

# Low-power wearable sensing for preventive healthcare

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**Abstract—** Low-power wearable sensing will soon allow the quantitative and continuous measurement of health parameters. In this paper we illustrate how wearable sensors can be used to track activity and energy expenditure, and measure stress. Soon such information may empower people in managing their own health, and provide the necessary data to enable a preventive approach to healthcare.

## I. THE SHIFT TO PREVENTIVE HEALTHCARE

Increasing healthcare costs are pushing for a disruptive change to the healthcare model. Healthcare should increase its focus on maintaining people healthy, by raising everyone's awareness of his own health and by inducing efficient behavioral changes. In the last few years we have seen a multiplication of consumer devices for tracking activity and calorie expenditure. Health savvy consumers embrace these devices although the relevance and accuracy of the information that is provided remains to be proven. One of the main challenges is to develop technologies and tools to gather accurate, reliable and actionable information of high quality that empowers people in managing their health.

Low-power wearable sensing promises to raise the quality of health monitoring in every-day life environments. Wearable sensors will enable continuous and reliable monitoring of health parameters over extended period of time. They will provide quantified data on specific health conditions that can be used to trigger and monitor behavior change. In this paper, two examples will demonstrate how wearable sensors may empower people with new tools for better health management.

## II. TRACKING ACTIVITY AND ENERGY EXPENDITURE

Lack of physical activity is one of the major health problems in most of the western world and is the 4th leading risk factor for global mortality. Accurate quantification and assessment of habitual physical activity in ambulatory settings is essential in order to unveil important links between physical activity and health [1]. We have developed a wearable sensor system tracking activity and energy expenditure. The system is based on low-power wireless sensor electronics that measure ECG and 3D-acceleration. The 3D-accelerometer data is used to classify activities. Energy expenditure is derived from the acceleration, heart rate and anthropomorphic data using activity-specific models [2]. The low power electronics lead to an autonomy of one week when streaming data points every second.

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The system has been validated on a population of 19 healthy subjects, asked to perform a wide set of sedentary, household, lifestyle and gym activities. An indirect calorimeter (Cosmed K4b2) system was used as reference. We reported an increase in EE estimation accuracy ranging from 18 to 31% for our energy model when compared to state of the art single and multi-sensor activity-specific methods [2]. When compared to the Cosmed system, our system achieves 90% accuracy on average, over all activities and subjects, in laboratory conditions.

## III. MEASURING STRESS

Stress is the second most frequent work-related health problems in the European population [3]. Many stress-related health problems could be prevented by detecting stress at an early stage, for example using physiological data. Following this idea, we have developed a network of wearable sensors to measure physiological signals known to be affected by stress responses: ECG, respiration rate, electrodermal activity and EMG of the Trapezius muscles. Specific features are extracted from these signals, which are then used to classify stressful and relaxing situations.

We evaluated our method on a population of 30 subjects, using questionnaires as reference. On average, we found that it was possible to distinguish stress from relaxing conditions with 80% accuracy [4] in a controlled environment. We then explored the possibility to extend this approach to obtain a continuous stress level estimate [5].

## IV. CONCLUSION

Low-power wearable sensing provides the fundamental data needed to drive behavior change. Here we discussed how wearable sensors can be used to track activity, energy expenditure and stress. Further validation of the technology, integrated with complete mobile health tool, will be required to demonstrate its ability to drive preventive healthcare.

## REFERENCES

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