

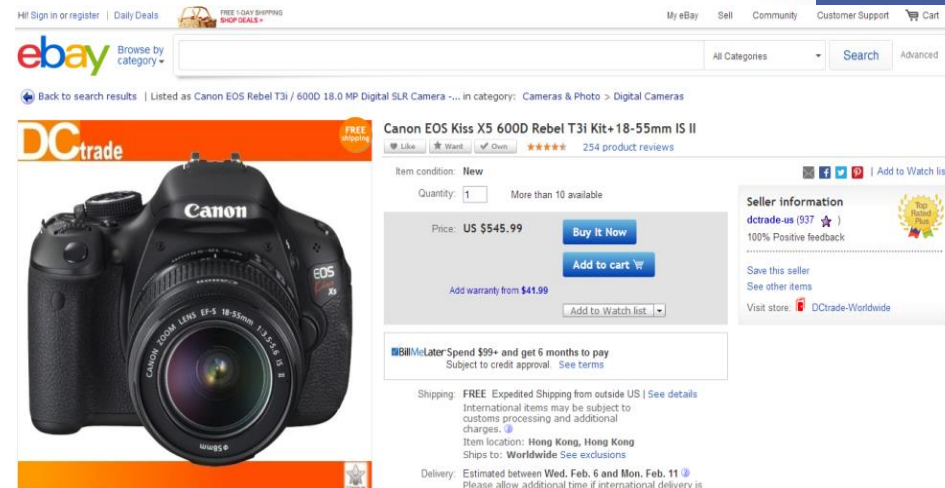
A consumer level 3D object scanning device using Kinect for web-based C2C business



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Introduction

- Internet shopping is popular
- C2C / auction websites
 - E-bay and Taobao
- Existing C2C sites
 - Textural
 - 2D still images



The screenshot shows an eBay product listing for a Canon EOS Kiss X5 600D Rebel T3i Kit+18-55mm IS II. The listing is from the seller 'DCtrade' and is priced at US \$545.99. The item is in 'New' condition and has 254 product reviews. The listing includes a 'Buy It Now' button, an 'Add to cart' button, and an 'Add to watch list' button. The shipping is free and expedited. The seller information shows a 100% positive feedback rating and a 'Top Rated Seller' badge.

Hit Sign in or register | Daily Deals | **FREE LOCAL SHIPPING** | **SHOP DEALS** | My eBay | Sell | Community | Customer Support | Cart

ebay Browse by category | All Categories | Search | Advanced

Back to search results | Listed as Canon EOS Rebel T3i / 600D 18.0 MP Digital SLR Camera -... in category: Cameras & Photo > Digital Cameras

DCtrade **FREE shipping** **Canon EOS Kiss X5 600D Rebel T3i Kit+18-55mm IS II** Like | Want | Own | 254 product reviews

Item condition: **New** | Quantity: 1 | More than 10 available | Add to Watch list

Price: **US \$545.99** | **Buy It Now** | **Add to cart** | Add warranty from **\$41.99** | **Add to Watch list**

Bill Me Later Spend \$99+ and get 6 months to pay | Subject to credit approval. See terms

Shipping: **FREE** Expedited Shipping from outside US | See details | International items may be subject to customs processing and additional charges. | Item location: Hong Kong, Hong Kong | Ships to: **Worldwide** See exclusions

Delivery: Estimated between **Wed, Feb. 6** and **Mon, Feb. 11** | Please allow additional time if international delivery is

Seller information
dctrade-us (337) | 100% Positive feedback | Save this seller | See other items | Visit store: **DCtrade-Worldwide**

E.g. An auction of a camera

Several pictures are acquired for the camera

← 返回搜尋結果 | Cameras & Photo > Film Photography > Film Cameras



Canon Model 7 Rangefinder
RF LTM L39 M39

物品狀況： 二手
剩餘時間： 9小時
出價紀錄： 0個出價

起標價： US \$24
大約 HK\$

輸入最高出價： US \$
(請至少)

運費： US \$53.
查看所有
跨國運送

付款： **PayPal**
用 PayPal
查看 PayF

退貨： 不接受退貨



加入「追蹤清單」

chusetts, 美國

列印 | 檢舉物品



👉 有類似物品要出售？ [自己賣](#)

Project Goal

- Use latest 3D technology
 - Understand better the condition of auction product
- Problems
 - Affordable solution of 3D content creation
 - 3D visualization of product on web-based environment

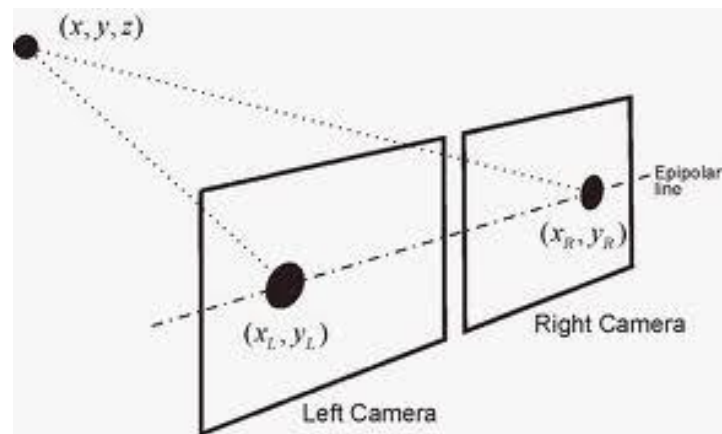
Project Goal

- 3D scanner with low cost camera
- Kinect
 - Around USD\$150
 - Provide depth data robustly
- Fast and simple scanning steps
- Automatic 3D reconstruction



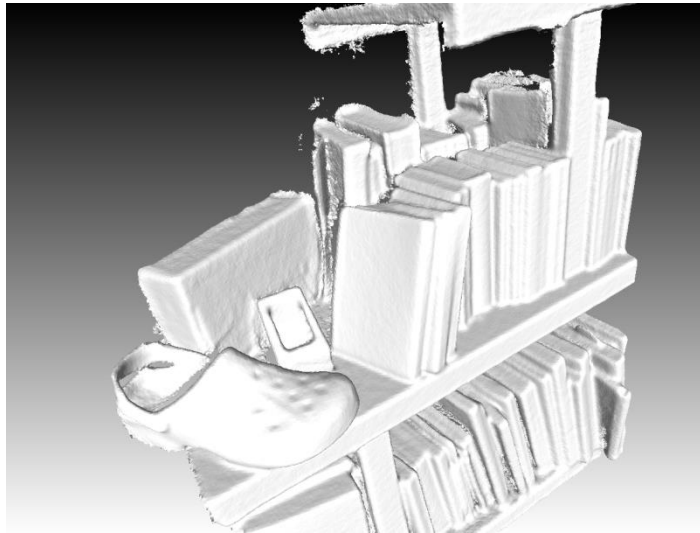
3D Reconstruction System

- To create 3D model from set of 2D images from the real world
- A common approach:
 - Reconstructed from stereo views
 - Similar to how human eyes and brain works



3D Reconstruction using Kinect

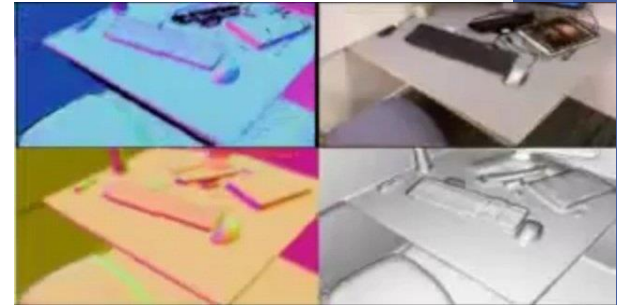
- ReconstructME



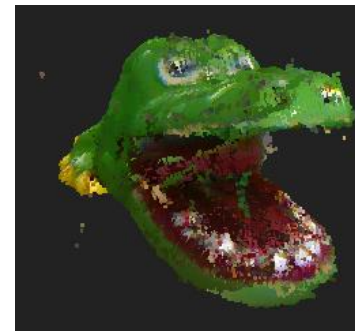
- 3D model without texture;
- Caused the capture lost easily.

3D Reconstruction using Kinect

- KinectFusion (Microsoft)
 - Colored 3D model from reconstruction;
 - Depends heavily on GPU



- 3D Scan 2.0
 - Lower quality Colored 3D model from reconstruction;
 - Support linux only.



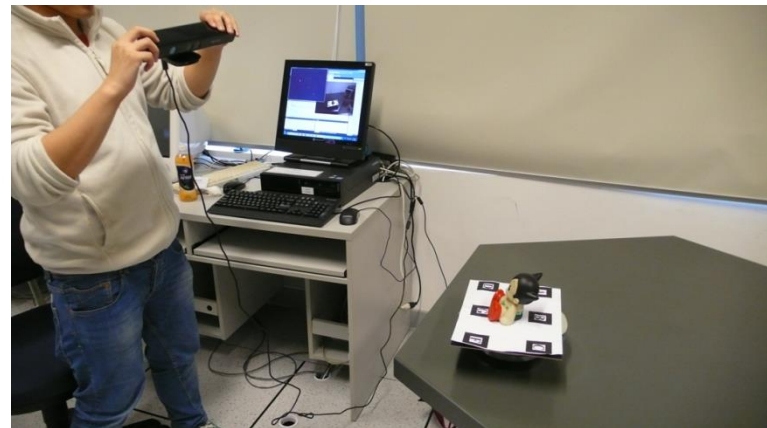
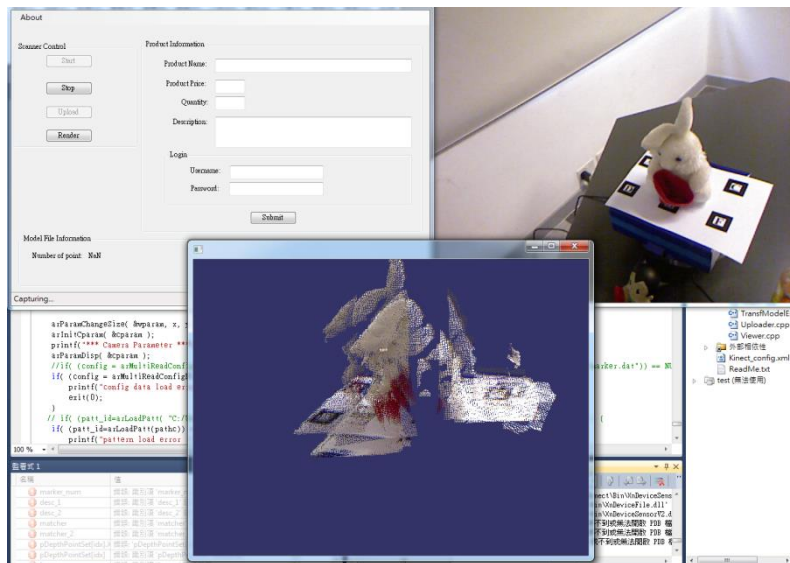
Overview of Our Approach

- Three major steps in 3D model creation
 - Capturing
 - Point Cloud Processing
 - Background removal & orientation matching
 - Point Cloud Registration



Model Capturing

- OpenNI SDK to obtain RGBD-data from Kinect
 - Point clouds are formed from RGBD-data
- Multiple frames from different views



Post-processing

- Our first problem:

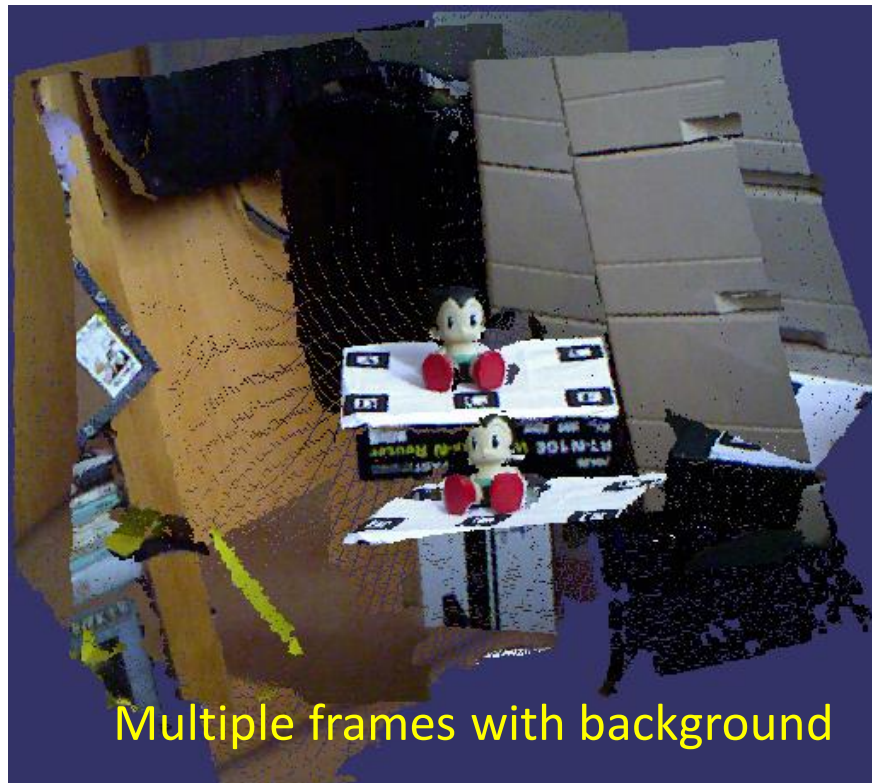
How to remove the background/noise ?



Post-processing

- Second problem:

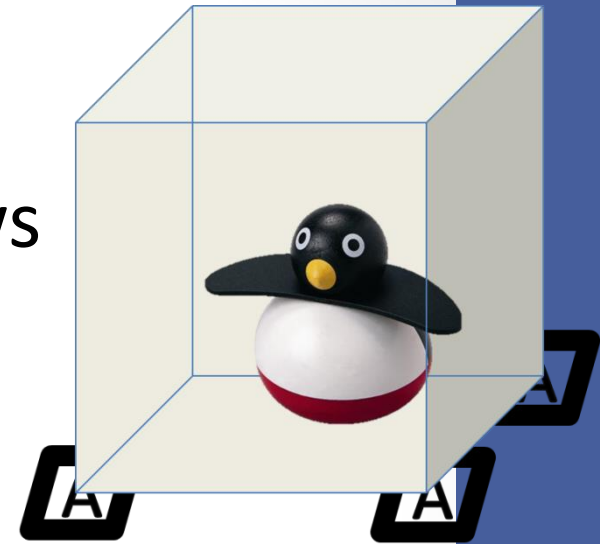
How to align point clouds captured at different view point ?



Multiple frames with background

Processing Point Cloud : Views Alignment

- To align points from different views
 - Marker-based detection
 - Fast response
 - ARToolKit is used
 - Markers is extracted from image captured
 - Estimate orientations from different views
 - Match the orientations of from different views



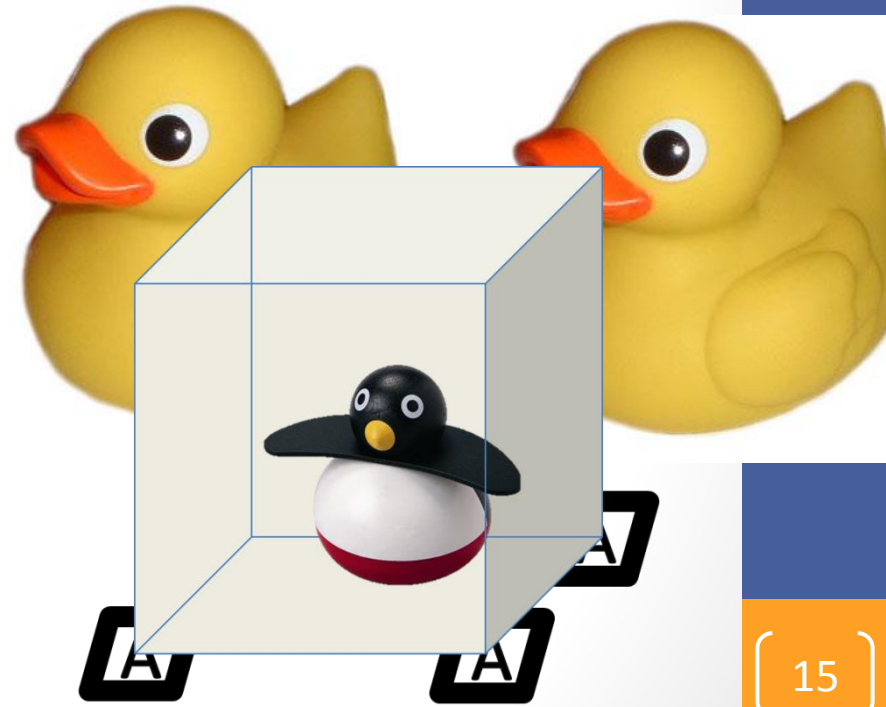
Processing Point Cloud : Views Alignment

- Result after alignment using markers



Processing Point Cloud: Background Removal

- Markers are used to define interested region
- Points outside are removed
- Left points within the markers.
- 90% of background can be removed



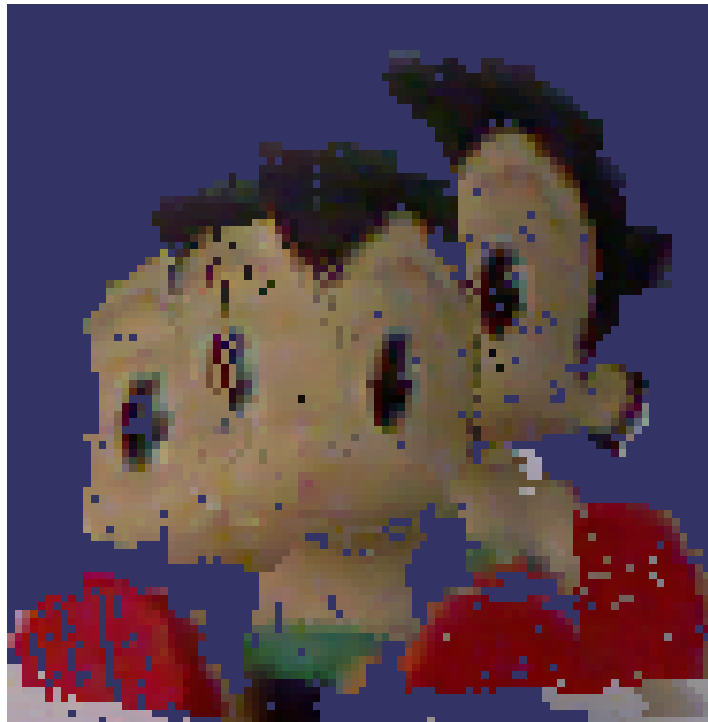
Processing Point Cloud: Background Removal

- Unwanted background is removed



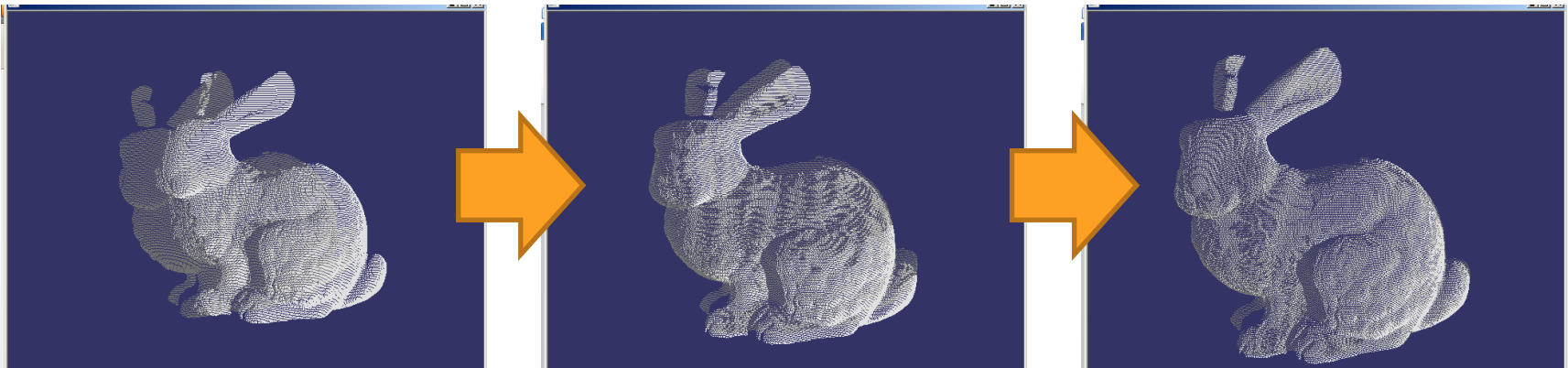
Processing Point Cloud

- However, a closer look...
- View alignment is still not satisfactory !
 - Large error exists in marker-based detection



Point Cloud Registration

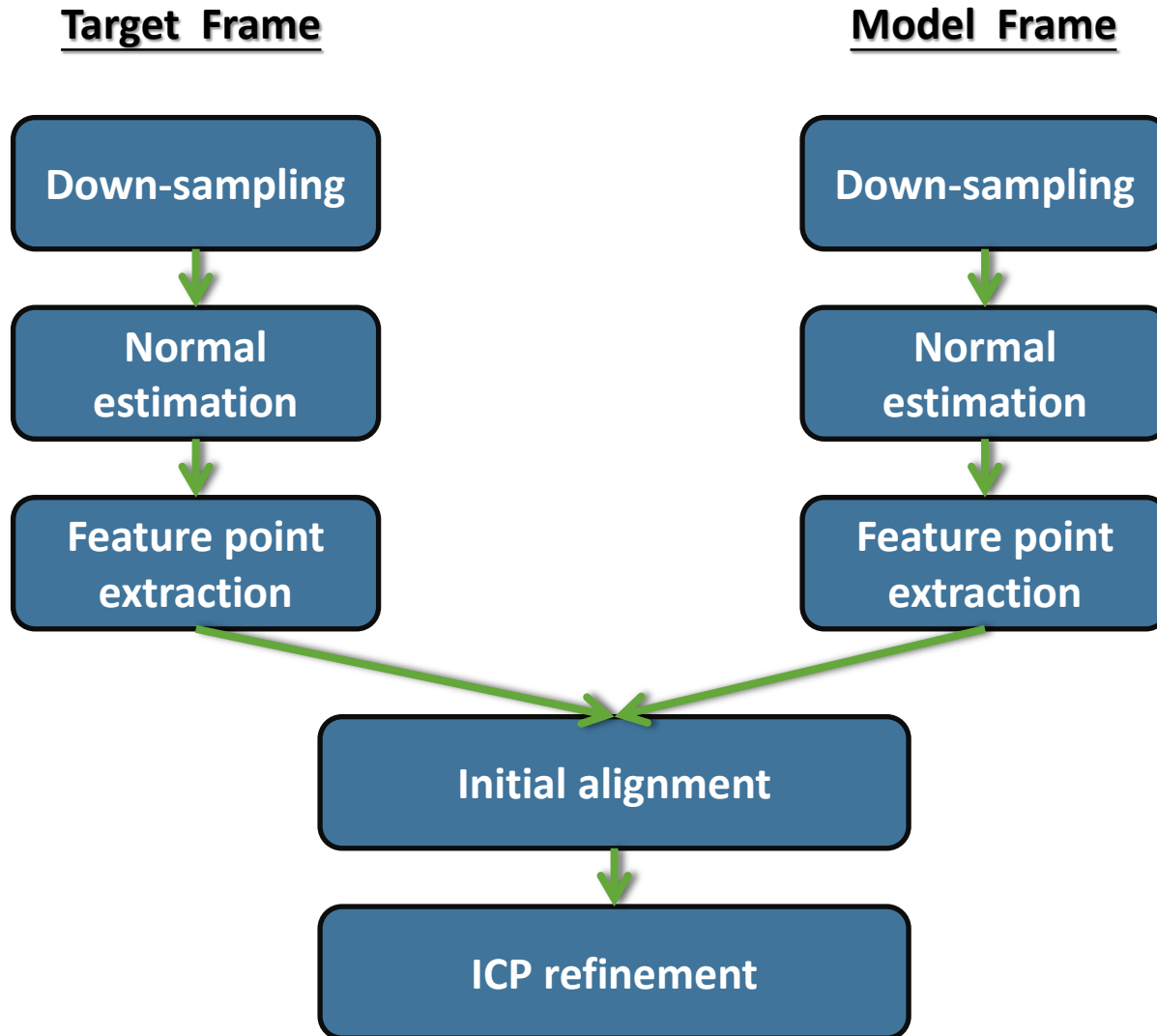
- Refine alignment of different views
- ICP (Iterative Closest Point)
 - Initial alignment
 - Transformation between frames
 - Iterative process



Point Cloud Registration

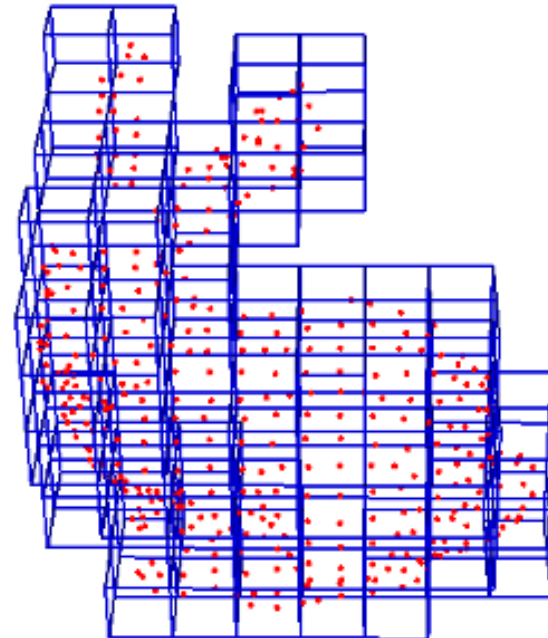
- Pure ICP is slow
- Reduce number of points
 - Down-sampling using voxel-grid
- Create a better initial alignment
 - Matching of feature points

Point Cloud Registration



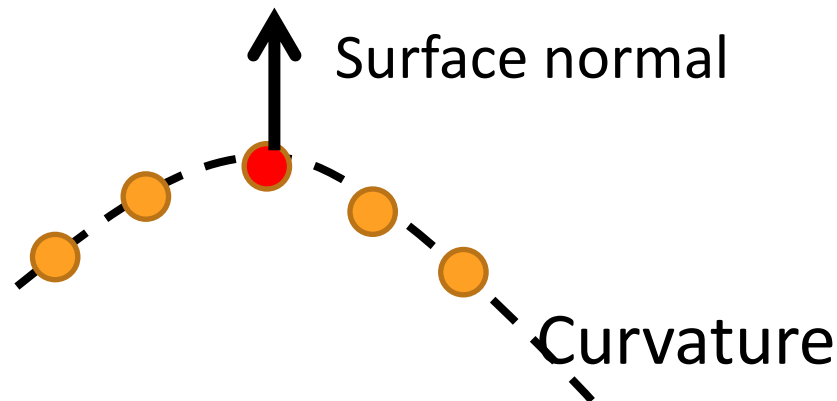
Down-sampling

- First step in the point cloud registration
 - Improve speed on point cloud alignment
 - Obtain the better features value on huge point cloud
- Voxel-grid down-sampling
 - Dividing the point cloud into the grids
 - Use centroid of points in each grid as the sample



Computation of Initial Alignment

- To extract key points
 - Base on large curvature value
 - Estimate using Principal Component Analysis (PCA)
 - involves neighboring points

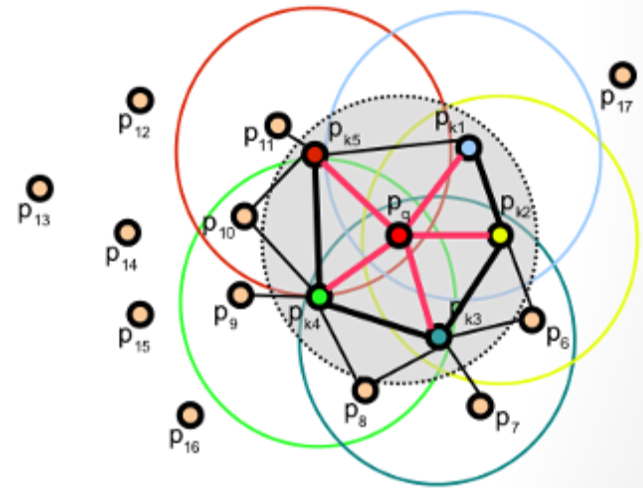
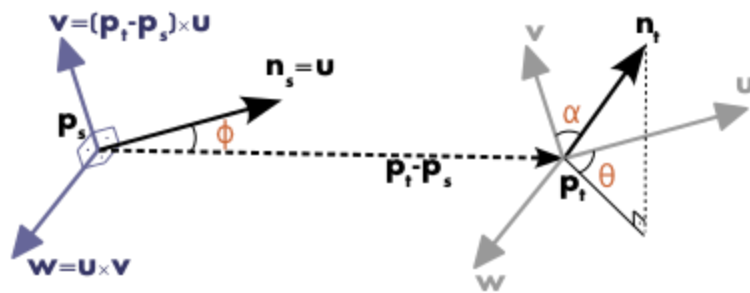


Computation of Initial Alignment

- Matching the corresponding feature key points between 2 frames
 - Fast Point Feature Histogram (FPFH) as the feature descriptor
 - KdTree(KNN search implementation with OpenCV)
- FPFH
 - 3 angles α, ϕ, θ and distance d

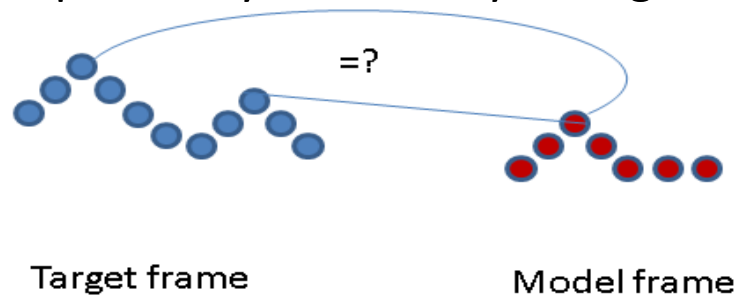
$$\alpha = \mathbf{v} \cdot \mathbf{n}_t \quad \phi = \mathbf{u} \cdot \frac{(\mathbf{p}_t - \mathbf{p}_s)}{d}$$

$$\theta = \arctan\left(\frac{|\mathbf{w} \cdot \mathbf{n}_t|}{\mathbf{u} \cdot \mathbf{n}_t}\right) \quad d = \|\mathbf{P}_t - \mathbf{P}_s\|_2$$



Computation of Initial Alignment

- Estimated the transformation between key pairs from 2 frames
 - Incorrect point pairs may be formed by taking the 1 nearest point.



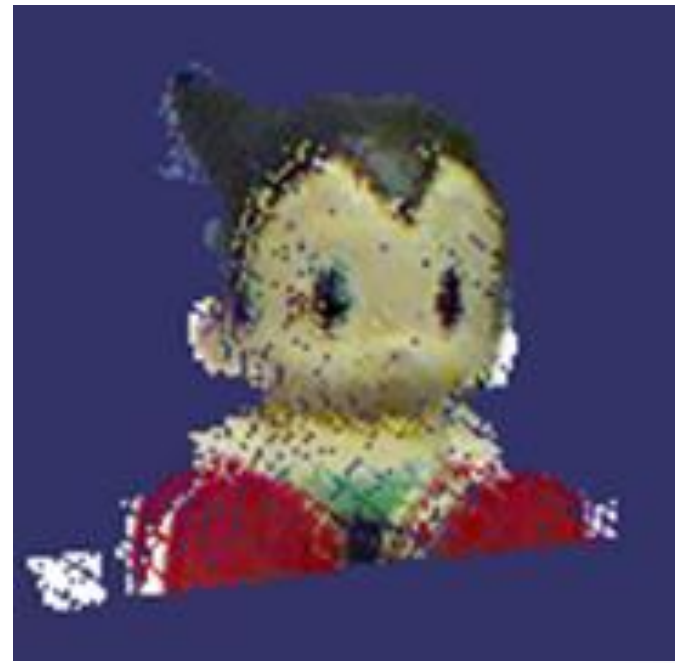
- Taking the best samples using RANSAC
 - Take 3 sample points for each iteration,
 - Form the point pairs by Kdtree,
 - Estimate the Transformation by SVD and apply it,
 - The 3 pairs with the minimum error is the best model.
- Compute the Transformation on best model by SVD

Point Cloud Registration

- Refine the alignment
 - Iterative Closet Point (ICP)
 - Extract the good key points from initial guess
 - Matching the corresponding key points between 2 frames (using XYZ)
 - Estimated the transformation between key pairs from 2 frames
 - Outlier Removal using RANSAC
 - SVD
 - Iterative until reach the acceptable error

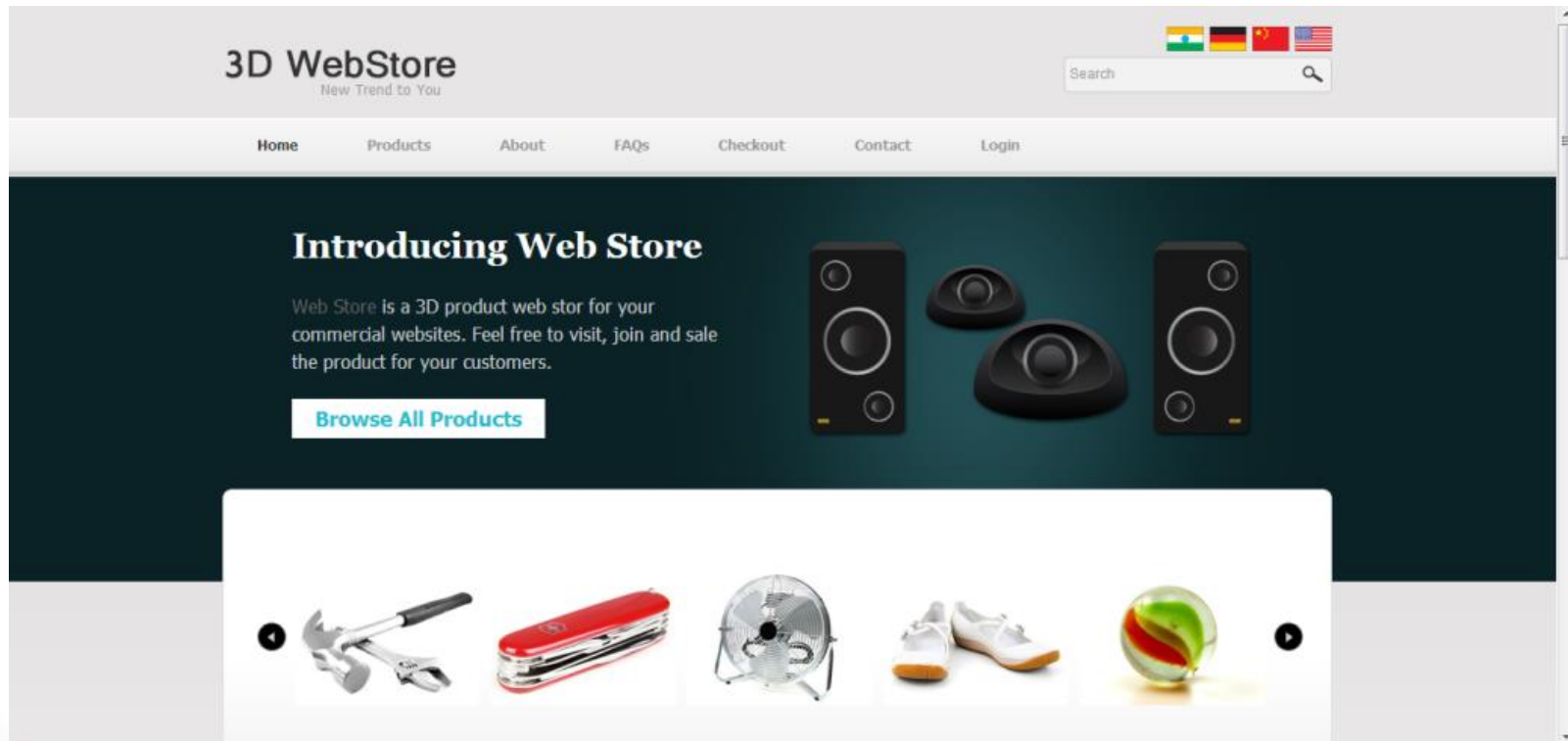
Point Cloud Registration

- The alignment is refined after using point cloud registration



3D Point Cloud

- After the registration, the 3D point cloud model can be upload to web host by using cURL



3D Point Cloud Format

.ASC files for point cloud storage

For example:

123.000	534.123	534.143	255	255	123
---------	---------	---------	-----	-----	-----

 One point

54.000	67.123	12.143	10	20	30
--------	--------	--------	----	----	----

54.000	67.123	12.143	10	20	30
--------	--------	--------	----	----	----

.....

(X, Y, Z and R, G, B data)

Rendering point cloud model

- WebGL
 - JavaScript API based on Open GL ES 2.0
 - Web browser without any plugins
 - XB Point Stream WebGL

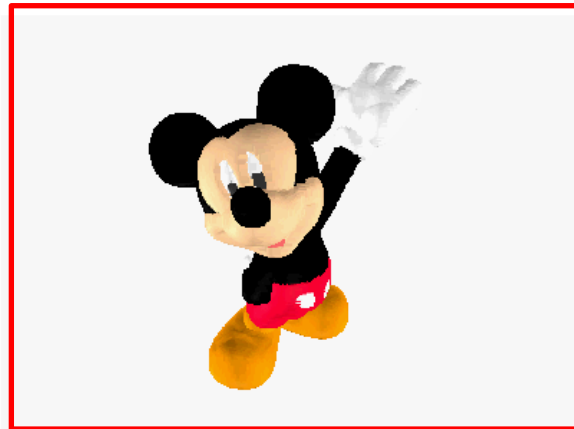
Categories

- › Prodcut1
- › Prodcut2
- › Prodcut3
- › Prodcut4
- › Prodcut5
- › Prodcut6
- › Prodcut7
- › Prodcut8
- › Prodcut9
- › Prodcut10

Newsletter

Present new 3D product to you

Product Details



Zoom In | Zoom Out

Product Description

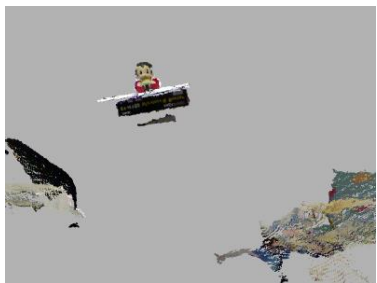


Price:	\$100
Availability:	In Stock
Model:	Product 123456
Manufacturer:	Apple
Quantity	<input type="text" value="1"/>

Add to Cart 




Result

Movie of Capturing Process

Result : 3D Scanning

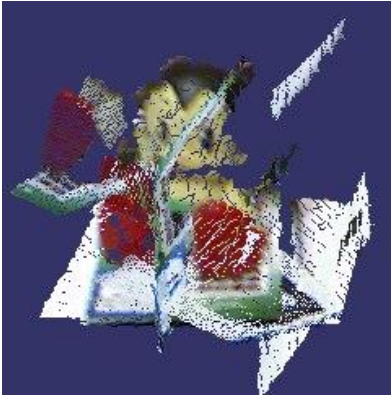

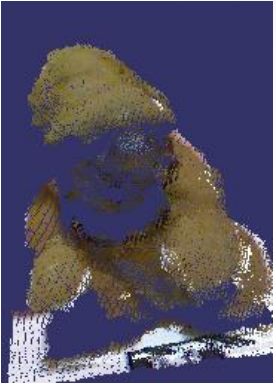
Test Model- Astroboy			
Number of total Points	247254	10089	10089
Size	9.34MB	387KB	424KB
Number of frame	1	3	3
Match	No	No	Yes
Noise/background	More	less	less

Result : 3D Scanned Products

			
Number of total Points	98024	44560	10089
Number of frames	8	6	4
Time*	3mins	1.5mins	57sec
Number of Iteration	560	390	160

*The testing is performed with an Intel i5-3.4GHz CPU

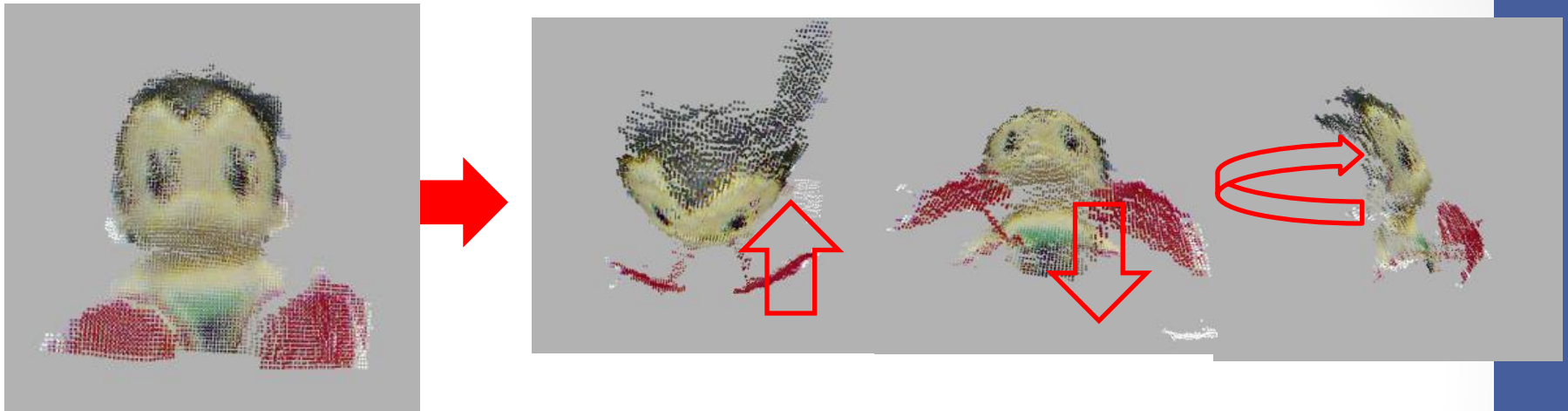
Result : Reconstruction Accuracy

			
Environment	Symmetric	Non-symmetric	Under strong light intensity
Minimized Error	0.002204m	0.002143m	0.003506m

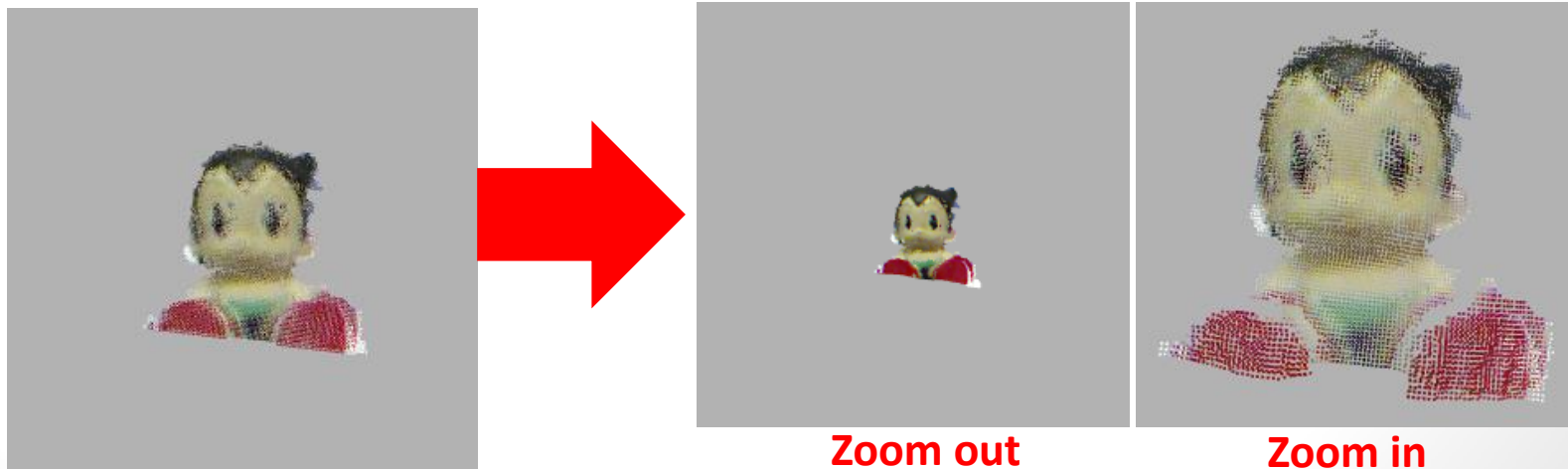
- **Symmetric (Shape containing similarity)**
 - Limitation on the curvature evaluation by PCA
- **Under strong light intensity**
 - infrared sensor will be affected by strong light confuse to the infrared reflection
- **Non-symmetric**
 - reconstructed better 3D feature and more matched points

Result : Control of views in browser

Mouse move to control rotation



Mouse scroll to control zooming



Result : Products Management

Products Management

Product Activation

Delete Activate Waiting

Product Name	Quantity	Price	Status	
test	100	\$100	!	<input type="checkbox"/>
act pro	99	\$900	✓	<input type="checkbox"/>
Peter Pan	1	\$50	!	<input type="checkbox"/>
	0	\$0	!	<input type="checkbox"/>

Activate the product status for public

Peter Pan

Click the product name for edit product detail

Manage

- > Member Information
- > Product Management

Edit Products



Zoom In | Zoom Out

Product Name: Peter Pan
Price: 50
Quantity: 1

Update Confirm

Product Description

Lucky Toy

Limitation

- The target object size is limited
 - Corresponding to AR marker size
- The target object cannot be transparent or translucency object
- The target scan distance is limited
 - The range about 0.6meter to 3 meter
- The Kinect resolution low quality
 - The large resolution only 640 * 480

Future Works

- Optimize the current algorithm to reduce post-processing time
- Increase matching accuracy
- Using ECE(Euclidean Cluster Extraction) for background noise remove
- Compress the 3D file size for increase store using

Conclusion

- Low-cost 3D reconstruction system
 - Using Kinect costs just USD\$150
 - Point with color
 - Simple object extraction
- Web-enabled 3D rendering of product
 - 3D rendering of point cloud in web browsers
- A comprehensive system
 - Easy to use 3D content creation
 - New 3D experience for online shoppers

Thank you