Introduction to ThumbTrak

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Overview:

- Motivation: **One-handed thumb-on-fingers** input scenarios.

- It allows the user to **use the thumb to continuously input on fingers** by tracking the position of the thumb using **2 IMUs**.

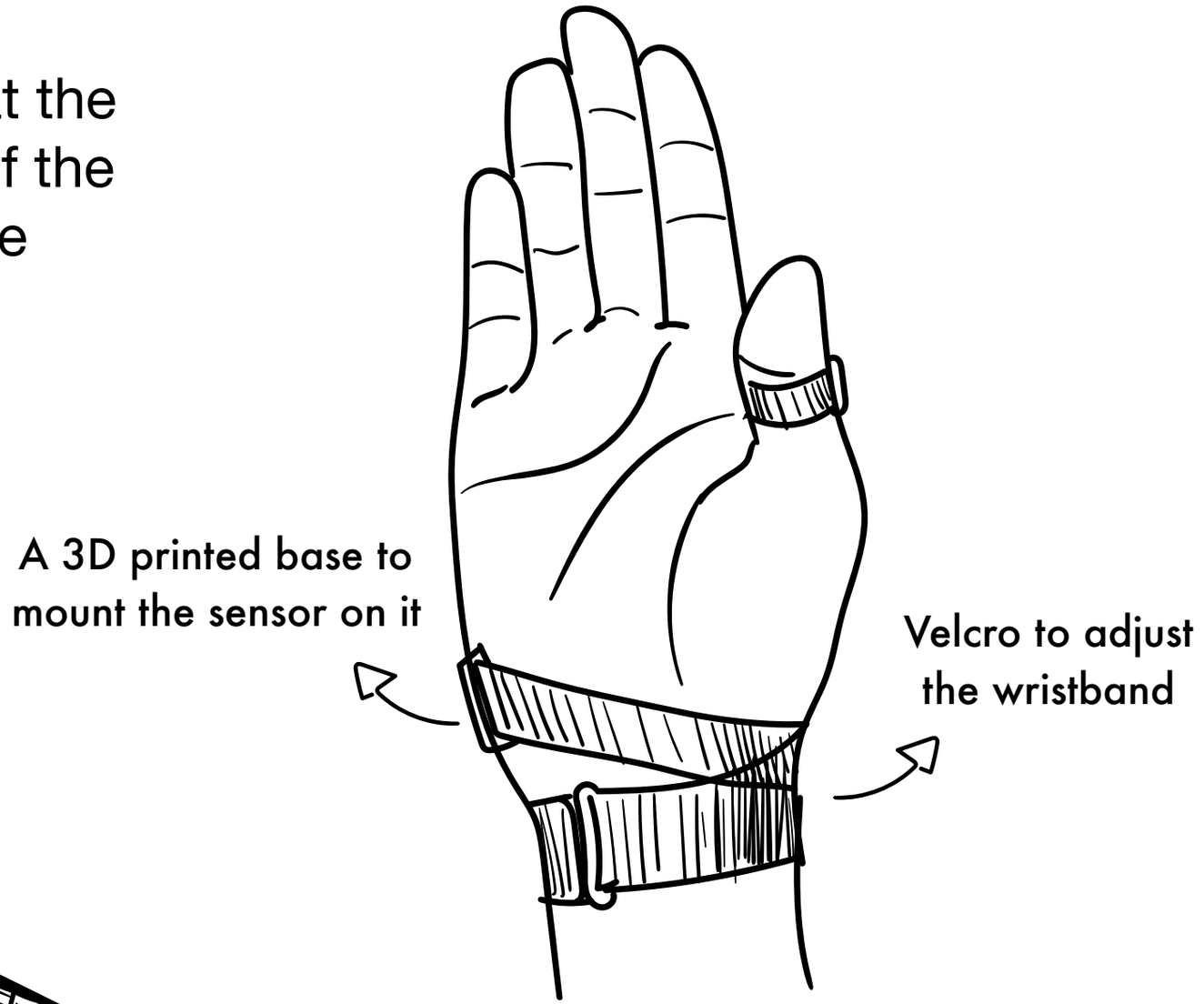
- It consists of a thumb-ring and a wristband.

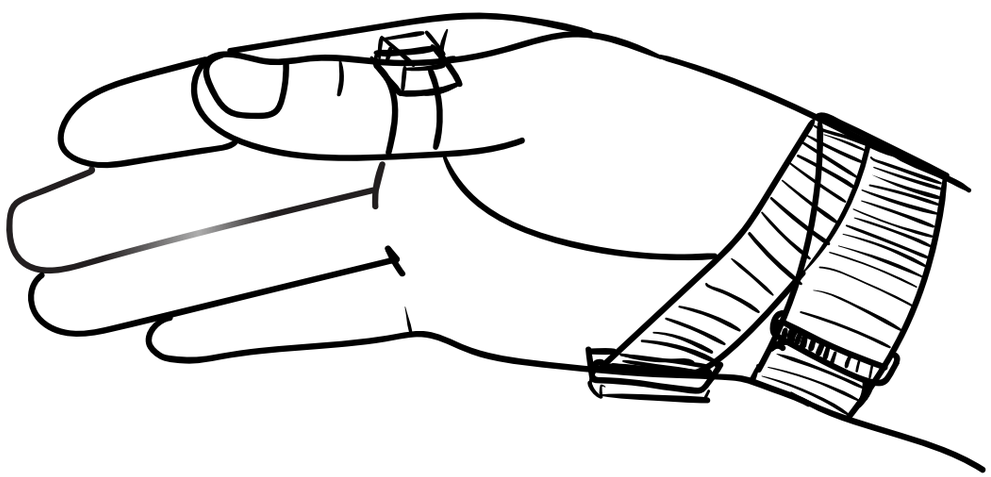
Form Factor:

- The user can fix the sensor at the bottom of the hand (on top of the wrist) by simply tightening the wristband.

- Without adhesive.

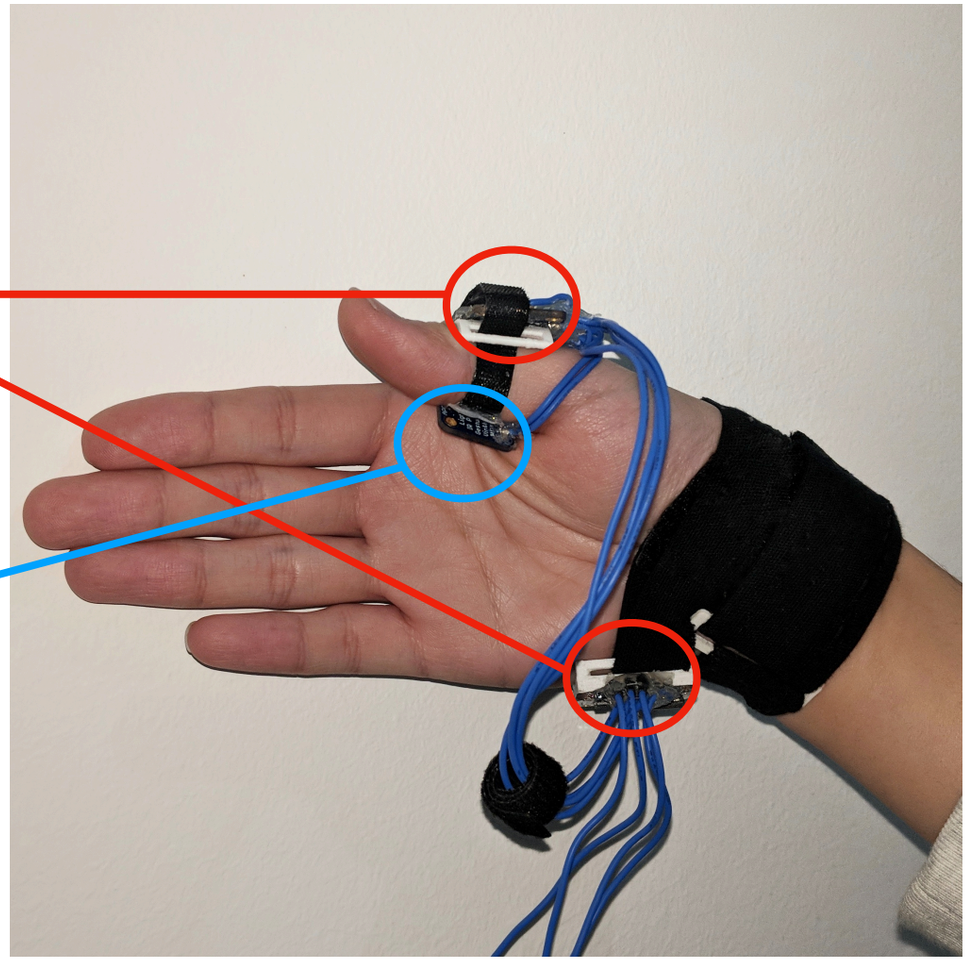
- Ensures flexibility.





Hardware Prototyping:

- **Teensy 3.2 board**: Micro controller.
- **2 IMUs (BNO055)**: To compute the relative orientation (rotation) of the thumb with respect to the hand.
- **Proximity Sensor (APDS9960)**: To measure the distance between the bottom of the thumb and the hand in order to detect tap and release.



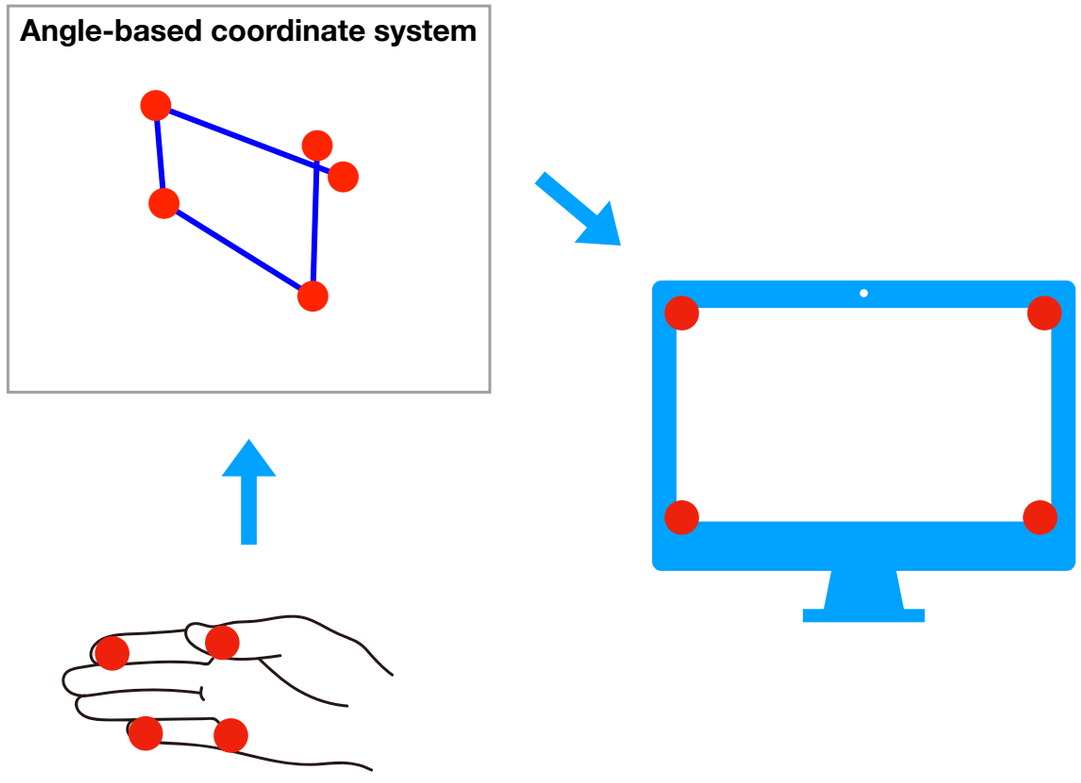
Algorithms:

- **Angle-based coordinate system**: We build a coordinate system based on the angle derived from the relative rotation.

- **Perspective transformation**: To map the user's drawing from the irregular quadrilateral canvas on angle-based coordinate system to a rectangular canvas on the screen.

- **KNN + $P Recognizer**[1]: To recognize the letter the user draws with this device. We collected 1400+ unistroke templates.

- **Kalman Filter**: To smooth the trajectory with low latency.



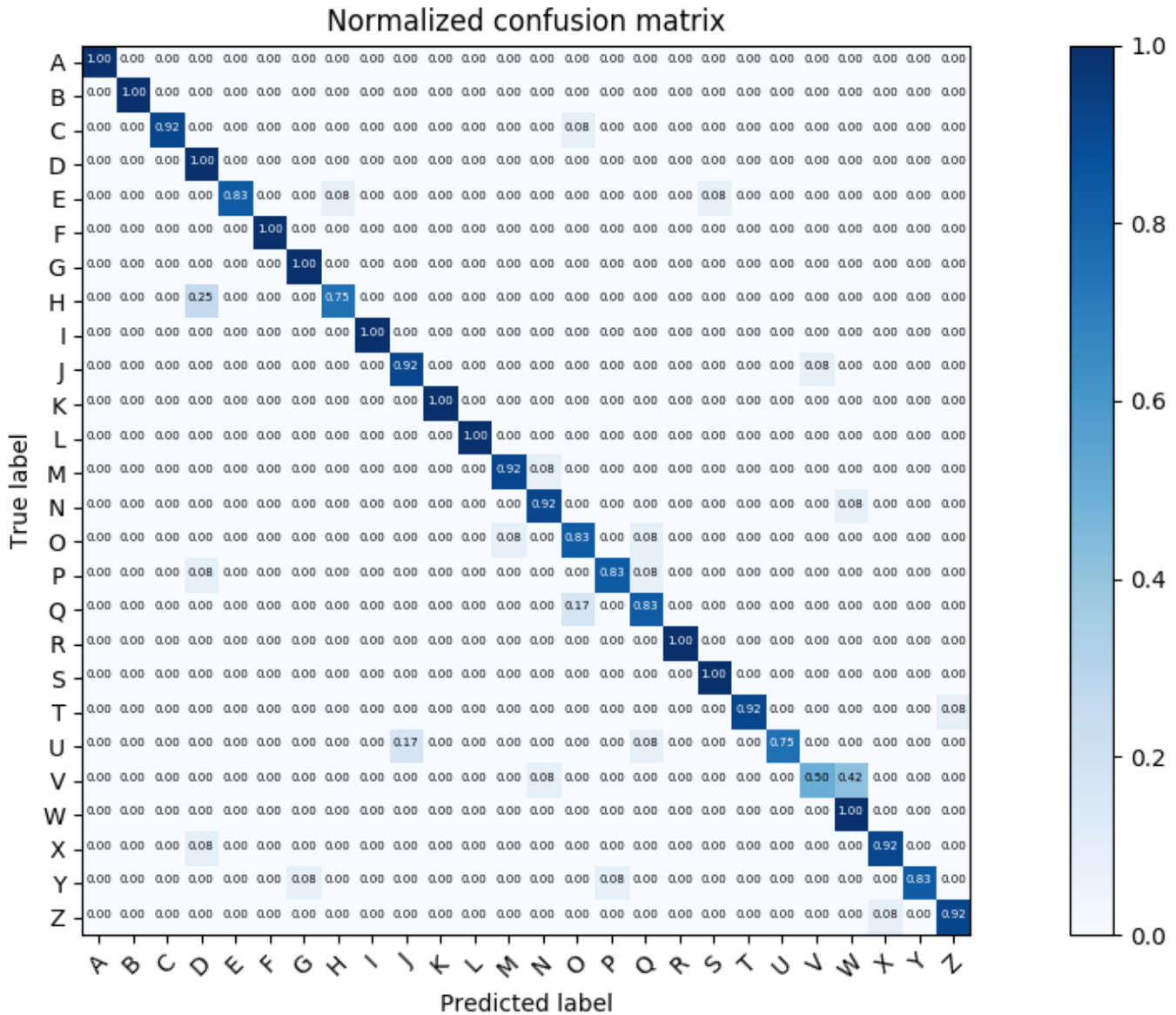
[1] http://depts.washington.edu/ilab/proj/dollar/pdollar.html

User Study:

- **Text Entry**: We let the participants use this device to write letters. The performance of our algorithm is shown on the right.

- **Gesture Entry**: We let the participants use this device to draw the graphics shown on the screen, and then we analyze the similarity of the shape.

- **Fitts' Law Test**: We let the participants use this device as a mouse to click on the red dots on the screen according to the prompt, and then we analyze the accuracy and the speed.



Demo

Video demo of text entry task:
https://www.youtube.com/watch?v=NEGMpqcbZIE