Investigation for knitting an inductive sensor using electroconductive yarn

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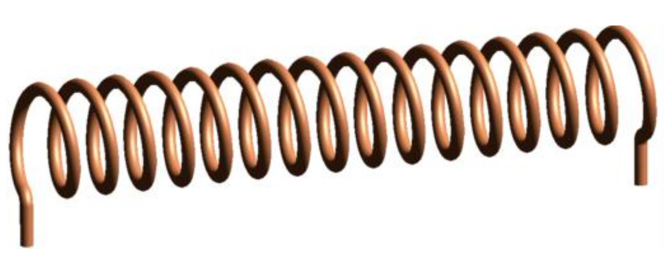
Introduction:

Health monitoring is one of the newest areas where wearable sensing concentrating in creating new products. This project investigates the manufacturing of inductive sensors through Computerized Flat Knitting technology for wearable health monitoring applications. An inductor is a passive electronic component consisting of a coil that is designed to exploit the relationship between magnetism and current as the current flows through the coil. When an electric current flows through a conductor, a magnetic flux is created around the conductor. An inductor is another passive type of electronic component that consists of coils of wire and uses this relationship to generate a magnetic field through a current flowing through the coil itself or its core. The sensor will use the change in the inductance of the coil due to the coil deformation or proximity to a magnetising material to sense.

The equation the inductance of a solenoid (coil):

$$L = \mu_0 \frac{N^2 A}{l}$$

Inductor Coil:



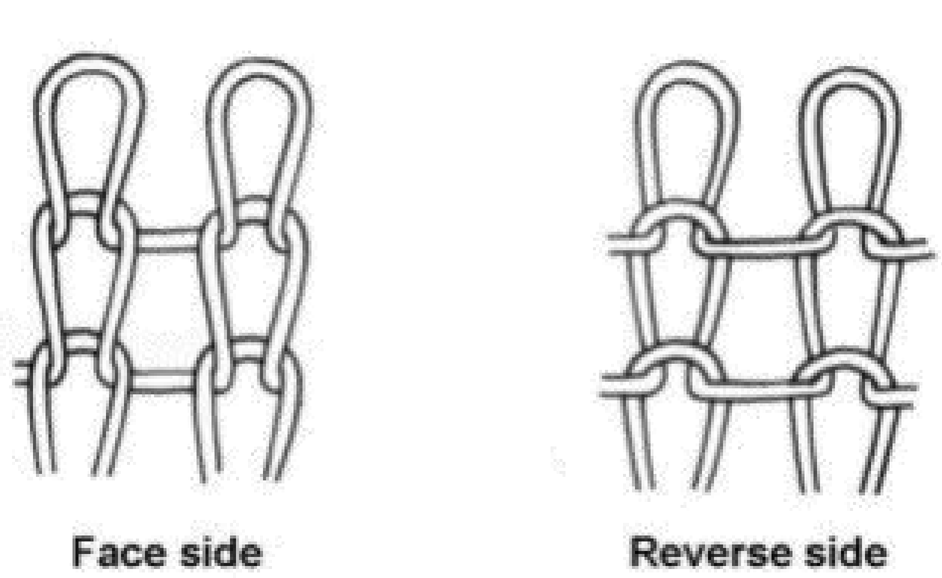
Materials:

copper yarn, silver yarn and acrylic yarn

Methodology:

1. Design the inductive sensors. One structure of the sensor is plain tubular, with a helical knitted electroconductive course knitted every 4th course and 8th course. The second design is a rectangular sensor based on a spacer structure.
2. Construct the inductive knitted sensor with Shima Seiki flat knitting machine.
3. Using a LCR meter to measure the inductance under sensor deformation, proximity to magnetisable material and variable input signal frequencies.

The knitting structure:



The knitted samples

The UNI-t UT612 LCR meter

Result of the testing:

The inductance of the knitted tubular inductors was tested for sensor deformation, proximity and variation in input signal frequency. The inductive sensor showed that a knitted inductive sensor would need to be produced with a high number of turns and highly magnetisable core materials for reliable inductive responses.

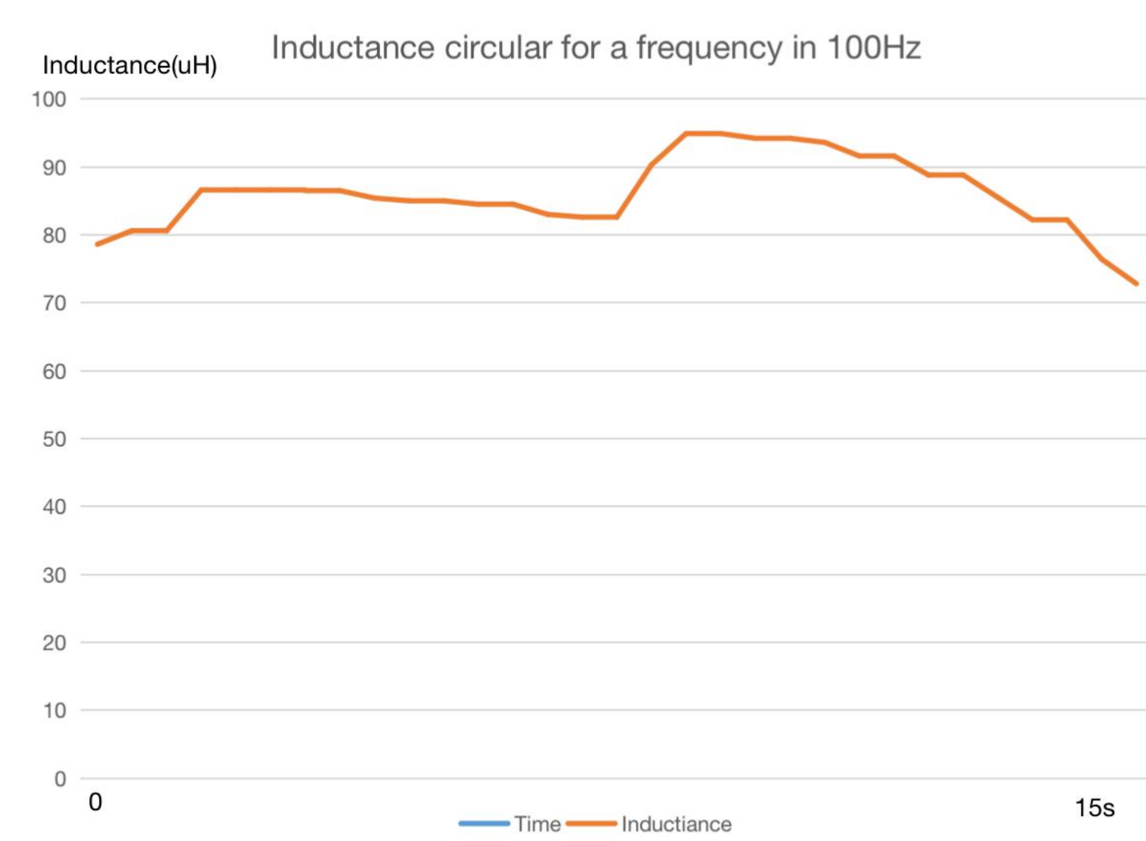


Figure: Inductance fluctuation during the test

The reasons for the variability in the test results:

1. The low inductance of the knitted solenoid is affected by nearby electromagnetic fields.
2. Movement in the electroconductive fibres due to air currents could change in inductance value.
3. The knitted inductive sensor has too few turns to generate a high enough inductance. Since the maximum inductance of the LCR meter is much more higher , it cannot accurately measure the inductance values, in which case the data fluctuates.

Recommendations:

The inductive sensor should have more conductive yarn turns and integrated knitted core magnetising material to achieve a usable inductance response. In the future, it could be used in detection for motion monitoring in textile based wearable sensing applications (Wijesiriwardana,2006)

Reference:
Wijesiriwardana, R. (2006). Inductive Fiber-Meshed Strain and Displacement Transducers for Respiratory Measuring Systems and Motion Capturing Systems. Vol.6 (3), p.571-579