Investigating hand dexterity in patients with hand injuries through a self-made data collection glove

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Jong-Chen Chen’s resume

- Associate professor, Information Management Department, National Yunlin University of Science and Technology, Taiwan, 1994-1999
- Professor, Information Management Department, National Yunlin University of Science and Technology, Taiwan, 2000-now

Research interests

- He has published a number of papers in the fields of evolutionary computation, neural network, biological information processing, sensors, applied science, and artificial intelligence.

- His research interests include evolvable hardware, brain-like computer simulation, ecosystem simulation, bio-computing, artificial life, molecular electronics, evolutionary computation, genetic programming, and pattern recognition.

Introduction

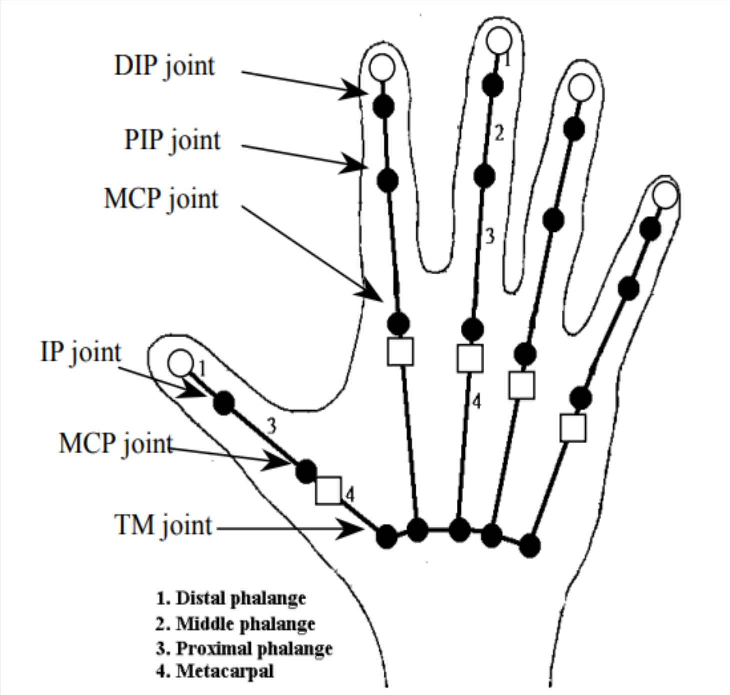
The flexibility of people's fingers plays a very important role in our daily life.

Unfortunately, a number of people lose some degree of finger dexterity due to finger injuries.

- The purpose of this study was to explore how people use their fingers in curvature and acupressure for daily movements.

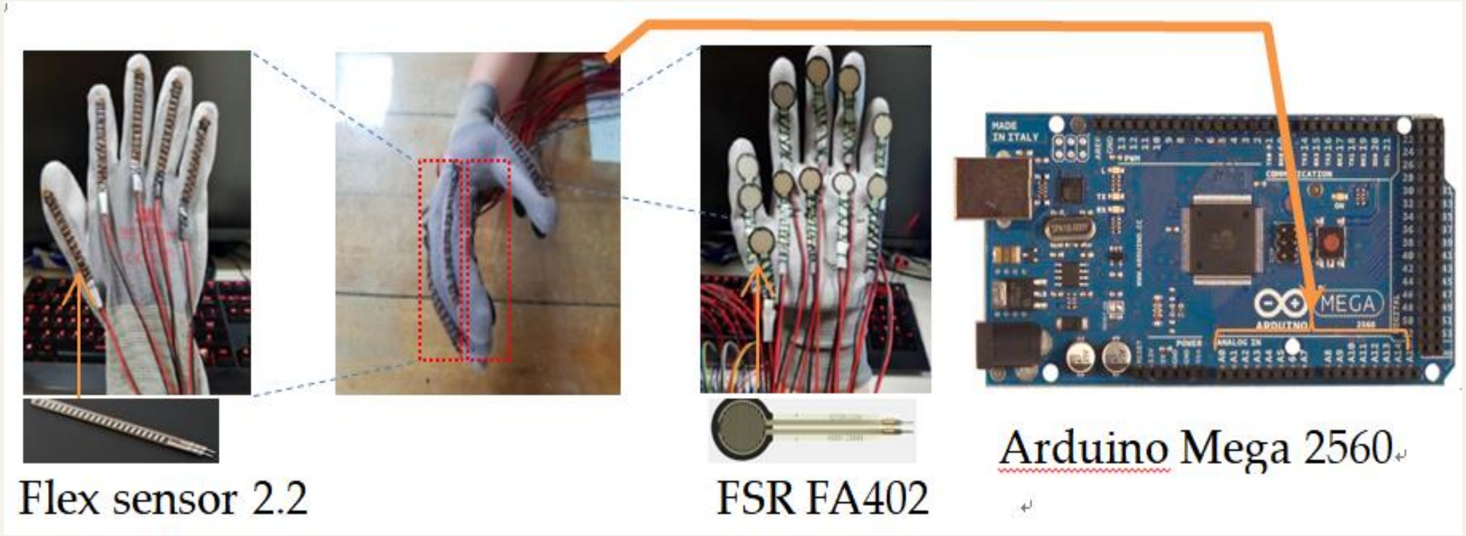
- The method adopted in this study is to first make an induction glove with curvature and acupressure, and then invite 30 healthy people to perform 8 daily movements.

Schematic diagram of hand's kinematic structure



The glove

- A homemade bending and pressure sensing glove.



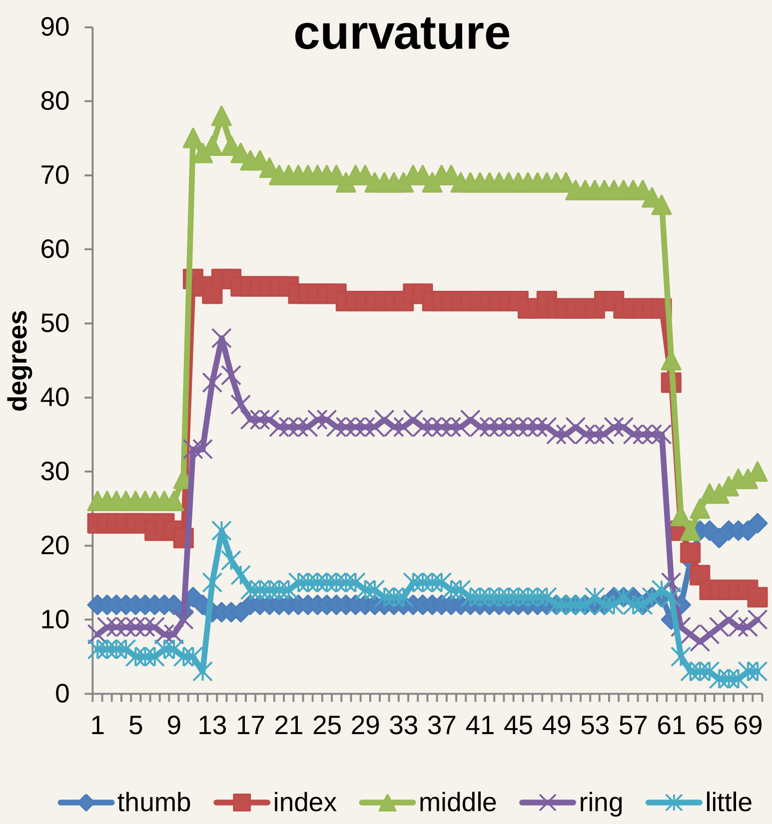
8 daily movements

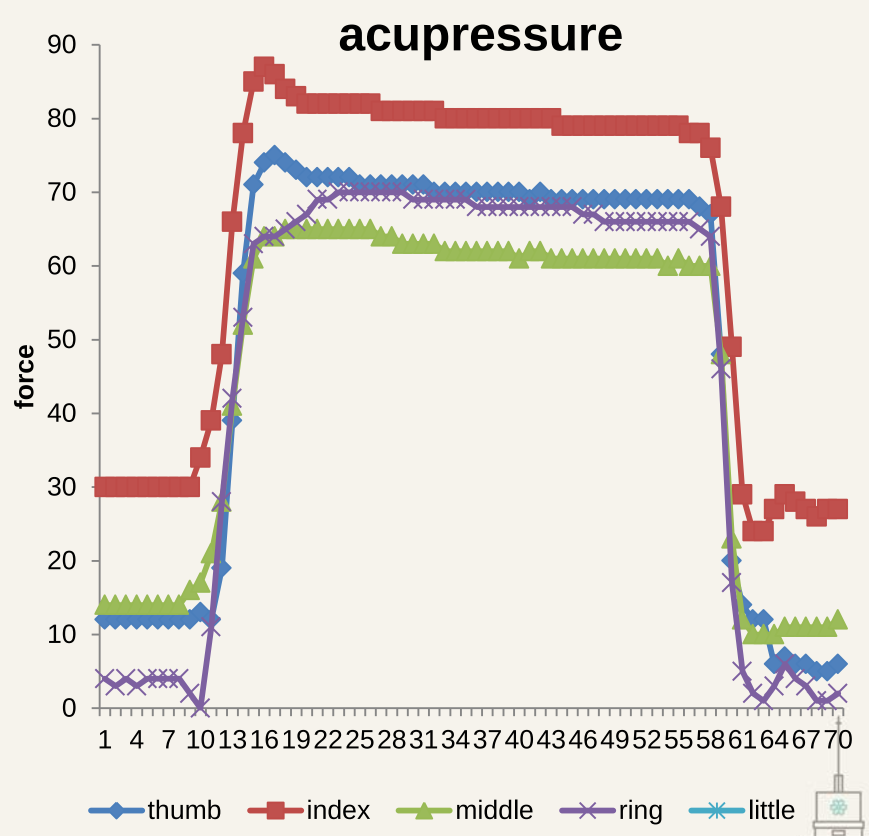
 hold a wine bottle	 hold a flat water bottle	 hold a mug	 squeeze toothpaste
 operate a mouse	 hold a ping-pong	 hold a marble	 write a Chinese

30 Healthy Subjects

Males	27
Female	3
Right-handed	30
Left-handed	0
Avg. age (years)	25.1±2.2
Avg. hand size (cm)	18.2±0.7

An example of curvature & pressure data (squeezing toothpaste)





Pearson Correlation

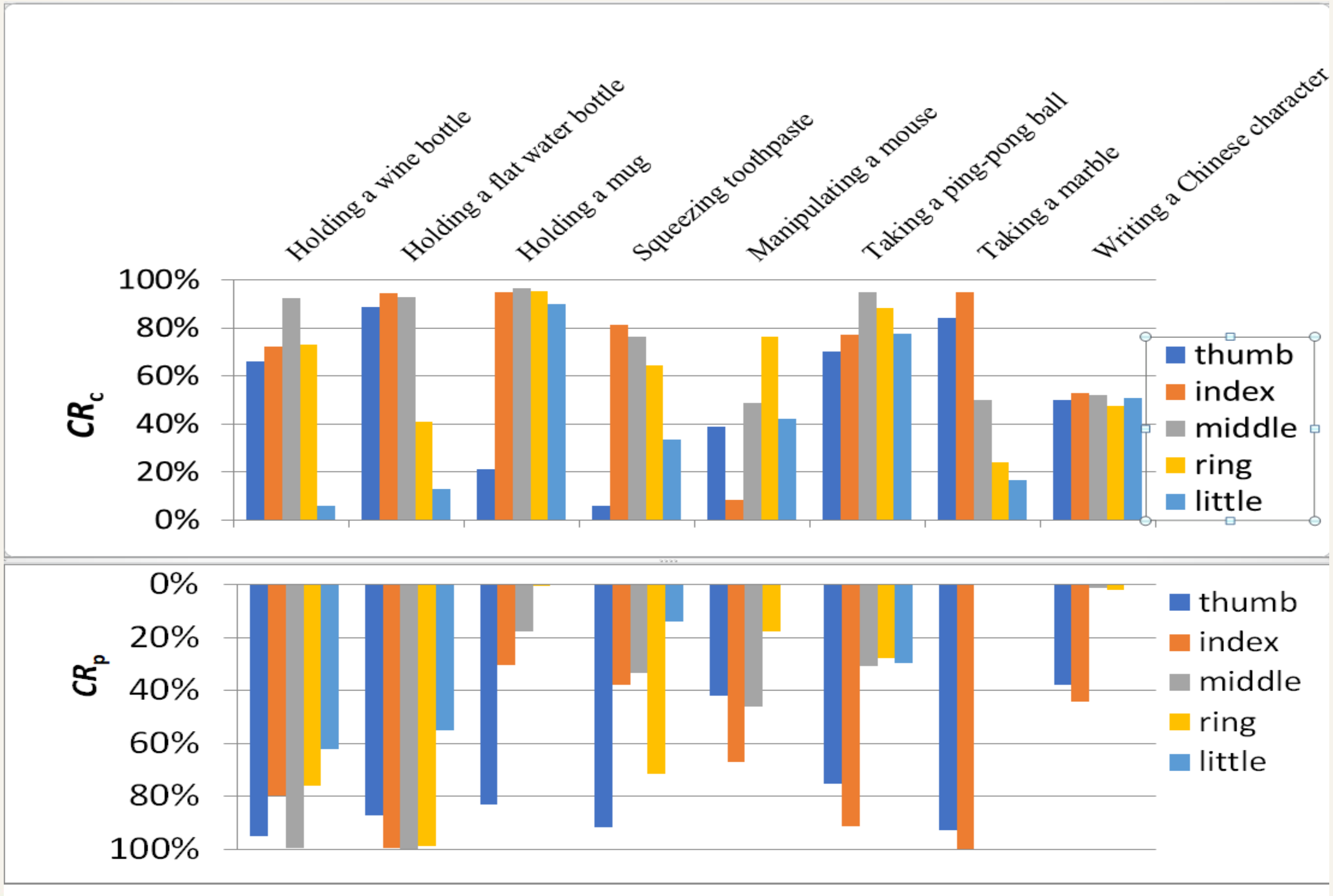
$$CR_c = \sum_{\substack{s_i=1,\\ s_j=1}}^{30} \sum_{r=1}^{4} \overline{\frac{\sum_{t=1}^{50}(C_{s_i rt}-\overline{C_{s_i rt}})^2 (C_{s_j rt}-\overline{C_{s_j rt}})^2}{\sqrt{\sum_{t=1}^{50}(C_{s_i rt}-\overline{C_{s_i rt}})^2}\sqrt{\sum_{t=1}^{50}(C_{s_j rt}-\overline{C_{s_j rt}})^2}}}$$

Where s_i, s_j=1,2 ,…,30; r=1,2,3,4; t=1,2,…,50

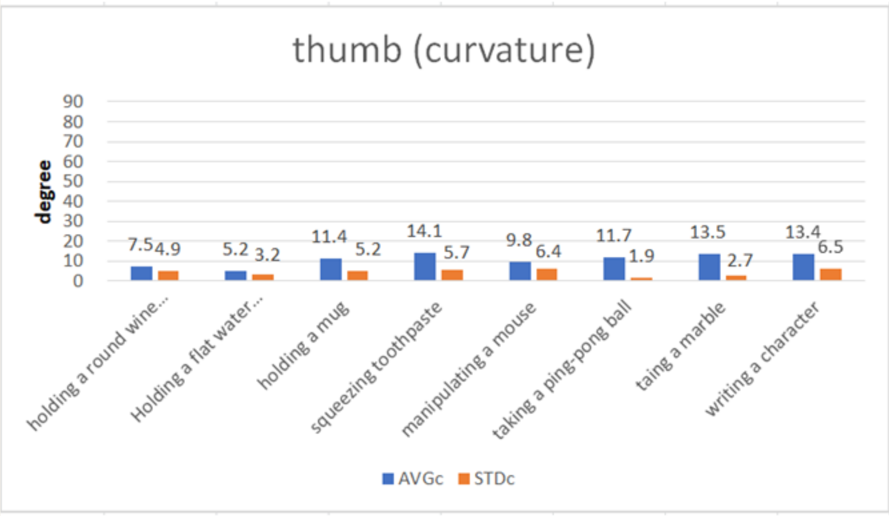
$$CR_p = \sum_{r=1}^{4} \sum_{\substack{s_i=1,\\ s_j=1}}^{30} \overline{\frac{\sum_{t=1}^{50}(P_{s_i rt}-\overline{P_{s_i rt}})^2 (P_{s_j rt}-\overline{P_{s_j rt}})^2}{\sqrt{\sum_{t=1}^{50}(P_{s_i rt}-\overline{P_{s_i rt}})^2}\sqrt{\sum_{t=1}^{50}(P_{s_j rt}-\overline{P_{s_j rt}})^2}}}$$

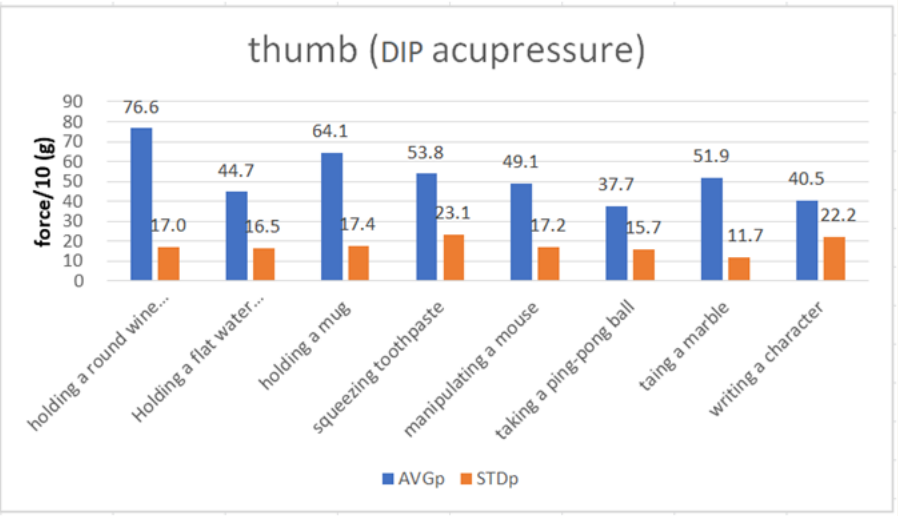
Where s_i, s_j=1,2 ,…,30; r=1,2,3,4; t=1,2,…,50

Dynamic time series data analysis

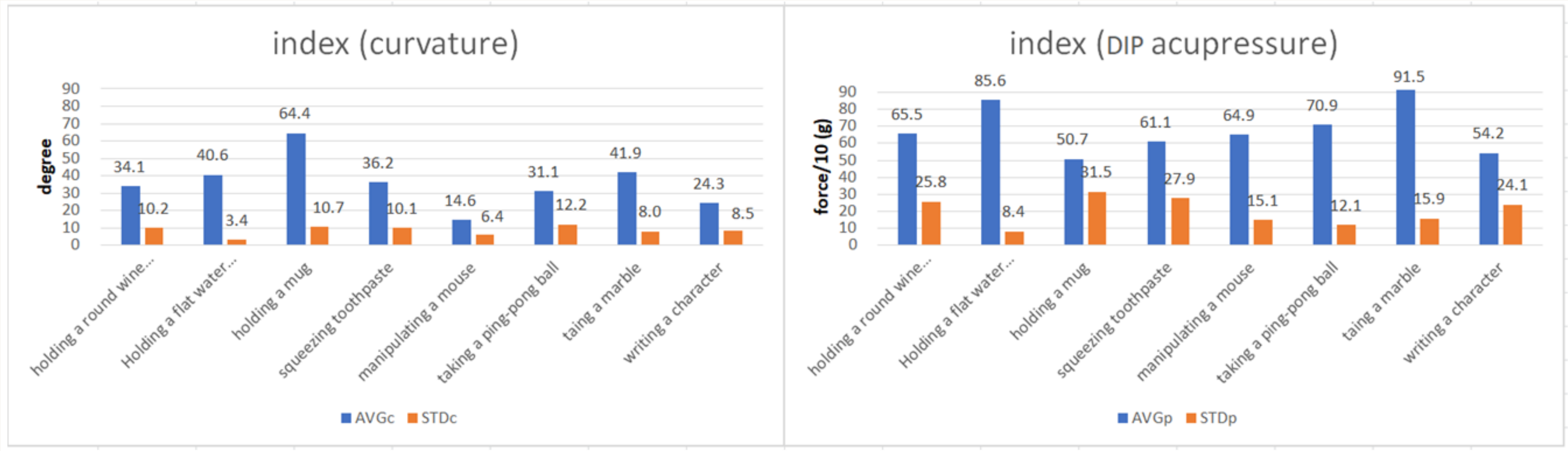


Static maximum data analysis (thumb)

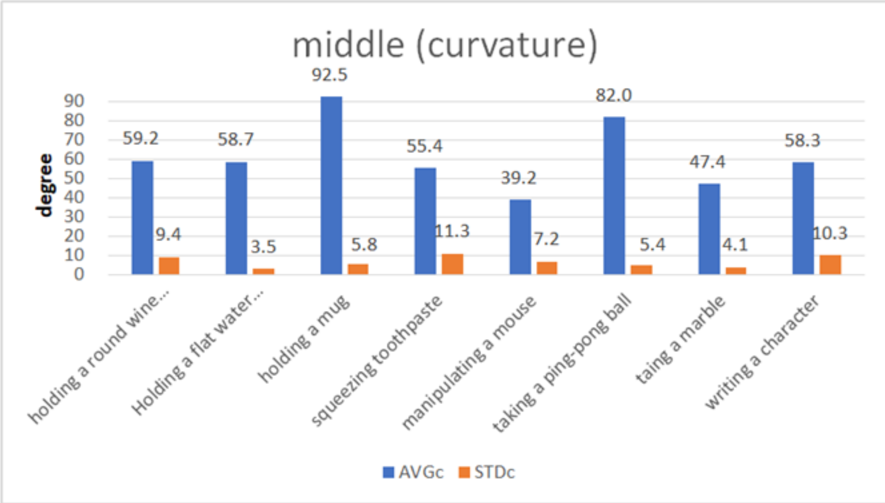


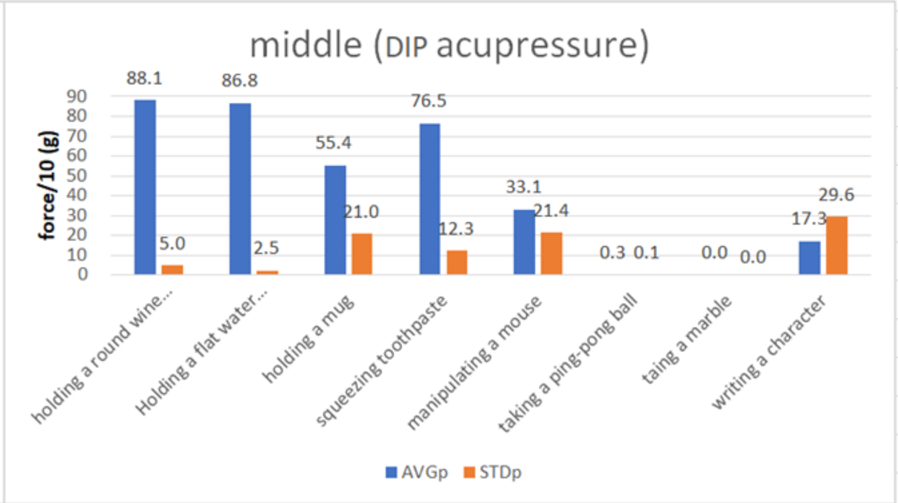


Static maximum data analysis (index)

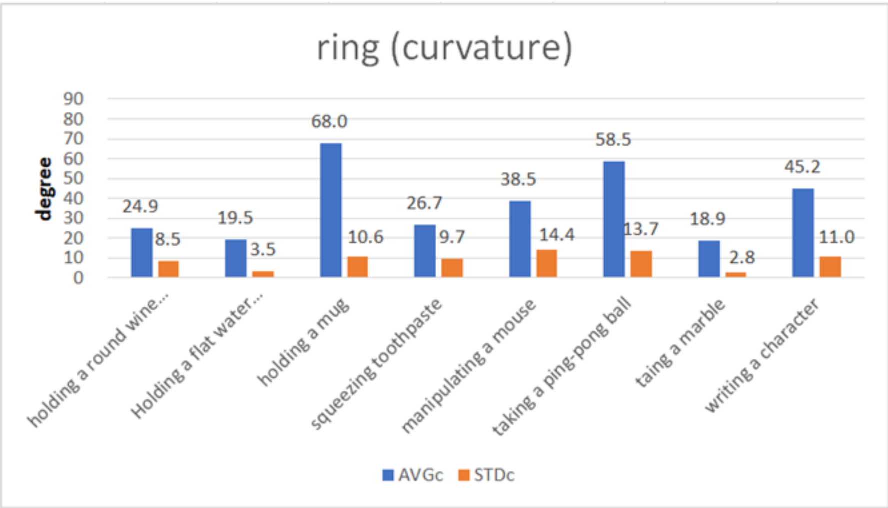


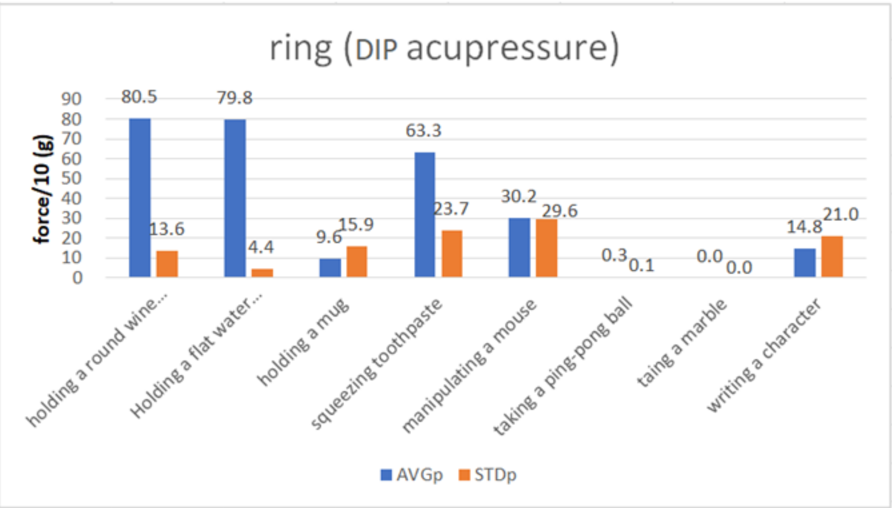
Static maximum data analysis (middle)



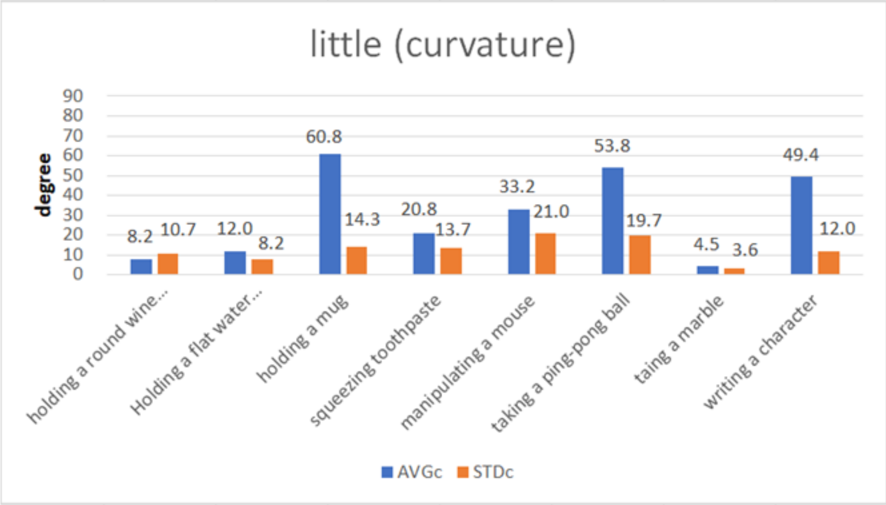


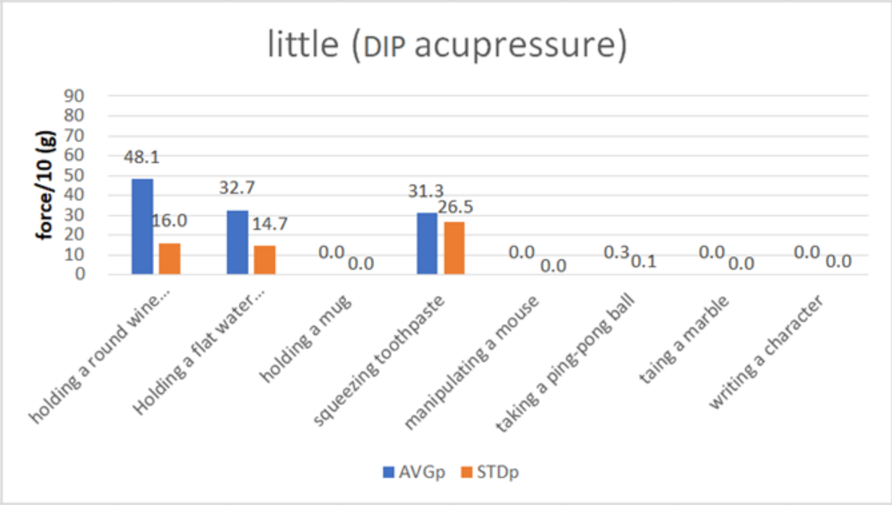
Static maximum data analysis (ring)





Static maximum data analysis (little)

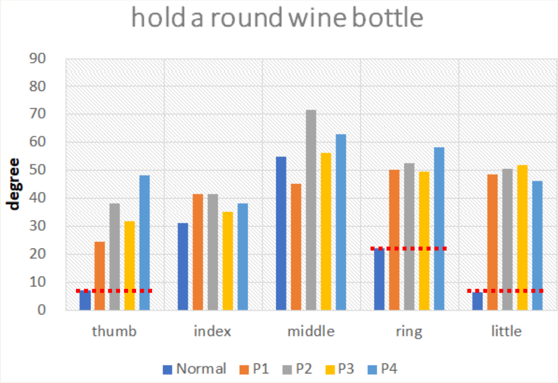


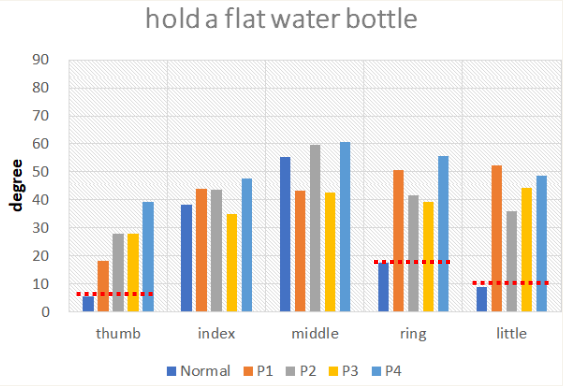


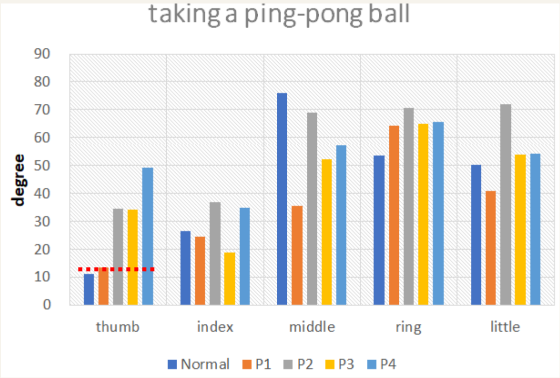
differentiate between healthy and injured hand function

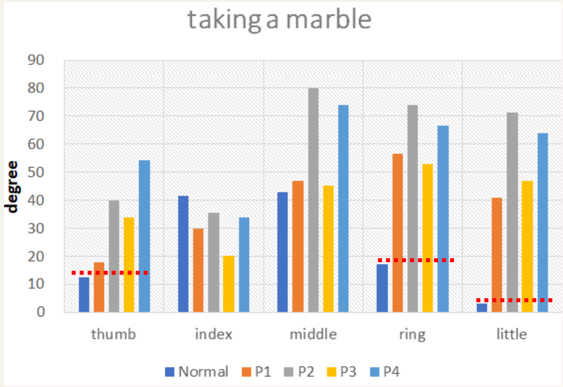
- We invited 4 patients with hand injuries to participate in this experiment.

Differentiate between normal hand function and injured hand function

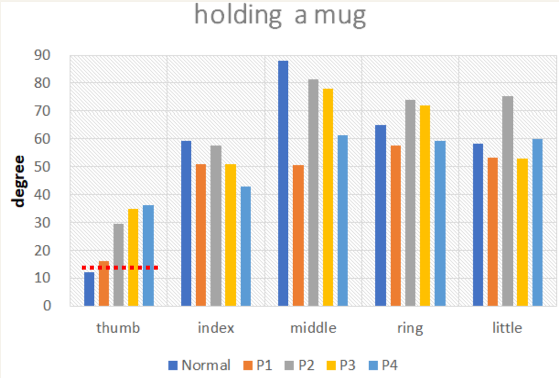


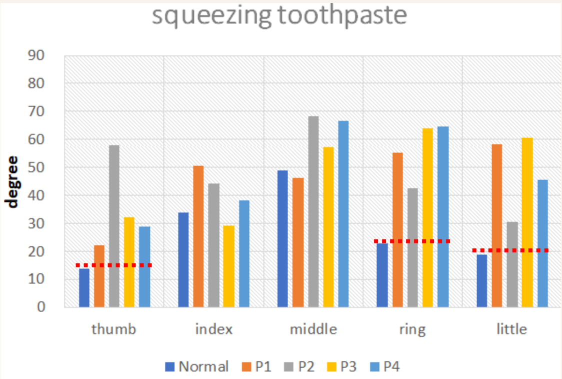


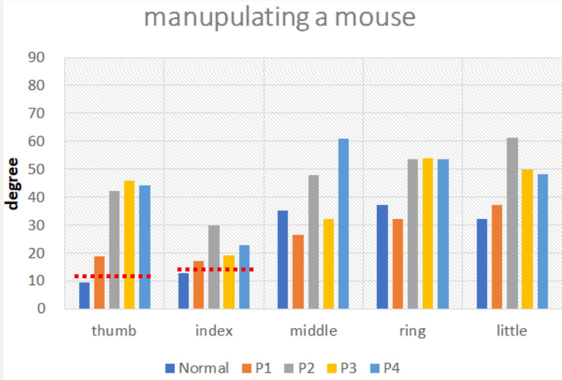


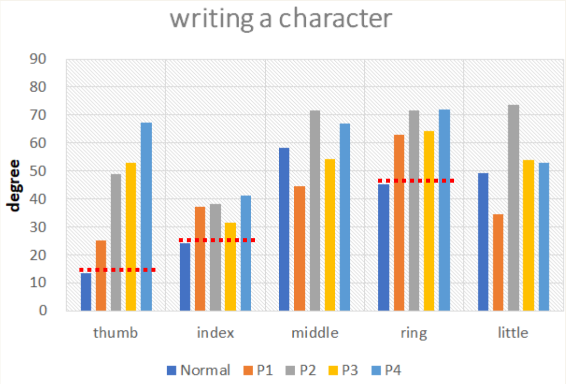


Differentiate between normal hand function and injured hand function









Conclusions

- Generally speaking, for a certain action, if a finger has obvious force in acupressure, we will call it an actuating finger.

- In contrast, if it is an auxiliary finger, it will not have a significant value in acupressure, but will show a relatively high value in curvature.

- Sometimes, we feel that certain fingers are not involved in a movement, but there are actually no fingers that are not really involved.
- In some movements, some fingers play both the role of actuating and auxiliary functions.
- In some movements, some fingers play a role in actuating function and some play a role in the auxiliary functions, but not both.

differentiate between healthy and injured hand function

- The experimental results showed that the curvature of the thumb, ring finger and little finger of these patients was larger than that of normal people.

- Due to the different injuries and sequelae of each person, the degree of finger bending is also quite different.

Thanks for listening.