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# 3D POINT CLOUD completion from 2.5D DATA

Modelling the unseen

## 1. Background

**Tactile Internet** can enable applications such as teleoperation Challenge: it needs ultra-low latency, which is not possible on long range

A solution is **Physics simulation:** simulating the robot's environment for instant sensory feedback

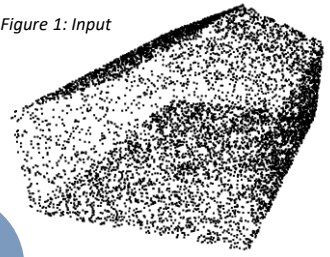
It needs **real data**, which can be obtained by use of a **depth camera**

Depth cameras can only take **single perspective** images, the backside of an object is unobserved *Figure 1*

So how to **model the backside** of objects?

**AI-based** approaches exist, but they are **not transparent**

*Figure 1: Input*



## 2. Research Questions

- Is it possible to create a **3D** point cloud completion algorithm **from 2.5D data**, without resorting to the use of AI?
- How to lessen the effect of **noise**?

## 3. Methodology

**Focus on reconstruction** as the most important and complex part.
Idea: Model the backside using **symmetry**, as it's common in nature and human design [1]

- Identify the **symmetry planes** of an object
- Use the **faces** of the object to create potential symmetry planes *Figure 2*
- Test the **accuracy** of these potential planes *Figure 3*
- If good, then add them to the final model *Figure 4*

*Figure 2: Faces*

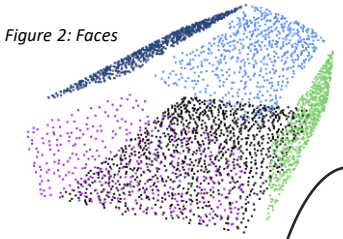


*Figure 3: Mirrors*

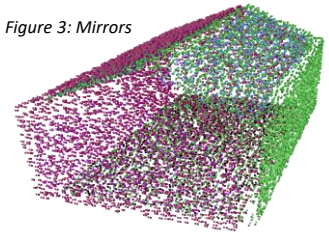
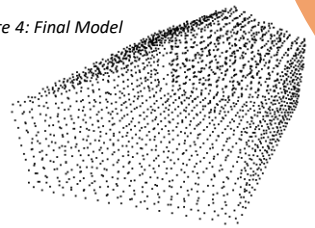


*Figure 4: Final Model*



## 4. Results

- The algorithm developed **works well for simple objects**
- Because **complex objects** have **more faces**, they are harder to model
- **Noise has a large negative impact** on the performance of the algorithm. And voxelization has a limited improving effect.

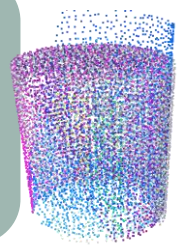
## 5. Conclusion

- **It is possible** to create 3D point cloud models from 2.5D data, without the use of machine learning
- The performance of the proposed algorithm has **problems** dealing with **complex objects** and **noise** *Figure 5*

## 6. Future Work

- Make use of **Updating** the point cloud model [2]
- Estimate the bottom side of an object by **surface plane continuation**
- **Optimize** the **efficiency** of the algorithm

*Fig 5: Complex Shape*



References:
[1] Rosen, J. (2009). Symmetry at the foundation of science and nature. In *Symmetry* (Vol. 1, Issue 1). https://doi.org/10.3390/sym1010003
[2] Kähler, O., Prisacariu, V. A., & Murray, D. W. (2016). Real-Time Large-Scale Dense 3D Reconstruction with Loop Closure. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics): Vol. 9912 LNCS* (pp. 500–516). https://doi.org/10.1007/978-3-319-46484-8_30