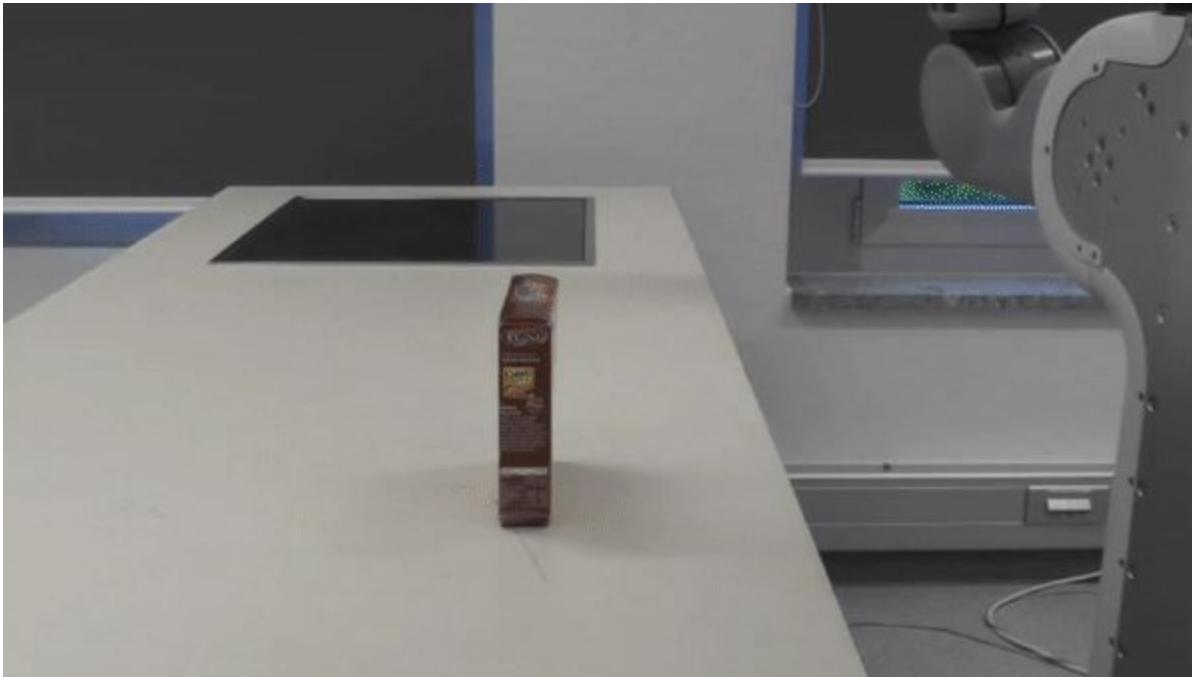


Visual Tactile Grasping

David Watkins-Valls



Source: <https://www.youtube.com/watch?v=rNLv7f2wmLQ>

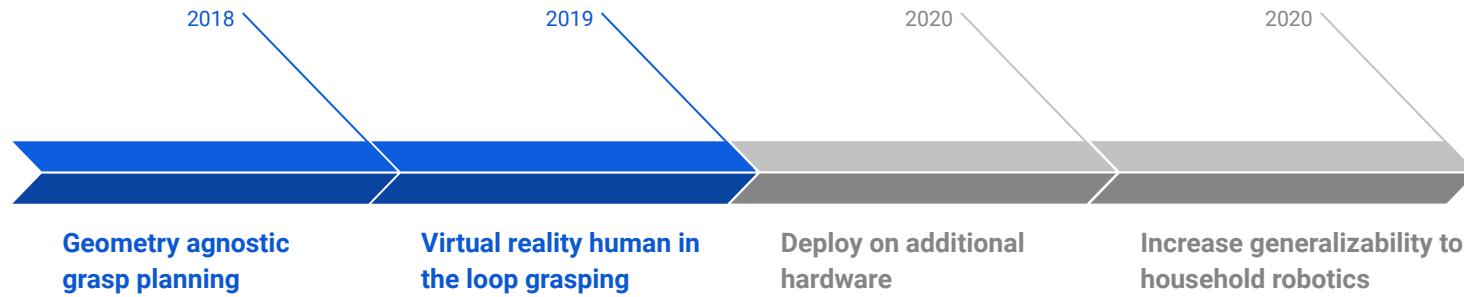


4X

Overview

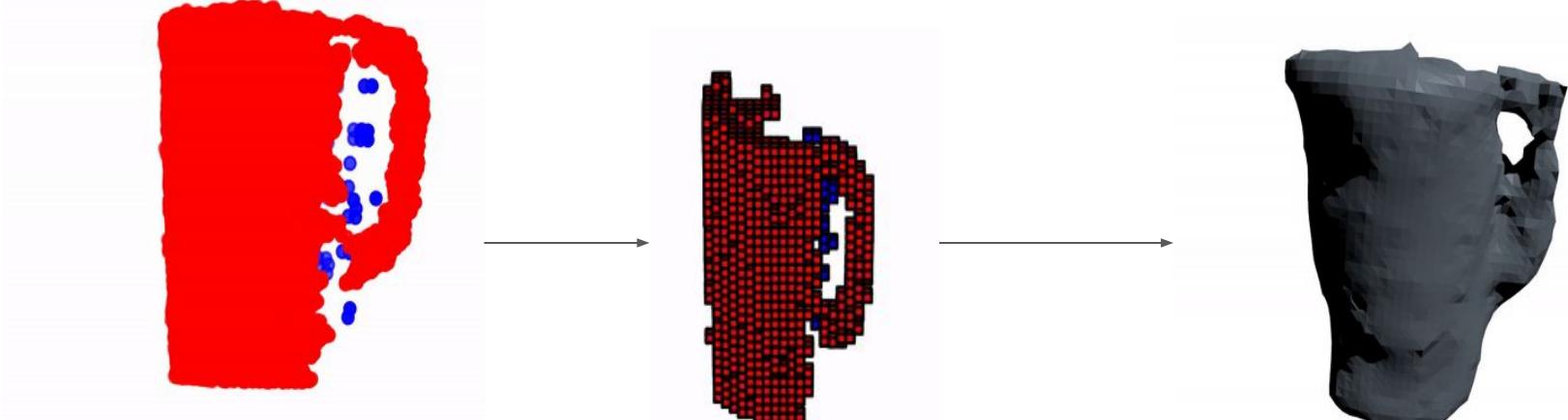
- Dataset generation
- Depth and tactile shape completion
- Grasping results
- VR to enable human in the loop grasping
- Future work

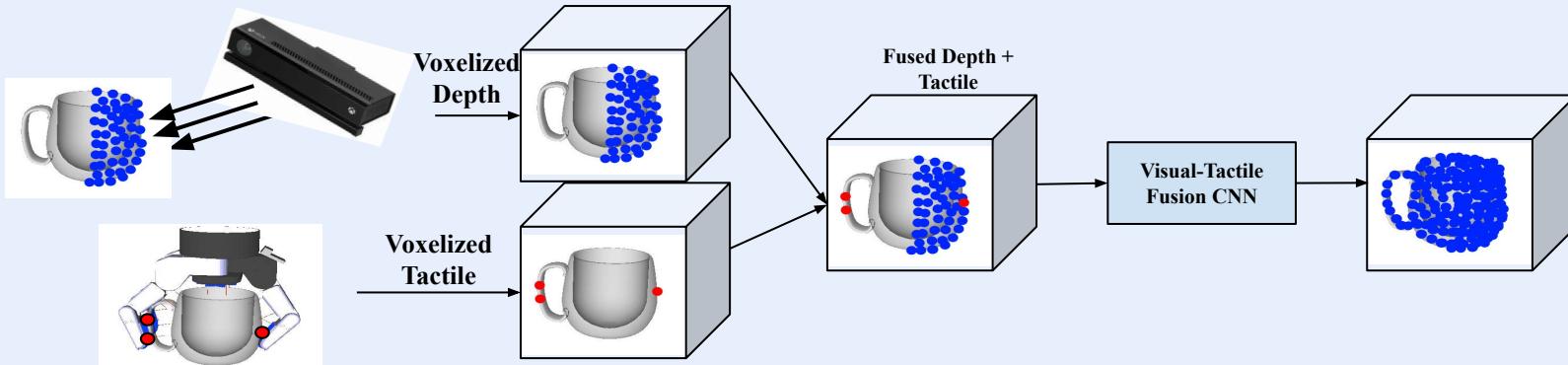
Timeline



Project summary

- Fellowship collaboration with Columbia Robotics lab
- Resources at Samsung
- Publications that are in the works





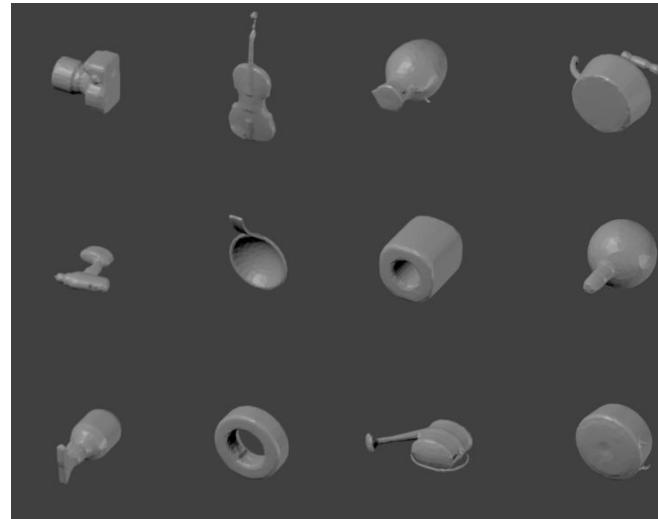
Dataset generation

YCB Object Dataset



28 unique 3D models

GRASP Dataset



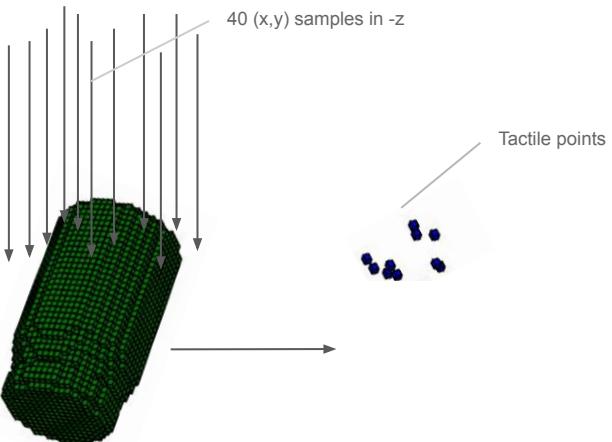
590 unique 3D models

618 objects

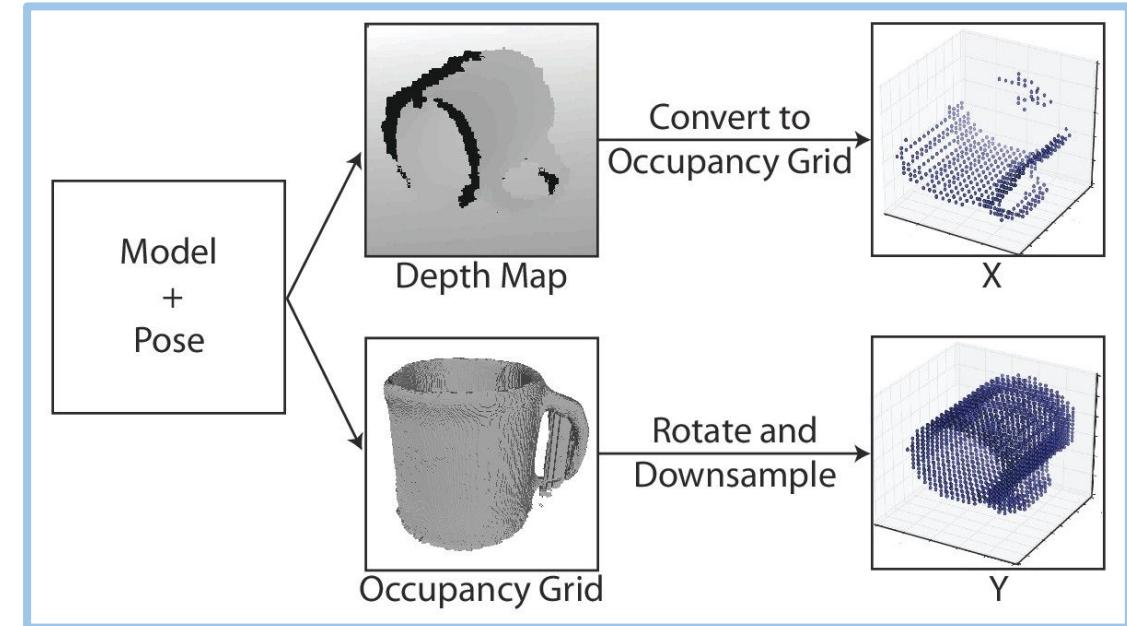
726 views per object

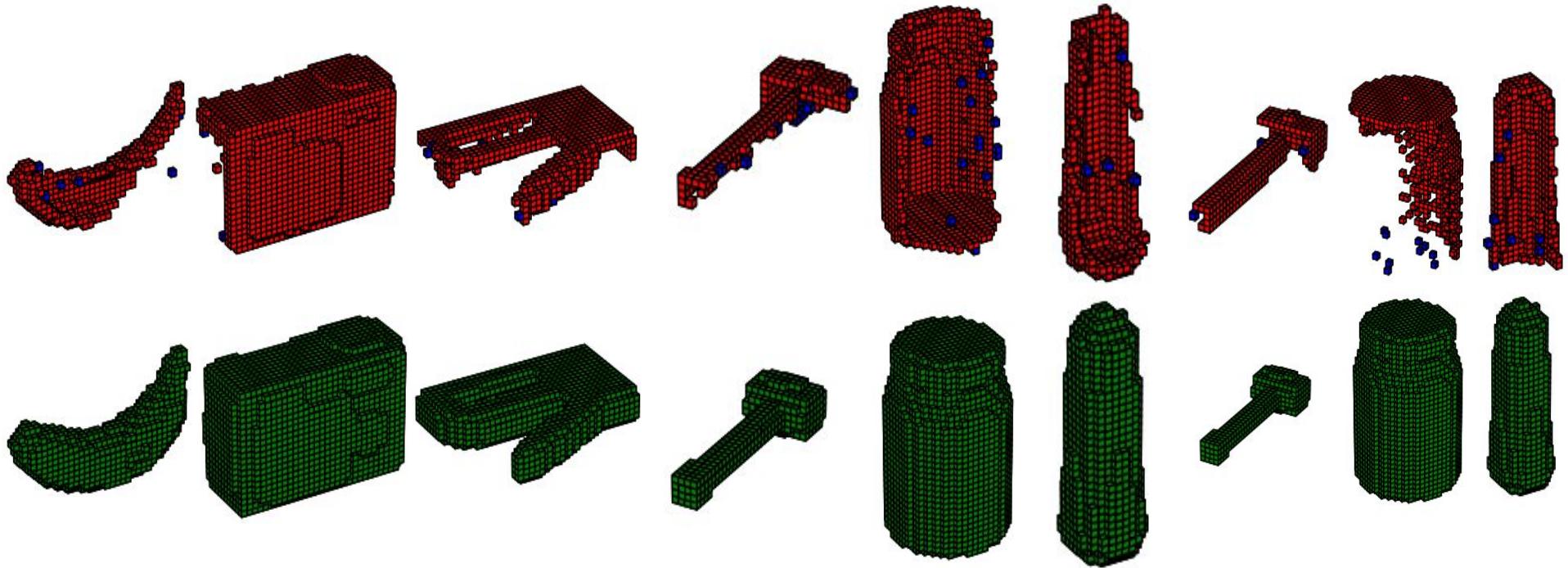
448,668 depth images

Capturing tactile samples

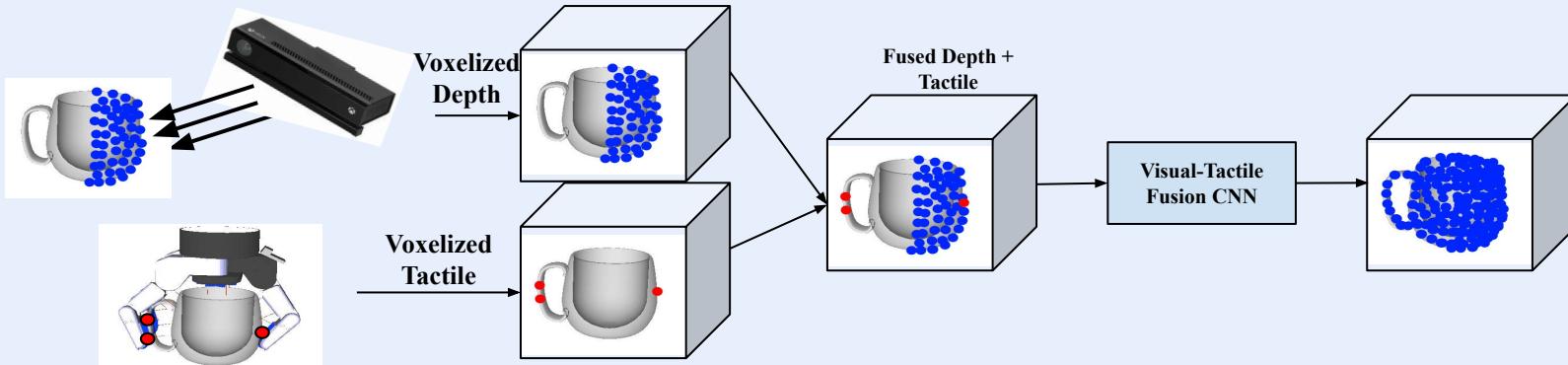


Capturing depth samples

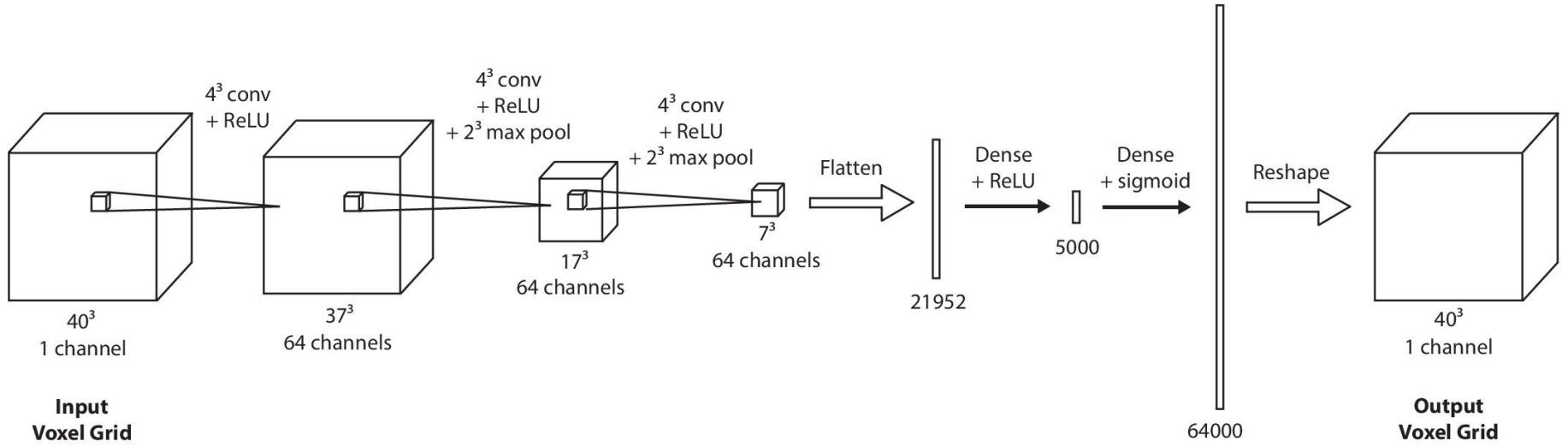




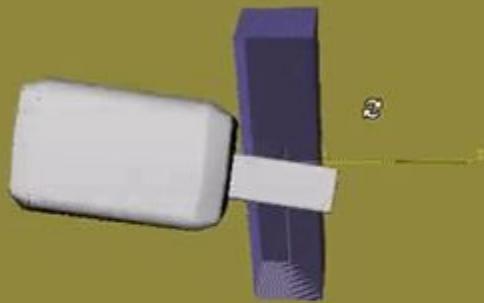
Depth and tactile completion



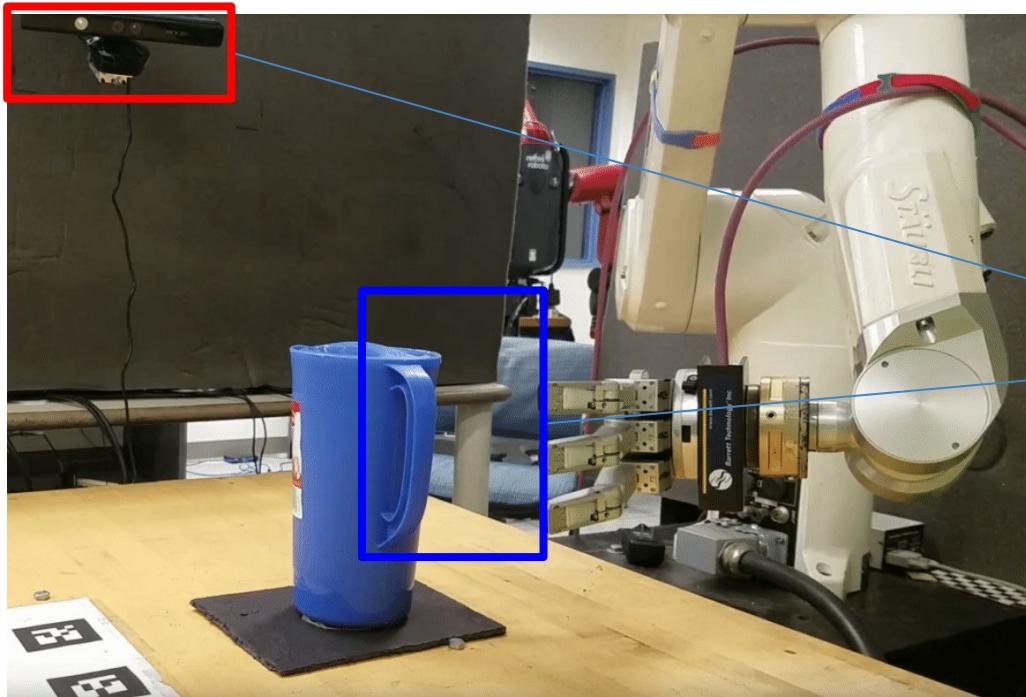
New Object
Geometry
Hypothesis



Grasp-It!

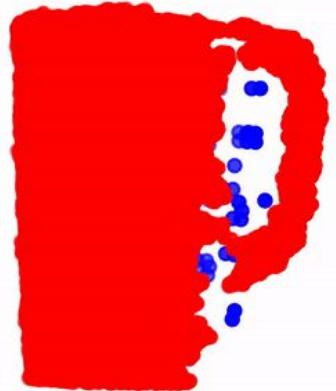


Results



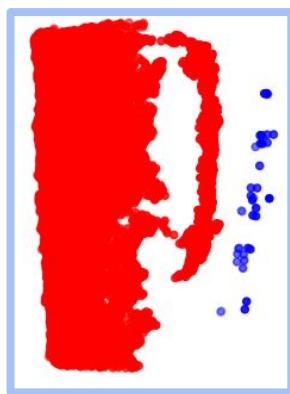
Depth (Red)

Tactile (Blue)





Ground Truth



Depth and
Tactile Clouds



Depth Only
Completion



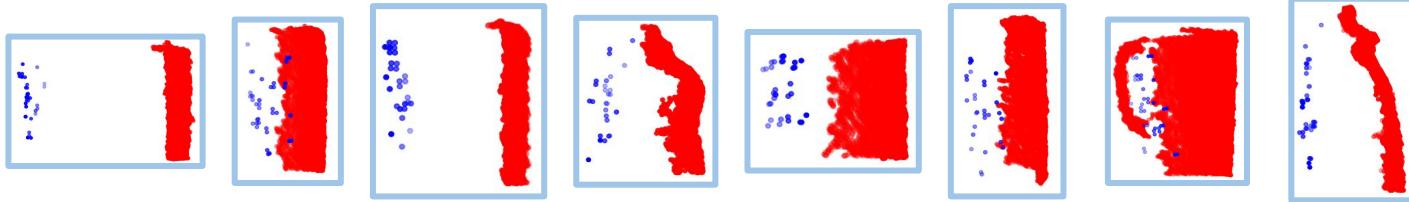
Tactile and Depth
Completion (ours)
© David Watkins-Valls 2019

Live results

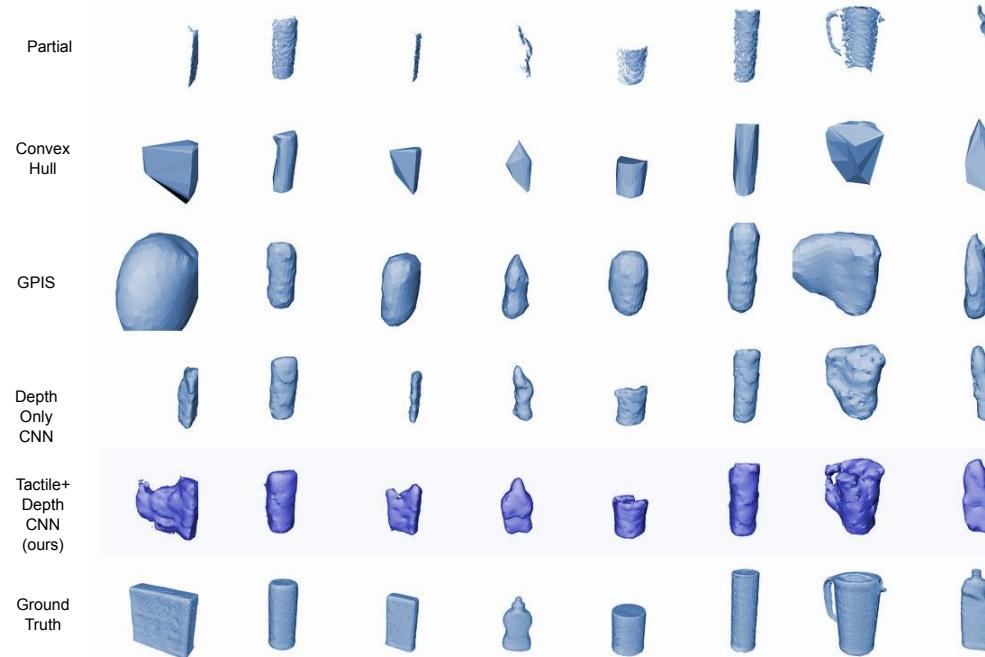
RGB



Depth
and
Tactile
Cloud



Completion comparisons

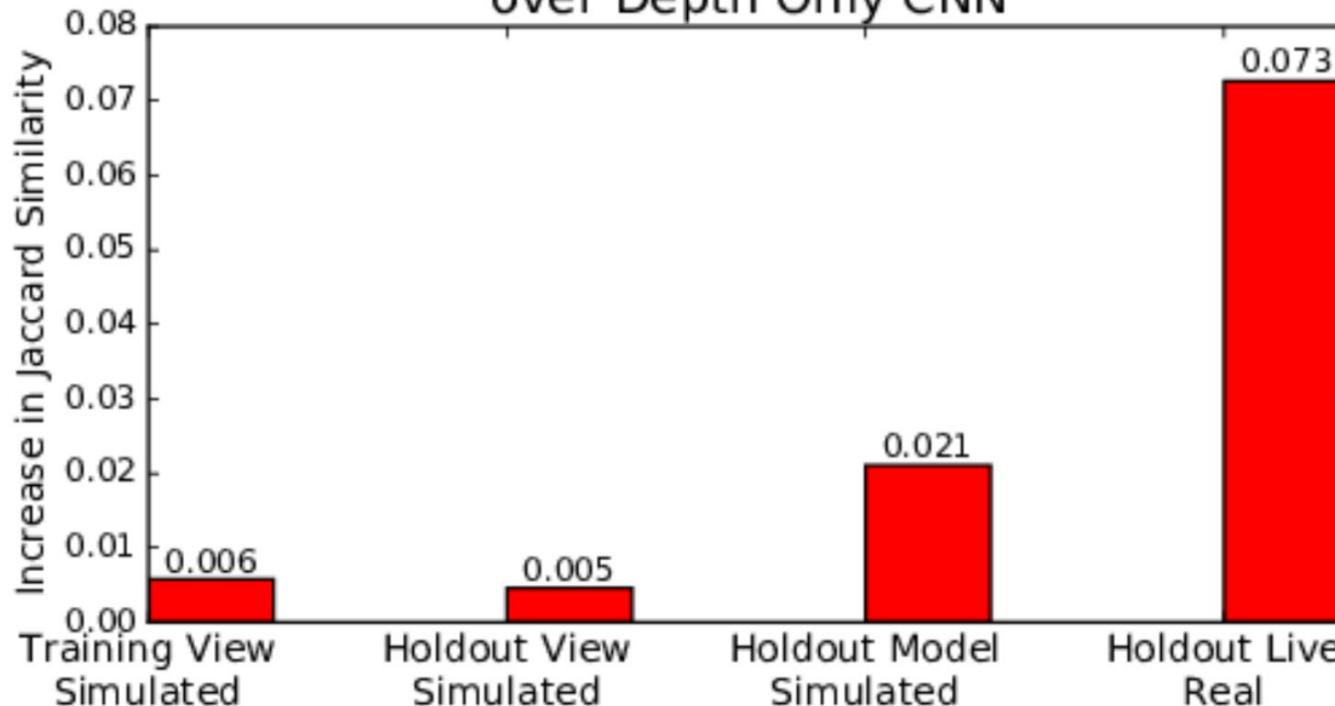


Completion results

| Completion Method | Train View(Sim) | Holdout View(Sim) | Holdout Model(Sim) | Holdout (Live) |
|--------------------------|------------------------|--------------------------|---------------------------|-----------------------|
| Partial | 7.8 | 7.0 | 7.6 | 11.9 |
| Convex Hull | 32.7 | 45.1 | 49.1 | 11.6 |
| GPIS | 59.9 | 79.2 | 118.0 | 17.9 |
| Depth CNN | 6.5 | 6.9 | 6.5 | 16.5 |
| Ours | 5.8 | 5.8 | 6.2 | 7.4 |

Hausdorff distance measuring the mean distance in millimeters from points on one mesh to points on another mesh

Tactile and Depth CNN Improvement over Depth Only CNN



Grasping Results

| Completion Method | Train View(Sim) | Holdout View(Sim) | Holdout Model(Sim) | Holdout (Live) |
|--------------------------|------------------------|--------------------------|---------------------------|-----------------------|
| Partial | 19.9mm | 21.1mm | 16.6mm | 18.6mm |
| Convex Hull | 13.9mm | 16.1mm | 14.1mm | 10.5mm |
| GPIS | 17.1mm | 16.0mm | 21.3mm | 20.8mm |
| Depth CNN | 12.1mm | 13.7mm | 12.4mm | 22.9mm |
| Ours | 7.7mm | 13.9mm | 13.6mm | 6.2mm |

L2 difference between planned and realized grasp pose averaged over the 3 finger tips and the palm of the hand



4X

Multi-Modal Geometric Learning for Grasping and Manipulation

[Back to main page](#)

Live Spill
Black And Decker Lithium Drill Driver
Clorox Disinfecting Wipes 35

Dominos Sugar 1lb
French's Classic Yellow Mustard 14Oz
Master Chef Ground Coffee 297G
Pringles Original

Rubbermaid Ice Guard Pitcher Blue
Soft Scrub 2lb 4Oz

Holdout Models Holdout Views
Banana Poison 004

Block Of Wood Bin
Book Poison 002

Book Poison 003

Book Poison 008

Book Poison 015

Book Poison 005

Book Poison 018

Box Poison 019

Box Poison 023

Camer Poison 014

Can Poison 001

Can Poison 014

CapriSuze Poison 009

Donut Poison 005

Egg Poison 011

Flashlight Poison 001

Hammie Poison 001

Hammie Poison 001

Hammie Poison 006

Hammie Poison 031

Hanselice Poison 000

Knot Poison 004

Kote Poison 011

Kote Poison 032

Melissa Doug Farm Fresh Fruit Banana

Mushroom Poison 007

Mushroom Poison 007

Mushroom Poison 013

Mushroom Poison 013

Picher Poison 003

Pliers Poison 000

Remote Poison 012

Remote Poison 012

Remote Poison 012

Remote Poison 013

Remote Poison 016

Soccer Ball Poison 003

Soccer Ball Poison 007

Stapler Poison 007

Stapler Poison 023

Tetra Pak Poison 020

Toaster Poison 009

Toilet Paper Poison 000

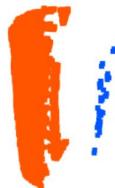
Toy Poison 001

Toy Poison 019

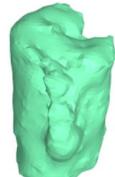
Treath Can Poison 011

Rubbermaid Ice Guard Pitcher Blue
Point Cloud (Depth cloud in red, Tactile cloud in blue)

Partial View



Completion



Ground Truth

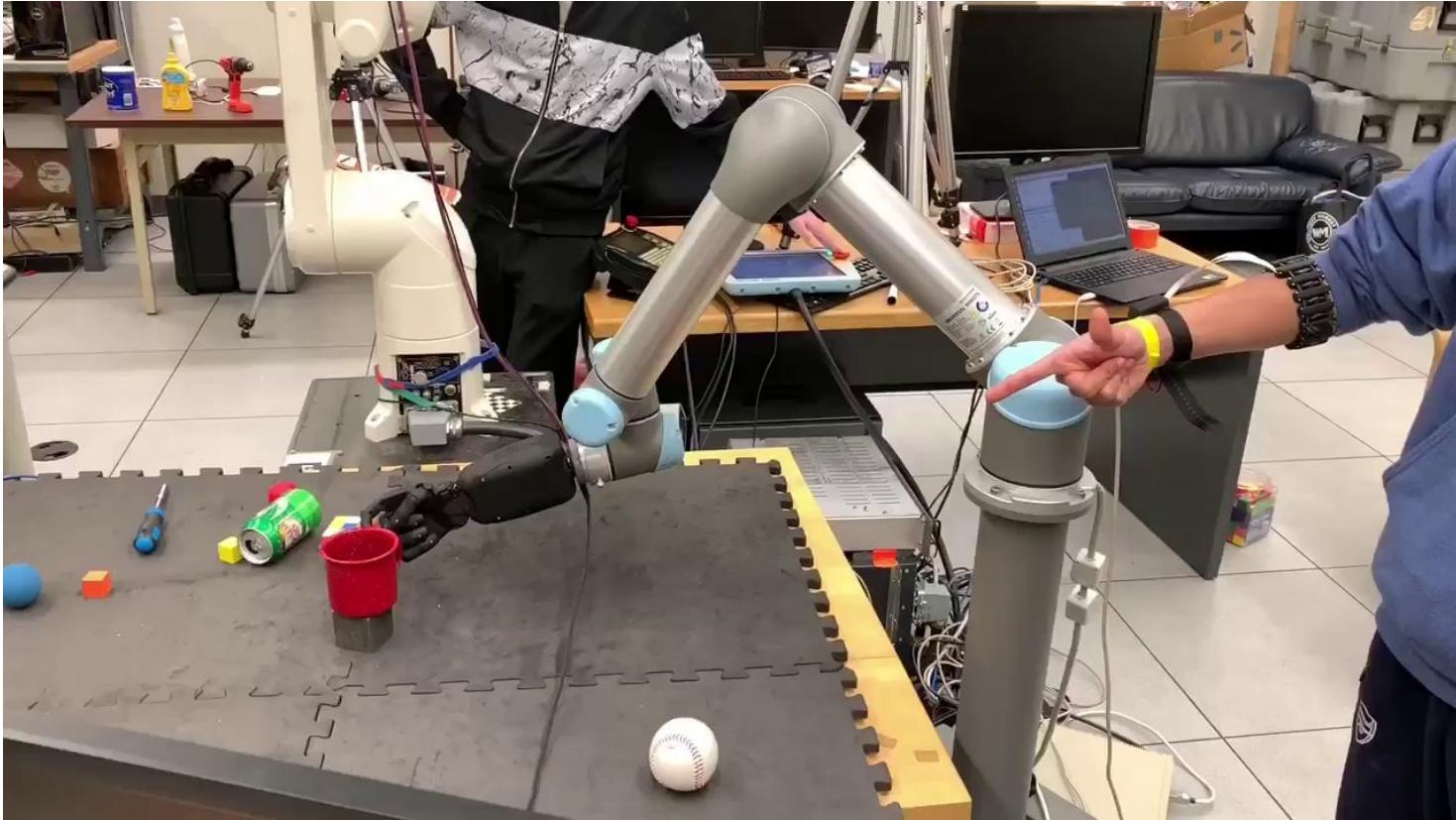


Virtual reality



Remote teleoperation





Next Steps

- RGB voxel grid
 - Affordance labeling of output voxels
 - Segmentation of resultant voxel grids
 - Next best touch
-
- Higher resolution grasping
 - Scene segmentation

Multi-Modal Geometric Learning for Grasping and Manipulation

David Watkins-Valls, Jacob Varley, Peter Allen

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