Demo: eSense - Earable Platform for Human Sensing

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Figure 1: (a) eSense open wearable platform with audio, motion, and BLE sensing powered by a CSR processor and a 40mAH battery and (b) eSense manifested in a well-being feedback application in a quantified enterprise environment

CCS CONCEPTS

• **Human-centered computing** → **Ubiquitous and mobile computing systems and tools**;

1 INTRODUCTION

The era of wearables has arrived. As more and more established forms (e.g., a timepiece, a ring, a pendant) get a digital makeover, they are reshaping our everyday experiences with new, useful, exciting and sometimes entertaining services. However, to have a broader impact on our lives, the next generation wearables must expand their monitoring capabilities beyond the narrow set of exercise-related physical activities.

To this end, we present eSense - an aesthetically pleasing, and ergonomically comfortable in-ear high definition wireless stereo wearable (Figure 1(a)) instrumented with a microphone, a 6-axis inertial measurement unit and dual model Bluetooth and Bluetooth Low Energy (BLE) in an open architecture. These embodiments collectively enable eSense to offer three sensing modalities - audio, motion, and proximity - derived from microphone, accelerometer, gyroscope, and BLE, respectively. Most importantly, eSense is an entirely open platform that allows developers to gather real-time data streams of these different sensory modalities as well as offering them with several configuration and reprogramming capabilities.

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We have systematically explored the differential characteristics of the BLE, audio and inertial signals captured by eSense in a variety of experimental settings. We have looked at how eSense compares against a smartphone and a smartwatch concerning some key factors that impact activity recognition pipelines, including sampling variability, signal to noise ratio, placement invariance, and sensitivity to motion artefacts. Analysis of these experimental results suggests that eSense is robust in modelling these signals and in most conditions demonstrates superior performance concerning signal stability and noise sensitivities. Inspired by these characteristics, we have designed a set of activity primitives related to physical, mental, and social well-being. Activity classifiers are then trained to model these activities with BLE, audio and motion signals, and their combinations. Experimental results demonstrate that eSense can reach up to 88% accuracy in converting BLE, accelerometer, gyroscope and audio signals into the targeted human activities. Taken together these and the rest of our findings demonstrate the exciting potential of eSense as an in-ear wearable sensing platform for designing individual scale multi-sensory applications.

2 DEMONSTRATION

The demonstration will showcase a quantified enterprise application (as depicted in Figure 1(b)) with eSense earbuds where this ultra-wearable enables personalised and conversational feedback on a variety of well-being attributes in an enterprise context [1, 2].

REFERENCES

[1] Mathur et al. Tiny Habits in the Giant Enterprise: Understanding the Dynamics of a Quantified Workplace. In *ACM UbiComp* 2015.
[2] Mashhadi et al. Understanding the Impact of Personal Feedback on Face-to-Face Interactions in the Workplace. In *ACM ICMI* 2016.