Day-long continuous measurement of hand movement for upper-limb prostheses

|Jessica Barnes, 130102201, MEng (Hons) Electronic & Electrical Engineering with Industrial Project | Under the supervision of Dr Kia Nazarpour |
|Biomedical Signal Processing Laboratory, School of Electrical and Electronic Engineering, Newcastle University |

Introduction

- Prosthetic hands can provide a route to functional rehabilitation and independence.
- A myoelectric hand prosthesis is controlled via electromyogram (EMG) recorded from muscle contraction within an amputee's residual forearm.
- Current prosthetic hands are limited to only a few degrees of freedom.

Aim

- Create a user-interface using computer programming to interact with a data glove.
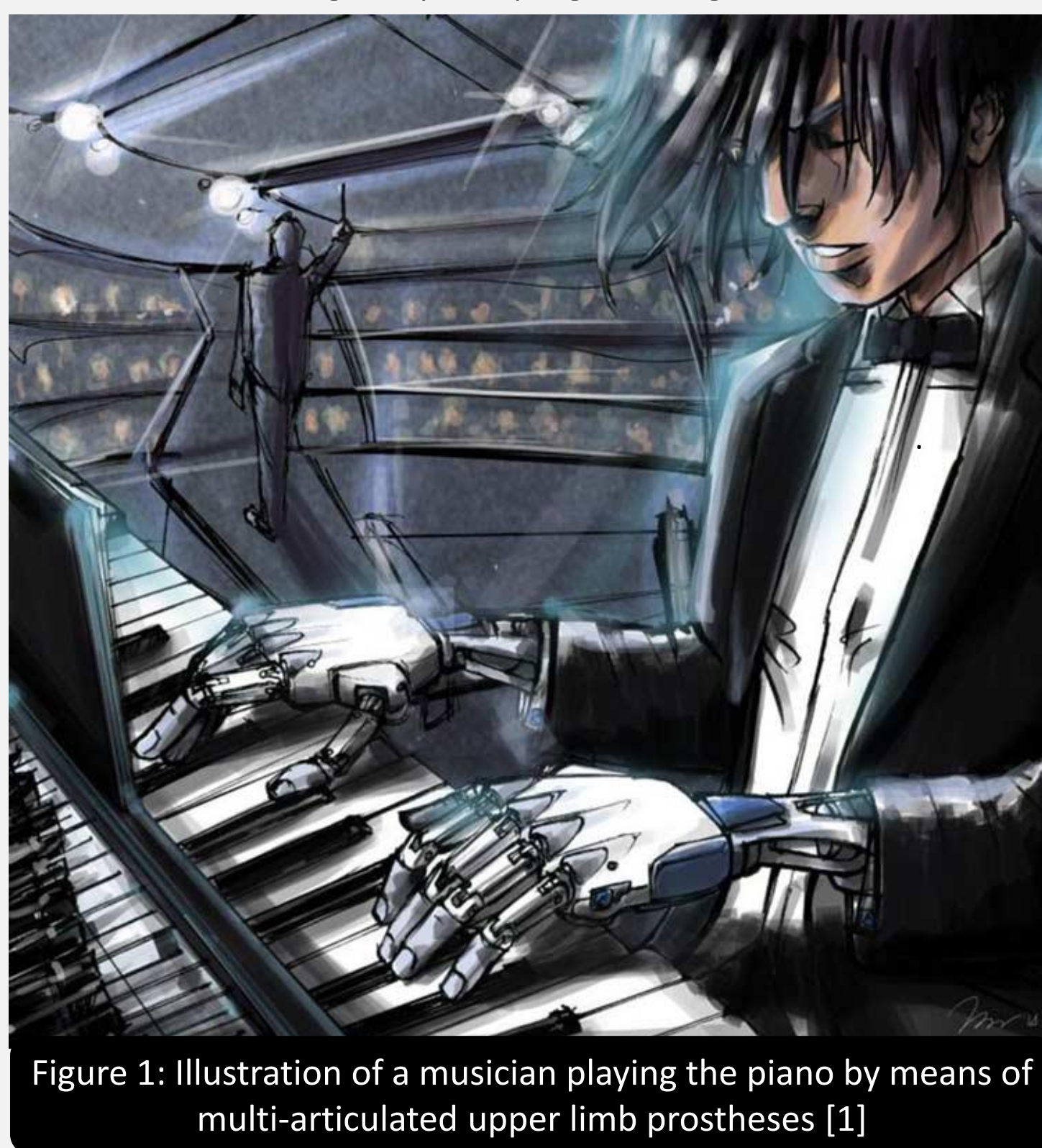

Figure 1: Illustration of a musician playing the piano by means of multi-articulated upper limb prostheses [1]

Objectives

- Design a graphical user-interface using C++ programming code.
- Record and save data of finger movements during natural behaviour; to be able to predict specific movements.

Societal Impact

This project addresses two of Newcastle University's societal challenge themes:

- **Ageing**: Data gloves could replace current 'labour intensive' ways in which patients' data is recorded, to improve a person's quality of life.
- **Social Renewal**: Amputees can overcome social barriers, to integrate back into society and live with a prosthetic as if it were their original hand [2].

Methodology

Data Glove Recording

Record Data   Record   Close Form

User Interface: Press record to start recording finger movement i.e. data from the glove

5DT Data Glove recording finger movement

Save measurements into a file to analyse data
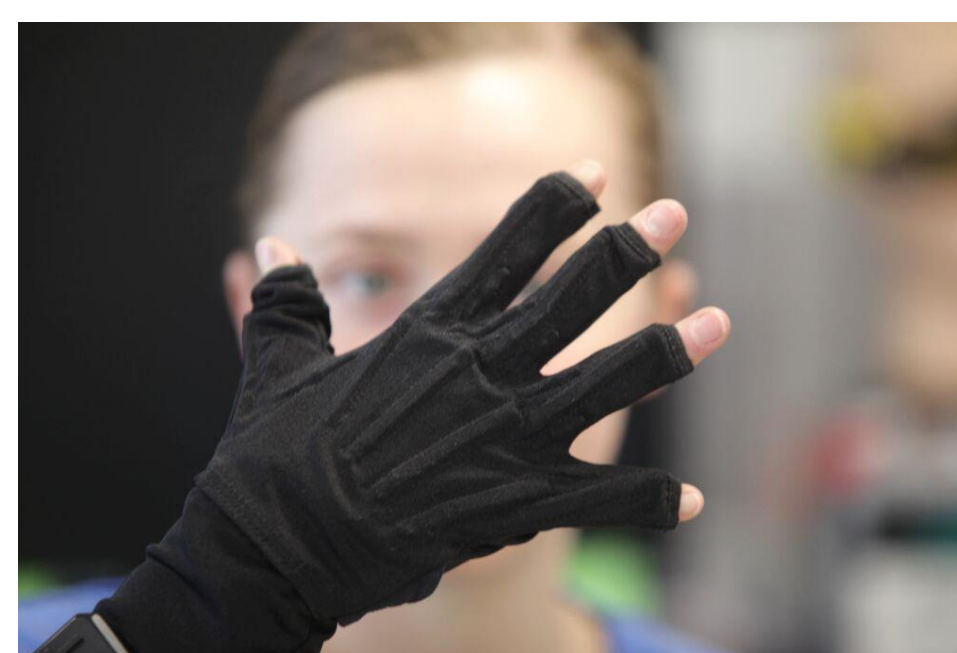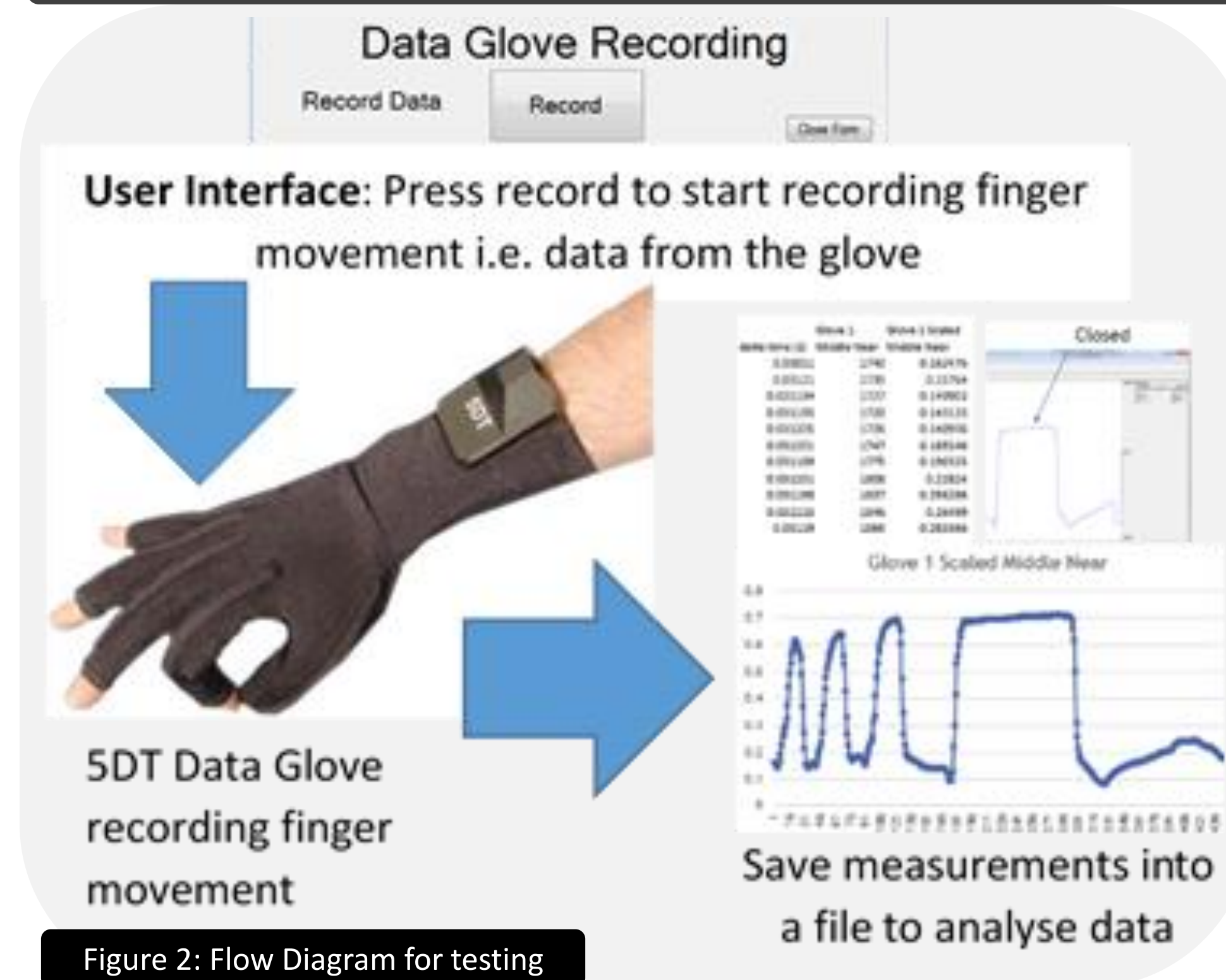
Figure 2: Flow Diagram for testing

Figure 3a: 5DT data glove open hand

- Data gloves measure finger flexion.
- Fibre optic strips of flexible material conduct to measure the finger position.

- Finger movements create electrical resistance.
- This is converted into data values by a Computer Processing Unit (CPU).
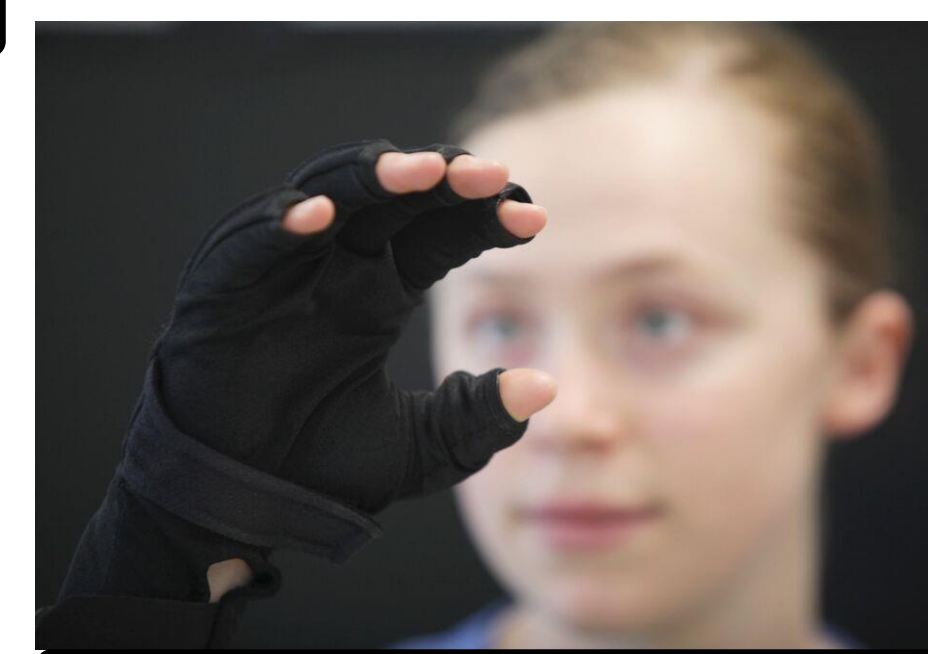

Figure 3b: 5DT data glove closing hand

Results and Discussion

- Figure 4 shows the recording of finger movements as graphs:
  - Right of the image which graph links to the finger recorded.
  - The hand is open at the start.
  - The hand begins to close (into a fist), one finger at a time.
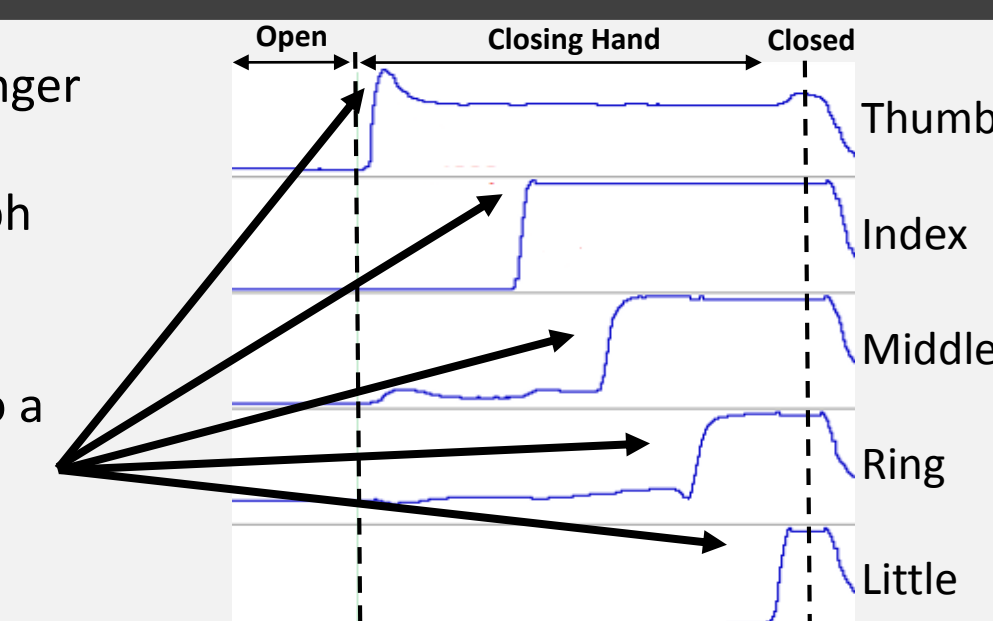 - Hand is then fully closed as annotated on the graph

Figure 4: Understanding the results

Open-Close Hand

Figure 5a: Glove Manager

Figure 5b: Graphical user-interface

- Figure 5a displays the data glove measurements of finger movement using the Glove Manager software.
- Figure 5b displays the data plot of the recorded data using the designed graphical user-interface.

- These results show the user wearing the data glove opening and closing their hand.

- Results show that the graphical user-interface can successfully record finger movement via the 5DT data glove, as it can produce the same results as the data glove software.

- Next steps: Addition of surface EMG to record muscle contractions, to record hand movement and muscle movement concurrently.
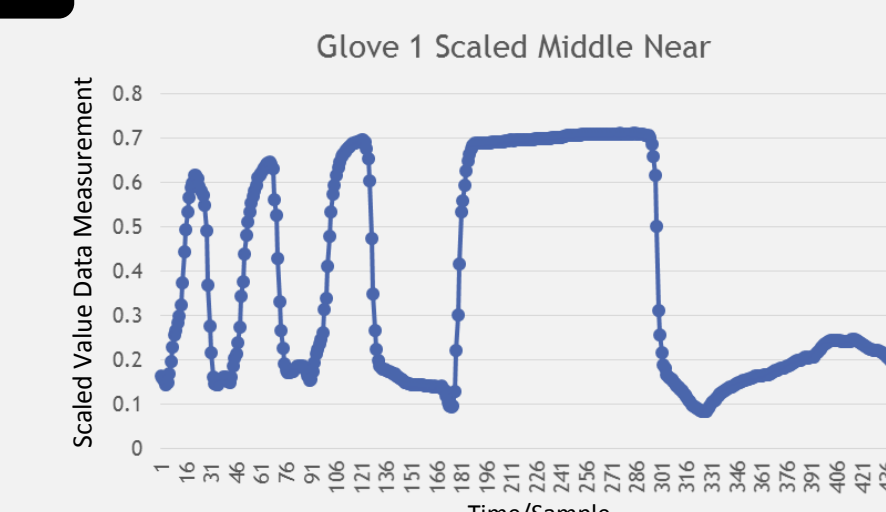
Conclusion

- The aim and objectives have been achieved: A graphical user-interface has been designed to interact with a 5DT data glove, and data has been recorded and analysed.

- In the future, such results may lead to further development of controllers that enable tasks that are unimaginable with current prostheses, e.g. playing the piano.

- This project has been a valuable experience to develop and prepare for further independent and post-graduate study.

References

[1] Guest Editorial, IEEE Transactions on Neural Systems and Rehabilitation Engineering, Vol.22, No.4, July 2014.
[2] Tackling Society's Big Challenges, http://www.ncl.ac.uk/about/assets/documents/bigchallenges.pdf

Further interest, please contact kia.nazarpour@newcastle.ac.uk

Newcastle University

Biomedical Signal Processing Laboratory

School of Electrical & Electronic Engineering