"**Human activity recognition is a vital component for intelligent robotics .**"
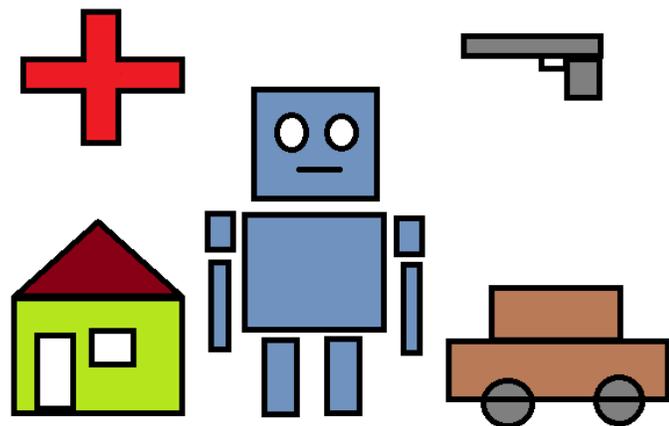
-Adam Beckford.

INTELLIGENT ASSISTIVE ROBOTICS

Adam Beckford

Machine vision and robotics have come a far way. There have been several improvements in face recognition, human activity recognition and emotion detection. These capabilities are tightly couple with robotics. Human activity recognition is a vital component for intelligent robotics. If the robots can accurately recognize facial expressions, human activities and the human's emotional states, it would be able to respond to these actions and provide a complimentary response. The intelligent robots would be able to aid in a variety of fields ranging from primary care, surgery, security to navigation. Last decade has seen tremendous advancements in computer

processing speeds, hardware and networking speeds. The costs of electronics have gone down and large disk space has become cheap. Thus, development of robots has reduced in cost and improved in processing speeds. At the

same time the machine vision field has seen improvement in object recognition and can rival human vision under controlled conditions. One such area where intelligent robotics can benefit from machine vision is the ability to sense emotions. Emotion sensing machines will soon become ubiquitous. There is an increasing interest in creating an eco-system of products that can communicate with each other. Wrist watches, smart phones, laptops, tablets, cars, household electronics will soon seamlessly interact with each other. The ability to recognize user emotions becomes increasingly important in such an environment. In the last decade, several studies have focused on improving the emotion recognition capabilities in computers with the help of input data from various channels such as webcam, infrared, audio and physiological devices.

Klein et al (2001) developed a system that identified the user's emotional state and provided feedback for support in the form of intelligent companion. A kiosk based system capable of sensing emotional response of consumers while sampling products such as perfumes, sunglasses, make up, wine and other over-the-counter products was developed by Patwardhan et al (2013) using 3D sensor and multi-modal data fusion. The novel idea enabled real time feedback to marketing department and significantly improved product sales and identification of popular consumer accessories proving to be a major advantage over competitors and is a major significant contribution in multimodal fusion technique. The system could recognize

six basic emotions such as angry, sad, happy, surprise, disgust and afraid. These emotions were modelled based on the work on basic emotions by Ekman (1999). The same capability could be extended to intelligent robotics in the role of a sales associate.

Lisetti and Nasoz (2002) created a system that could replicate the users emotional by recognizing fear and anger. The system used features from the face, in combination with physiological data to predict the user's state of mind and represent it in the form of virtual agent. Duric et al (2002) integrated perceptual and cognitive abilities into a multimodal environment that enabled intelligent interaction between the human users and computer devices. Maat and Pantic (2006) developed a tool for efficient human computer interaction. The tool could proactively assess the user's mood and adapt the interface corresponding to the detected emotion. This affect aware feedback improved the quality of interaction greatly. This technology could be embedded in intelligent robots for interactive interfaces in public places such as shopping malls and schools.

Kapoor et al (2007) implemented an affect sensing companion program which could automatically help a frustrated user based on data obtained from specially designed chair to detect physiological information, skin sensor and cameras. These are all examples of how emotional sensing environments can create a synergy between humans and computers and vastly enhance the interaction level between the user and the surrounding devices.

Various techniques have been used to achieve the emotion sensing technology including facial expression recognition, voice recognition, body language detection and physiological cues. There are still challenges such as lighting conditions, background noise, outdoor scenarios in which such systems still fail to produce accurate results. The research community is heading towards resolving these issues in recent years. However; a lot of improvements in the robustness of systems still need to be done before it will become pervasive.

Emotion recognition can find use in many fields ranging from security, counselling, marketing, sports, advertisement, medicine and simulated environments. It is important to combine information from various modalities and successfully fuse the data while also maintaining the context awareness. Most of the studies have proved effective only in controlled environments and evaluating spontaneous data remains a challenge. Furthermore,

performance in terms of recognition accuracy and real time feedback remains an area that needs improvements. However, a world with intelligent robots serving as navigation assistants, medical assistants and assistants to security personnel is not far from a reality.

REFERENCES

[1] Zeng Z, Pantic M, Roisman GI, Huang TS (2009) A survey of affect recognition methods: Audio, visual, and spontaneous expressions. IEEE Trans on Pattern Anal and Mach Intell 31(1):39–58

[2] Wang L, Gu T, Tao X, Chen H, Lu J (2011) Recognizing multi-user activities using wearable sensors in a smart home. Pervasive Mob Comput 7(3):287–298

[3] van den Broek EL, Westerink JHDM (2009) Considerations for emotion-aware consumer products. Appl Ergon 40(6):1055–1064

[4] Stead L, Goulev P, Evans C, Mamdani E (2004) The emotional wardrobe. Pers Ubiquitous Comput 8(3–4):282–290

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

[6] A. S. Patwardhan, "An Architecture for Adaptive Real Time Communication with Embedded Devices," LSU, 2006.

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

[8] 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).

[9] A. S. Patwardhan, "Multimodal Affect Recognition using Kinect", Journal Archive, arXiv, 2016.

[10] A. S. Patwardhan, "Augmenting Supervised Emotion Recognition with Rule-Based Decision Model", Journal Archive, arXiv, 2016.

[11] Arnrich B, Setz C, Marca RL, Troster G, Ehlert U (2010) What does your chair know about your stress level? IEEE Trans Inf Technol Biomed 14(2):207–214.

[12] Bradley MM, Lang PJ (1994) Measuring emotion: the self-assessment manikin and the semantic differential. J Behav Ther Exp Psychol 25(1):49–59.

[13] Cowie R, Douglas-Cowie E, Tsapatsoulis N, Votsis G, Kollias S, Fellenz W, Taylor JG (2001) Emotion recognition in human–computer interaction. IEEE Signal Process Mag 18(1):32–80.

[14] Levenson RW, Carstensen LL, Friesen WV, Ekman P (1991) Emotion, physiology, and expression in old age. Psychol Aging 6(1):28–35

[15] C.L. Lisetti and F. Nasoz, "MAUI: A Multimodal Affective User Interface," Proc. 10th ACM Int'l Conf. Multimedia (Multimedia '02), pp. 161-170, 2002.

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

[17] Z. Duric, W.D. Gray, R. Heishman, F. Li, A. Rosenfeld, M.J. Schoelles, C. Schunn, and H. Wechsler, "Integrating Perceptual and Cognitive Modeling for Adaptive and Intelligent Human-Computer Interaction," Proc. IEEE, vol. 90, no. 7, pp. 1272-1289, 2002.

[18] L. Maat and M. Pantic, "Gaze-X: Adaptive Affective Multimodal Interface for Single-User Office Scenarios," Proc. Eighth ACM Int'l Conf. Multimodal Interfaces (ICMI '06), pp. 171-178, 2006.

[19] A. Kapoor, W. Burleson, and R.W. Picard, "Automatic Prediction of Frustration," Int'l J. Human-Computer Studies, vol. 65, no. 8, pp. 724-736, 2007.