Homeland Defense & Security
Information Analysis Center

Technical Inquiry 2019-5176

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Overview

A member of the United States Special Operations Command (USSOCOM), Special Operations Forces Acquisition, Technology and Logistics (SOF ATL) Center requested information on wearable sensors for the detection, collection, and transmission of human emotion and sentiments through biomarker data.

Findings

As there are few U.S.-based biometric sensor platforms capable of real-time emotion detection, HDIAC expanded this inquiry to include a limited number of systems developed internationally. Relevant information, including primary point of contact, email, phone number, and a brief description of the solution is provided below.

Biometric and Emotion Identification: An ECG Compression Based Method [1]

Performing Organization: University of Aveiro (Portugal)	Primary POC: Susana Bràs
Email: Susana.bras@ua.pt	Phone: N/A

Description: Researchers at the University of Aveiro in Portugal have developed a method of emotion identification using an electrocardiogram (ECG). Due to the heart's connection with the nervous system, data can be collected on the human emotional state. The use of data models, along with data compression algorithms, allow for more effective comparisons of ECG records. This enables the identification of the person's identity, as well as the individual's emotional state at the time of data collection. This method has proven to be 98% accurate in biometric identification and 90% accuracy in emotion recognition [1].

Deep Learning Analysis of Mobile Physiological, Environment and Location Sensor Data for Emotion Detection [2]

Performing Organization: Nottingham Trent University (UK)	Primary POC: Eiman Kanjo
Email: eiman.kanjo@ntu.as.uk	Phone: +44 (0)115 848 4820

Description: Researchers at Nottingham Trent University have developed a method of deep machine learning for emotion detection by utilizing various sensors from different modalities. Data was collected using smart phones and wearable devices by merging interactions of three sensor types: on-body, environmental, and location [2]. The merging of heterogeneous data was accomplished using convolutional neural networks and long short-term memory recurrent neural networks (CNN-LSTM). This merged data enabled analysis as to the emotional state of the individual.

Emotion-Relevant Activity Recognition Based on Smart Cushion Using Multi-Sensor Fusion [3]

Performing Organization: University of Calabria (Italy)	Primary POC: Raffaele Gravina
Email: r.gravina@dimes.unical.it	Phone: N/A

Description: Researchers at the University of Calabria in Italy designed an emotion detection system comprised of body worn inertial sensors attached to the wrist and combined with a sensor deployed on a seat. This system was developed to monitor emotional states from the seated position due to the increasing demand of jobs that require a person to sit several hours per day. The study focuses on four common basic emotion relevant activities: interest, frustration, sadness, and happiness [4]. Results show that high accuracy can be achieved in identifying these common emotions as they achieved a 91.8% accuracy rate [3].

Towards Unravelling the Relationship Between On-Body, Environmental, and Emotion Data Using Sensor Information Fusion Approach [4]

Performing Organization: Nottingham Trent University (U.K.)	Primary POC: Eiman Kanjo
Email: eiman.kanjo@ntu.as.uk	Phone: +44 (0)115 848 4820

Description: Researchers at Nottingham Trent University in the U.K. have identified an approach based on direct sensor data to assess the impact of the environment around the user to detect physiological changes and emotion [4]. The objectives of this study are to model the short term impact of the ambient environment of the human body and to predict emotions based on body sensors and environmental data. In order to develop analytical and predictive models, data was collected from participants walking around the city of Nottingham [4].

Conclusion

HDIAC identified solutions that can address the SOF ATL Center's need for wearable sensors capable of detecting, collecting, and transmitting biometric data pertaining to human emotion and sentiment. A more comprehensive analysis is available through an HDIAC Core Analysis Task, which would feature in-depth subject matter expert elicitation and coordination with leading industry representatives, as well as prototype development of leading technology candidates to meet requirements in biometric sensors capable of detecting human emotion and sentiment.

We request your feedback on this Inquiry: https://www.hdiac.org/new-inquiry-assessment-form/

References

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3. Gravina, R., Li, Q. (2018, August). Emotion-relevant activity recognition based on smart cushion using multi-sensor fusion. *Information Fusion.* https://doi.org/10.1016/j.inffus.2018.08.001.
4. Kanjo, E., Younis, E.M.G., Sherkat, N. (2017, May). Towards unravelling the relationship between on-body, environmental and emotion data using sensor information fusion approach. *Information Fusion.* http://dx.doi.org/10.1016/j.inffus.2017.05.005.