EchoType: A Novel Finger-Assisted Touch-free Text-entry System Without Training

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2018/9/27

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Motivation

Related Work

Observation

System Design

Evaluation



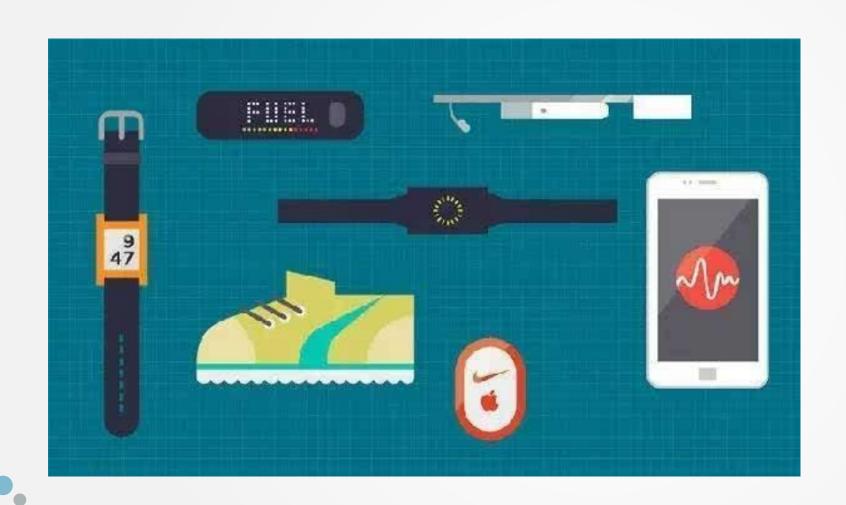
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PC

Mobile phone

Wearable devices

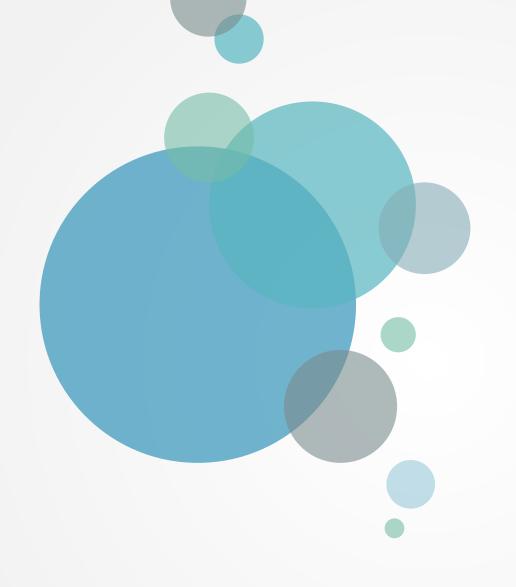


Wearable devices





Finger is too big to input text on small screens.



02 Related work

- 03 Observation
- 04 System design
- 05 Evaluation

Related Work

Speech Recognition





Wi-Fi

Widraw: Enabling hands-free drawing in the air on commodity wifi devices, MobiCom 2015.

RF signal

Rf-idraw: virtual touch screen in the air using rf signals. ACM SIGCOMM 2014.

Tagoram: Real-time Tracking of Mobile RFID Tags to High Precision Using COTS Devices, ACM Mobicom 2014.

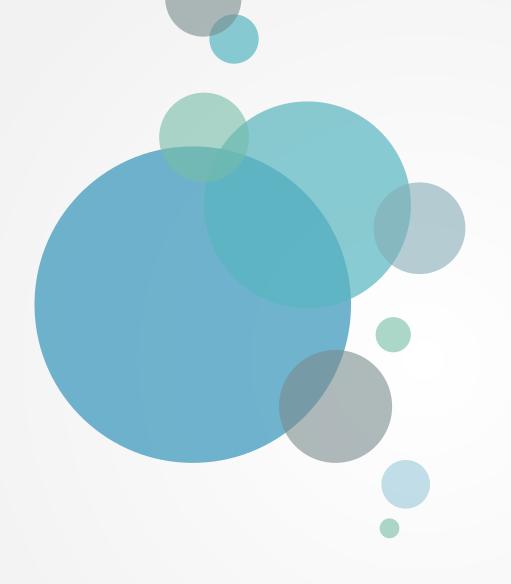
Sensors

Typingring: A wearable ring platform for text input. Mobisys 2015.

FingerIO: Using Active Sonar for Fine-Grained Finger Tracking. CHI 2016.Wei Wang et.al.

LLAP: Device-Free Gesture Tracking Using Acoustic Signals. ACM Mobicom 2016. Sangki Yun et.al.

Strata: Fine-Grained Acoustic-based Device-Free Tracking. ACM Mobisys 2017.

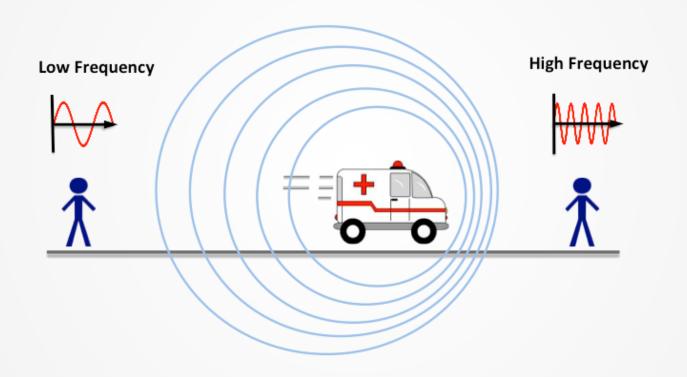


- 01 Motivation
- 02 Rationale

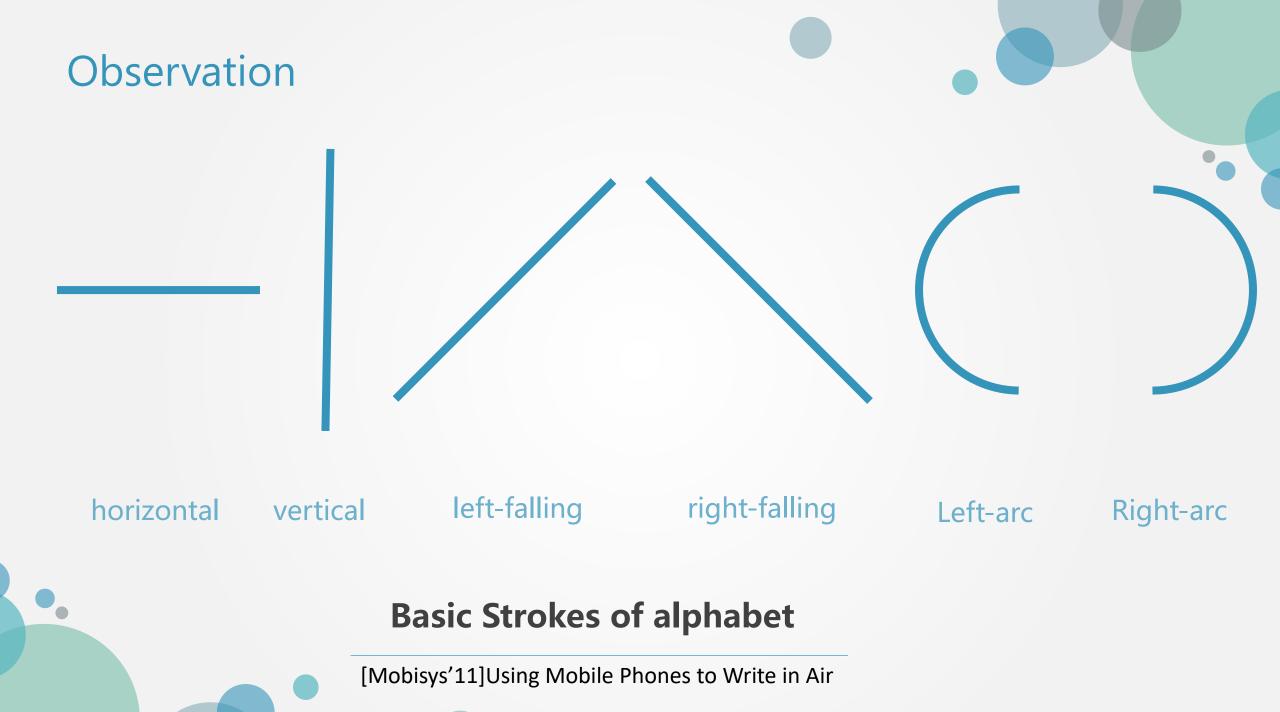
03 Observation

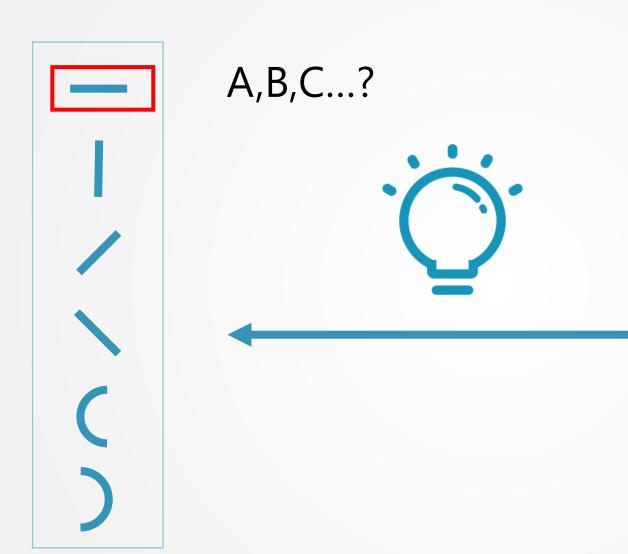
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Doppler Effect



Doppler shift

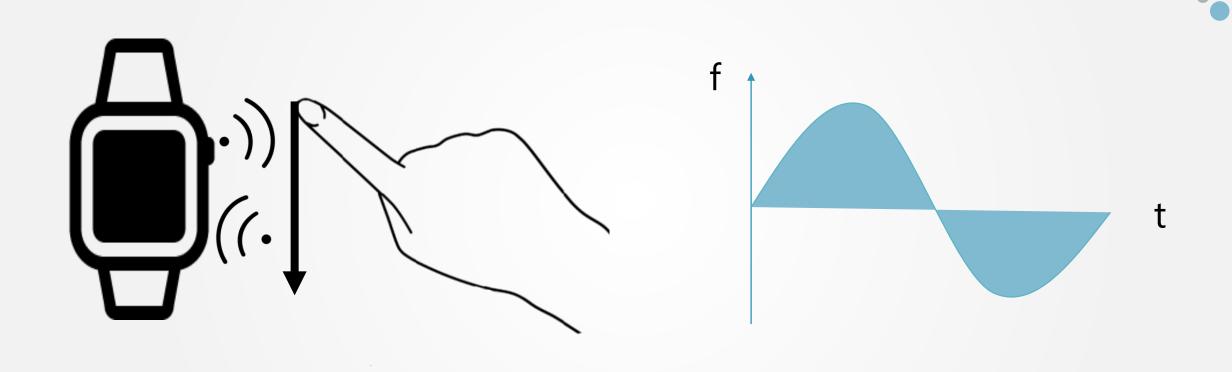


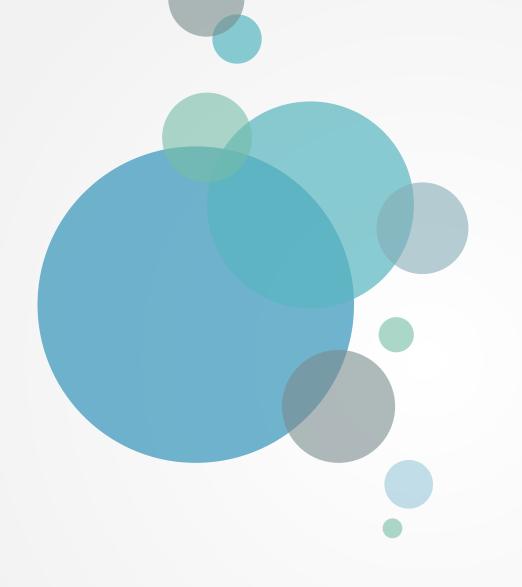


A,B,C



T9 Keyboard





- 01 Motivation
- 02 Rationale
- 03 Observation

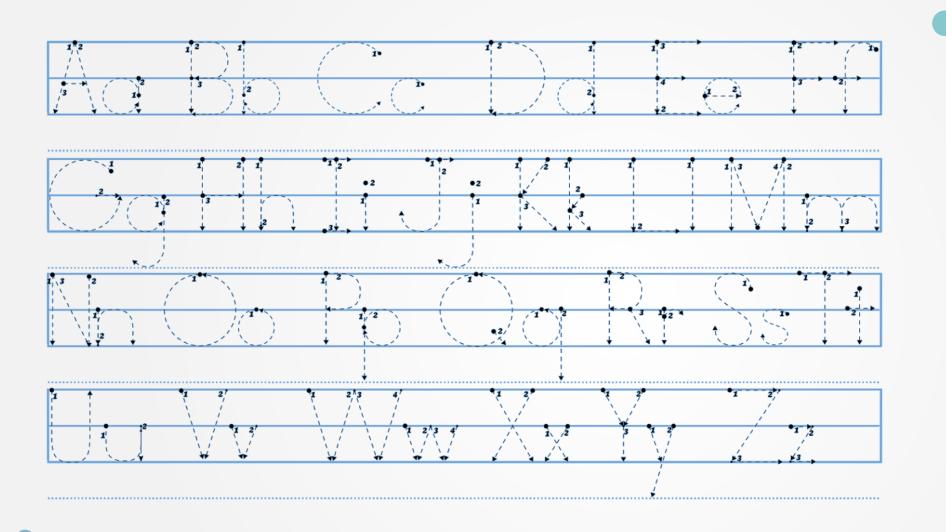
04 System design

05 Evaluation

Scheme design

1 How to group these characters according to basic strokes?

How to map basic strokes to unique Doppler shifts?



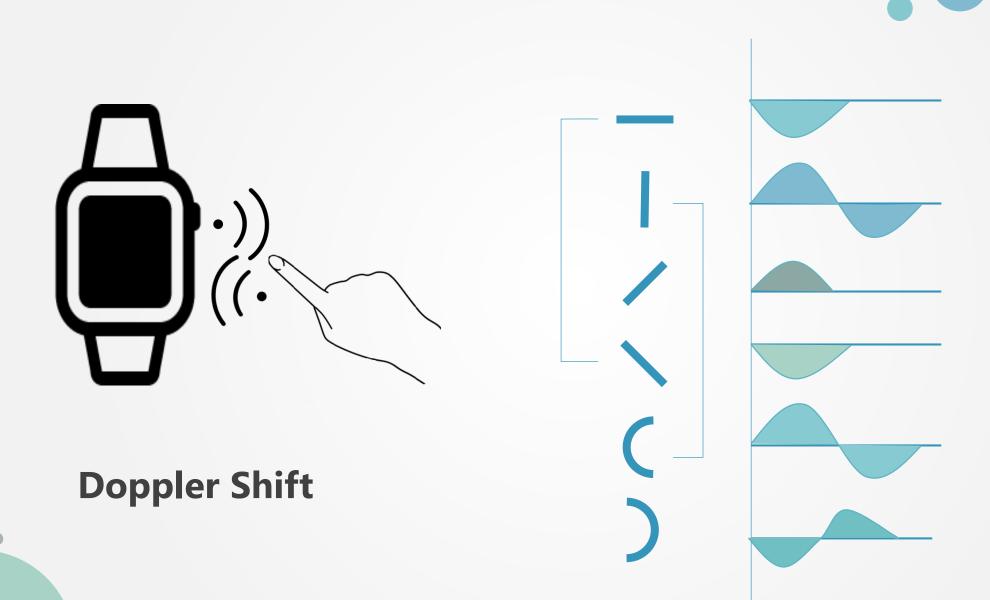
Stroke Order

http://www.superenglishkid.com/2014/11/stroke-order-worksheet-for-teaching-how.html

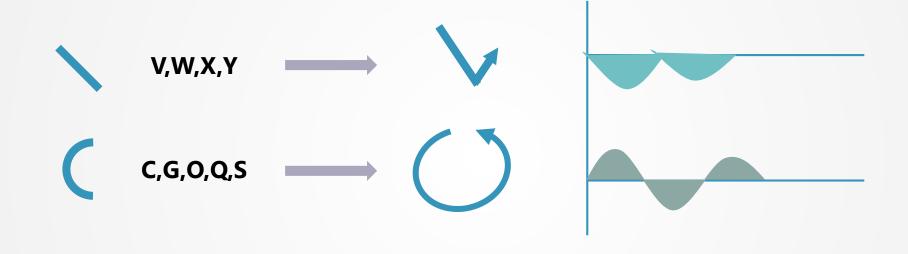
Grouped by the first stroke

- I,T,Z,J
- B,E,F,H,K,L,D,P,R
- / A,M,N
- V,W,X,Y
- **C,G,O,Q,S,U**

Letter adjustment

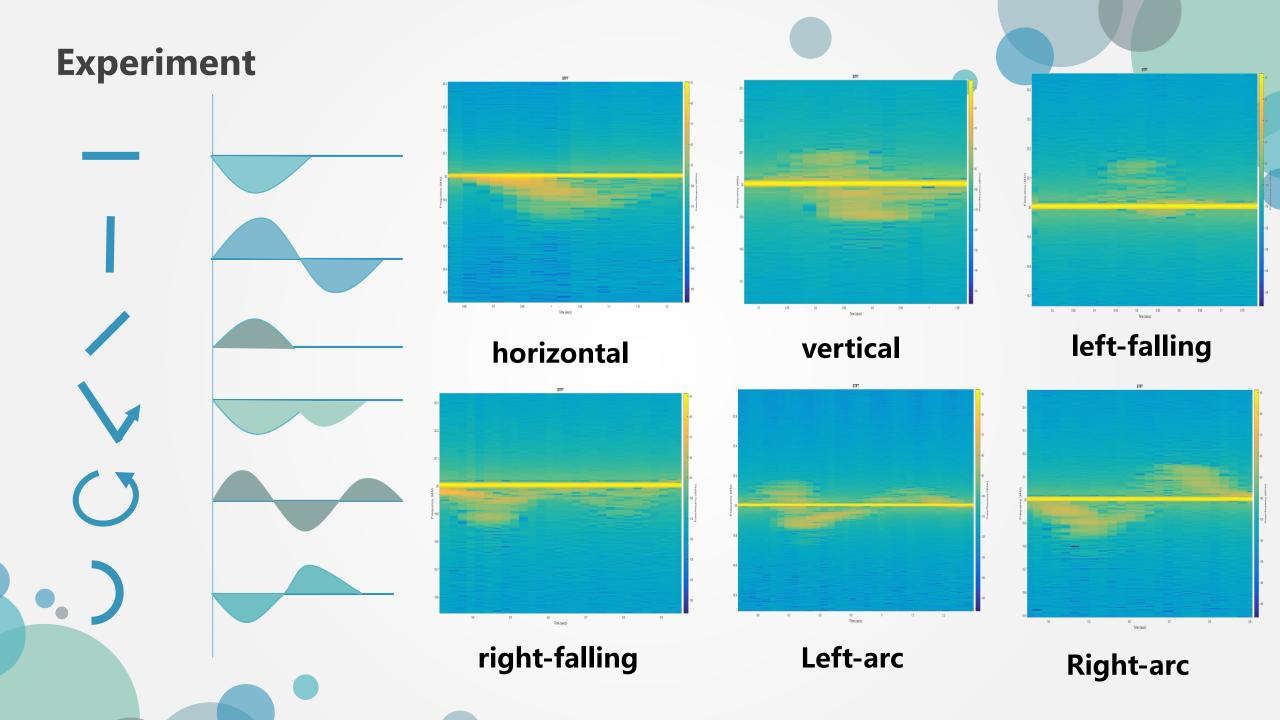


Modified Strokes

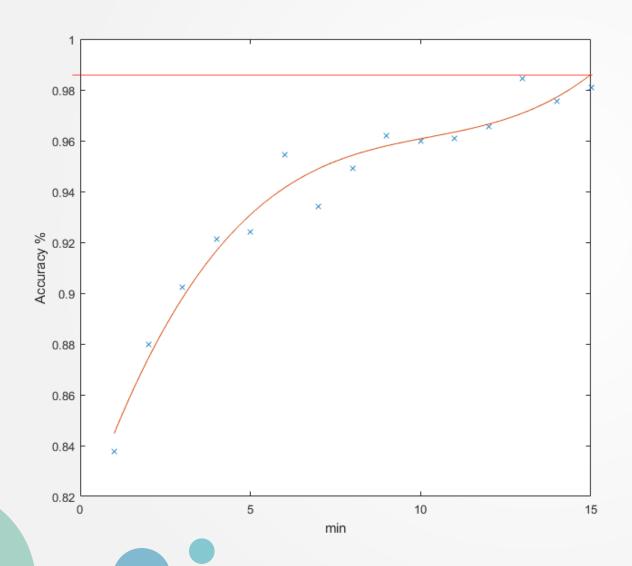


2 Stroke adjustment

Final scheme design



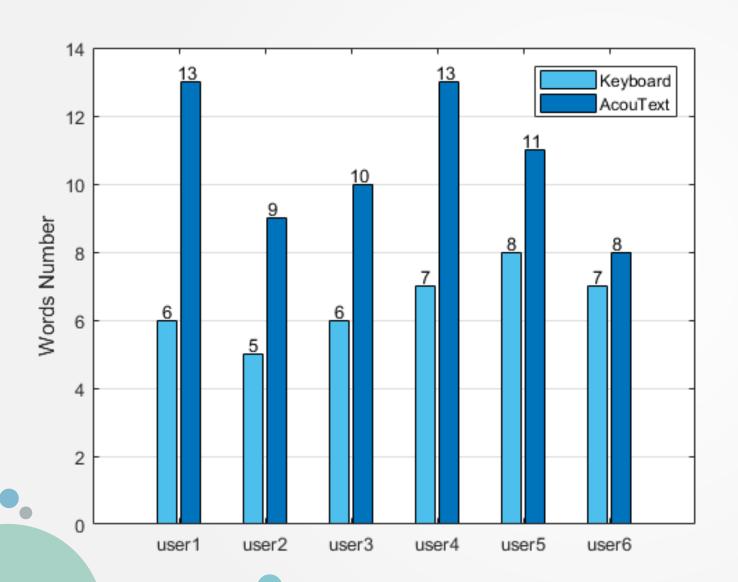
Preliminary user study



Learning overhead

Average accuracy per min

Preliminary user study

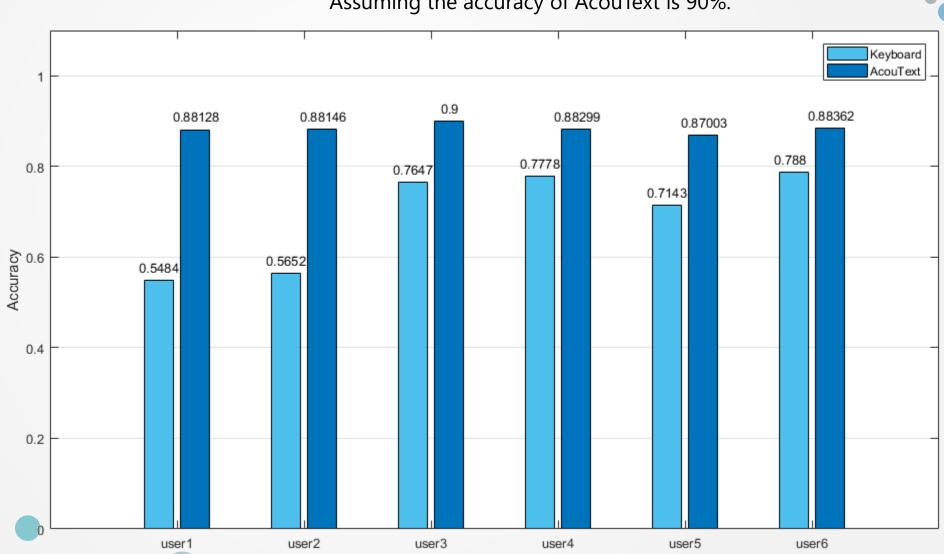


After training (15 mins)

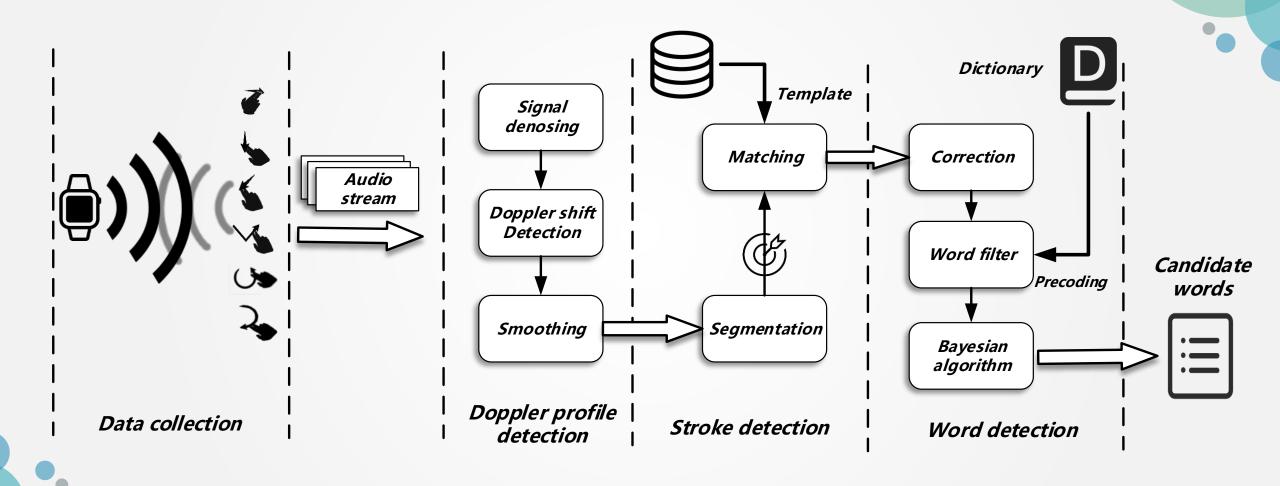
Words per min

Accuracy of letters in 15th min





Workflow



Problems



How to extract the Doppler shift profile?



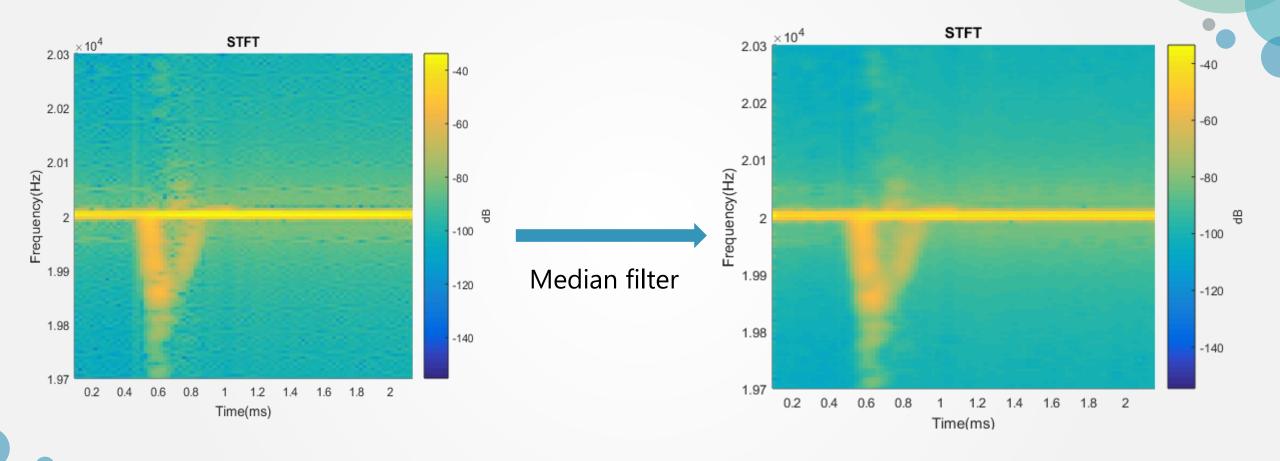
How to segment the continuous time series to some single strokes?



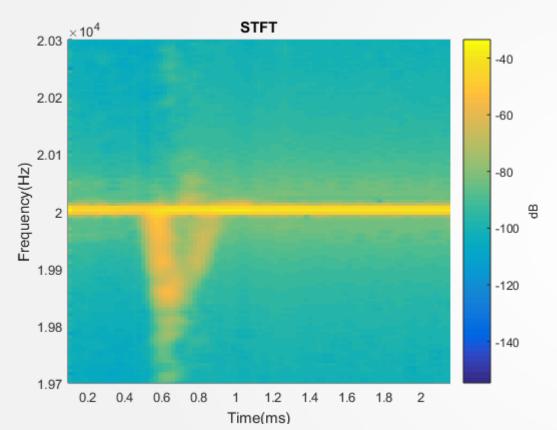
How to recognize which the stroke is?

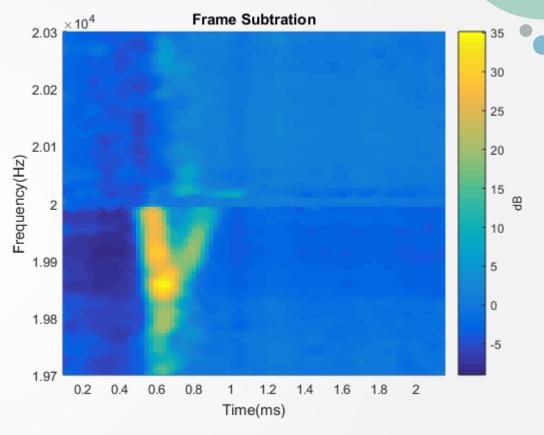


How to build a linguistic model using recognized strokes?



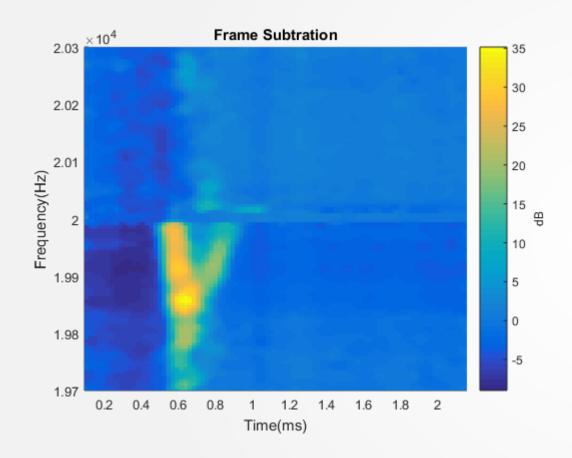


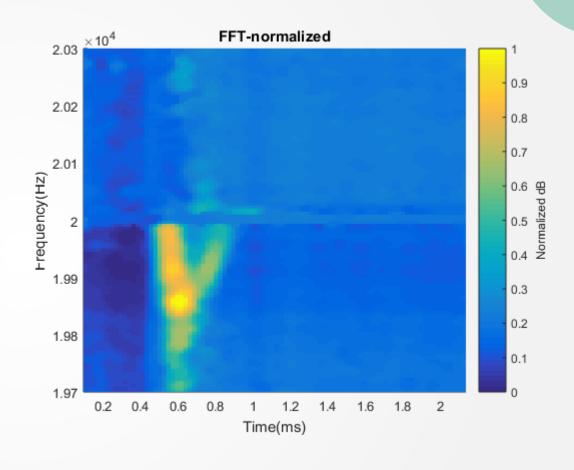




Spectrum subtraction

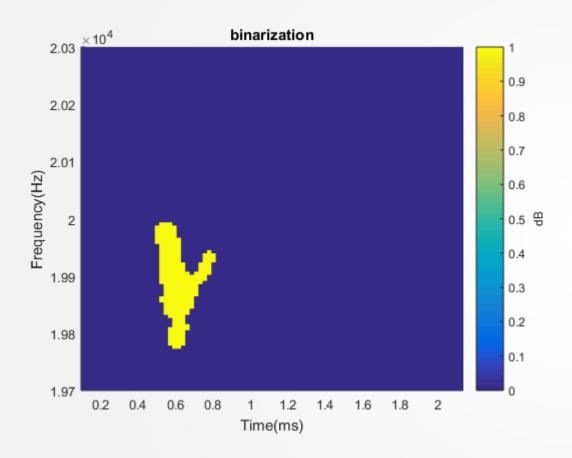






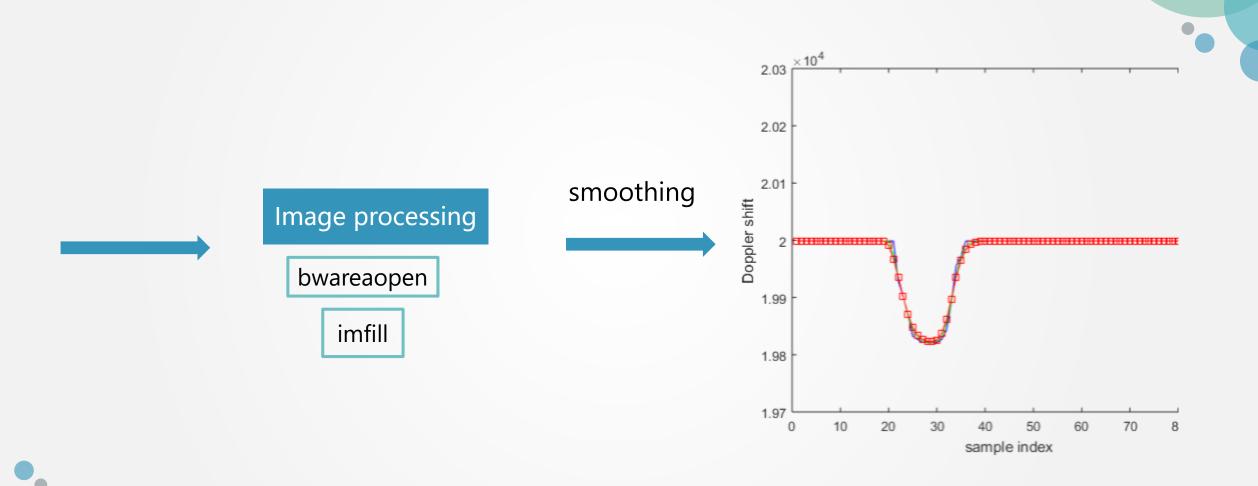
Normalization





Binarization





horizontal

Problems



How to extract the Doppler shift profile?





How to segment the continuous time series to some single strokes?

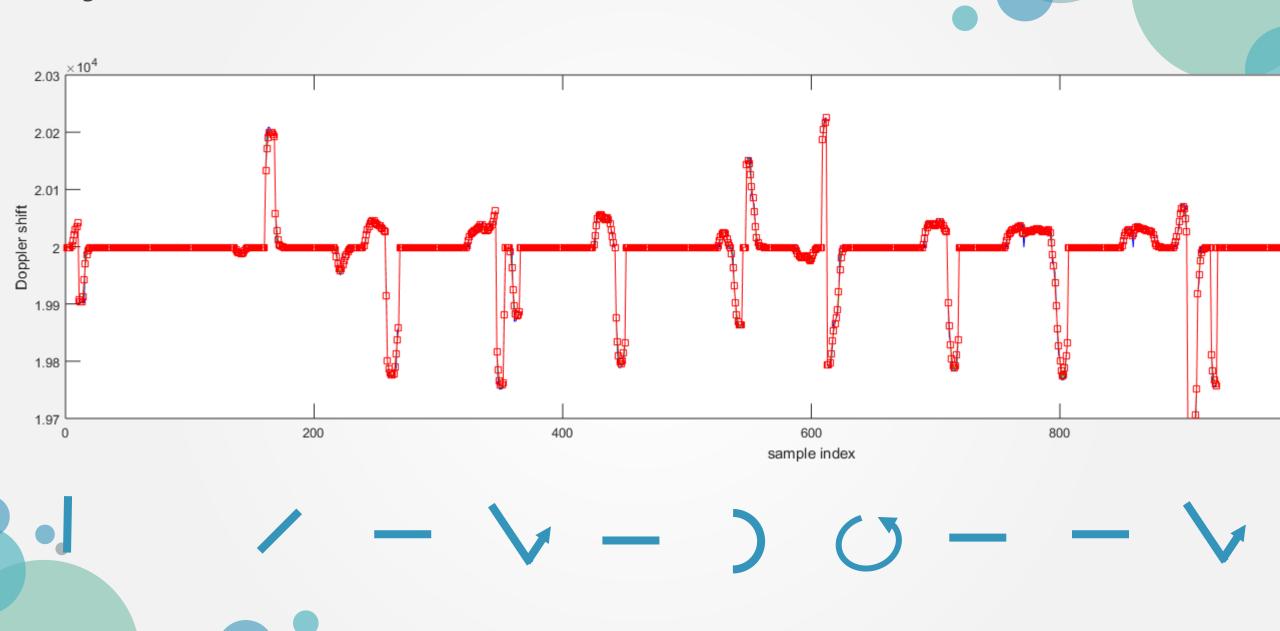


How to recognize which the stroke is?

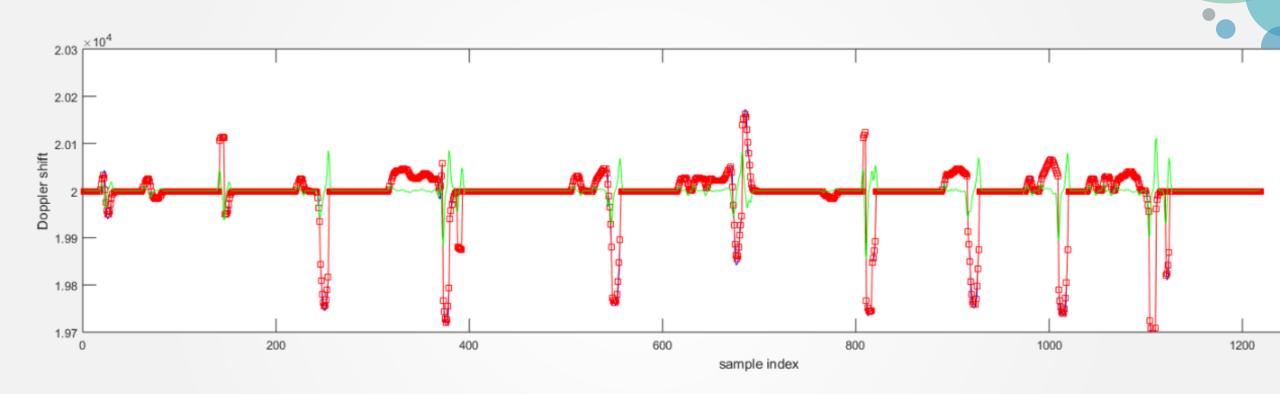


How to build a linguistic model using recognized strokes?

Segmentation



Segmentation

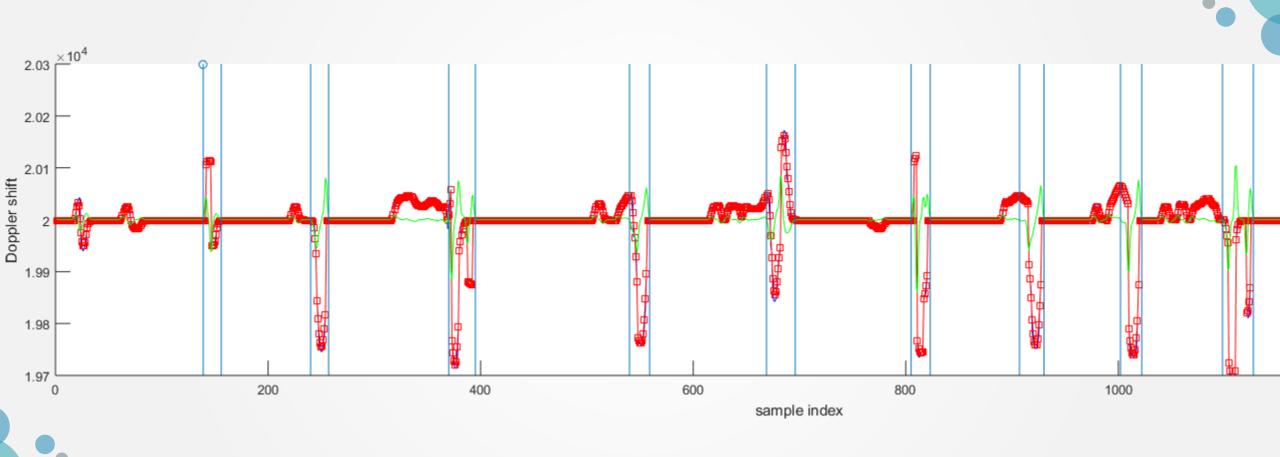


Based on acceleration (noise-robust first differentiator)

Start point: |acc|>30

End point: continuous 15 zeros

Segmentation



Problems



How to extract the Doppler shift profile?





How to segment the continuous time series to some single strokes?



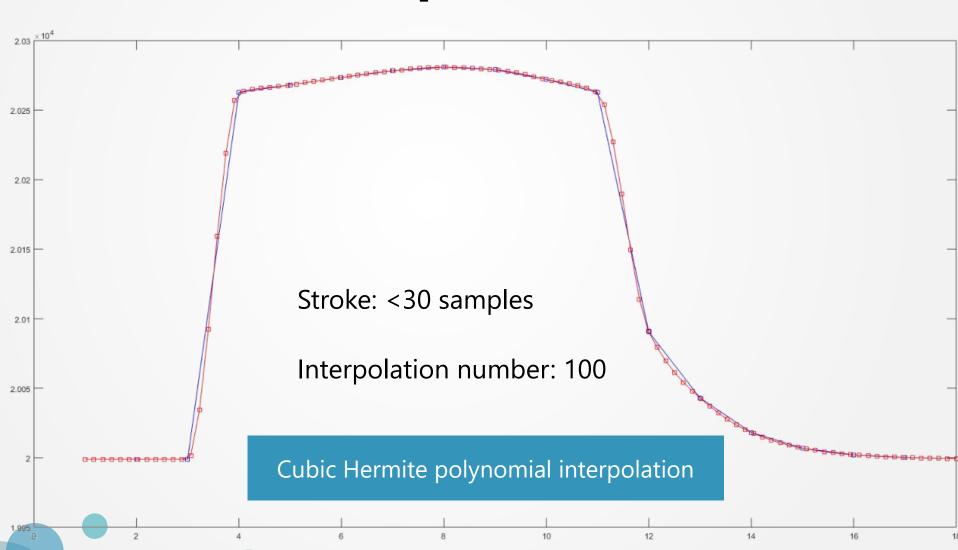
How to recognize which the stroke is?



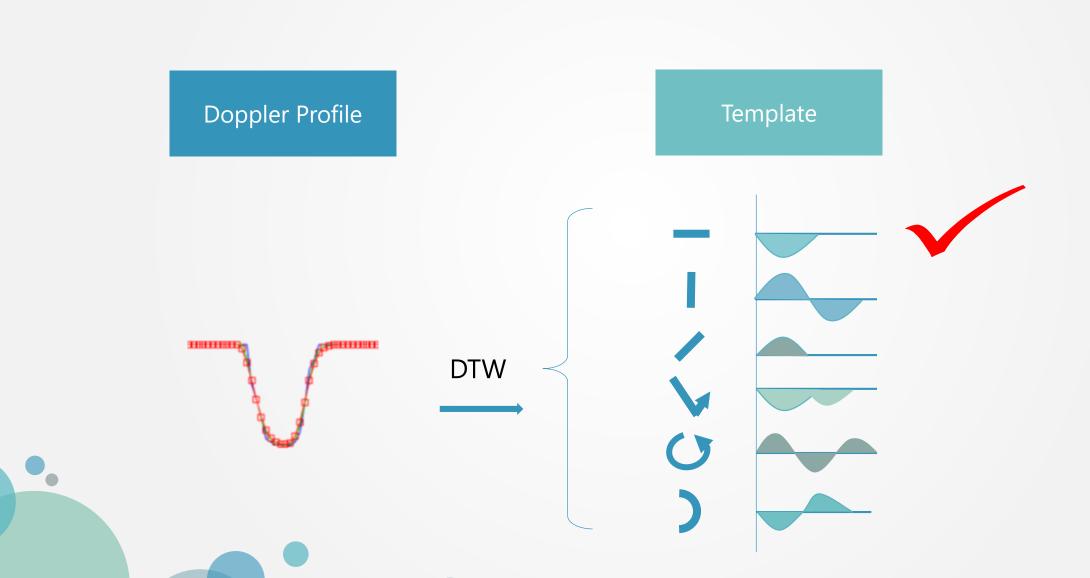
How to build a linguistic model using recognized strokes?

Stroke detection

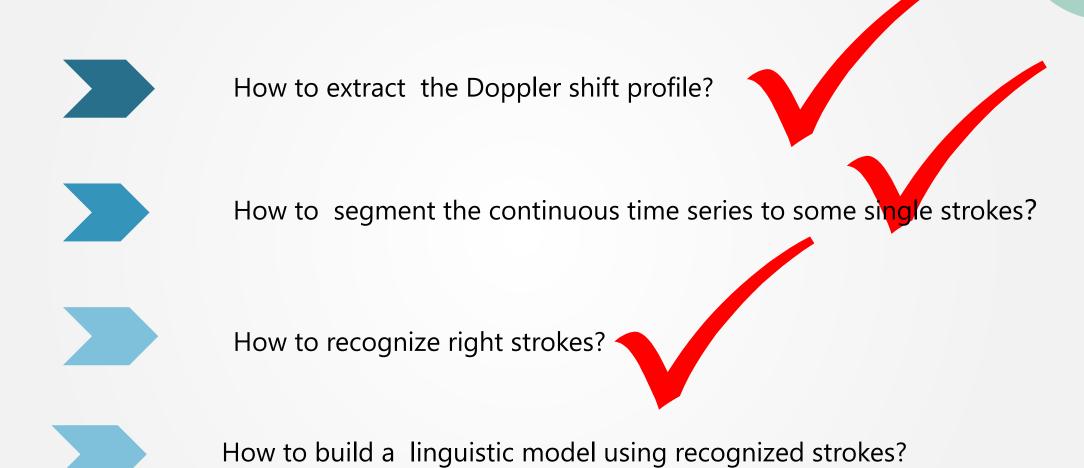
Template



Stroke detection



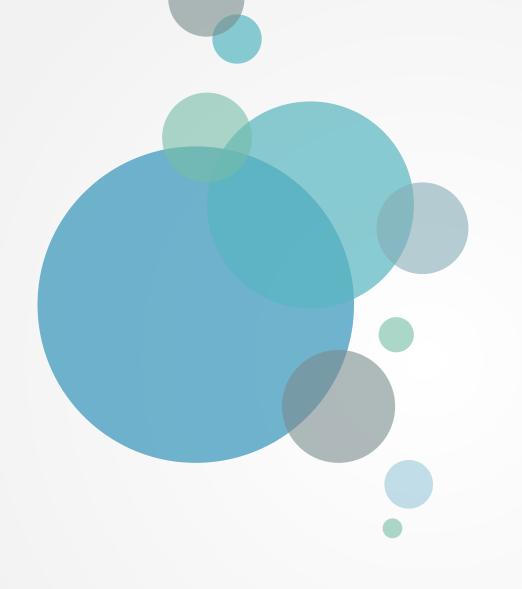
Problems



Word detection

```
Input: stroke sequence I;
Output: candidate words W;
Candidate I=correct(I);
W=Ø;
for each I belongs to [candidate I] do
  words=findtree(Dictionary,I);
  W=WUwords;
end for
for each word belongs to [W] do
  find P(word);
  compute P(si|li) of this word;
end for
W=sort(W) by [P(word)*\pi P(si|li)];
```

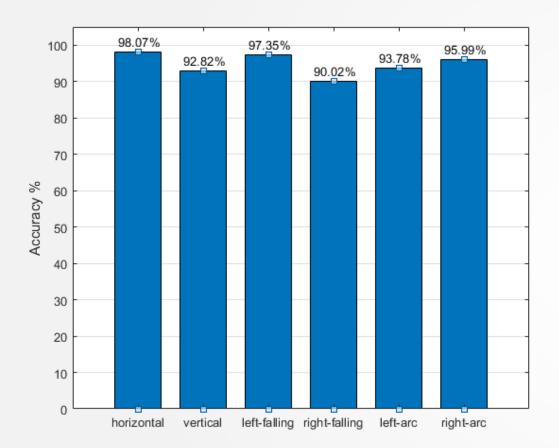
Recommend according to POSTERIOR PROBABILITY

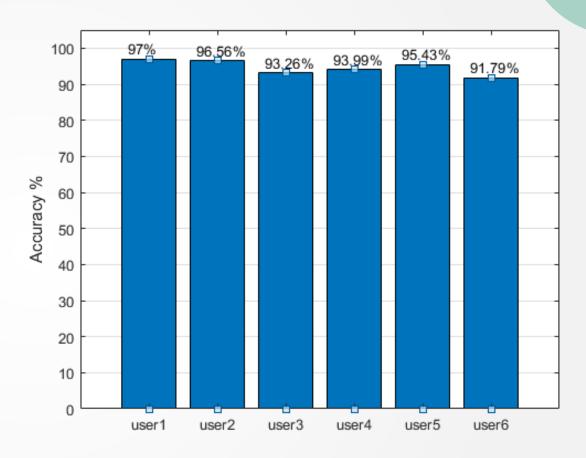


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Stroke

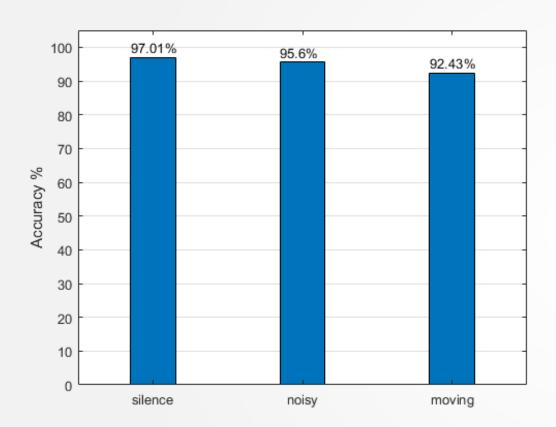


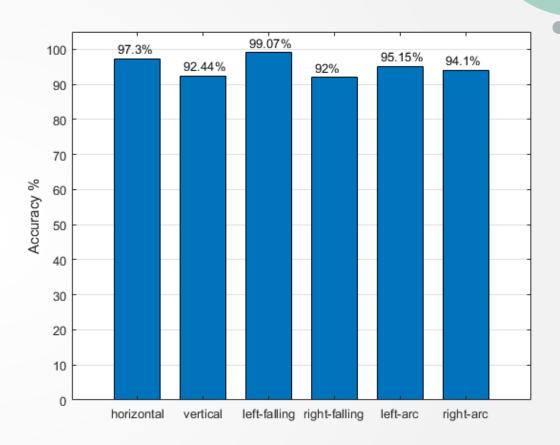


Different strokes

Different users

Stroke

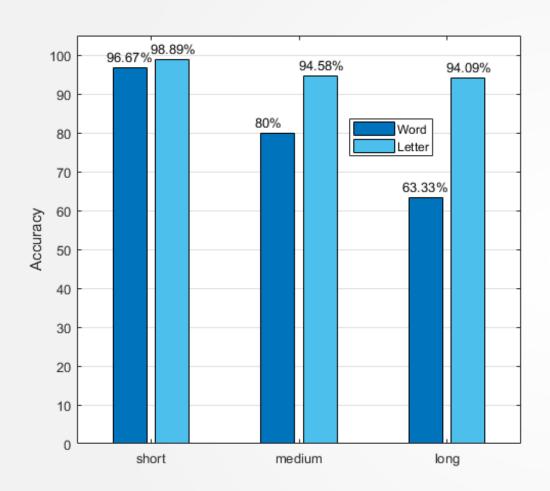


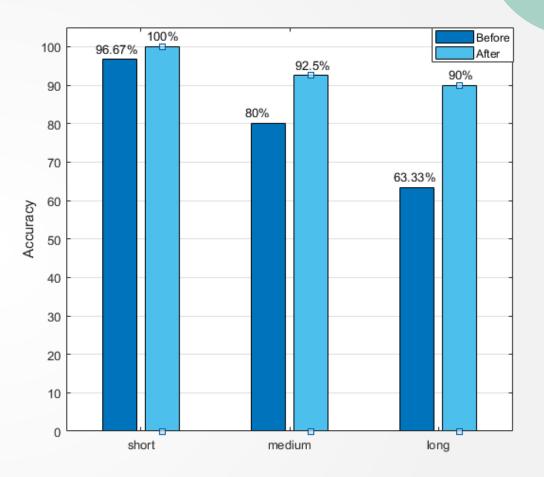


Different scenarios

Strokes in different scenarios

Words





Before correction

After correction(words)

