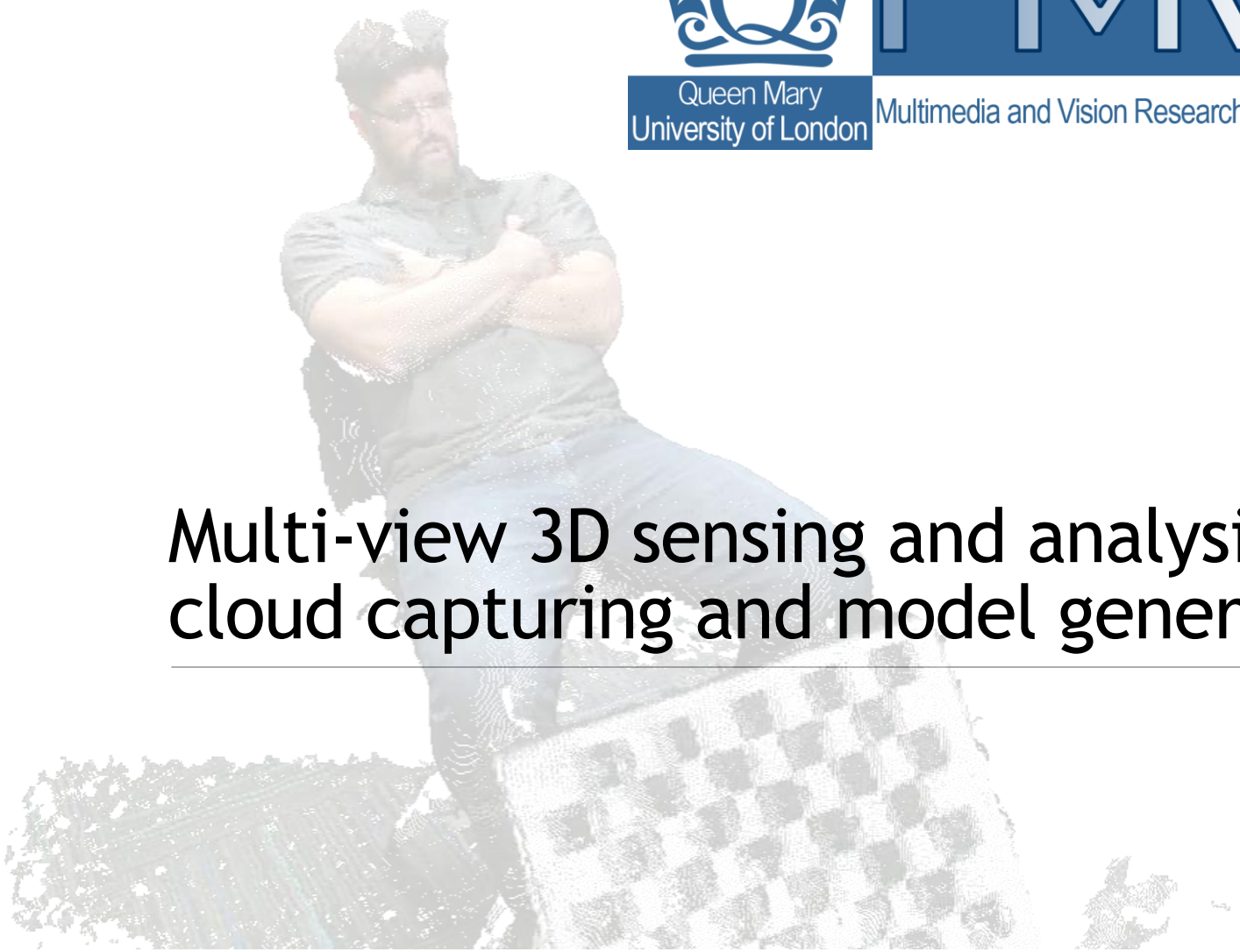

Queen Mary University of London

Multimedia and Vision Research Group

Multi-view 3D sensing and analysis for high quality point cloud capturing and model generation

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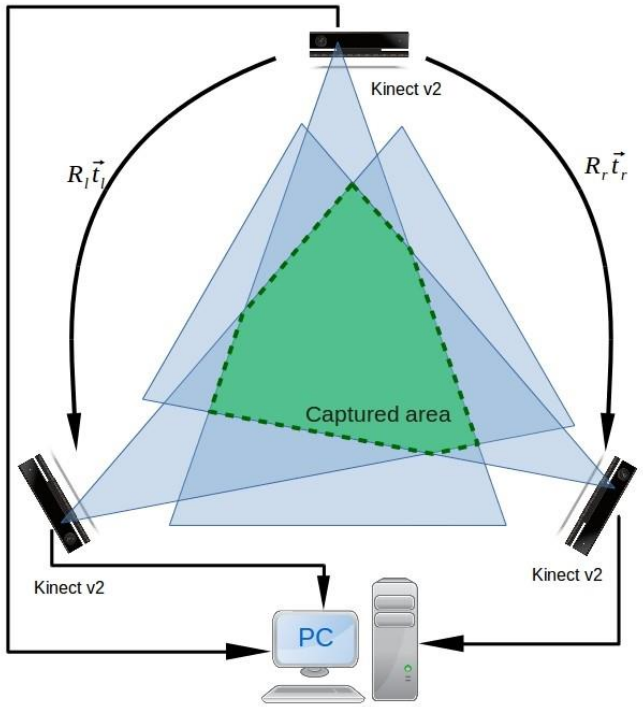
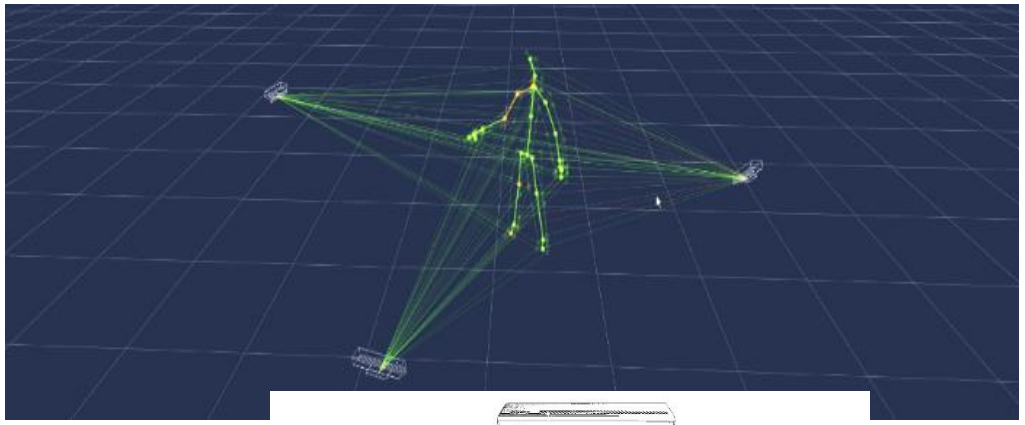
Introduction

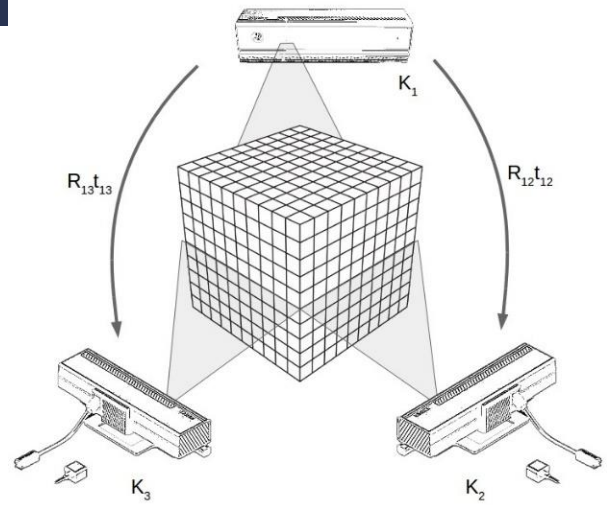
- Providing high-quality depth data has been one of the most important issues in the field of 3-D computer vision and can be used in many applications such as image-based rendering, 3DTV, 3-D object modelling, robot vision, and tracking.
- RGB-D sensors placed around capturing area providing full reconstruction of the scene
- Surface reconstruction became also one of the most important stage primarily as a result of the ability to acquire 3D point clouds.
- By registering the consecutive set of depth images, one can obtain an increased point density and seamlessly object from multiple views

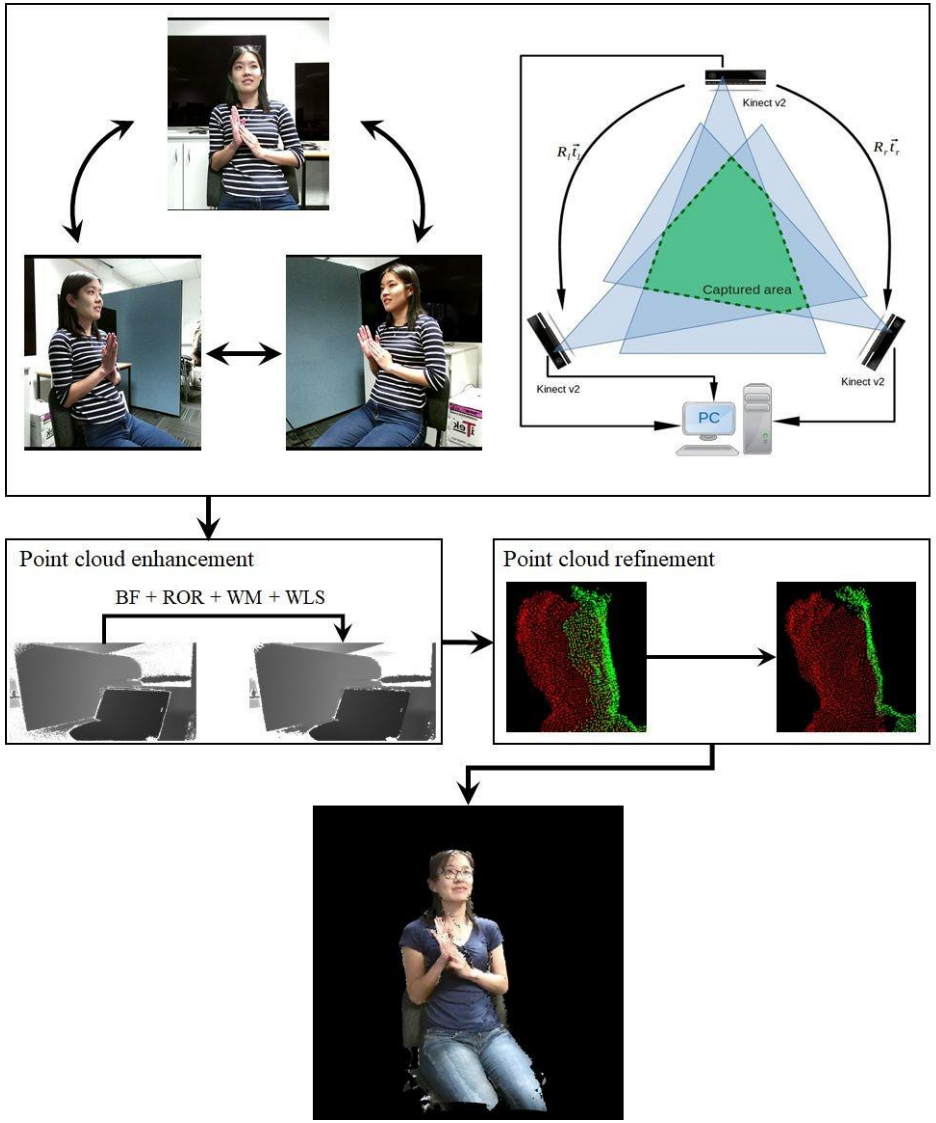


Motivation

- Real-time 3D reconstruction of object
- Multi-view MOCAP - Capture movement of hidden body parts
  - Marker-based Motion Capture (MOCAP) and analysis systems have received commercial success, however, the need for markers, the technical expertise required for using the system, and the high hardware cost limit its adoption in many practical applications.
- Providing streaming content
- Real-time holographic video capture with interactive gesture control and can be used with Kinect
- Can be connected to single machine and can create a 3D hologram - create a realistic holographic experience that places the digital in the real world.

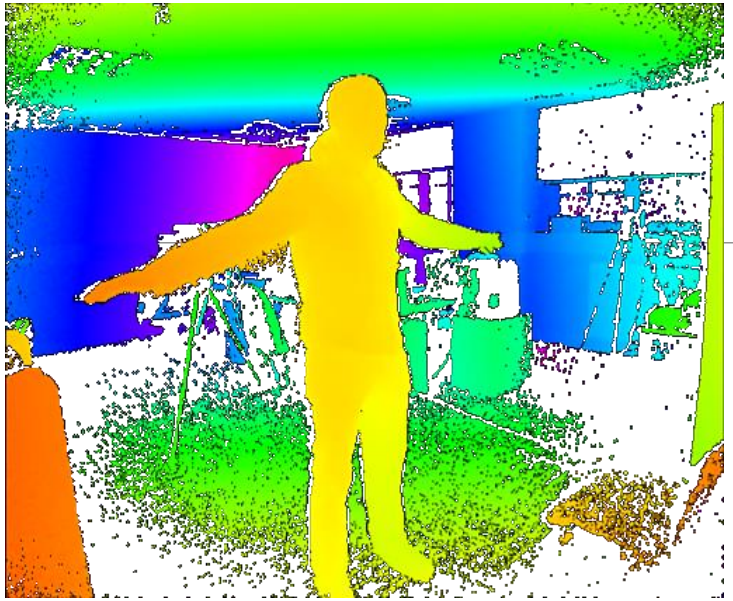
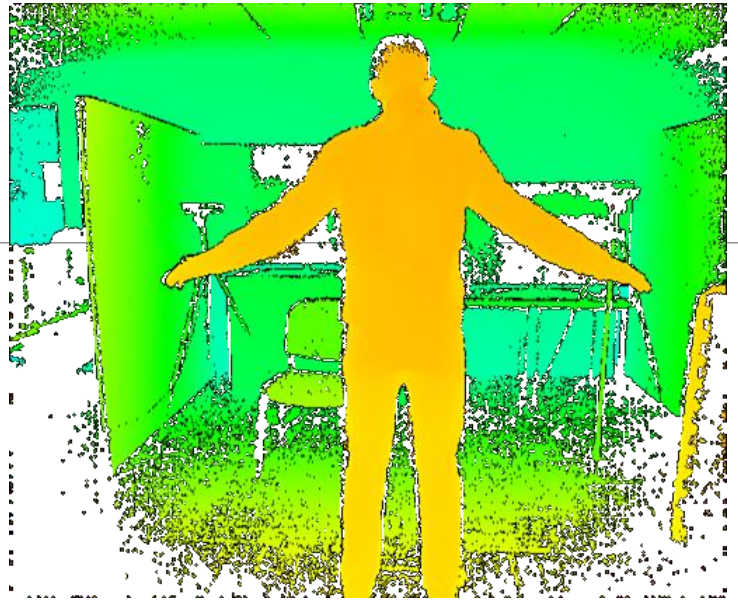
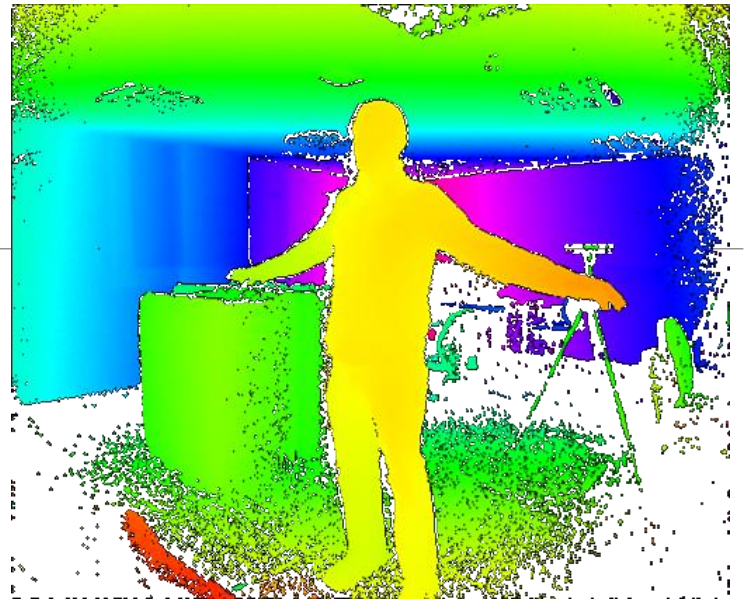


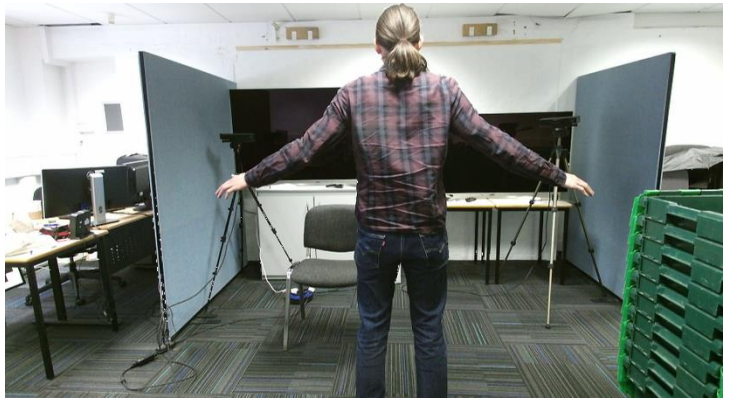
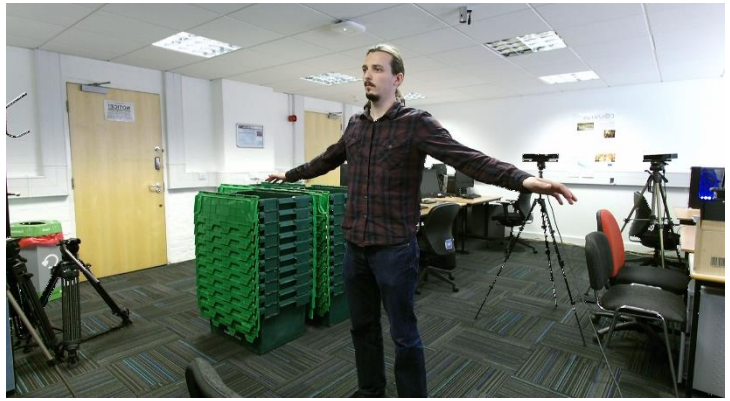




Multi-view reconstruction system

- Connection of multiple RGB-D sensors
  - Extension of USB3 – 5Gbps
  - high-speed serial computer expansion bus card
- Extrinsic calibration of devices
- Depth map enhancement and denoising
- Point cloud retrieval and reconstruction

Calibration

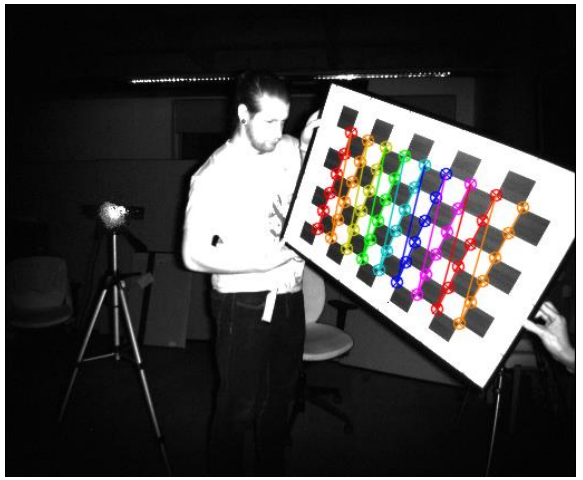
- Pattern corner detection
  - Double-sided pattern
- 2D Corners to 3D points
  - Calculate a 3D coordinates of points

$$P = K[R \mid t]$$

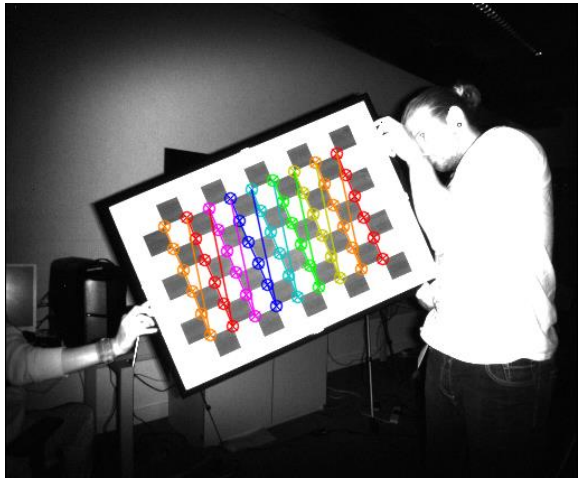
  - Find rotation matrix R (SVD)
  - Find translation vector t

Uncalibrated

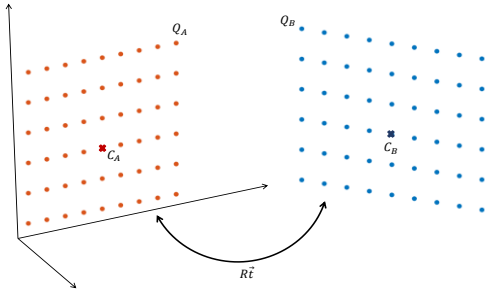
Calibrated



Left Kinect



Right Kinect



$$H = \sum_{i=0}^{N} (Q_L^i - C_L)(Q_R^i - C_R)$$

1

$$H = U\Sigma V^T$$

$$R = VU^T$$

Depth map enhancement

- The quality of the depth image is a key factor for model generation and reconstruction which often suffers from limited accuracy and stability due to depth inconsistencies and structural defect
- Enhancement using spatial neighbourhood
  - Bilateral filter
  - Weighted Median filter
  - Radius Outlier removal
  - Weighted Laplace-based smoothing
  - Weighted Inter-Frame filter
  - Machine learning – CNN, GAN

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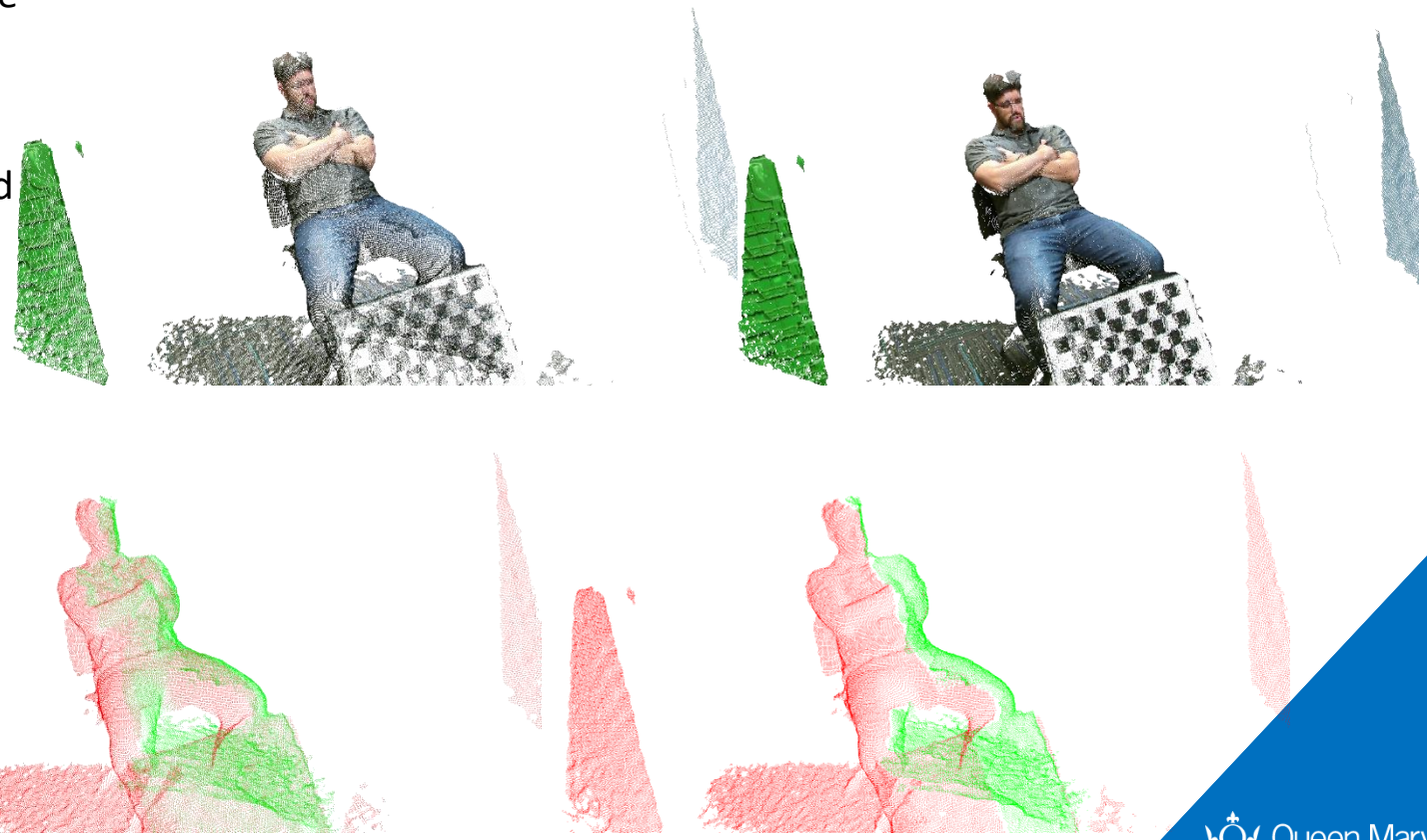
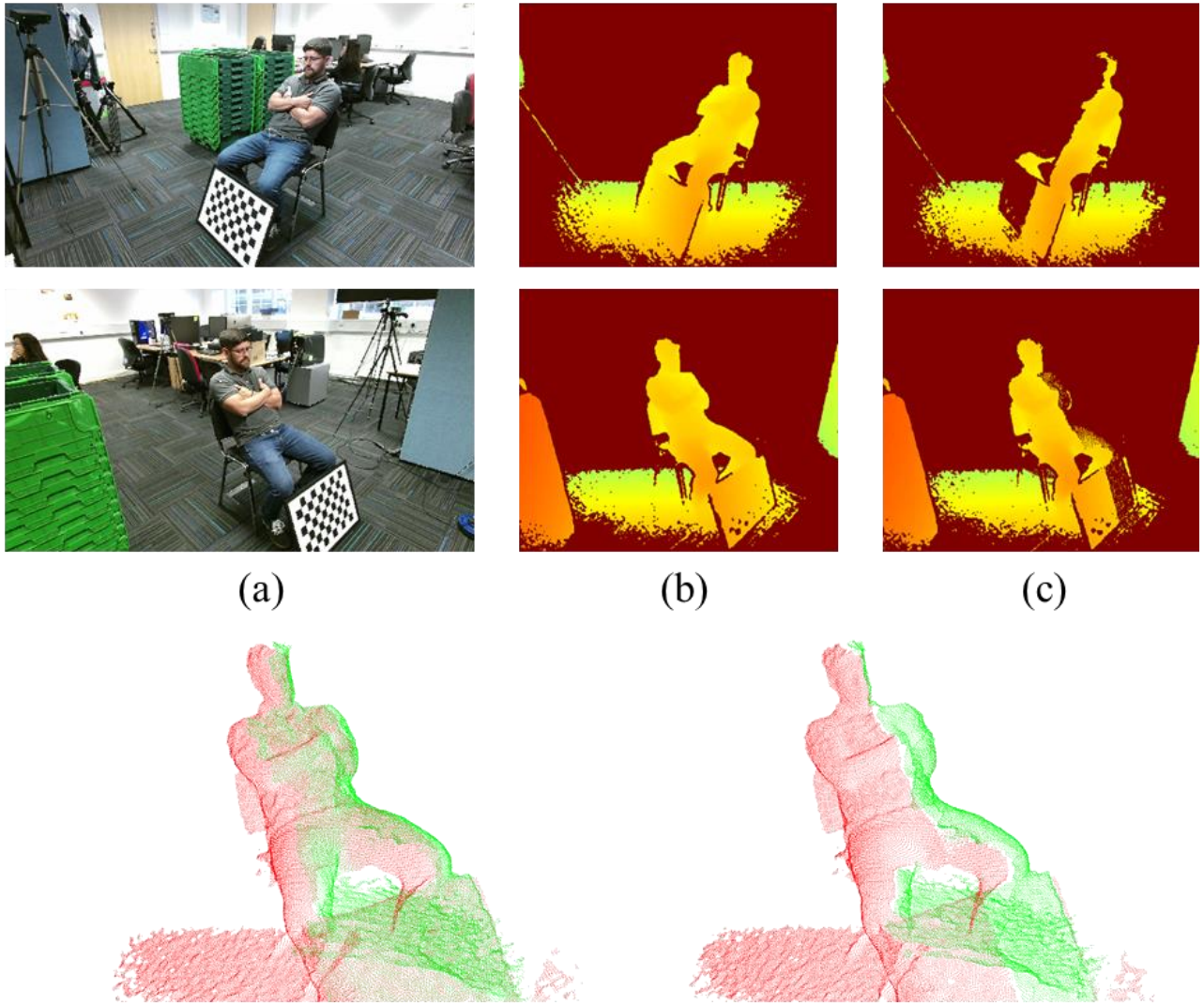
Refinement

- Improving point cloud representation and remove redundant points.
  - Remove overlapping areas
- Absence of topological information of point cloud
  - Fill empty space between points



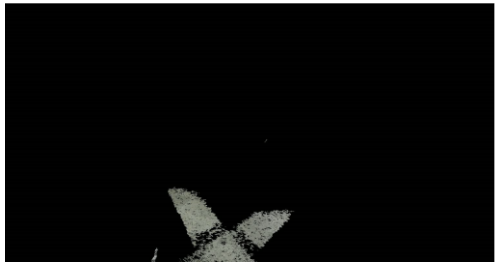


Refinement

Rendering and results










Evaluation

GTX770 2GB

Process	Time[msec]	Load [%]
Weighted Median filter	1.95	12.53
Radius Outlier Removal	3.36	21.59
Interframe Average filter	1.05	6.75
Acquisition of point cloud	2.35	15.1
Point cloud refinement	6.85	44.02
Overall	15.56	100

Thank you for your attention

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