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Enhancing Dementia Screening in Ageing Deaf Signers of British Sign Language via Analysis of Hand Movement Trajectories

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Project Objectives

- Dunhill Medical Trust funded project: "RPGF1802\37 -Automated Diagnostic Toolkit for Dementia in Ageing Deaf Users of British Sign Language (BSL)", Oct 2018 – March 2020.
- Deaf population receives unequal access to diagnosis and care for acquired neurological impairments, due to unavailability of health staff with appropriate language skills.
  - Resulting in poorer outcomes
  - Increased care costs
- Aims to improve early screening for dementia among ageing signers of BSL
  - thus assisting clinicians who have limited knowledge about BSL in diagnosing dementia in deaf people

What is BSL?

- Sign languages are natural human languages, created by Deaf communities, and unrelated to spoken languages. They make use of
  - Hand actions
  - Face, head, and mouth movements
  - Body movements

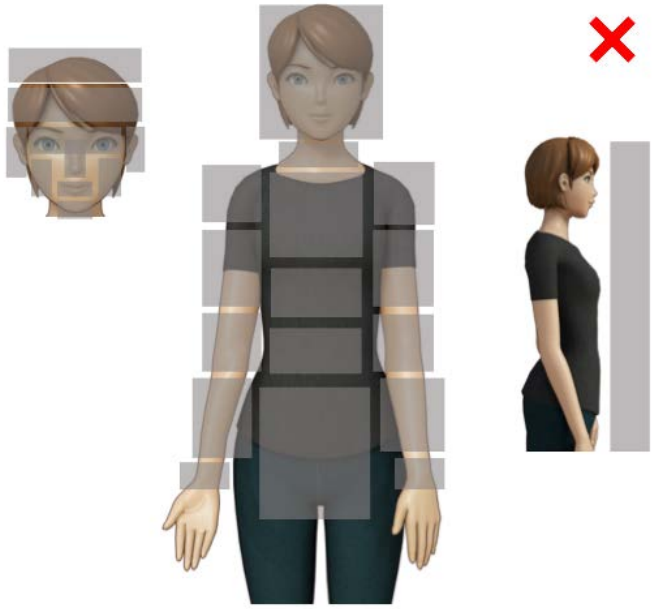
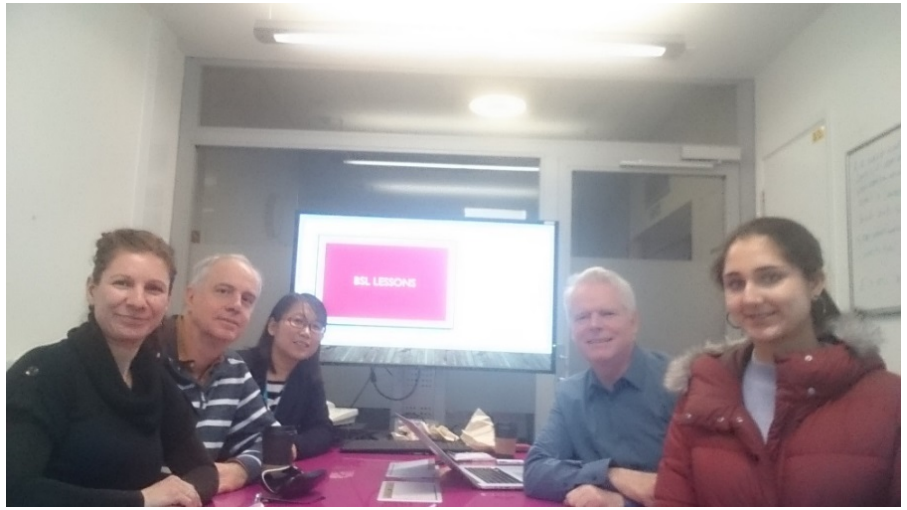


Figure 1: Sign Space in front of a Signer's Body

BSL Corpus Conversation: https://bslcorpusproject.org/



BSL Class for Computer Science Research @ UCL

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STAGES APPROACHED

- Stage 0: Literature on sign language, different possible feature extraction methods such as depth map model.
- Stage 1: Data Gathering- 4 BSL Data Sources
  - –BSL Corpus of 60 signers aged over 50
  - –BSL Cognitive Screen norming data of 250 signers aged between 50-80
  - –Case studies of signers with early stage dementia.
  - –Standard 2D videos on the BSL Signbank

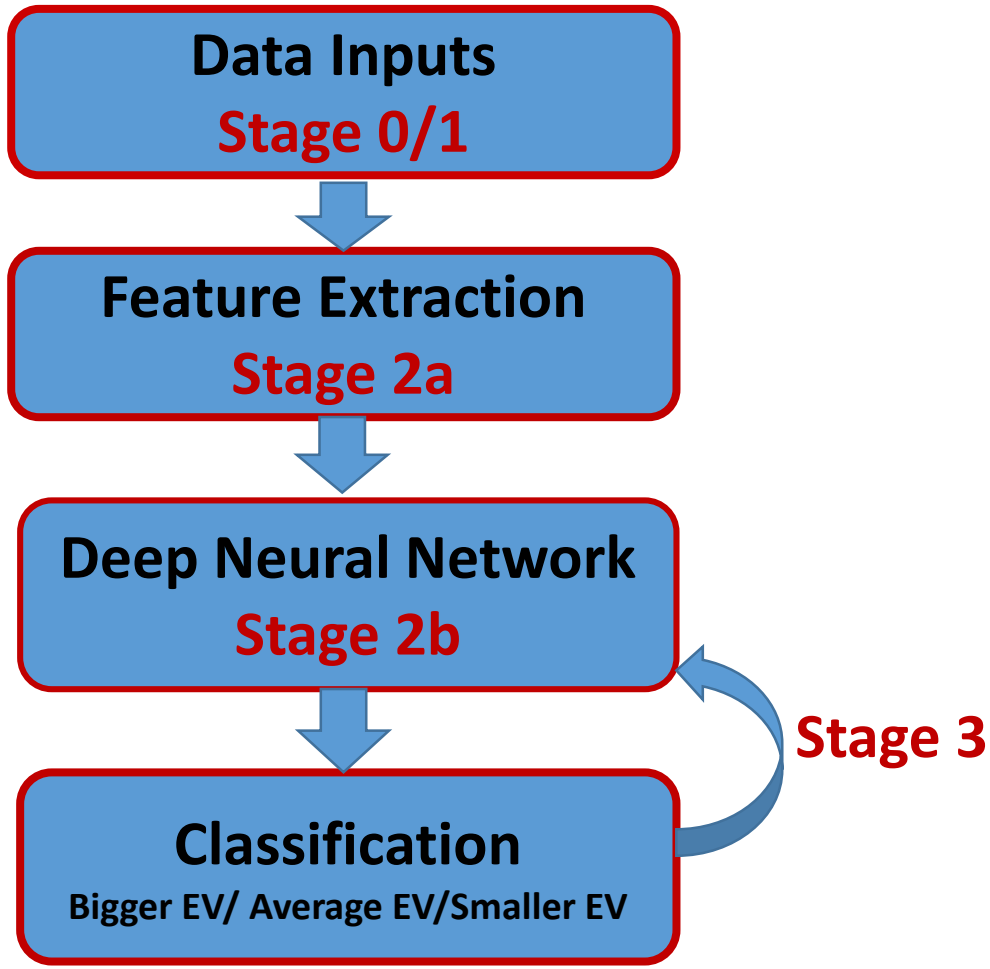

Figure 2: Project Procedures

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Current Stage 2: Platform-architecture

- Stage 2a: Provide a technological foundation using machine learning approaches to identify differences in the sign space envelope and facial expressions of signers as a key to identifying language changes associated with dementia
  - sign space envelope: sign trajectories/depth/speed
  - facial expressions of deaf individuals

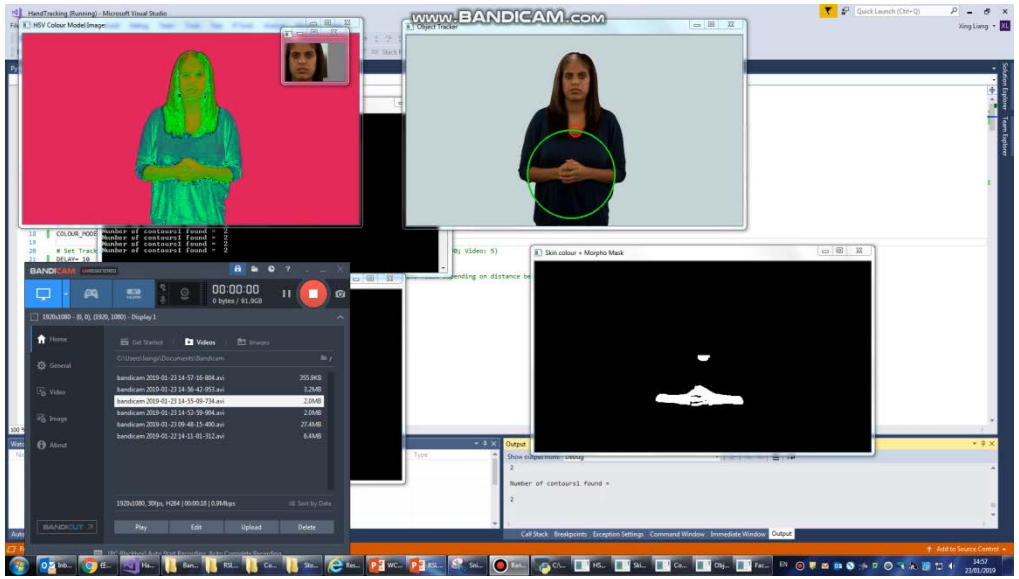

Figure 3: Signbank dataset and trajectory tracking

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SOFTWARE DEVELOPMENT

- **Platform**: Open Source Software – OpenCV https://opencv.org/; NumPy http://www.numpy.org/; Matplotlib: https://matplotlib.org/ are implemented in the current platform.
- **Methodology:**
  - based on CRoss-Industry Standard Process for Data Mining Standard
  - Software Engineering approach is being Agile
- **Achievement:** real-time two hands trajectory tracking
- **Further Experimentation:** more open source libraries/deep learning
- **Research Outcomes:**
  - https://www.screeningdementiabsl.uk/
  - Code and datasets of the project will be released under an open source licensing model. https://github.com/XingLiangLondon
  - Software Toolkit deployed will be well documented for re-usability and sharing among peers, researchers and developers.

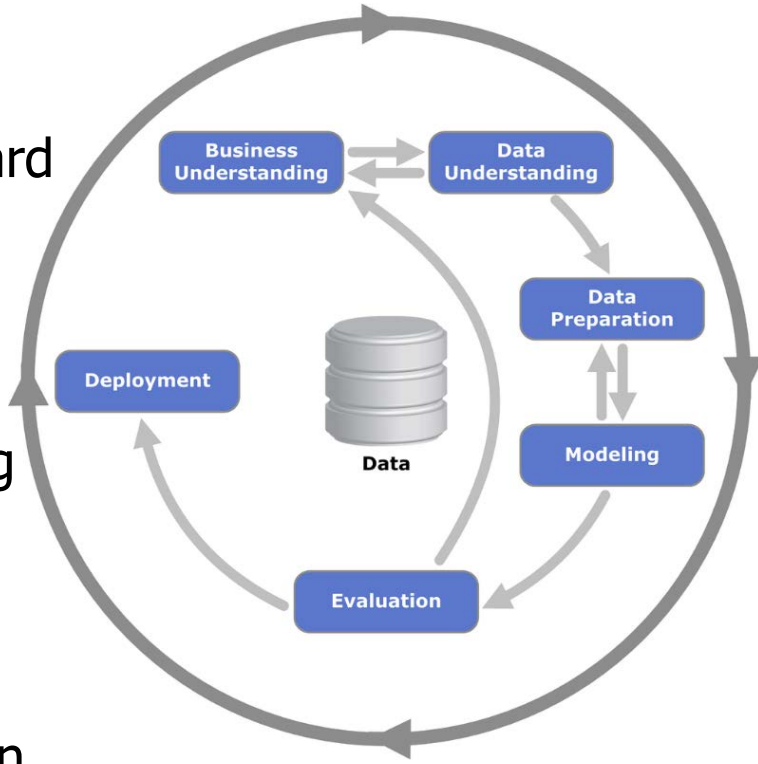

Figure 4: CRISP_DM

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SOFTWARE IMPLEMENTATION (1)

- Hand movement trajectory tracking developed in Python 3.6.5 and OpenCV 3.3.1 environment.

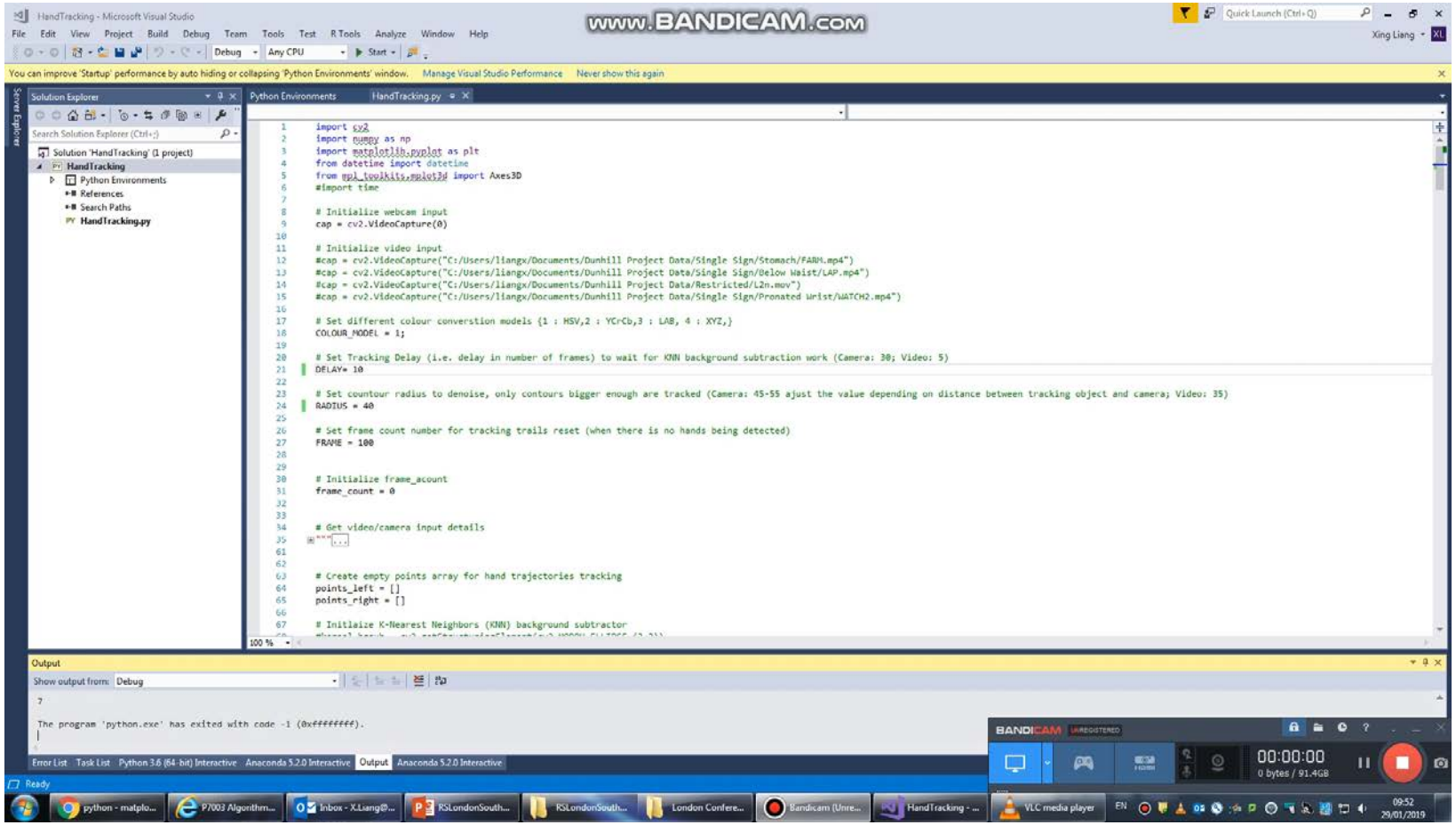

Figure 5: Hand Trajectory Tracking Demo

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SOFTWARE IMPLEMENTATION (2)

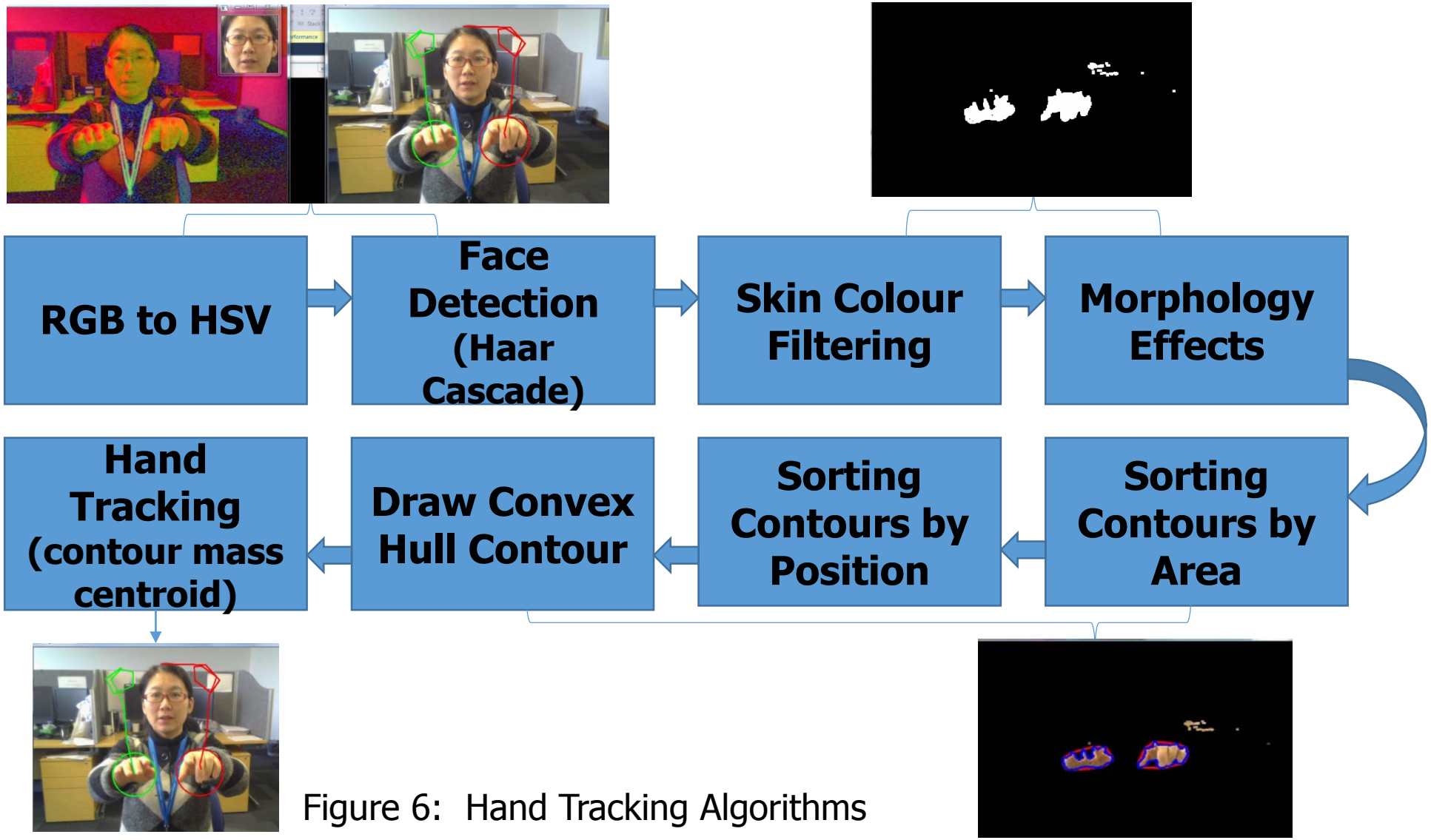

Figure 6: Hand Tracking Algorithms

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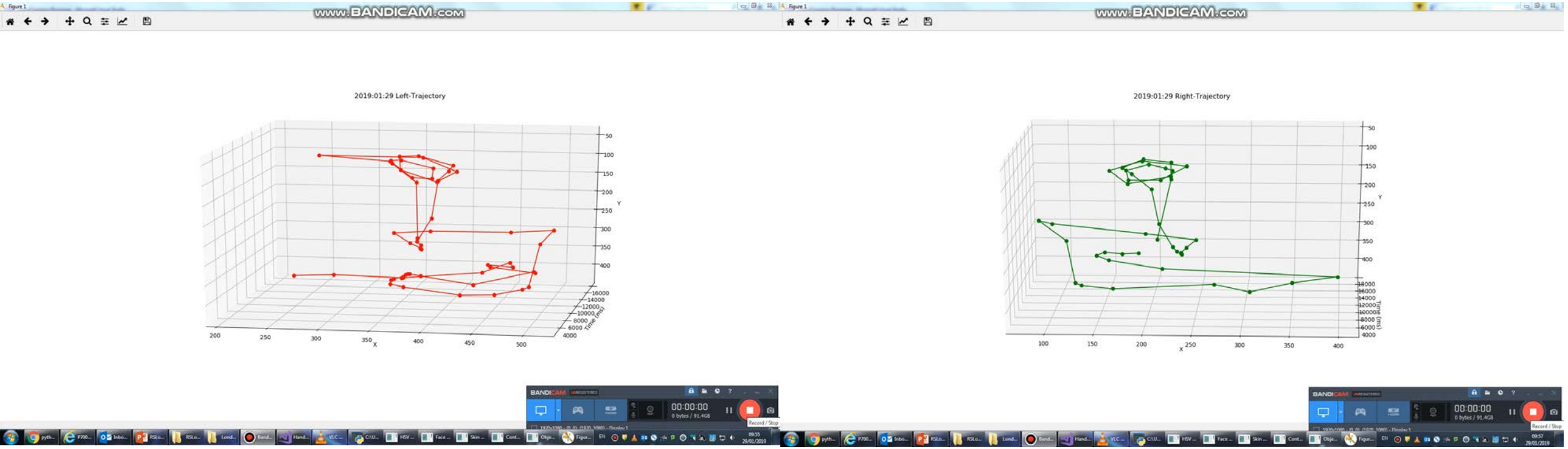

Figure 7: 3D Hand Tracking Trajectory

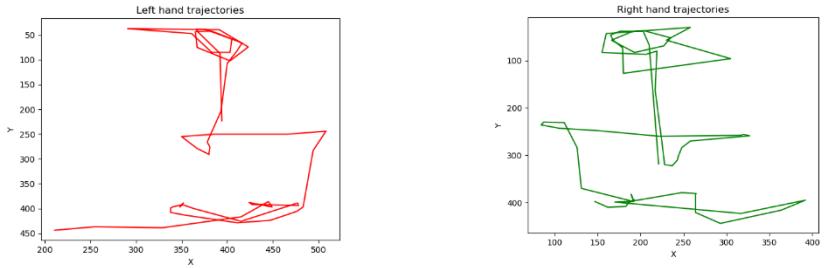

Figure 8: 2D Hand Tracking Trajectory

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Further Stages

- Stage 2b: Machine Learning algorithms
  - Deep Neural Network Models will be used for the incremental improvement of dementia recognition rates based on the differences in patterns from facial and trajectories motion data.
  - Convolutional Neural Network/Recurrent Neural Network/Hybrid
  - Train/Validate the results with cognitive screening results
- Stage 3: Pilot-evaluation
  - As necessary, participants will be recruited in collaboration with Deaf organisations such as Sign Health and Sonus for the evaluation of the Automated Screening Toolkit.

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CONCLUSIONS

- A computer vision and deep learning based automated screening toolkit will support screening for dementia in deaf signers of BSL.
- Unlike other current computer vision systems used in dementia stage assessment (RGB-D video or monitoring using ICT facilities), the proposed system focuses on analysing the sign space envelope and facial expressions of deaf individuals using standard 2D videos.
  - Potential for economic, simple, flexible, and adaptable assessment of other acquired neurological impairments associated with motor changes, such as stroke and Parkinson's disease in both hearing and deaf people.

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Questions?

https://www.screeningdementiabsl.uk/

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