KNITTED STRAIN SENSOR FOR RESPIRATION MEASUREMENT

The Improvement of Sensor Characteristics by Intarsia Knitting

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Sensor Material and Structure:

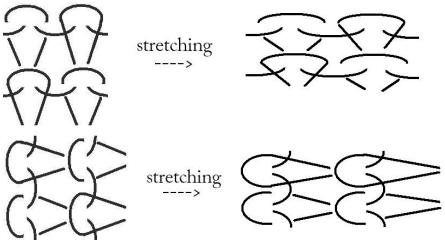

Figure 1: Structure deformation by stretching in course direction and wale direction.

Knitted strain sensors are made by Lycra and conductive yarns with knitting and intarsia knitting techniques. The fabrics were 1x1 ribs in both cases. When stretch applied on knitted fabrics there are two kinds of deformations, deformation of structure and deformation of yarn. When stretch occurs on course direction the main deformation is structure deformation along the course direction, which happens by the relative position and shape change of knitted loops. On the other hand, when stretch happens on the wale direction, the major mechanism of deformation is the yarn deformation. Integration the conductive yarn into the wale direction has been done by intarsia technology. A schematic picture in figure 1 shows the strain application direction.

Sensor Sensitivity (Gauge Factor) and Transfer Function:

$$GF = \frac{\Delta R/R}{\Delta L/L}$$

Sensitivity can be defined as the ratio of relative change in electrical resistance to the mechanical strain. By calculation, gauge factor is 0.4 when stain applied on course direction while it is 1.8 on wale direction. The transfer function gives the relationship between sensor output and input. Transfer function of two samples are given in figure 2, intarsia sample gives an linear or quadratic resistance change corresponds to the stain, the standard deviation of quadratic are smaller than linear one. The transfer function of normal 1x1 ribs are not so fitin with both first and second order relations.

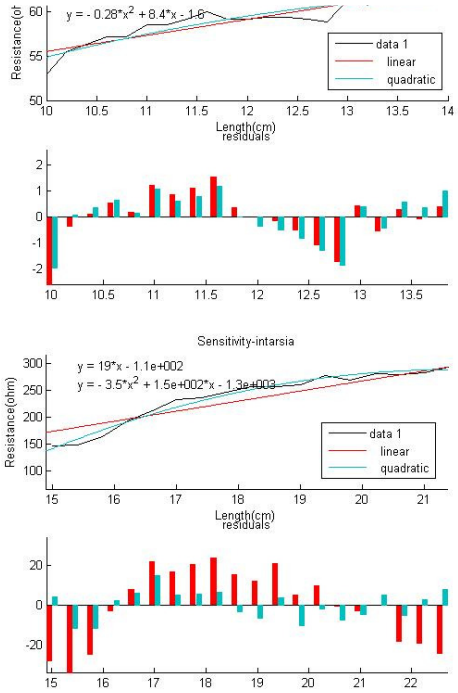

Figure 2: Sensor sensitivity and the transfer function

Experimental Results:

Sensors used as respiration sensor measured both normal breath and the deep breath. As we can see from figure 3, by knitting with intarsia technology and applying strain in wale direction improves the measurement result. The normal breath is almost no detectable when stretching in course direction. When breathing deeply, breath cycles can be easily measured with the intarsia sample.

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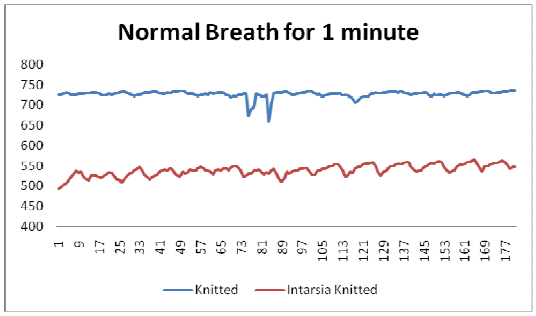

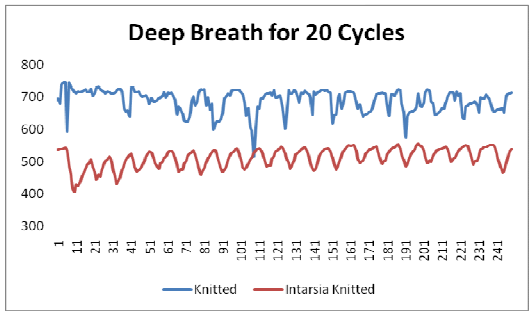

Ref: 1.J.Fraden.chap.2, Handbook of modern sensors.3rd Edition.
2.L.Guo,L.Berglin. Test and evaluation of textile based stretch sensors. Autex 2009

Figure 3: Respiration measment with normal and deep breath by normal knitted and intarsia knitted sensors.