Combining psycho-physiological and social signal processing methods in health communication: Acute stress detection

Kim Groeneveld[1], Marie Postma-Nilsenová[1], Erik Holt[2], Lena Heyn[3] & Arnstein Finset[2]

[1]TiCC, Tilburg University

[2]University of Oslo

[3]Lovisenberg Diaconal College

Social signal processing (SSP) offers a range of methods for the semi-automatic measurement of facial, vocal, and bodily expressions. The results of these measurements may be used to analyze the communication between doctors and patients and to provide feedback to doctors in a training setting. The main challenge for SSP methods is to deal with the inherent ambiguity of human expressions. For instance, the experience of acute stress in a patient communicating with her doctor can be reflected in vocal parameters such as fundamental frequency (F0), jitter, shimmer or speaking rate, due to the effect of increased heart rate and bronchodilation (Giddens, Barron, Byrd-Craven, Clark, & Scott Winter, 2013; Orlikoff & Baken, 1989). However, the same parameters can be used as signals of emotional states or even reflect speakers' personality because in general, there is no direct mapping between a cue and its interpretation. Depending on the context and the speaker, vocal stress expression may be highly individual as well (Giddens et al., 2013; Kurniawan, Maslov, & Pechenizkiy, 2013). A possible solution to the mapping problem may be the combination of behavioral cues with traditional psychophysiological data. Past studies have shown that bodily reactions accompanying acute stress, such as increase in heart rate, rapid blood flow, activation of sweat glands, and increase in the respiration rate (Kurniawan et al., 2013) can be measured using modern technology sensors. Among these, the most commonly used method in research on medical interactions involves galvanic skin response measurements, which assess sweating of the skin (Bakker et al., 2011).

In our pilot study involving the analysis of a recorded doctor-patient interaction, we first explored the relation between vocal data and skin conductance measurements. Interestingly, as reported by Kurniawan, Maslov, and Pechenizkiy (2013), in some settings, the vocal parameters might be more successful predictors of acute stress than direct physiological measures which differ from person to person, with variances in age, gender, ethnicity, and hormonal cycle. Given that vocal analyses and skin conductance measurements are typically conducted independently of each other, we focused on finding a link between the two types of cues. For this investigation, we used a subset of the data collected by by Heyn, Ruland and Finset (2012) and Heyn, Finset, Eide and Ruland (2013) with available galvanic skin response measurements. Their corpus consists of conversations of adult patients admitted for initiation of, or continuation of treatment/follow up for leukemia, lymphoma, multiple myeloma, or testicular cancer. In a comparison of short fragments of speech before, during and after a galvanic response episode (T1, T2, and T3), a negative correlation between the slope and SD of fundamental frequency and the galvanic measurements has been found. We also observed a significant increase in Relative Average Perturbation (RAP), a measure of jitter in the voice of the patient, in the fragments of speech selected from T1/T2 and T3. In the second stage of the study, we are currently comparing the vocal and psycho-physiological measurements in a larger sample, using the raw galvanic skin response data.

References

Bakker, J., Pechenizkiy, M., & Sidorova, N. (2011, December). What's your current stress level? Detection of stress patterns from GSR sensor data. In *Data Mining Workshops (ICDMW), 2011 IEEE 11th International Conference on* (pp. 573-580). IEEE.

Cohen, S., Kessler, R. C., & Gordon, L. U. (1995). Strategies for measuring stress in studies of psychiatric and physical disorders. *Measuring stress: A guide for health and social scientists*, 3-26.

Glanz, K., & Schwartz, M. D. (2008). Stress, coping, and health behavior. *Health behavior and health*

education: theory, research, and practice. 4th edition. San Francisco (CA): John Wiley, 211-236.

Healey, J. A., & Picard, R. W. (2005). Detecting stress during real-world driving tasks using physiological sensors. *Intelligent Transportation Systems, IEEE Transactions*, *6*(2), 156-166.

Heyn, L., Ruland, C. M., & Finset, A. (2012). Effects of an interactive tailored patient assessment tool on eliciting and responding to cancer patients' cues and concerns in clinical consultations with physicians and nurses. *Patient education and Counseling*, *86*(2), 158-165.

Heyn, L., Finset, A., Eide, H., & Ruland, C. M. (2013). Effects of an interactive tailored patient assessment on patient–clinician communication in cancer care. *Psycho-Oncology*, *22*(1), 89-96.

Kurniawan, H., Maslov, A. V., & Pechenizkiy, M. (2013, June). Stress detection from speech and Galvanic Skin Response signals. In *Computer-Based Medical Systems (CBMS), 2013 IEEE 26th International Symposium on* (pp. 209-214). IEEE.