‘Disappearing Sensor’-Textile Based Sensor for Monitoring Breathing

Li Guo[1,2,#], Suchawadee Ratnarathorn[3], Lena Berglin[1], Urban Wiklund[4], Leif Sandsjö[5,6,*]

1) The Swedish School of Textiles, University College of Borås, Borås, Sweden 2). Tampere University of Technology, Tampere, Finland
3)Chalmers University of Technology, Gothenburg, Sweden 4) Department of Biomedical Engineering & Informatics, University Hospital, Umeå, Sweden
5) School of Engineering, University of Borås, Borås, Sweden 6) MedTech West, Sahlgrenska University Hospital, Gothenburg, Sweden

li.guo@hb.se, * leif.sandsjo@medtechwest.se

1. Introduction

The monitoring and interpretation of respiration pattern plays an important role for the early detection and the prevention of serious illness, such as asthma, sleeping apnea, bronchitis, and lung cancer. In this interdisciplinary project a system based on a smart shirt with integrated textile sensor for personal respiratory monitoring was developed. Textile products are flexible, washable and bring no discomfort to wearers. The smart shirt is an excellent interface for performing long term respiratory monitoring in real-life situations outside the clinic.

2. Prototype Garment

• The garment was made of highly stretchable knitted fabrics;

• The sensing unit was coated by conductive silicone (brand name ELASTOSIL® LR 3162 from Wacker. Ltd);

• Conductive braided yarns was piped into the seams of the vest as data transmission wire;

• Snap buttons were used as the interface between SmartShirt and the portable electronic box;

• Velcro was used in both shoulder and underarm positions to guarantee the shirt to fit tightly to the wearer which increase the sensitivity of the sensor.

• Reference Sensor: EZ- Piezoelectric Respiratory belt from EPM Systems, Midlothian, VA.

Figure 1: The prototype garment and the testing setup.

3. Testing Methods

A sketch of the testing circuit is shown in fig.2. A Data Acquisition Device (DAQ) from National Instrument (NI) has been used to collect the signal. A LabVIEW programme was developed for real time monitoring.

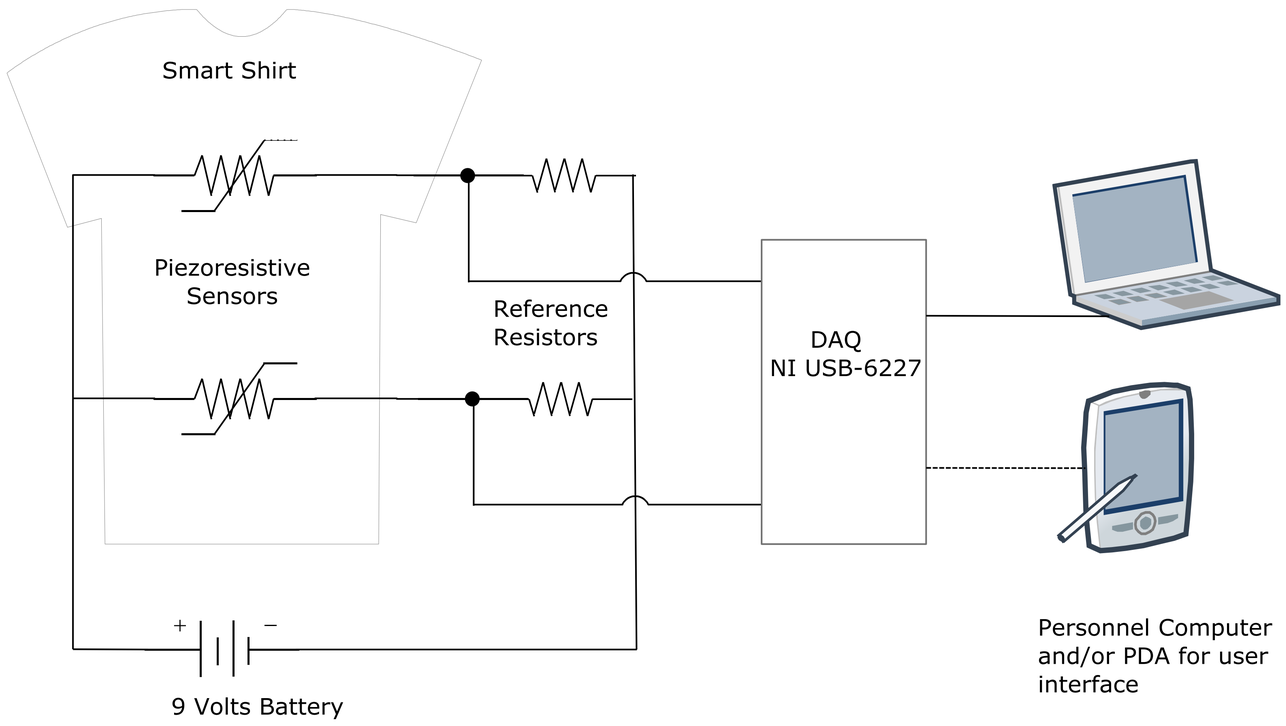

Figure 2: SmartShirt system block diagram

4. Results

Results were obtained from different breathing patterns in a healthy young subject.

Agreement between the reference sensor and the SmartShirt (Fig. 3A) :
• chest sensor: r=0.74 0.12, p=0.01
• abdomen sensor : r=0.70 0.07, p=0.01
• Intra-class correlation coefficient: r=0.92 0.05, p=0.01

Breathing rate detection (Fig.3B):
• Normal Breath: Error rate= 0
• Fast Breath: Error rate= 1.28% (subject No. 4)
• Slow Breath: Error rate= 0

Apnea simulation (Fig.3C):
• The Smart Shirt system was able to detect 10-seconds interruption in breathing

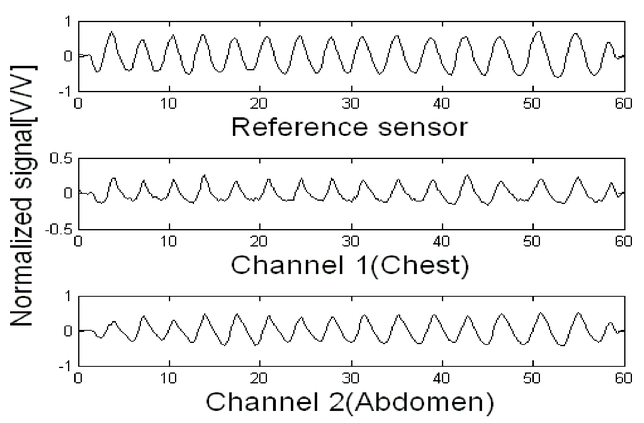

Figure 3A : Comparison with reference sensor.

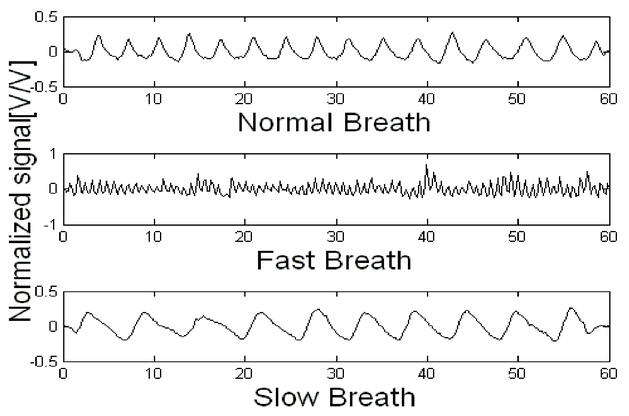

Figure 3B Breathing rate detection.

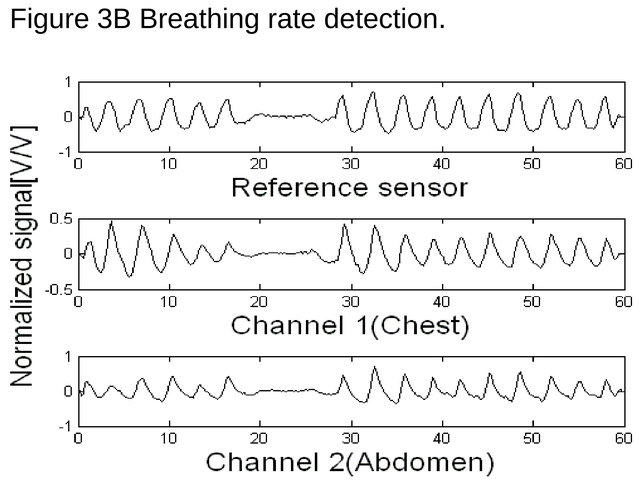

Figure 3C: Apnea simulation.

5. Conclusions

The smart shirt successfully combines the functionality with ease of integration into a textile product. The shirt maintains the accuracy of sensing without sacrifice the level of comfort for the wearer. Future work should focus on removing the movement artifacts and with the further development of the network communication home healthcare and monitoring can be expected.

THE SWEDISH SCHOOL OF TEXTILES
UNIVERSITY OF BORÅS

TAMPERE UNIVERSITY OF TECHNOLOGY

CHALMERS

MedTech West

UMEÅ UNIVERSITET

UNIVERSITY OF BORÅS
SCHOOL OF ENGINEERING