language, and Facial Features,” User Modeling and User-Adapted Interaction, vol. 10, pp. 147-187, 2010.

[25] T. Baenziger, D. Grandjean, and K.R. Scherer, “Emotion Recognition from Expressions in Face, Voice, and Body. The Multimodal Emotion Recognition Test (MERT),” Emotion, vol. 9, pp. 691-704, 2009.

[26] C. Busso et al., “Analysis of Emotion Recognition Using Facial Expressions, Speech and Multimodal Information,” Proc. Int’l Conf. Multimodal Interfaces, T.D.R. Sharma, M.P. Harper,G. Lazzari, and M. Turk, eds., pp. 205-211, 2004.

[27] N. Sebe, I. Cohen, and T.S. Huang, “Multimodal Emotion Recognition,” Handbook of Pattern Recognition and Computer Vision, World Scientific, 2005.

[28] R. Cowie, E. Douglas-Cowie, N. Tsapatsoulis, G. Votsis, S. Kollias, W. Fellenz, and J. Taylor, “Emotion Recognition in Human-Computer Interaction,” IEEE Signal Processing Magazine, vol. 18, no. 1, pp. 32-80, 2001.

[29] A. Kapoor and R.W. Picard, “Multimodal Affect Recognition in Learning Environments,” Proc. 13th Ann. ACM Int’l Conf. Multimedia, pp. 677-682, 2005.

[30] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Fear Detection with Background Subtraction from RGB-D data, Computer Science and Emerging Research Journal, vol 1, 2013.

[31] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Code Definition Analysis for Call Graph Generation, Computer Science and Emerging Research Journal, vol 1, 2013.

[32] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Multi-View Point Drowsiness and Fatigue Detection, Computer Science and Emerging Research Journal, vol 2, 2014.

[33] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Group Emotion Detection using Edge Detecttion Mesh Analysis, Computer Science and Emerging Research Journal, vol 2, 2014.

[34] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Polarity Analysis of Restaurant Review Comment Board, Computer Science and Emerging Research Journal, vol 2, 2014.

[35] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Sentiment Analysis in Code Review Comments, Computer Science and Emerging Research Journal, vol 3, 2015.

[36] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Temporal Analysis of News Feed Using Phrase Position, Computer Science and Emerging Research Journal, vol 3, 2015.

[37] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Decision Rule Driven Human Activity Recognition, Computer Science and Emerging Research Journal, vol 3, 2015.

[38] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Depression and Sadness Recognition in Closed Spaces, Computer Science and Emerging Research Journal, vol 4, 2016.

[39] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Dynamic Probabilistic Network Based Human Action Recognition, Computer Science and Emerging Research Journal, vol 4, 2016.

[40] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Fight and Aggression Recognition using Depth and Motion Data, Computer Science and Emerging Research Journal, vol 4, 2016.

[41] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Sensor Tracked Points and HMM Based Classifier for Human Action Recognition, Computer Science and Emerging Research Journal, vol. 5, 2016.

[42] Anne Veenendaal, Elliot Daly, Eddie Jones, Zhao Gang, Sumalini Vartak, Rahul S Patwardhan, Drunken Abnormal Human Gait Detection using Sensors, Computer Science and Emerging Research Journal, vol 1, 2013.

[43] A. S. Patwardhan, “Edge Based Grid Super-Imposition for Crowd Emotion Recognition”, International Research Journal of Engineering and Technology (IRJET), May. 2010.

[44] A. S. Patwardhan, “Human Activity Recognition Using Temporal Frame Decision Rule Extraction”, International Research Journal of Engineering and Technology (IRJET), May. 2010.

[45] A. S. Patwardhan, “Low Morale, Depressed and Sad State Recognition in Confined Spaces”, International Research Journal of Engineering and Technology (IRJET), May. 2011.

[46] A. S. Patwardhan, “View Independent Drowsy Behavior and Tiredness Detection”, International Research Journal of Engineering and Technology (IRJET), May. 2011.

[47] A. S. Patwardhan, “Sensor Based Human Gait Recognition for Drunk State”, International Research Journal of Engineering and Technology (IRJET), May. 2012.

[48] A. S. Patwardhan, “Background Removal Using RGB-D data for Fright Recognition”, International Research Journal of Engineering and Technology (IRJET), May. 2012.

[49] A. S. Patwardhan, “Depth and Movement Data Analysis for Fight Detection”, International Research Journal of Engineering and Technology (IRJET), May. 2013.

[50] A. S. Patwardhan, “Human Action Recognition Classification using HMM and Movement Tracking”, International Research Journal of Engineering and Technology (IRJET), May. 2013.

[51] A. S. Patwardhan, “Feedback and Emotion Polarity Extraction from Online Reviewer sites”, International Research Journal of Engineering and Technology (IRJET), May. 2014.

[52] A. S. Patwardhan, “Call Tree Detection Using Source Code Syntax Analysis”, International Research Journal of Engineering and Technology (IRJET), May. 2014.

[53] A. S. Patwardhan, “Walking, Lifting, Standing Activity Recognition using Probabilistic Networks”, International Research Journal of Engineering and Technology (IRJET), May. 2015.

[54] A. S. Patwardhan, “Online News Article Temporal Phrase Extraction for Causal Linking”, International Research Journal of Engineering and Technology (IRJET), May. 2015.

[55] A. S. Patwardhan, “Online Comment Processing for Sentiment Extraction”, International Research Journal of Engineering and Technology (IRJET), May. 2016.