# Energy and Cost Reduction in Localized Multisensory Systems through Application-Driven Compression

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Localized multisensory systems for medical diagnostics are becoming increasingly important due to the prevalence of lightweight sensors and new communication devices such as mobile phones. These systems are often comprised of multisensory arrays that can be inefficient in terms of energy and cost both in sensing and transmission.

We reduce these inefficiencies through an application-driven sensor selection and subsampling methodology. We use a wearable system containing a large multisensory array designed with the purpose of assessing balance and instability in patients through the measurements of 99 pressure sensors distributed on the sole of a shoe [1].

Traditional data reduction methods reduce the size of the sensor array by removing redundant sensors while retaining full sensor predictability [1]. However, we make the following two key observations: (i) the raw sensed data itself is unimportant; only those metrics relevant to diagnosis are needed; and (ii) it is often the case that the information relevant to medical diagnosis can be easily derived from the raw sensed data.

Therefore, we drive our optimization procedure by selecting a subset of sensors that can predict gait metrics well[1], and eliminate all others, through an iterative process comparing correlation strengths of various sensor groupings to the metrics. Prior research has leveraged gait analysis however was limited to analysis of same size sensors [3]. Thus, we introduce pre-constructed combinations of adjacent sensors to our sensor set motivated by the patterns of high correlations between single sensor measurements.

Finally, we subsample the selected sensors by leveraging the observation that: (i) most sensors need only be sampled after a physiological event is triggered; and (ii) such events tend to be predictable from semantic information and therefore a high sampling rate is unnecessary [4]. Ultimately, we apply our iterative sensor selection methodology to the sensor-sample selection problem.

Evaluating our algorithms on the medical shoe reduces the sensor array from 99 sensors to 9. By coupling this reduction with sensor-sample reduction we gain an additional order of magnitude in energy savings while still maintaining high gait prediction accuracy.

[1] H. Noshadi, F. Dabiri, S. Meguerdichian, M. Potkonjak, and M. Sarrafzadeh, "Energy optimization in wireless medical systems using physiological behaviour," *Wireless Health*, pp. 128-136, 2010.

[2] J. M. VanSwearingen, K. A. Paschal, P. Bonino, and J. F. Yang, "The modified gait abnormality rating scale for recognizing the risk of recurrent falls in community-dwelling elderly adults", *Physical Therapy*, vol. 76, no. 9, pp. 994-1002, 1996.

[3] J. B. Wendt and M. Potkonjak, "Medical diagnostic-based sensor selection," *IEEE Sensors*, pp.1507-1510, 2011.

[4] S. Meguerdichian, H. Noshadi, F. Dabiri, and M. Potkonjak, "Semantic multimodal compression for wearable sensing systems," *IEEE Sensors*, pp. 1449-1453, 2010.

[1] Gait characteristics, such as step stride, lateral pressure, and guardedness, correlate to a number of ailments and diseases in the elderly and directly contribute to the prediction of risk of falling [2].