Development & accuracy analysis of structured light 3D scanner based on fringe projection technique

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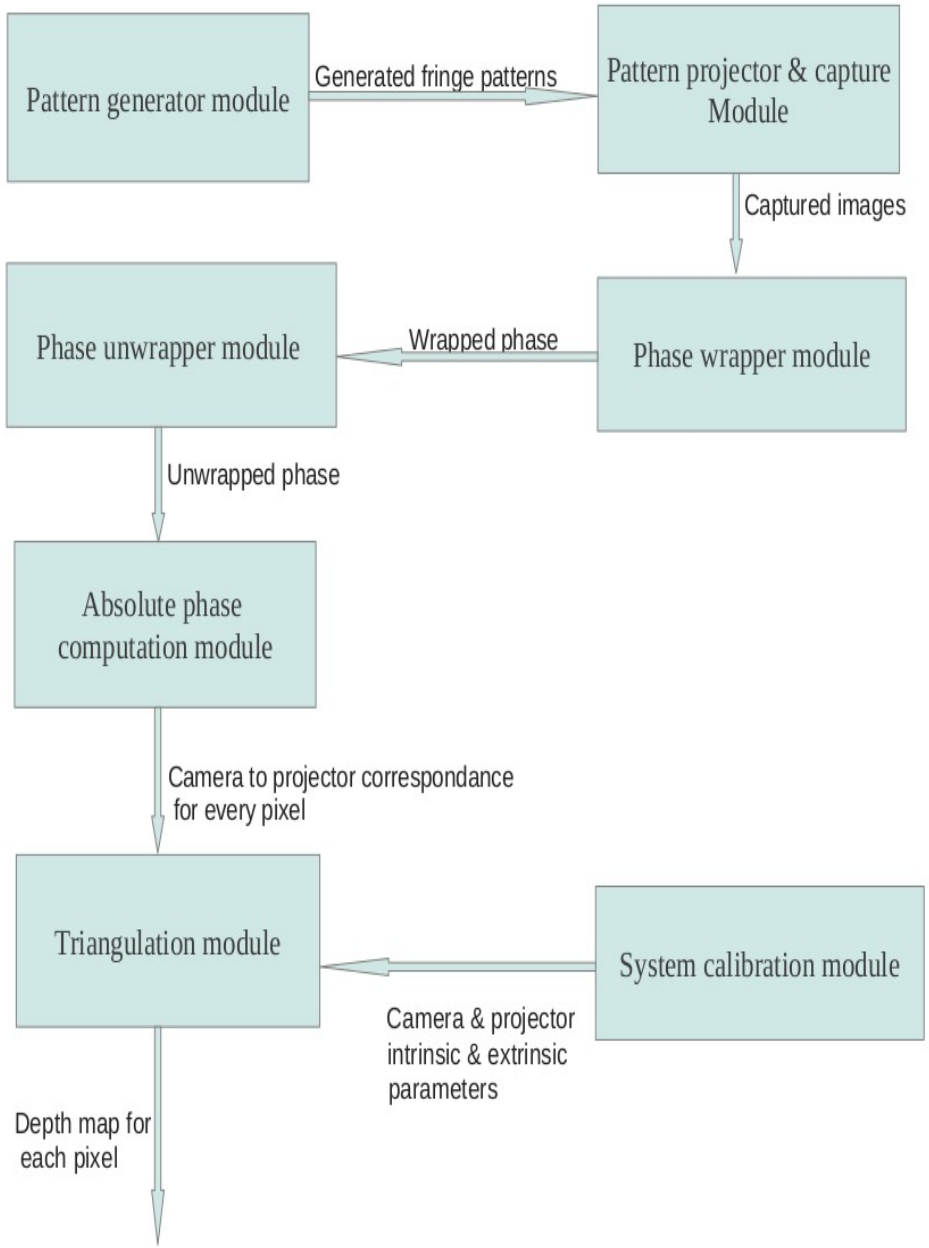
Computer Division

System details

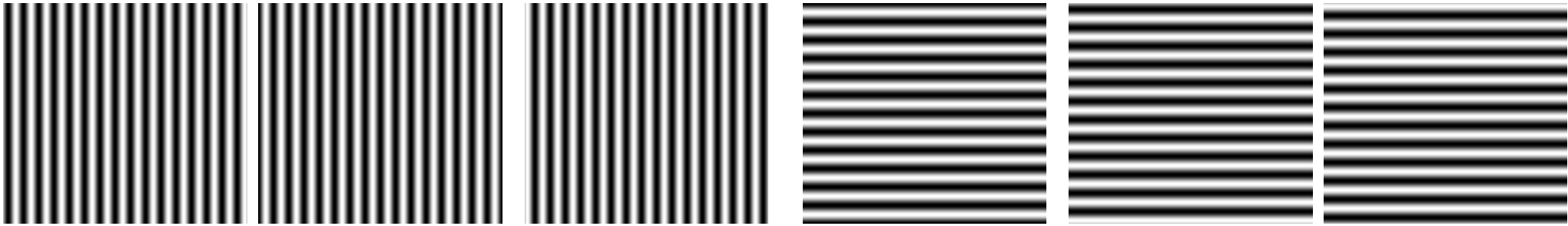
System setup

Software components



Pattern generation

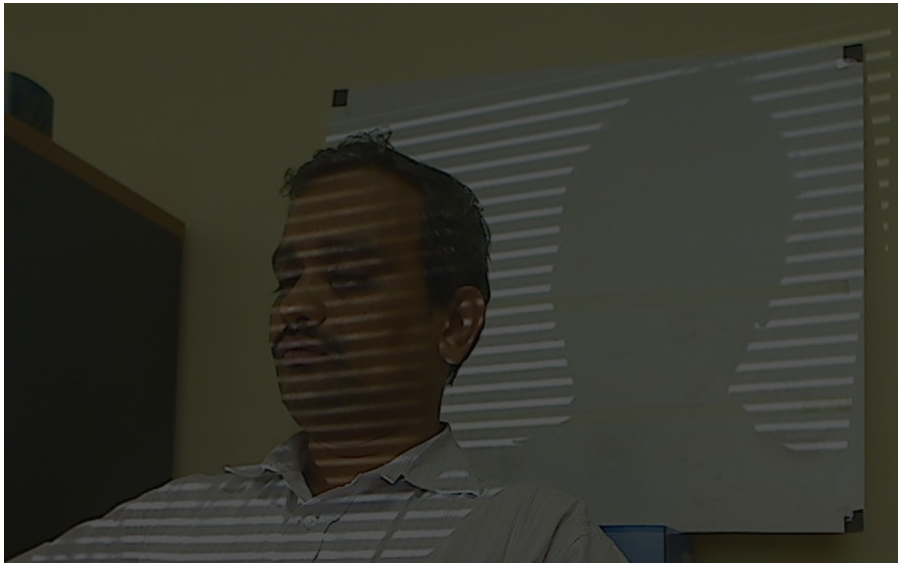
Fringe patterns



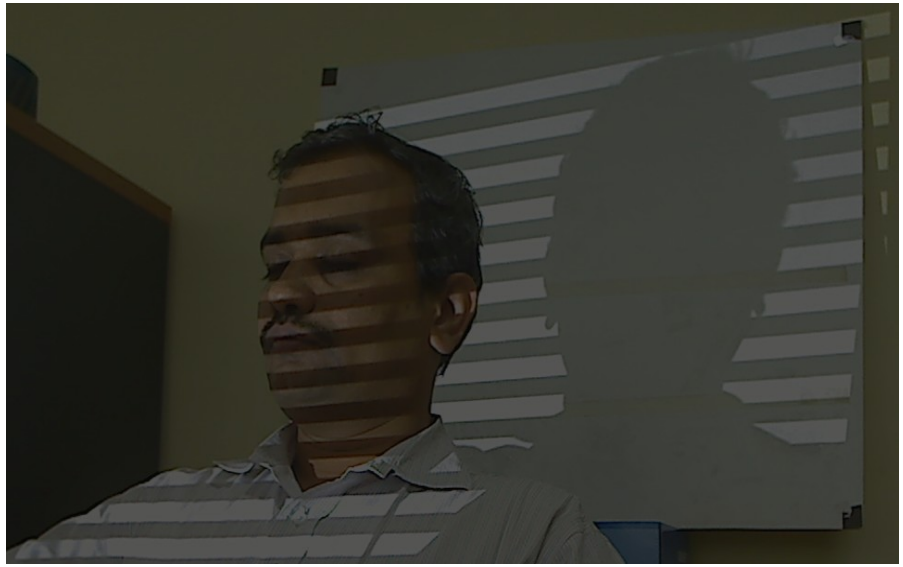
Binary coded patterns(for decoding fringe period number)

Pattern projection

Phase shift patterns

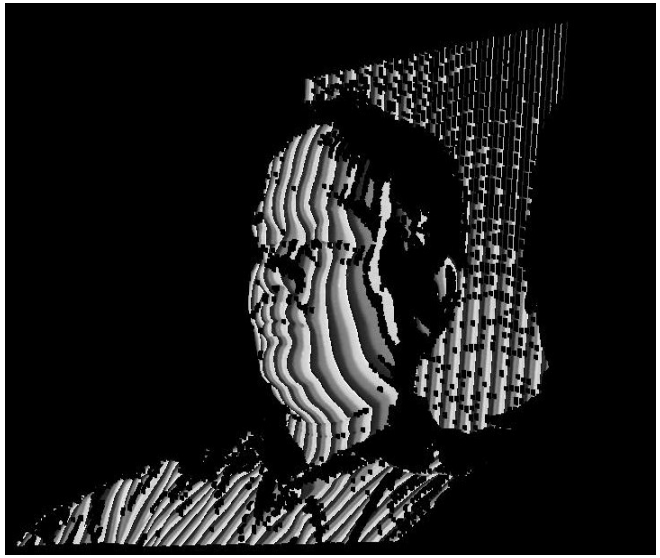


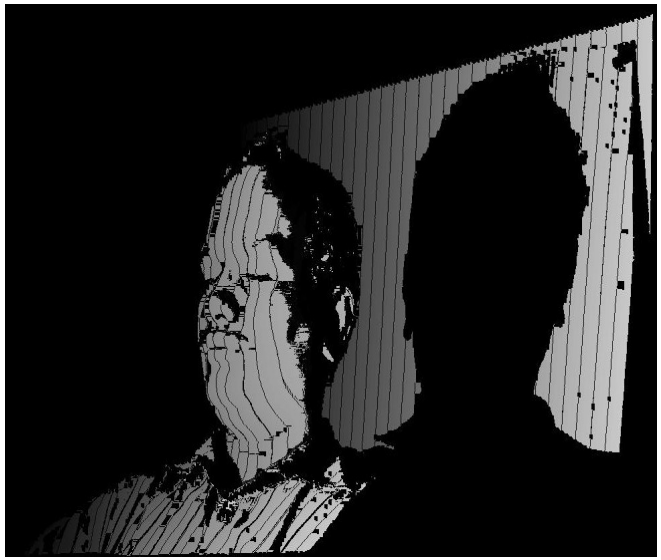
Binary coded patterns



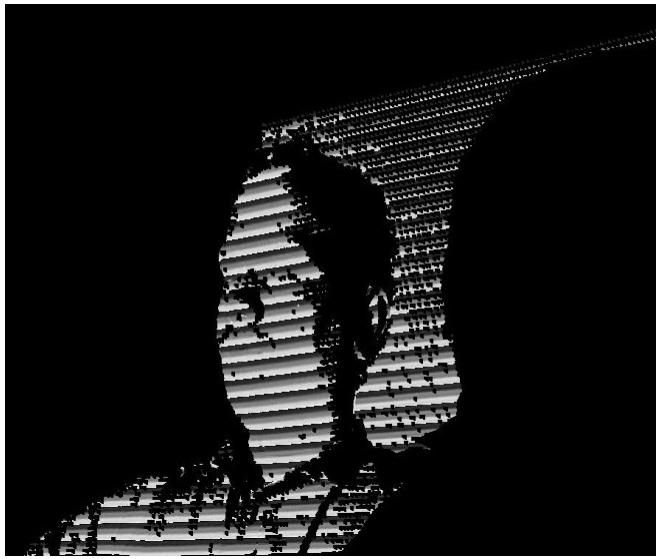
Wrapped & unwrapped phase

Vertical wrapped & unwrapped phrase



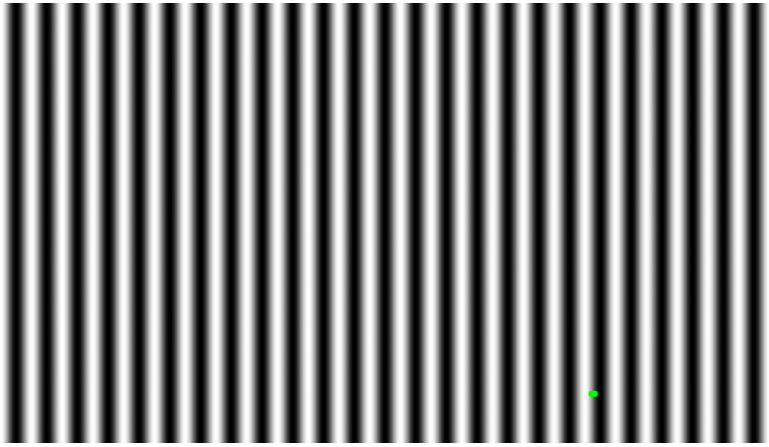


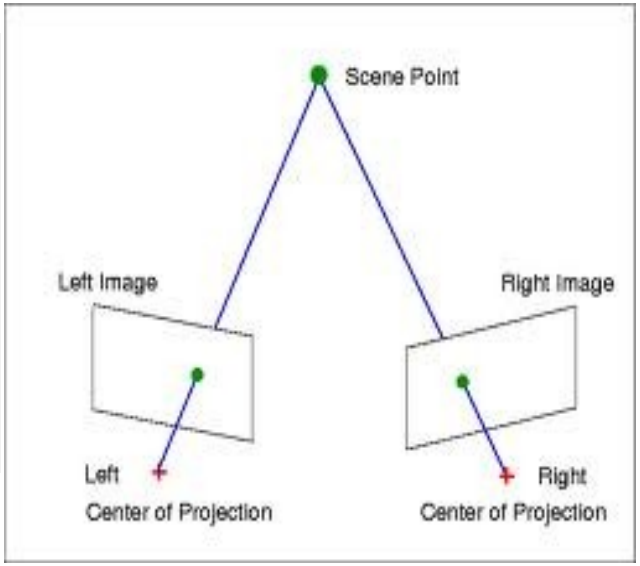
- Horizontal wrapped & unwrapped phase



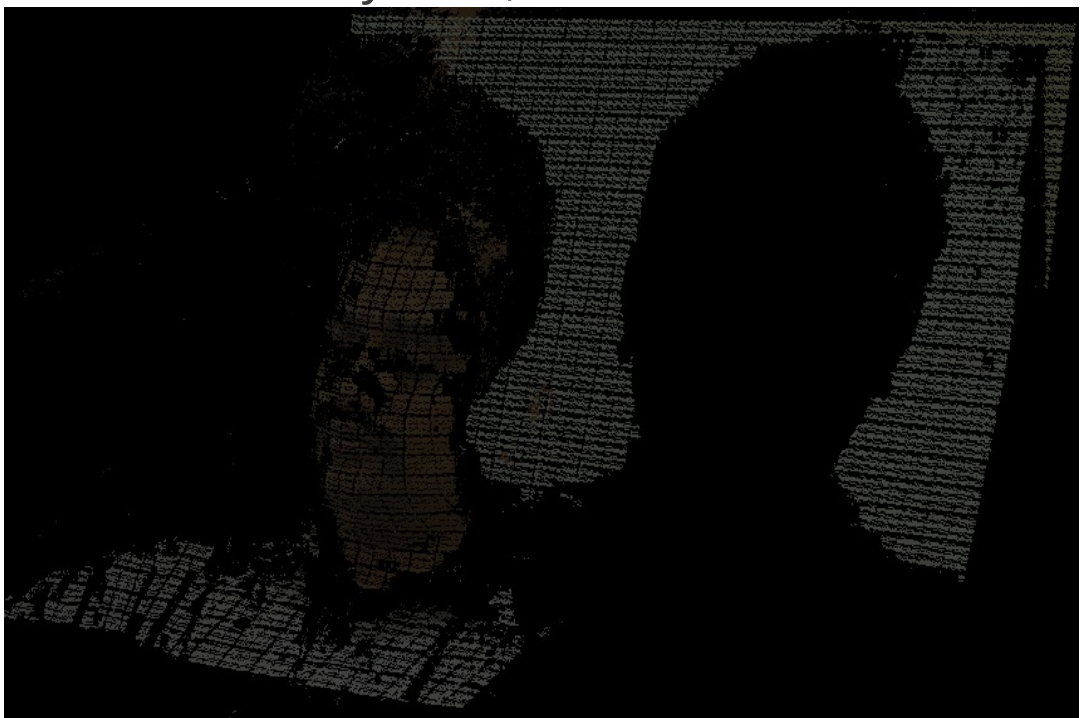
Correspondence & triangulation

Camera pixel Projector pixel



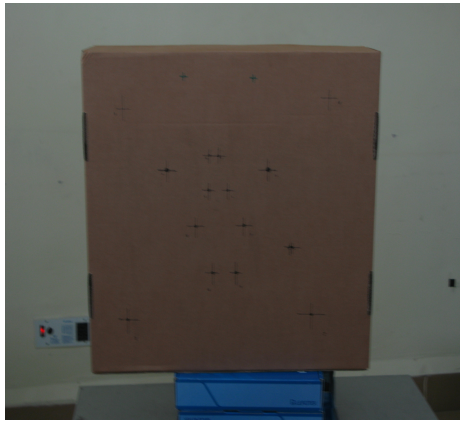


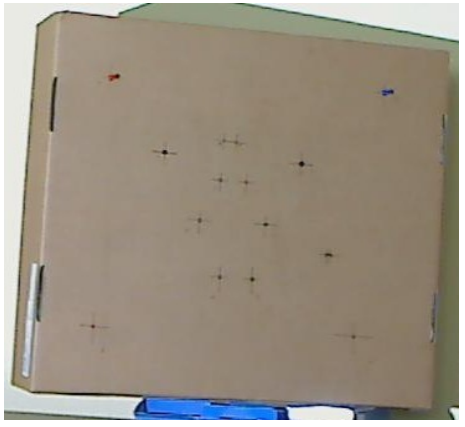
For metric reconstruction,optical ray must be defined for each camera & projector pixel in common coordinates system,which are estimated through system calibration.

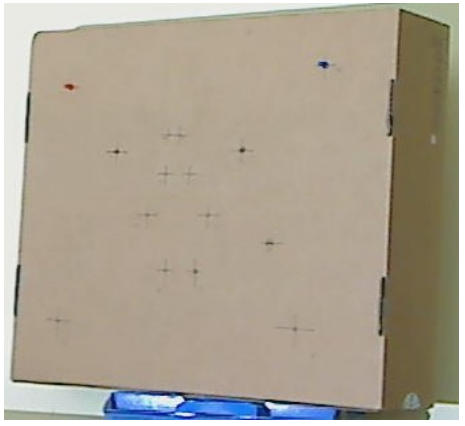


Accuracy evaluation

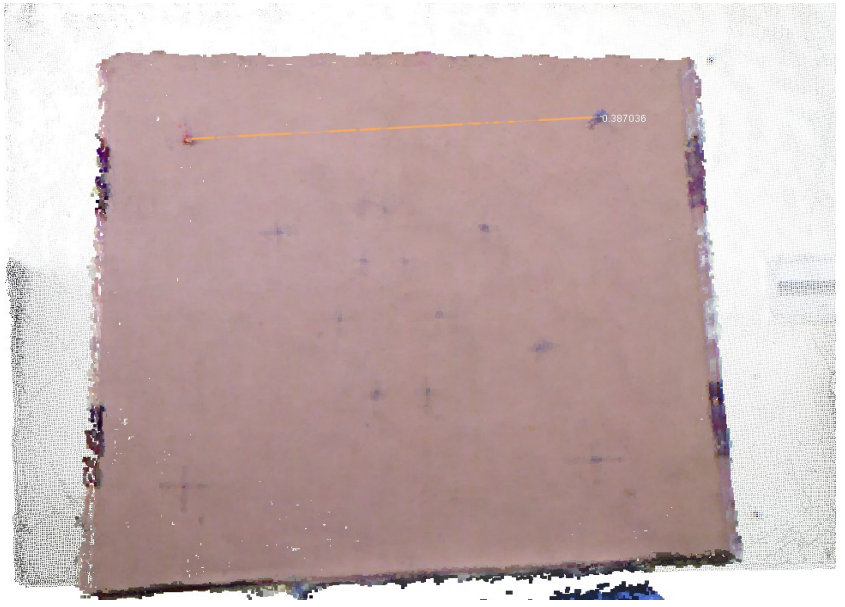
- Views of measured object







Measurement on point cloud



Sources of error

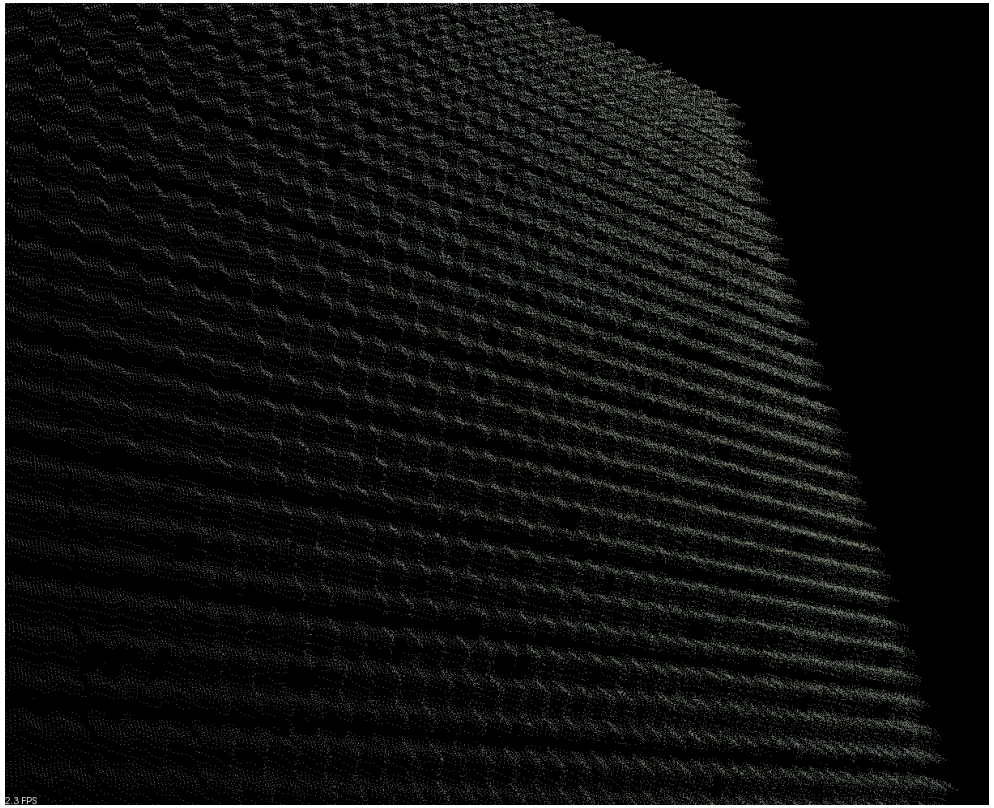
1. Inaccurrate system calibration
2. Non-linearity of projector-camera system(gamma)

Measurement results:

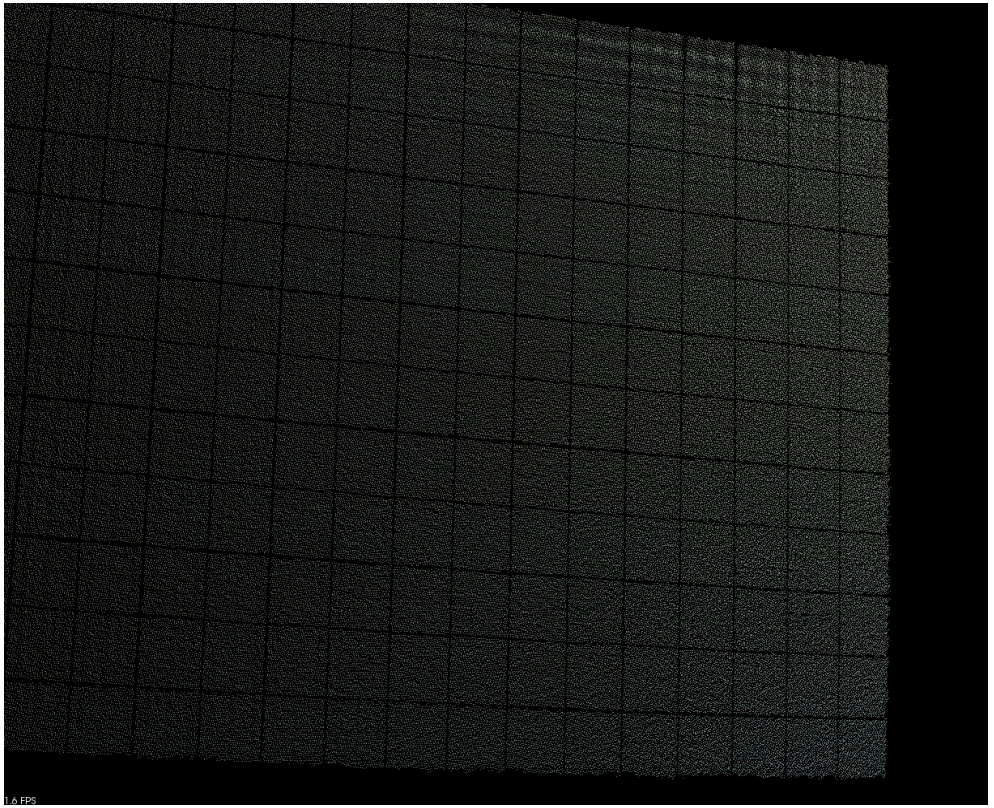
Distance from camera	Average error
~1.9 m	~3.32 mm
~1.7 m	~5.95 mm
~1.4 m	~3.74 mm
~1.1 m	~5.59 mm
~0.8 m	~7.06 mm

Effect of gamma on reconstruction

Without gamma correction



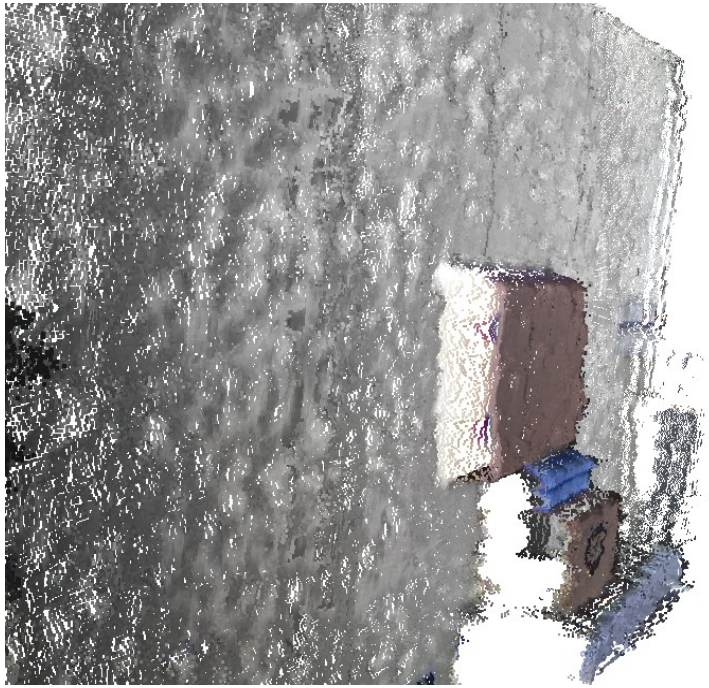
With gamma correction



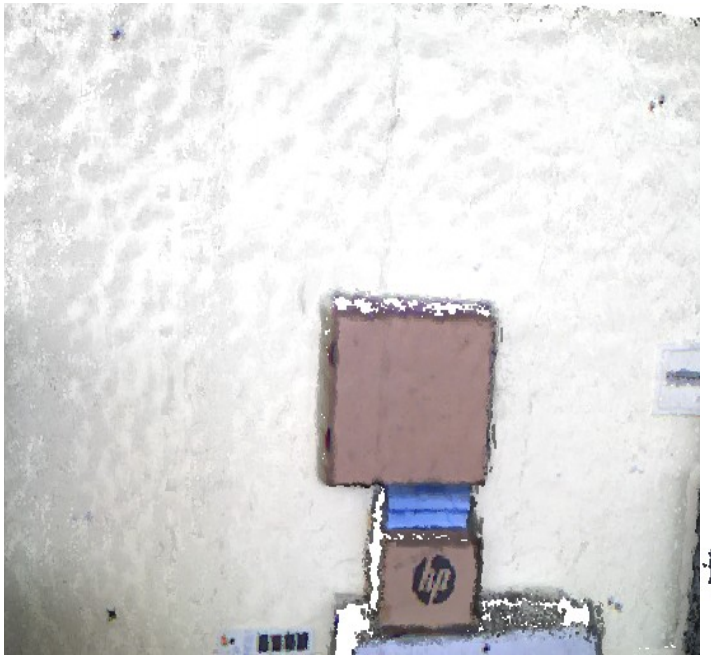
Measurement accuracy comparision with Microsoft Kinect

Kinect reconstruction at a distance of ~1.9 m:

Left view



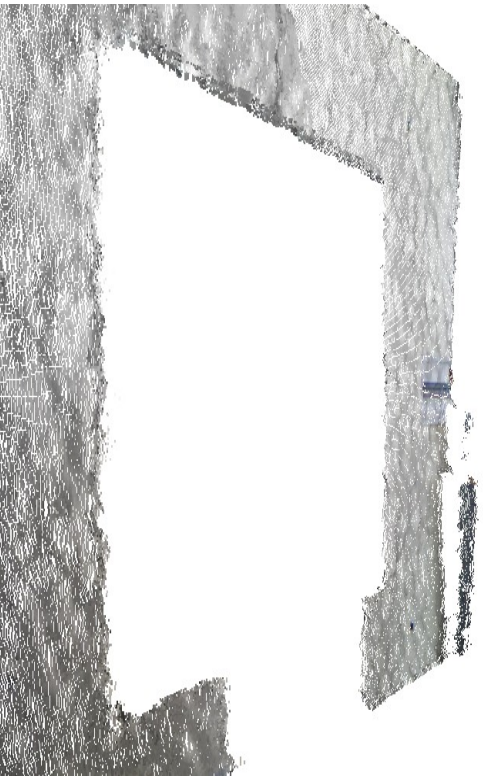
Front view

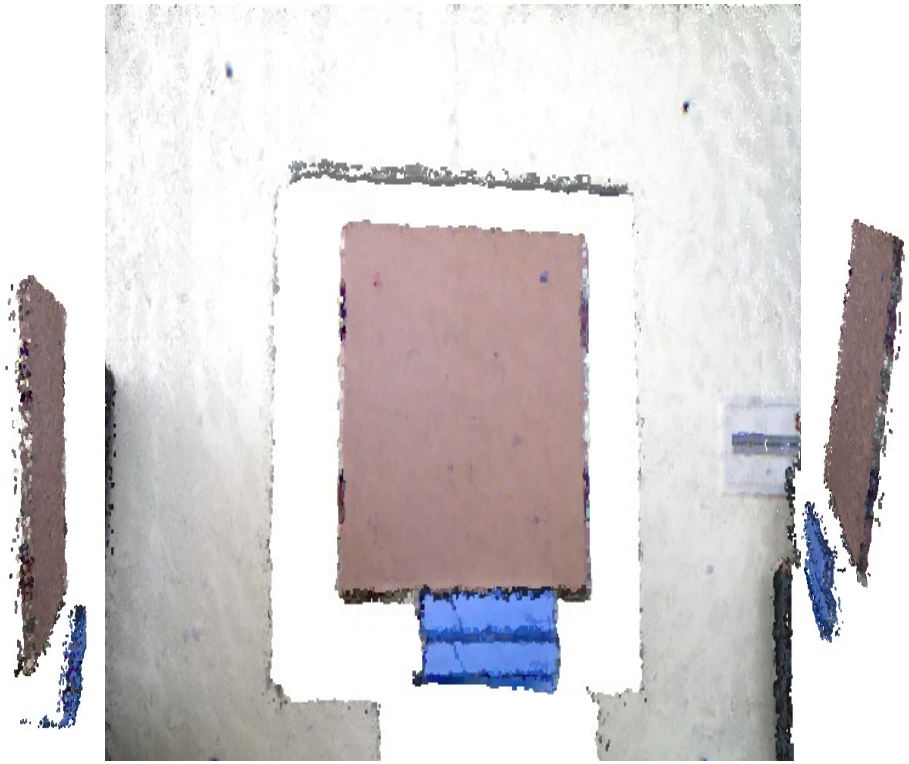


Right view

- **<u>Kinect reconstruction of object at ~0.8m:</u>**

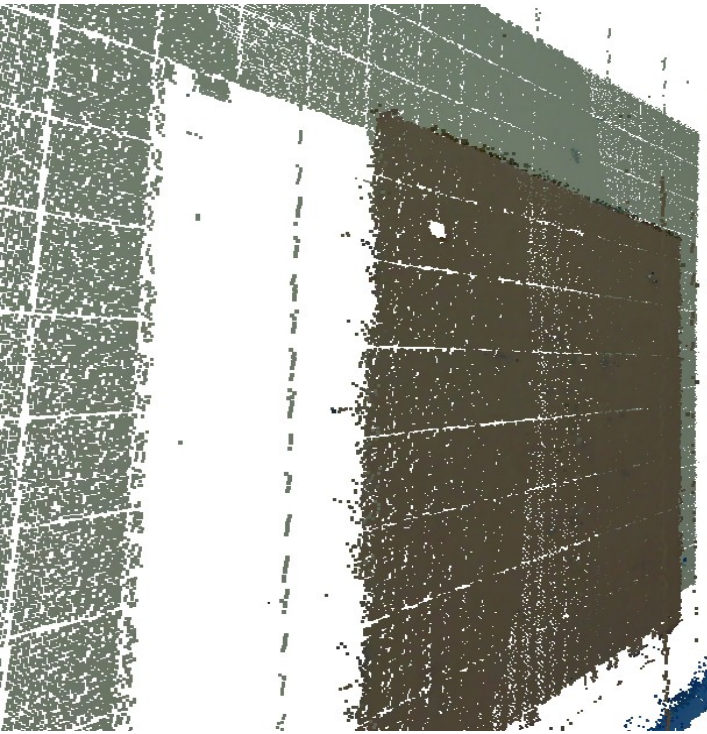
<u>Left view</u> <u>Front view</u> <u>Right view</u>



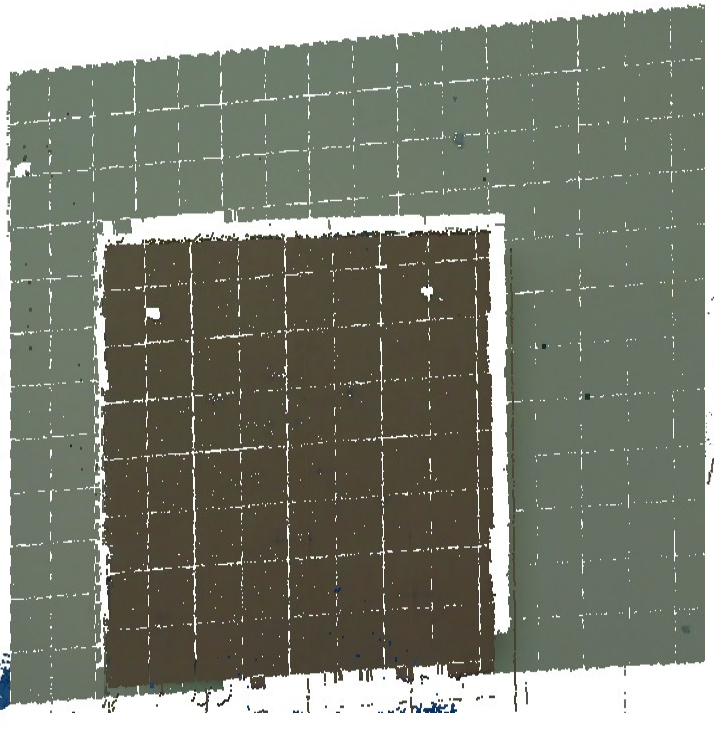


- **Our system at ~1.9m:**

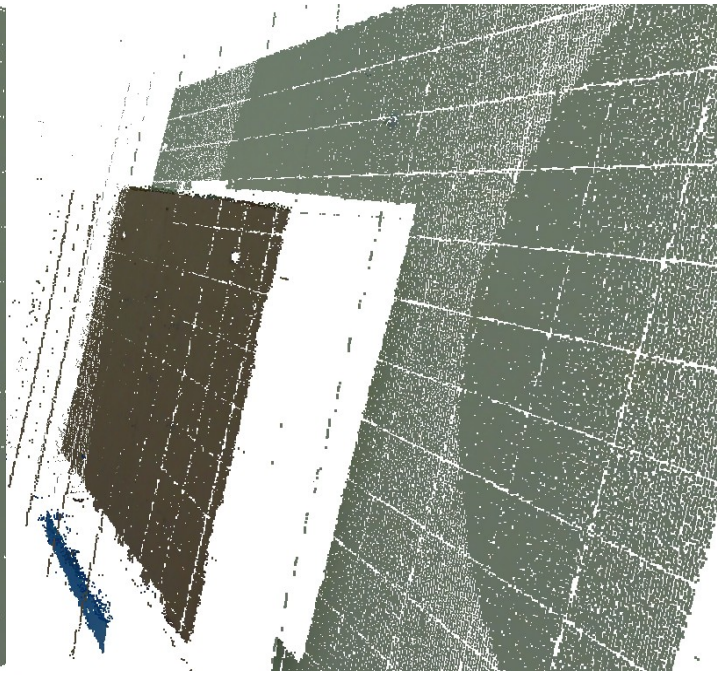
Left view



Front view

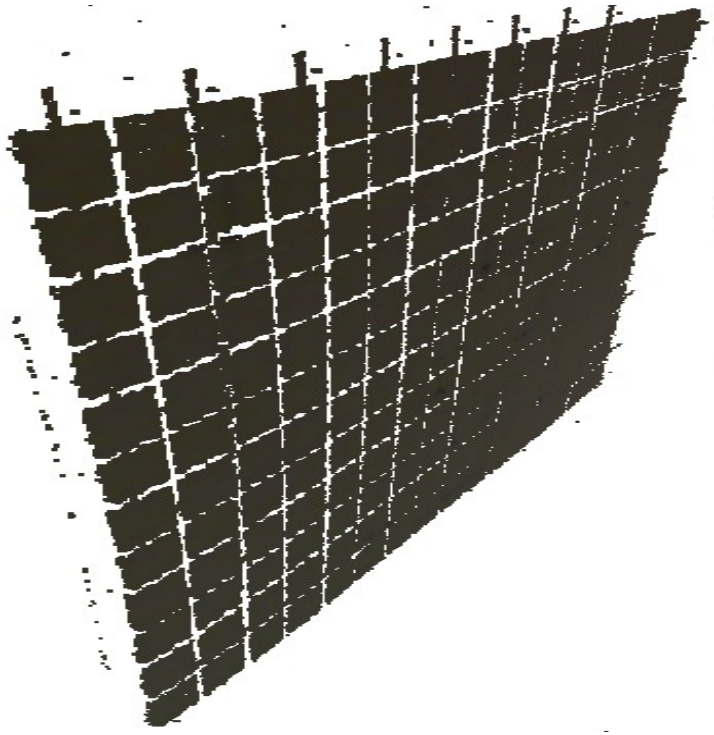


Right view

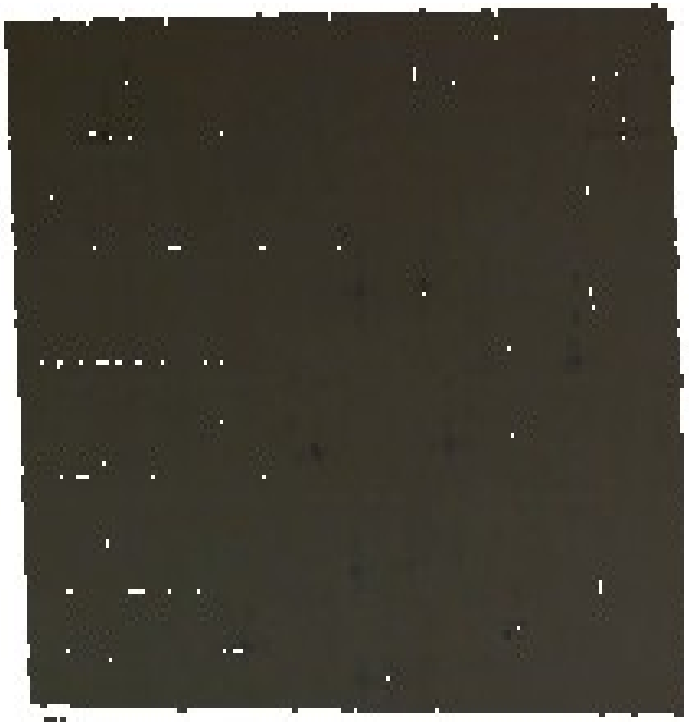


- **<u>Our system at ~0.8m:</u>**

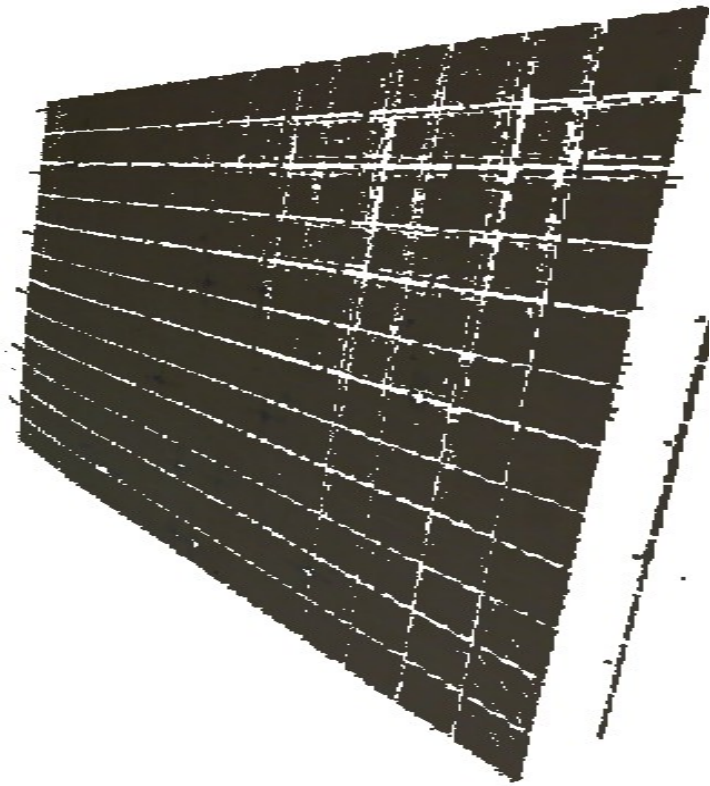
<u>Left view</u>



<u>Front view</u>



<u>Right view</u>



Comparision

Setup

Results

Distance from camera(Our system)	Average absolute error
~1.9 m	~3.32 mm
~1.7 m	~5.95 mm
~1.4 m	~3.74 mm
~1.1 m	~5.59 mm
~0.8 m	~7.06 mm
Distance from Kinect	**Average absolute error**
~1.9 m	~12.2 mm
~1.7 m	~10.6 mm
~1.4 m	~5.24 mm
~1.1 m	~4.44 mm
~0.8 m	~3.67 mm

Work to be done

- Reperform system calibration experiments
- Reevaluate mesurement accuracy after using re-estimated calibration values
- Both tasks collectively require 3-4 days of experimention