Textile sensor glove for health monitoring - Application in home assessment of Rheumatoid Arthritis

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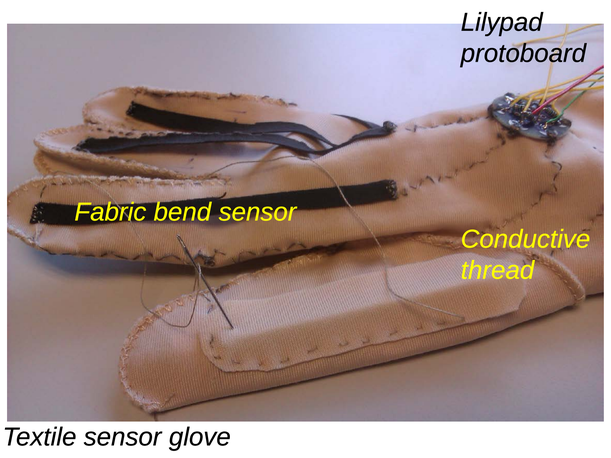
BACKGROUND

Wearable sensors and smart textiles offer the possibility of monitoring the body in an unobtrusive manner. Smart garments may be used to assess chronic conditions at home and may also be used as a rehabilitation tool. As part of a user interface system, visual and audio feedback can be given to motivate users and encourage adherence to prescribed exercises. Home monitoring of exercise performance can indicate effectiveness of treatment to therapists.

This work focusses on the use of a sensor glove for home assessment of rheumatoid arthritis in assessing joint stiffness through range and velocity of movement.

MATERIALS AND METHODS

A sensor glove has been developed using fabric stretch sensors integrated into an oedema glove. The stretch sensors are made of a knit fabric coated with conducting polymer, giving them piezoresistive properties. This means that when the fabric is stretched the resistance changes, which can be measured using straightforward circuitry and captured using a microprocessor platform. An arduino fio with integrated Xbee radio is used to collect and wirelessly transfer the data to a laptop.



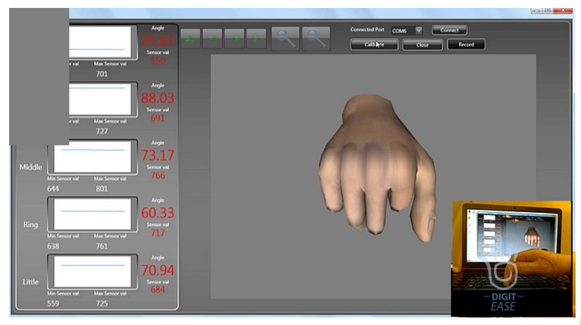
Textile sensor glove

Bespoke software records objective routines that are defined by the clinician and performed by the patient at home at set times throughout the day. Each routine is analysed by controlling software and partitioned into constituent repetitions. These are further subdivided and provide timing information on flexion and extension movement. Information is presented to the clinician as an assistive tool to aid with finger joint range of motion (ROM) assessment.

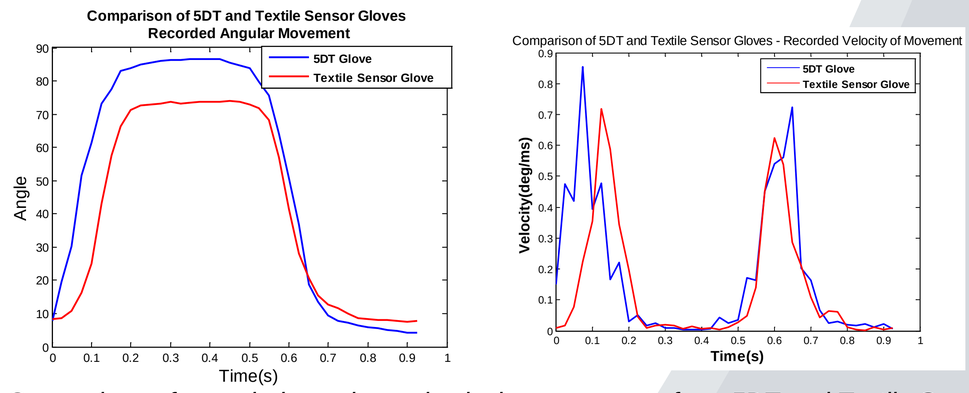
The oedema fabric sensor glove has been compared to the 5DT off-the-shelf virtual reality glove to determine accuracy of ROM measurement. The 5DT glove is a popular high-end commercial product that is representative of current state-of-the-art data gloves.

RESULTS

Both gloves were simultaneously worn on the dominant right hand of a subject with 7 ¾ hand size. Both gloves were connected to individual computers hosting identical copies of controlling software. The subject completed an objective routine defined within the controlling software. The routine consisted of 12 flexion and extension repetitions that measured movement of the middle metacarpophalangeal (MCP) finger joint. The first repetition was used to synchronise recordings between computers.



Bespoke software instructs the user and provides feedback



Comparison of recorded angular and velocity movements from 5DT and Textile Sensor Glove for extension/flexion repetition no. 11 of 12.

Initial results demonstrate a high correlation ($p > 0.96$) of recorded angular movement between the oedema fabric sensor glove and 5DT virtual reality glove. The high movement interdependence demonstrates comparative ROM capability between both gloves, although the oedema glove costs a lot less than the 5DT glove.

CONCLUSIONS

The advantage of the glove is in the fit and comfort for the wearer, the sensors and the glove itself are made from a lycra and spandex material. Conventional bend sensors and fibre optics are more rigid and while suitable for computer gaming and motion capture applications, they are not ideal for use in people with impaired dexterity and mobility.

This work presents a low-cost solution for home assessment of conditions such as rheumatoid arthritis and a means for user feedback to assist and motivate users with prescribed therapeutic exercises

Initial comparative testing between the oedema fabric sensor glove and 5DT virtual reality glove demonstrate high levels of interdependence. This achievement exhibits the gloves capabilities when compared to a commercial state-of-the-art glove product.