Mobile System For Self-Monitoring Of Asthma

Justice Amoh, Teresa Y. Ou, Malika Khurana, Vibhu Yadav, and Kofi M. Odame

***Abstract*— A wearable device for self-monitoring of asthma symptoms is introduced. Experimental results from an early prototype show that the proposed device is a feasible approach for asthma symptom monitoring.**

I. INTRODUCTION

Each year, more than 700 million hospitalizations and emergency department visits in the US result from episodes of asthma and chronic obstructive diseases [1], largely due to poor management of symptoms [2]. In this paper, we present a novel wearable device that continuously monitors patients' asthma symptoms.

II. DEVICE OVERVIEW

Figure 1 shows the proposed device. It is attached to the user's chest like a bandaid, and includes a piezoelectric transducer (PZT) for acquiring pulmonary sounds and a 3-axis accelerometer for measuring motion data. The device weighs 6.02g and has an average power requirement of 5.26mW. The sensor signals are conditioned, digitized and wirelessly transmitted to a smartphone for further processing. The accelerometer data is used as a reference signal in a least mean square adaptive filter for removing any motion artifacts that have corrupted the PZT-acquired pulmonary signal. Next, hidden Markov model (HMM) classifiers [3] are used to detect asthma symptom events (coughs and wheezes) in the pulmonary signal.

A smartphone application for visualizing the user's symptom severity and frequency is currently under development. We are considering using a virtual 'pet' whose wellbeing is tied to how well the user manages his symptoms.

III. EXPERIMENTAL RESULTS

We played sounds through a silicone chest phantom, to which the prototype device was attached. Figure 2 shows that, when the PZT is mechanically disturbed, the motion artifact removal algorithm is able to recover a clean cough sound sample. Figure 3 shows the different responses of the PZT when attached to the chest phantom with various types of adhesive, suggesting that adhesive type and topology barely affects sensitivity and hence choice of adhesive can be entirely based on sensor aesthetics, user comfort and mechanical robustness. The measured accuracy of the HMM cough classifier, using 50 cough samples and 50 speech test samples, was 94 % sensitivity and 71% specificity.

IV. CONCLUSION

The proposed device has the weight, size, power consumption and robustness to motion artifact that make it a feasible solution for continuous monitoring of asthma symptoms. Future work will include improvements to the classifier to increase its specificity, as well as the development of a visualization application for the user's smartphone.

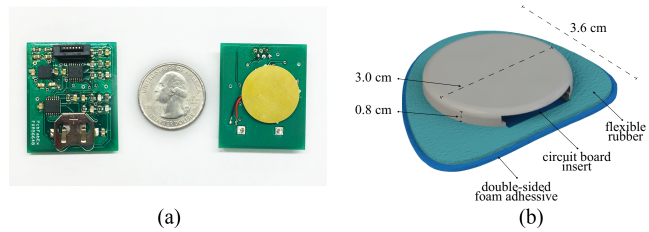

Figure 1. (a) Image of front and back of sensor showing piezoelectric transducer and front-end electronics. (b) Render of ergonomic casing for sensor with attached foamy adhesive.

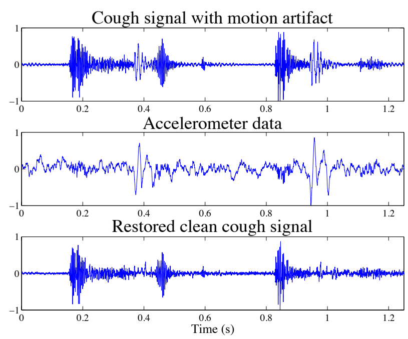

Figure 2. Motion artifact present in cough signal is removed through adaptive filtering, using accelerometer data.

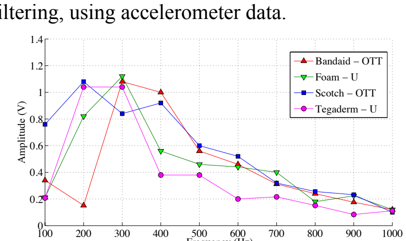

Figure 3. Sensor sensitivity and frequency response for different adhesives with either an over-the-top (OTT) or underneath (U) topology.

REFERENCES

[1] David W Brown, Janet B Croft, Kurt J Greenlund, and Wayne H Giles. Trends in hospitalization with chronic obstructive pulmonary disease-united states, 1990–2005. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, 7(1):59–62, 2011.

[2] P.G. Gibson, H. Powell, J. Coughlan, A.J. Wilson, M. Abramson, P. Haywood, A Bauman, MJ Hensley, and EH Walters. Self-management education and regular practitioner review for adults with asthma. *Cochrane Database Syst Rev*, 3, 2002.

[3] Sergio Matos, Surinder S Birring, Ian D Pavord, and David H Evans. Detection of cough signals in continuous audio recordings using hidden markov models. *Biomedical Engineering, IEEE Transactions on*, 53(6):1078–1083, 2006.

*Research supported by Neukom Institute for Computational Science and the Digital Arts, Leadership & Innovation Laboratory.

The authors are with Dartmouth College, Hanover, NH 03755 USA. (e-mail: justice.amoh.jr@dartmouth.edu; phone: 603-513-8411).