Guest Editorial
Sensor Informatics and Quantified Self

WEARABLE sensors, combined with signal processing, machine learning, and the ability to collect large sets of human data comfortably 24/7, are advancing new ways to learn about human well being. Measurements that used to be confined to short-term sampling in a lab or medical facility are now able to be conducted continuously, while at home, work, sleep, or play. Studies are no longer limited to a focus on disease progression or to the effect of therapeutic measures provided in clinical settings—instead, it is becoming possible to quantify *healthy* activities and behavior, and capture how these slowly change as illness develops or progresses.

The quantified self movement, where people can monitor their own health and fitness-related data, is closely linked to the emergence of new methods in biometric sensing. As the papers in this volume show, relatively inexpensive sensors, such as accelerometers, can be pressed into service for research and medical applications with complex analytical payoffs. The research progress evident in the papers published here, which mainly focus on increased sensitivity, accuracy, and individualized calibration, as well as on the identification of human relevant and human readable patterns from unannotated data, is likely to drive a wide range of new applications, whose reach extends far beyond the conventional health and medical research.

This special issue includes the following five papers, which all passed over a high bar including iterations of scientific peer review with a team of expert reviewers:

A. R. Fekr *et al.* present "Design and evaluation of an intelligent remote tidal volume variability monitoring system in e-health applications." This work shows that it is possible to calculate continuous measurement of both tidal volume and respiration rate from an accelerometer sensor placed on the chest. They demonstrate an overall respiration rate error of 0.29%, and correlations for tidal volume, evaluated over different breathing patterns, ranging from 0.72–0.96. They further show that the combination of the two measures can detect events of significance over daytime continuous wear, so that alarms may be provided with an accuracy of 80–98% for medically critical events as they happen in daily life.

A. Q. Javaid *et al.* demonstrate new more accurate ways to measure cardiac parameters from the subtle cardiac-driven motions known as ballistocardiography (BCG), sensed from a person putting their feet on a weighing scale. In their paper, "Quantifying and reducing posture-dependent distortion in ballistocardiogram measurements," they show how to improve measurements of BCG, while a person stands straight or slouched on the scale, or sits with their feet on the scale, allowing for improved robustness and usability of BCG at home.

The next two papers examined data from people with chronic obstructive pulmonary disease (COPD). H. Banaee and A. Loutfi worked with a large set of real-life physiological data from a population, including both COPD and healthy participants. In their article, "Data-driven rule mining and representation of temporal patterns in physiological sensor data," they show new ways to automatically express the underlying physiological patterns of the data in ordinary semantic language; thus, expanding the ways in which even expert observers can detect patterns that may have otherwise remained invisible.

G. Spina *et al.* in "Identifying physical activity profiles in COPD patients using topic models," worked also on data from COPD patients, but their emphasis is on unsupervised learning of physical activity patterns from the patients' longitudinal data. This paper and the one below, borrow methods from machine learning for text analysis. The main analogy exploited is to compare routine physical activities that come up during the day with "topics" that may come up during a conversation. Topic modeling is a technique that can discover and label these main themes. The authors show that the use of topic modeling for physical activities enables showing that physical activity routines for healthy participants and for COPD patients are substantially different in composition and in timing.

M. Altini *et al.* also use topic models in "Personalization of energy expenditure estimation in free living using topic models," but their focus is on solving the problem of how methods for computing energy expenditure can be personalized to adjust for differences caused by the fitness level that affects the heart rate produced by an activity, without having to do calibration or lab tests. They show that their method, applied to 14-day free-living data, can estimate heart-rate normalization parameters in a way that can reduce error in energy expenditure estimates by over 10%.

This special issue would not have been possible without the thorough and helpful effort of all the reviewers, the editorial team of the IEEE JOURNAL OF BIOMEDICAL AND HEALTH INFORMATICS, and especially the hard work of Editor-in-Chief G.-Z. Yang for his extensive hands-on wisdom and guidance throughout the preparation of this special issue.

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