Microsoft Research

# Microsoft Research Asia
# Faculty Summit 2012

# Sign Language Recognition and Translation Based on Kinect

Xilin Chen

Institute of Computing Technology,
Chinese Academy of Sciences

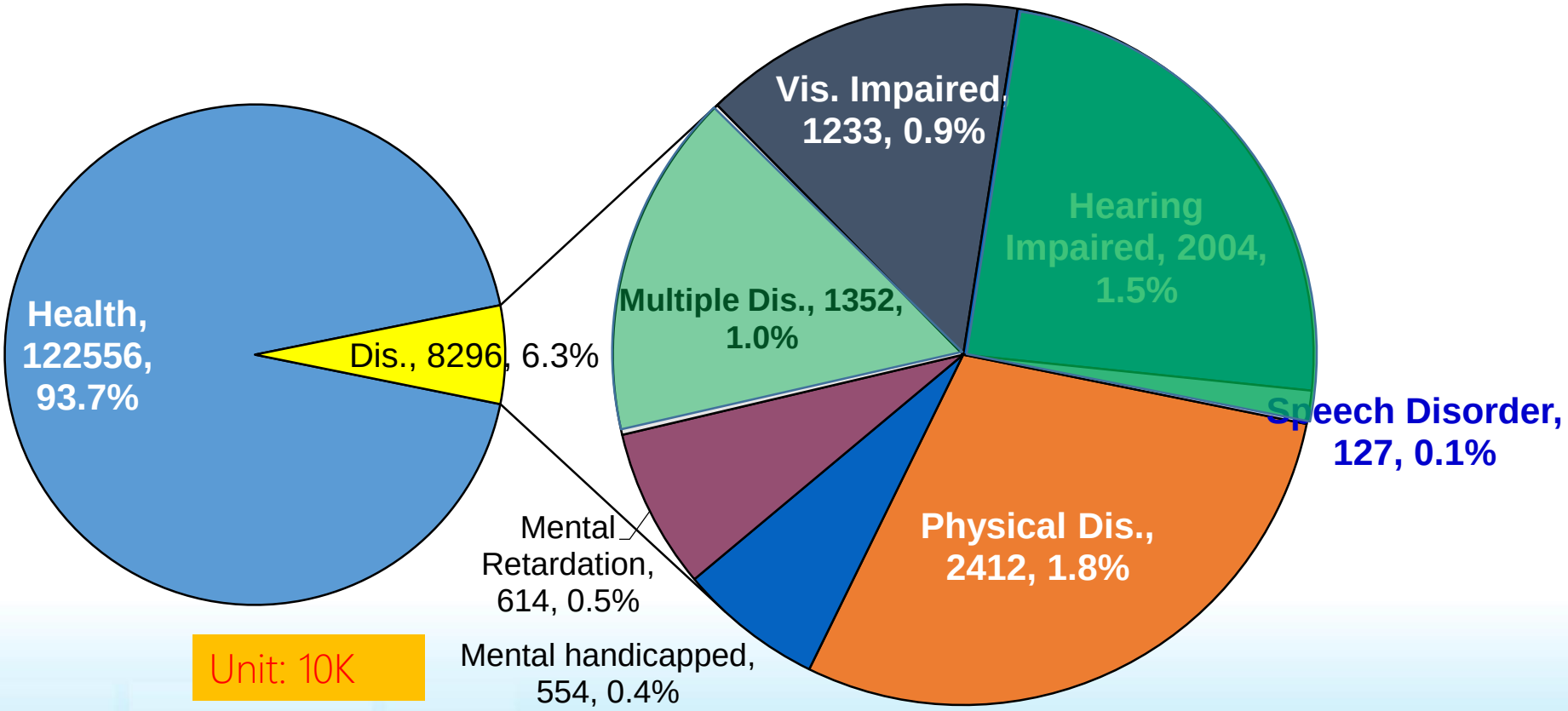


Microsoft Research Asia
Faculty Summit 2012

# Acknowledgement


- This is a joint work with
  - Guang Li, Yushun Lin, Zhihao Xu, Yili Tang, Jialu Zhu, Xiujuan Chai from ICT, CAS
  - Hanjing Li from Beijing Union University
  - Xin Tong, Zhuowen Tu, Jian Sun, Ning Xu, Guobin Wu, Ming Zhou from MSRA
  - Zhengyou Zhang from MSR
- Thanks for those students who make big contribution on data collection from BUU, especially thanks for Hui Liu , and Dandan Yin

# Disabled People in China

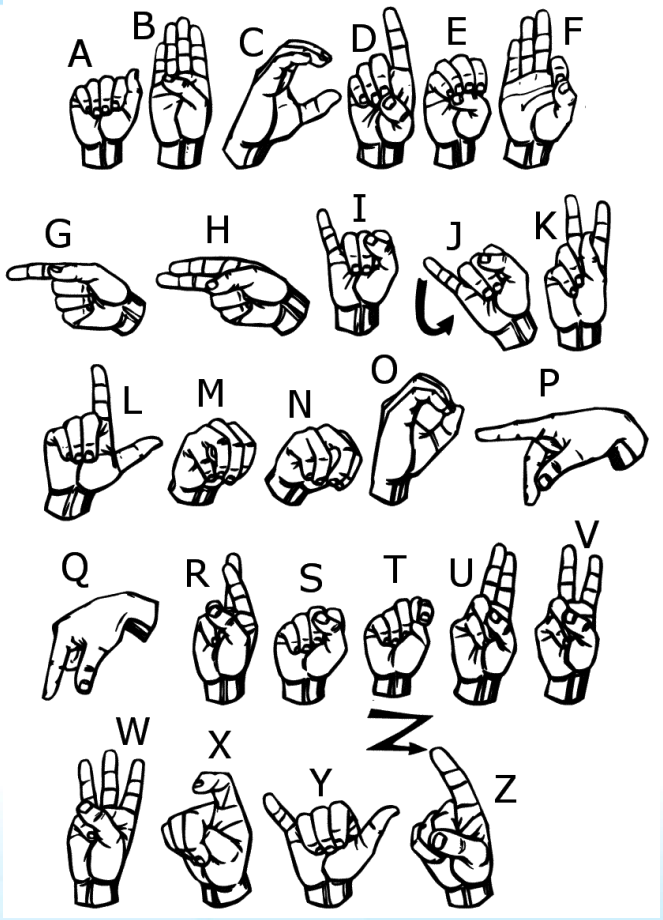


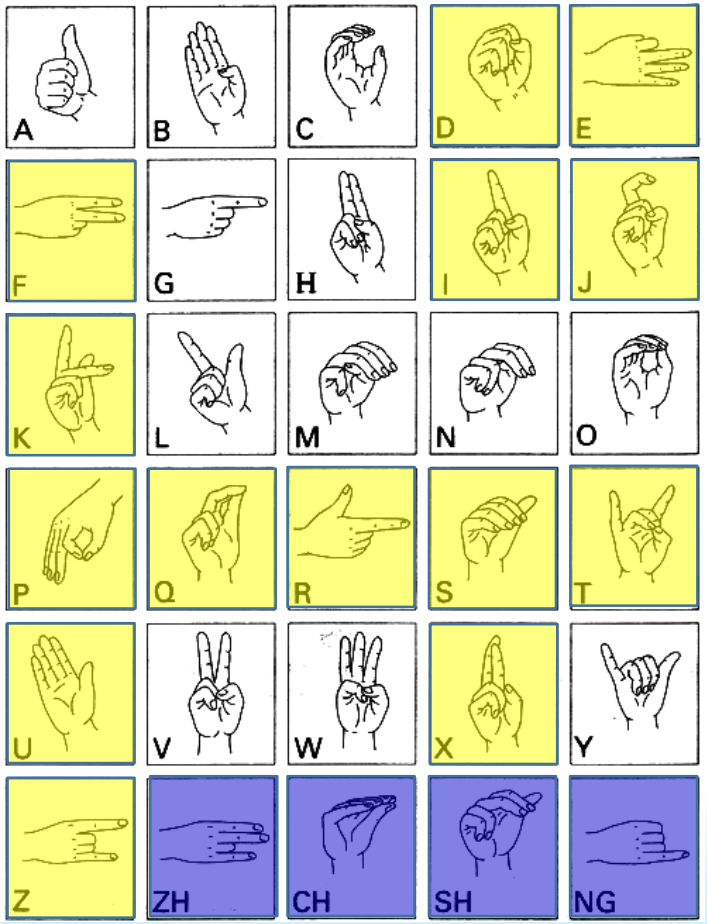

Source: 2nd census of disabled people in China, 2006

# Sign Language

- 100 million people use sign language in China and 200 million people in the world
- Sign language is recognized as a natural language in many countries
- Language barrier between deaf-mute and health people
  - Human sign language translator is a hot job
- Automatic sign language translator
  - Automatic sign language recognition and generation

# Alphabets in American / Chinese SL

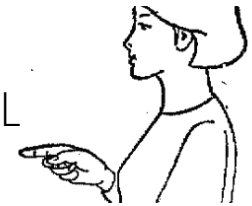


# Some words in ASL / CSL

ASL

CSL

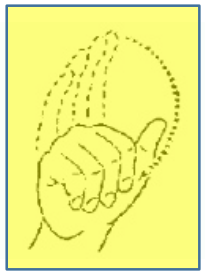


你(You)

好 (Good)

来(Come)

我(Me)



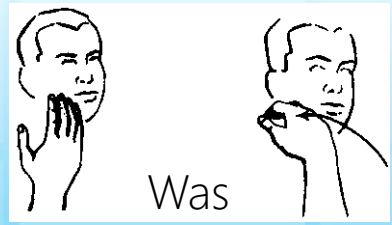
能(Can)

请(Please)

不(No)

Are

Be



Was

是 (be/is/are/was/were)

# Challenges in SL Translation

- A large vocabulary set for recognition
  - 5000+ words in Chinese Sign Language

# Challenges in SL Translation

- A large vocabulary set for recognition
- Motion and posture in different scale
  - Some words with only one posture
  - Some words only with fingers motion, e.g. 谢谢 (thanks)
  - Some words with significant hand / arm motion, e.g. **大家**(everyone)

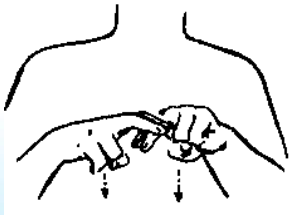
**五**(Five)

谢谢(thanks)

**大家**(everyone)

# Challenges in SL Translation

- A large vocabulary set for recognition
- Motion and posture in different scale
- Vocabulary set is relatively smaller than spoken language
  - Thousands words vs. 100+ thousands ones
  - Many to one mapping
    - Sit / Chair → same gesture



# Challenges in SL Translation

- A large vocabulary set for recognition
- Motion and posture in different scale
- Vocabulary set is relatively smaller than spoken language
- Grammar is different
  - English: I like to fly small planes.
  - Sign: SMALL PLANES — FLY — LIKE ME

# Lessons from Previous Works

- SL recognition with video camera
  - Only works on a small vocabulary set
  - Segmentation is a big challenge
  - Sensitive to lighting change

# Lessons from Previous Works

- SL recognition with video camera
- Data-glove based sign language recognition
  - Input: Data-glove + Location Sensor
  - Recognition Model: HMM
  - Merits
    - Stable Input
    - Supportable to large vocabulary set (5000+ words)

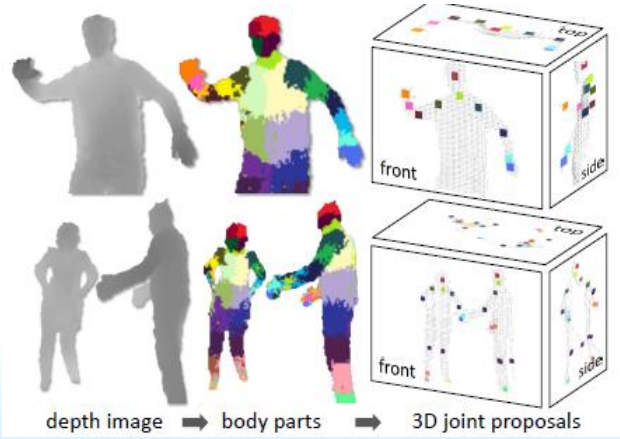
# CSL Recognition with Data-glove

# Lessons from Previous Works

- SL recognition with video camera
- Data-glove based sign language recognition
  - Input: Data-glove + Location Sensor
  - Recognition Model: HMM
  - Merits
    - Stable Input
    - Supportable to large vocabulary set (5000+ words)
  - Demerits
    - Too expensive
    - Extra accessories
    - Easy damaged

# Kinect – an opportunity for SL Recognition

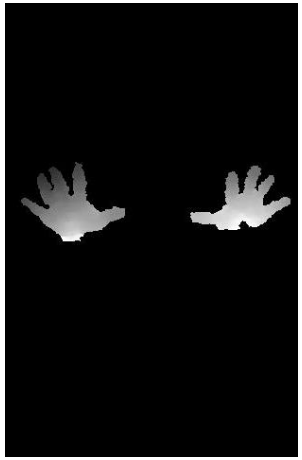
- Depth provides additional robust information
  - Body segmentation / tracking
- Balance between data-glove and pure visual camera
  - Cost
  - Robustness
  - Understandable to raw data

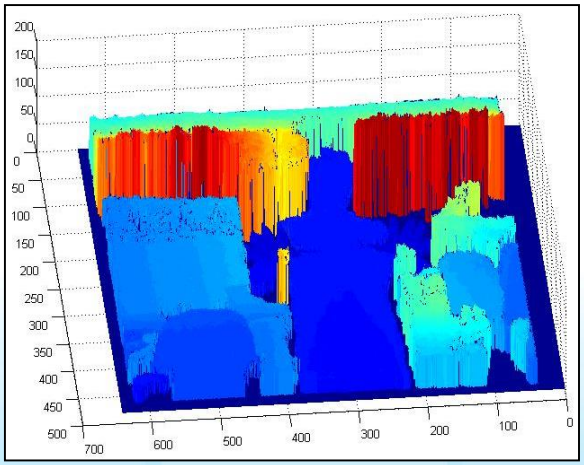


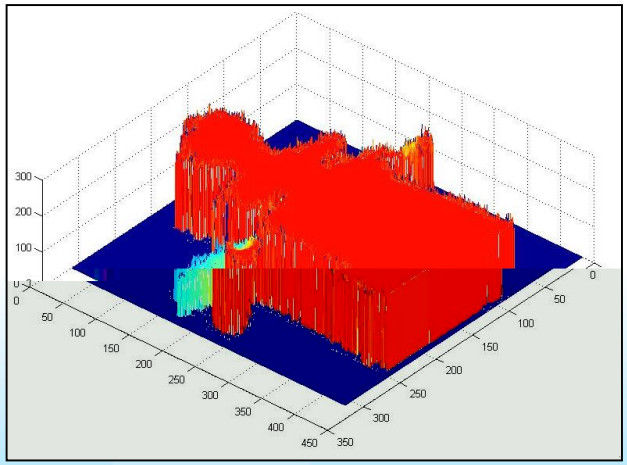

Shotton et al. CVPR11

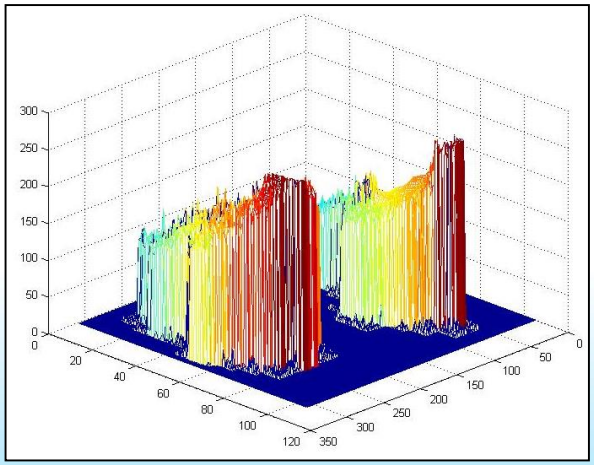
# An Example from Kinect





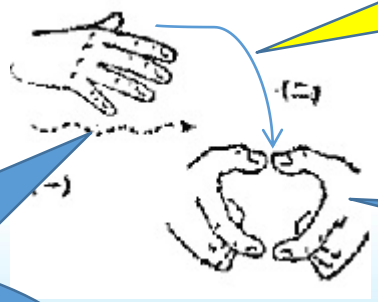
# Basic Idea

- SL = Hand Motion + (Face expression)
- Hand Motion = Trajectory + Key postures
- Basic idea from SL dictionary
  - Postures + a few trajectories

# Basic Idea

- SL = Hand Motion + (Face expression)
- Hand Motion = Trajectory + Key postures
- Basic idea from SL dictionary
  - Postures + a few trajectories

Even some clips aren't essential elements in SL, they still encode important context



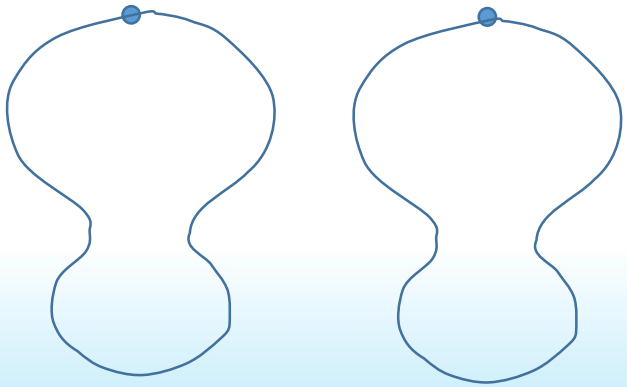
水果 (Fruit)

Some clips of the trajectory are essential elements in SL

Postures are basic elements in SL

# Recognizing SL from trajectory

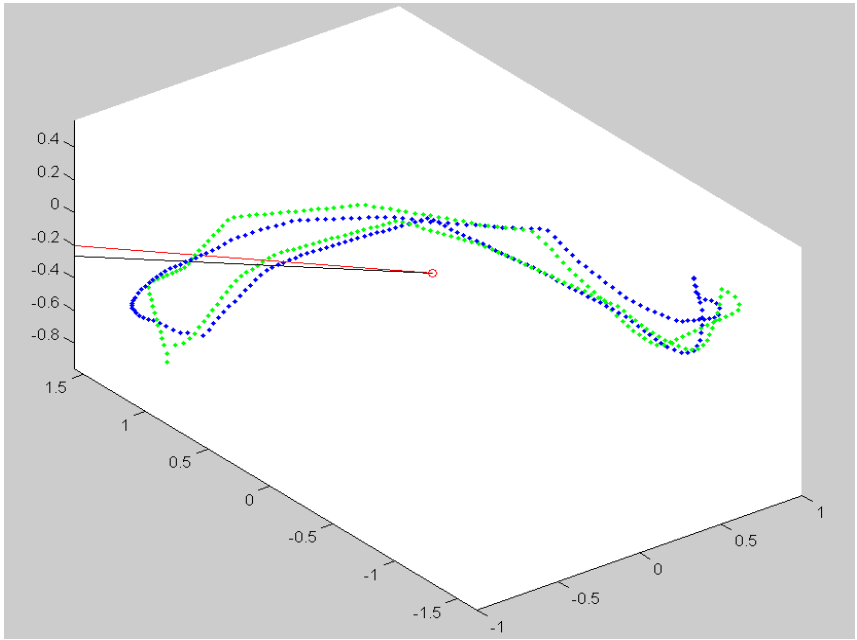
- Basic task
  - $D = f\ (c_1, c_2)$, where $c_1$ and $c_2$ are two curves in 3D space
  - Manifolds matching and distance measuring
- People play SL in different cases
  - Speed (duration) to play a sign
  - Height of the signer
  - Slightly different in pose



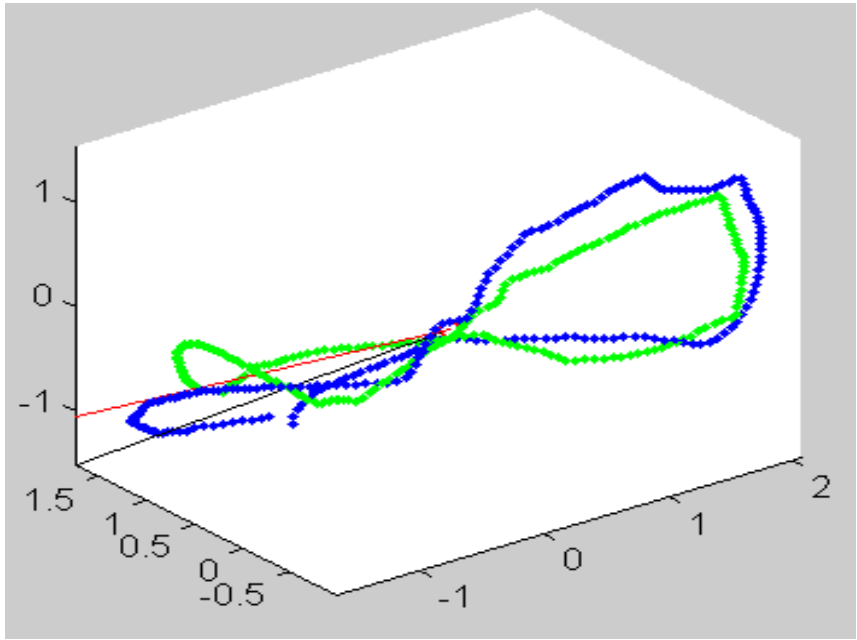
# Alignment of Trajectories

- A essential step to deal with various distortions
  - Speed (duration) to play a sign
  - Height of the signer
  - Slightly different in pose
- Noise remove to improve robustness
- Trajectory interpolation
  - Improve the performance on different speed
- Trajectory length normalization
  - Improve the performance between different signers (height)
- Calculation principle direction
  - Independent with pose

# Examples of Aligned Trajectories




Everyone(**大家**)

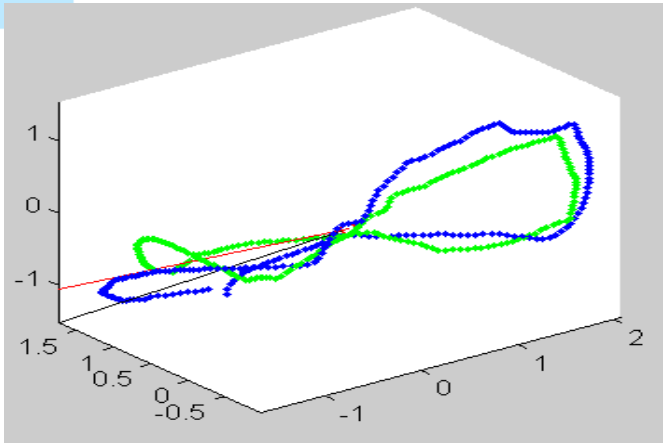



On purpose (**故意**)

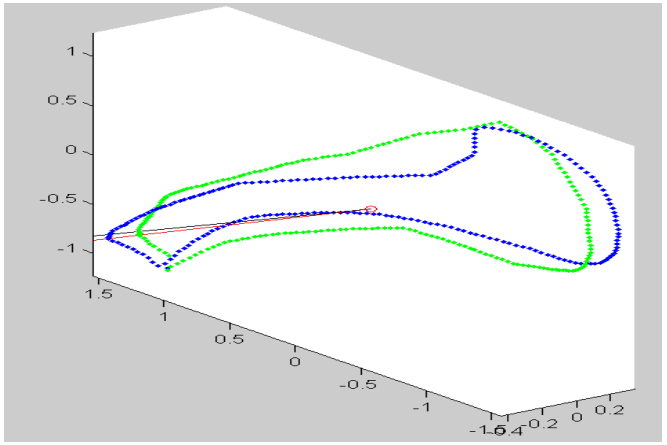
Black line: principle direction of blue curve
Red line: principle direction of green curve

*All trajectories above from right hand

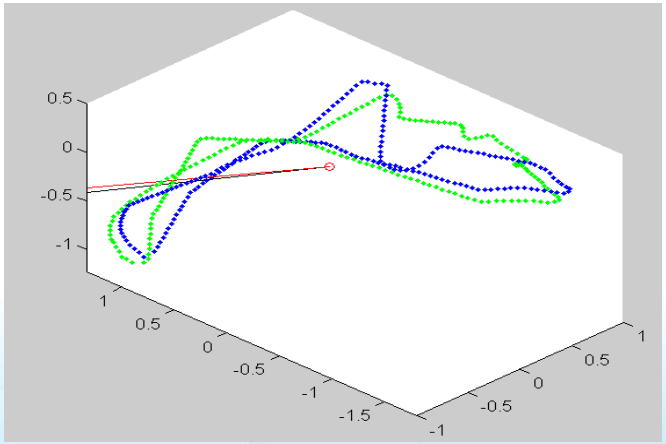
# Matching Same Word Trajectories



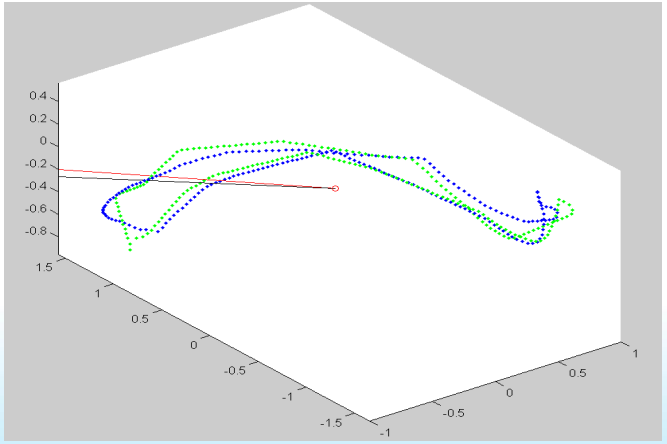
Everyone (**大家**) (d = 561)



Reach(**到**) (d= 162)



Reserve(**保留**) (d=400)



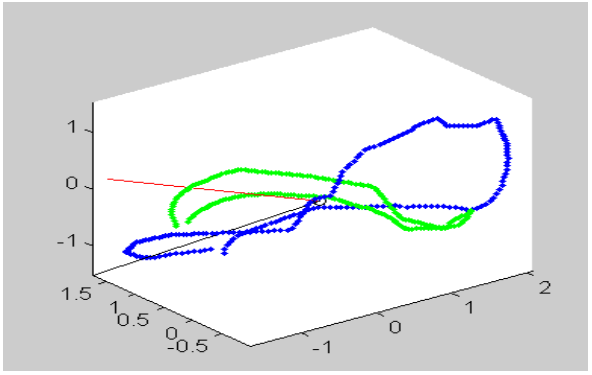
On purpose(**故意**) (d=212)

# Matching Different Word Trajectories

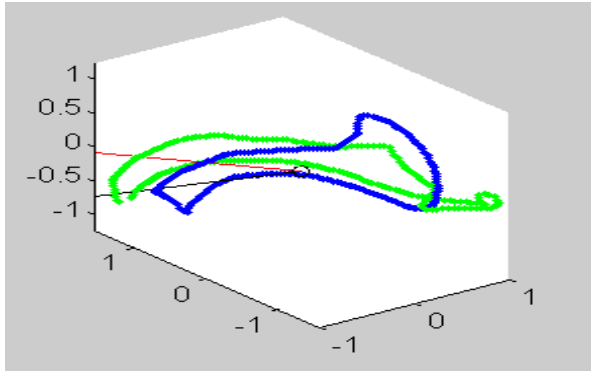
Everyone(blue)

Reach (Blue)

On Purpose (Green)

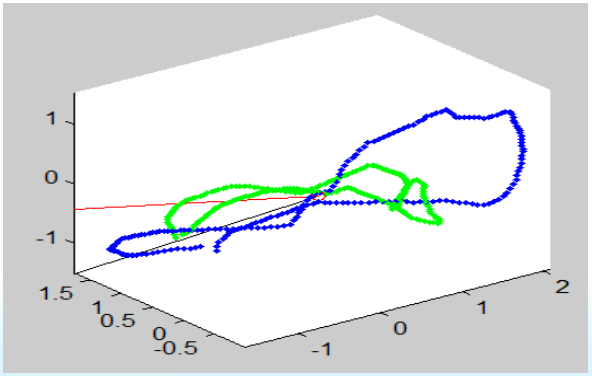


d=1,079

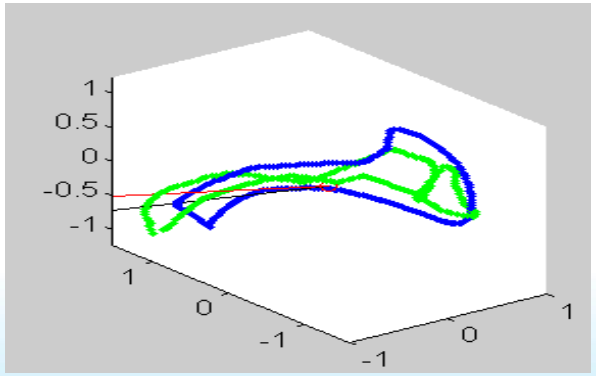


d=380

Reserve (Green)



d= 41,149



d=40,508

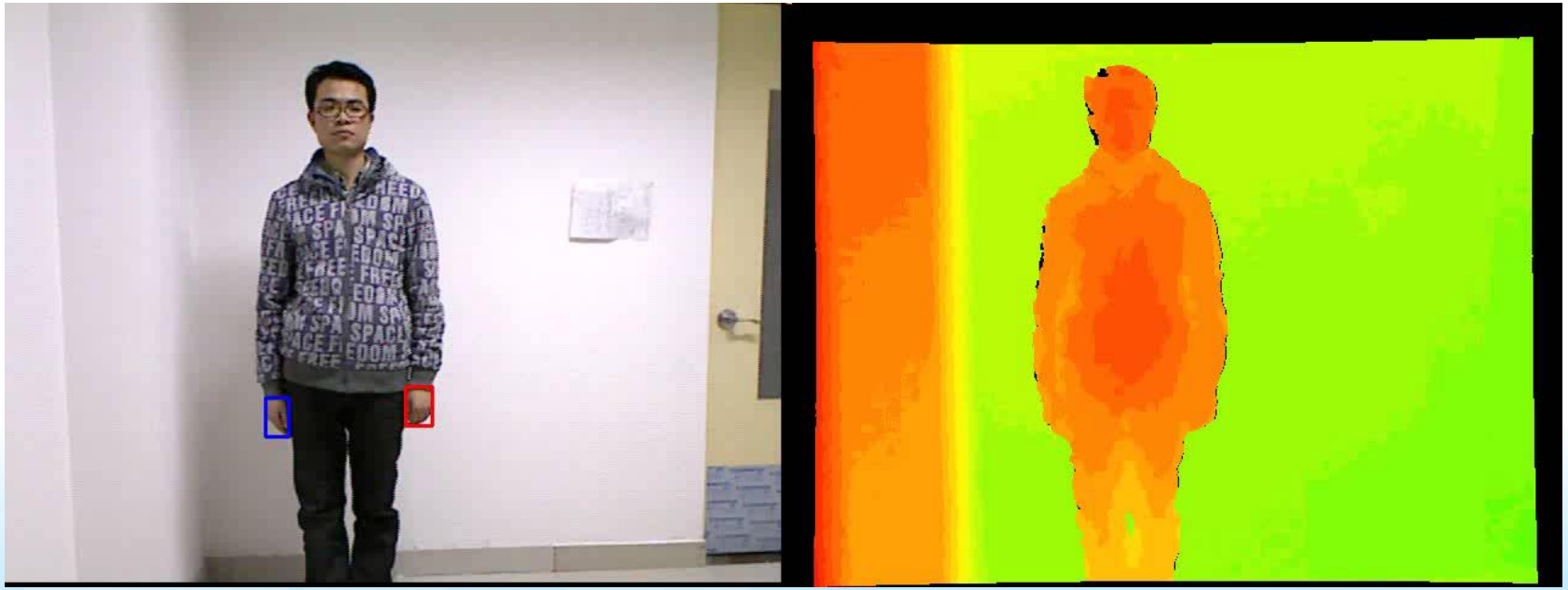
# Trajectory-based Recognition Result

| rank | count | rate |
|---|---|---|
| 1 | 180 | 75.3% |
| 5 | 225 | 94.1% |
| 10 | 232 | 97.1% |
| 20 | 235 | 98.3% |
| 50 | 237 | 99.2% |

- Vocabulary set size: 239

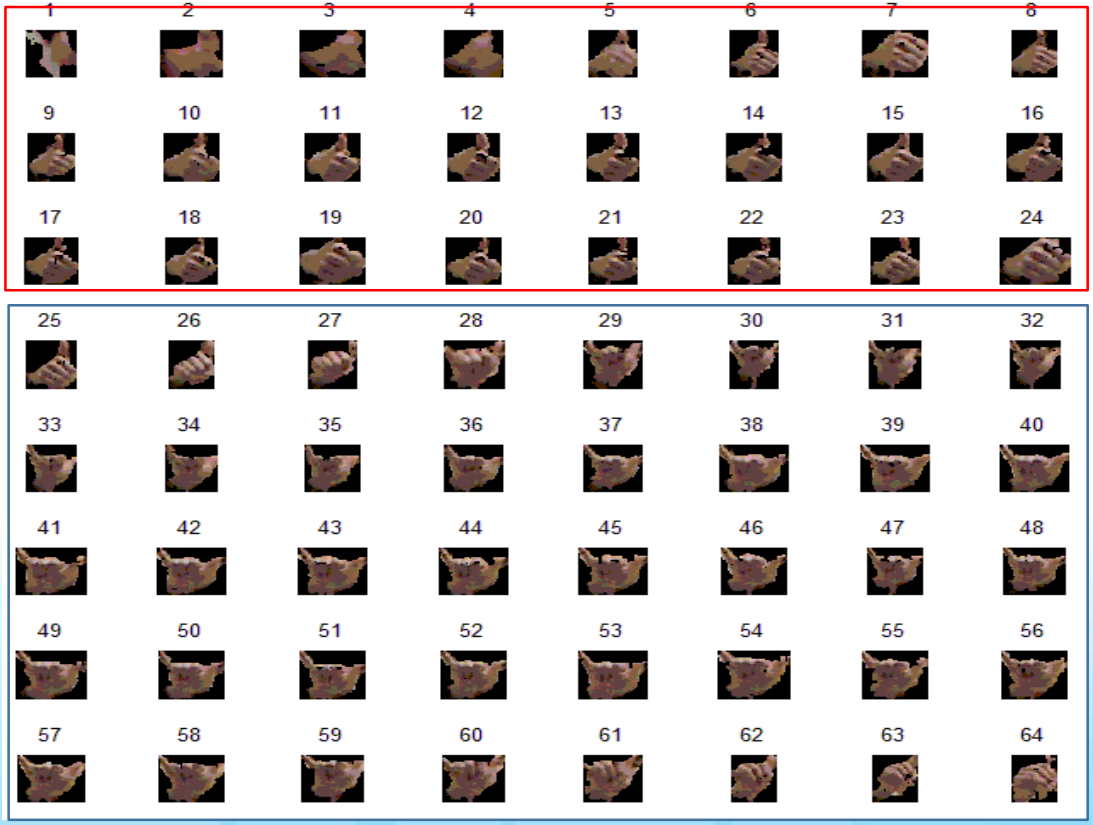
# Posture Recognition

- Key posture detection
- Key posture recognition



# Posture Recognition

- Key posture detection
  - Intersection-union ratio



# Posture Recognition

- Key posture detection
  - Intersection-union ratio
- Key posture recognition
  - PCA used for orientation normalization
  - Normalize hand size to 64*64
  - HOG feature
    - block size(8*8)
    - cell size(8*8)
    - 9 bins
  - LDA use for recognition

# Towards Better Communication with Kinect

Institute of Computing Technology, CAS
Beijing Union University
Microsoft Research Asia

Oct. 2012

Microsoft Research

# Thank you!

Microsoft Research Asia
Faculty Summit 2012

Microsoft Research

# Microsoft Research Asia
# Faculty Summit 2012