3D Dance Head using KINECT and 3D projector

Chan Wai Yeung 1155005589
Lai Tai Shing 1155005604

Agenda

- Introduction & Background
- Design and implementation
- Conclusion
- Difficulties
- Future Work
- Q & A

Introduction

- Background
- Motivation
- Objective

Background

- What is Dance Head?
- A company called “Dance Heads” present
- Video shows people dancing
- Participants stand alone and wear clothes
- Participants’ heads are superimposed to the dancers

Motivation

- Entertainment for the public
- Limitation of current Dance Head
- KINECT is popular electronic device

Objective

- Design and implement an algorithm to extract Head part
  - Study KINECT SDK
  - Study open source libraries
    - OpenCV & OpenNI

KINECT

- Device developed by Microsoft
- XBOX 360
  - Mainly used in game

KINECT

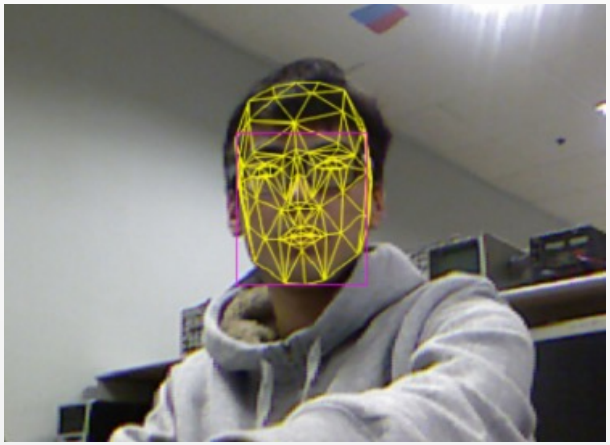
- **3D Depth sensor**
  - infra-red projector and monochrome CMOS sensor
  - Range 1.2m-3.5m
  - 320*240 resolution with 16-bit sensitivity
  - video captured is in 30Hz frame rate
- **RGB camera**
  - camera with resolution 640*480 in 32-bit colour
  - 30Hz frame rate

KINECT SDK

- Software development kit (SDK)
  - launched by Microsoft
  - Several versions
  - Drivers for using the Kinect
  - APIs and device interfaces for Windows sensor
  - Develop in Windows 8, Windows 7

KINECT Application

- Face tracking
- Skeleton tracking



OpenNI

- Open source
- Cross platform framework
  - Provides the interface for physical and software components
  - Application programming interface (API)
- As a channel to get data from KINECT
  - Color image
  - Depth map

OpenCV

- OpenCV (Open Source Computer Vision)
  - Library of programming functions for real time computer vision
  - Open source software
  - Used in different platforms
  - Image processing

Face Detection

- From Kinect SDK V1.5
  - tracking the face position, orientation and the face features
  - Larger faces are easily tracked
  - 87 2D points on the face
  - 13 points that aren't shown on the face
    - center of eye, the corner of mouth and the center of noise

Face Detection

- OpenCV
- Haar-Like features to identify object
  - Classifier
- Cascade classifier for detection of face
  - Classifier is trained with particular object
  - Applied to the input image
  - Return 1 if likely to that object
  - Step by step

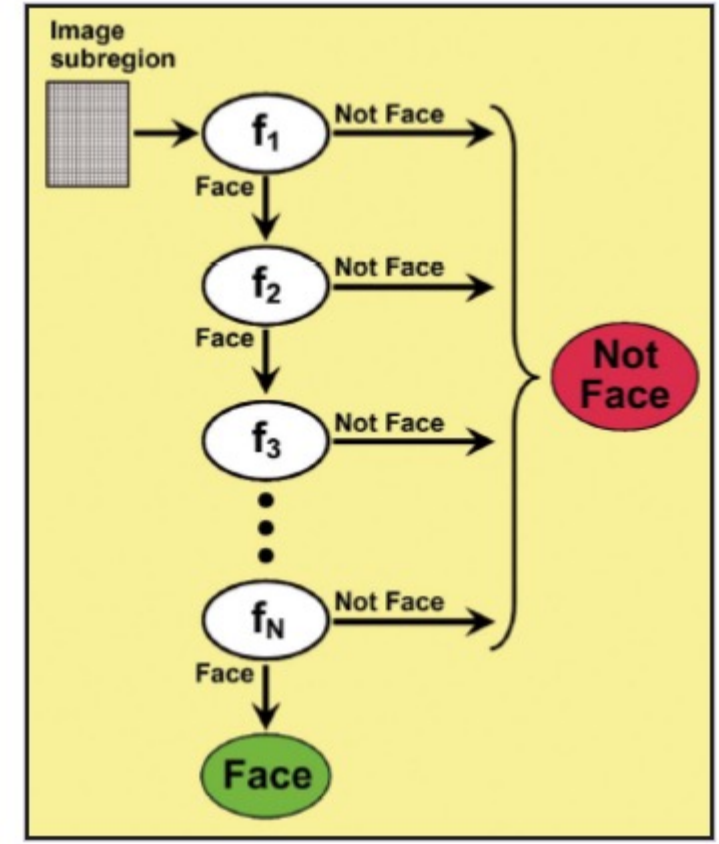


Image subregion
f1
Not Face
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Comparison

- Working platform
- Programming language
- Principle of face tracking

- Decide to use face detection in OpenCV
  - Run in different platforms

Design & Implementation

- Study the background
- Study KINECT SDK
- Study open source libraries
- Decide the best way to extract the head

- 3 milestones
- Milestone 1
  - Manipulate the image by the depth value
  - Learn how to program in OpenNI
- Milestone 2
  - Program with face detection in OpenCV
  - Use the concept of connected component
  - Improve the output image by filling the holes

- Milestone 3
  - Try out different method to extract
  - Superimpose the head to the video

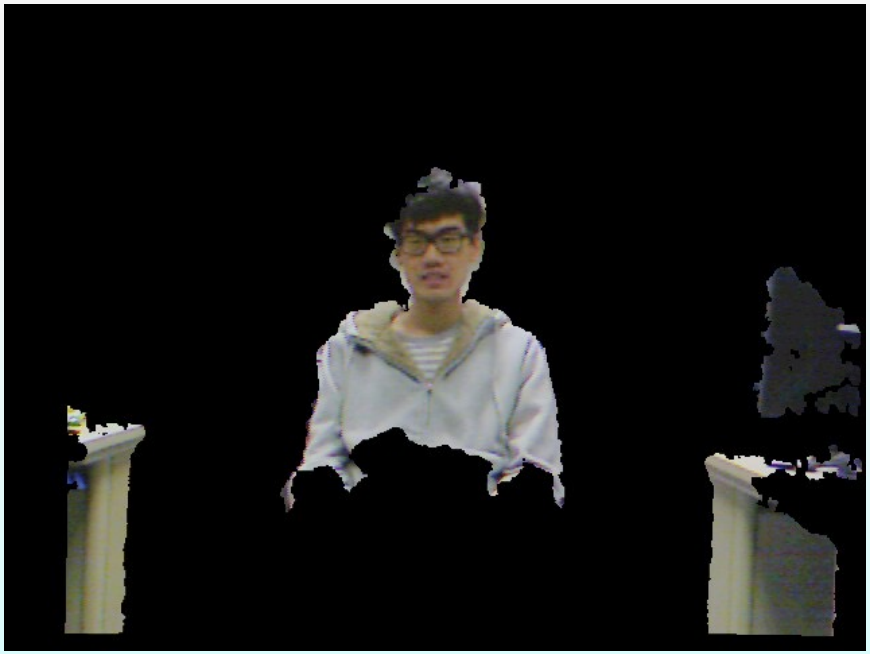
Milestone 1

- Use the depth data received from the KINECT
- Show the image within certain depth

Milestone 2

- Make use of face detection in OpenCV
  - Use cascade classifier to identify face
  - Extract the head part
  - To obtain the face's depth

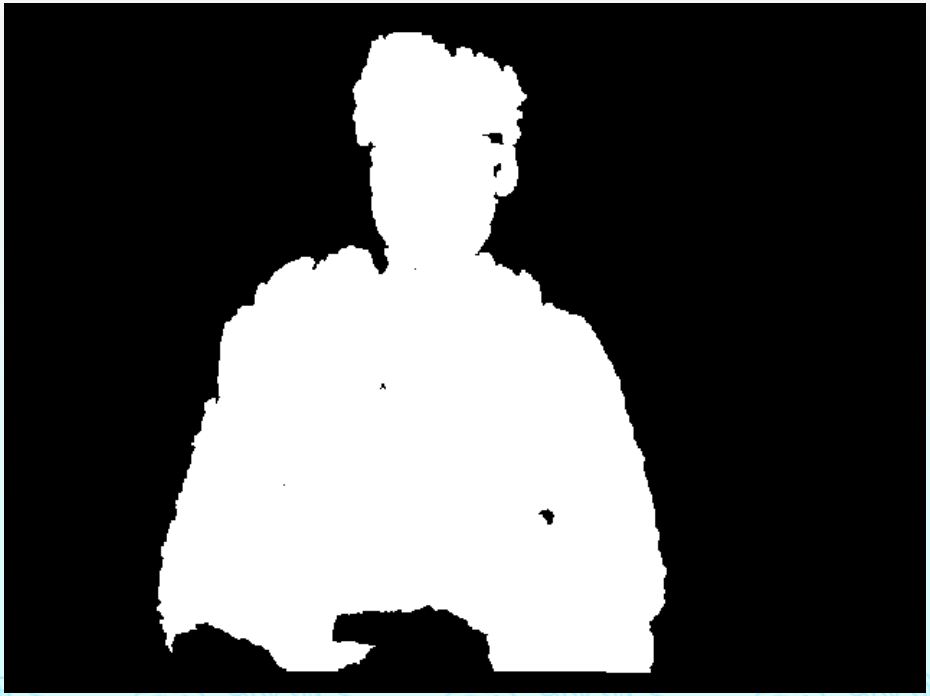
- Combine with milestone1
  - Show the object within face's depth



Milestone 2

- Connected component
  - Other objects also shown in result image
  - To exclude the other image
  - No other object is shown

- Noise reduction
  - Black holes appear
  - Improve the result image by filling the holes

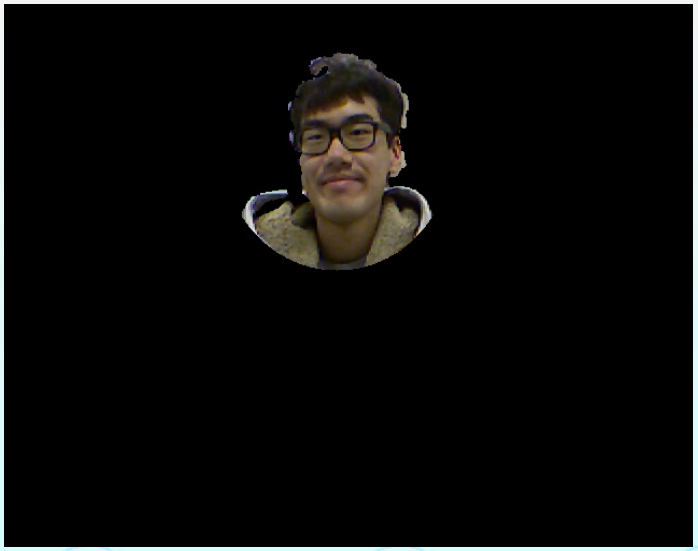


Milestone 3

- Find out the best method to extract the head
- Cutting the head by radis
- Edge detection
- Surface normal
- Surface normal combined with depth value

Cut the face by radius

- Based on Face detection in OpenCV
  - Find the center of the face
  - Set the radius
  - Cut the head by a circle with the radius



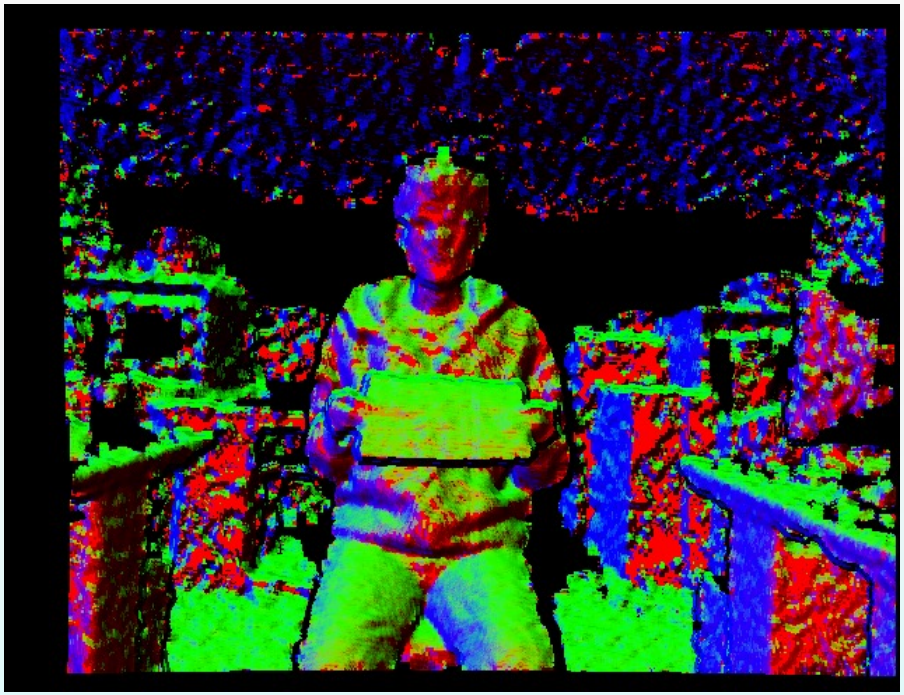
Edge detection

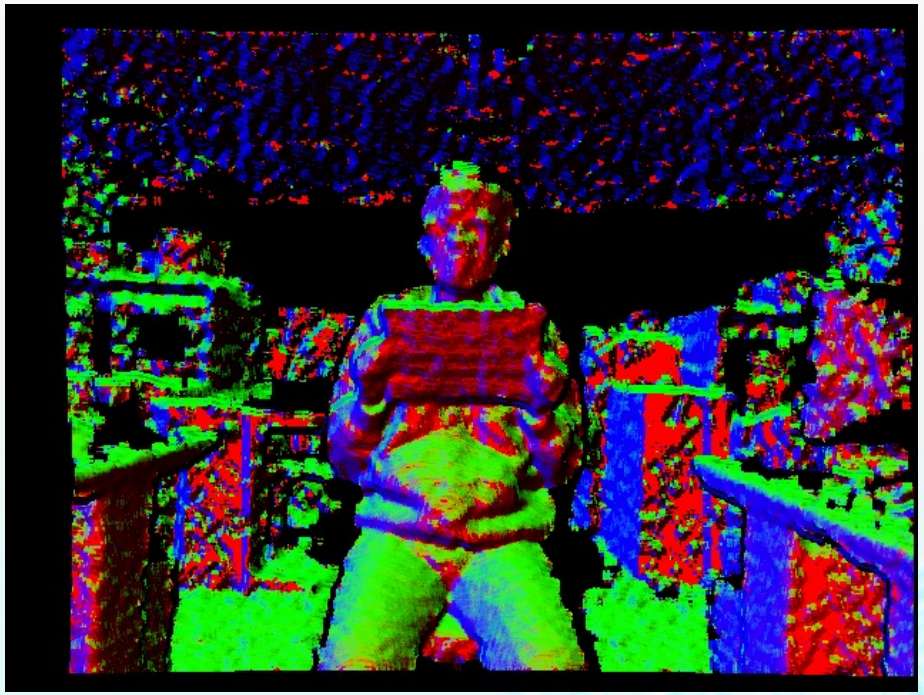
- Try to extract the face by edge
  - Use Canny edge detector
  - Create the edge image of depth and color

- Not possible method
  - No great gradient different in edge map
  - Cannot extract the face

Surface normal

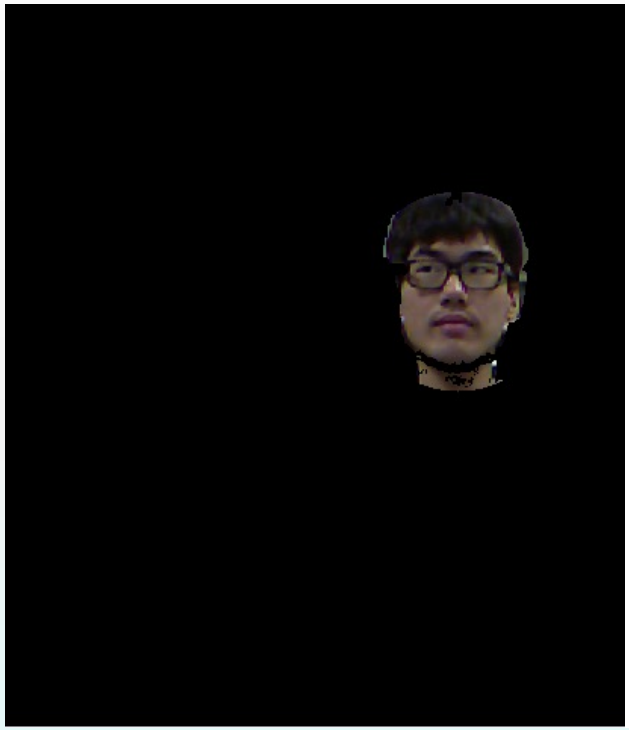
- Vector at a point that perpendicular to the tangent plane to that surface at that point
- Different surface normal on the face point
  - use difference gradient of the chin
  - Extract the head by the change of the chin
- Seem to a better way to extract the head

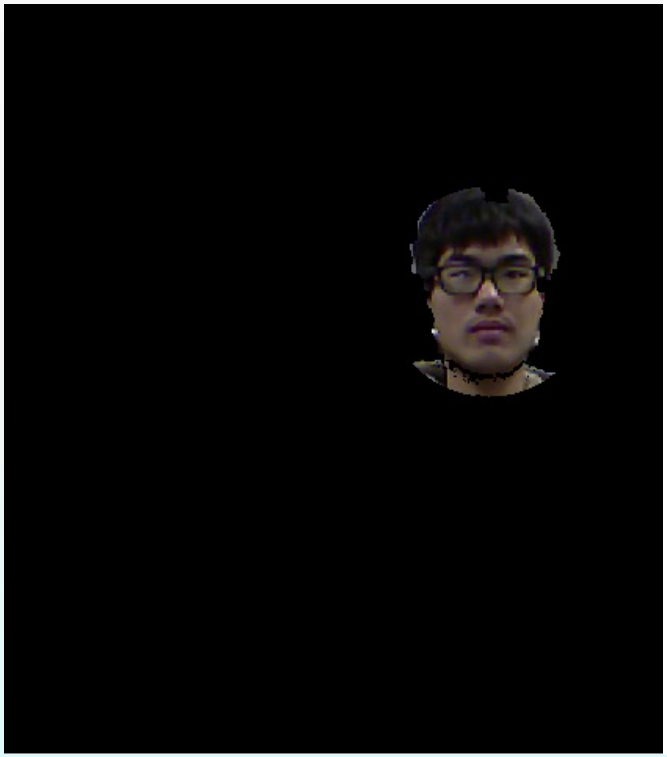


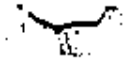


Surface normal combined with depth

- Surface normal of the chin is pointing down
- Depth value larger than certain range
- Only if these two conditions are fulfilled
  - the head extracted
- Best result
  - Smooth curve of the chin







Conclusion

- Study KINECT SDK
- Study open source libraries
- Try out different methods to extract the head
- Find out the best way for extraction of the head


DOGS
LIBRARY

Difficulties encountered

- Lack of knowledge in image processing
- Difficult to find the best way for extracting the head
- Limited resources and documentation

Current limitation

- Kinect limitation
- Detection of multi-face
- Side view problem
- Low frame rate

Further work

- Improvement of the output image
- Improve the frame rate
- Implement advance features to Dance Heads
- Point Cloud
- Link with 3D Projector

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Q &A