Optimizing Gazebo Simulation

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Intrinsic

Simulation Performance

Focus

- Simulation Environment, Physics
- Other factors: robots, sensors, networking, etc

Large Scale Simulation

Slow-downs due to:

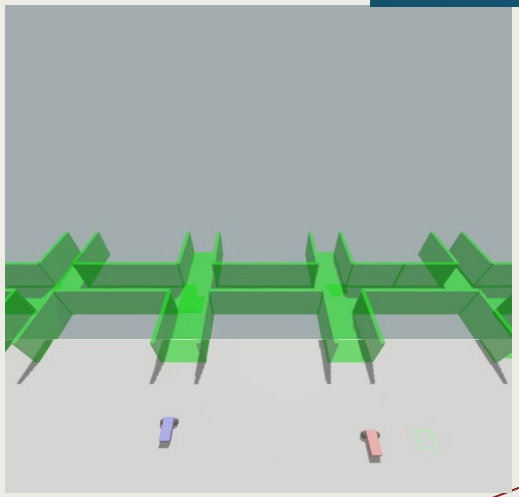
- Number of (dynamic) objects
- Number of meshes

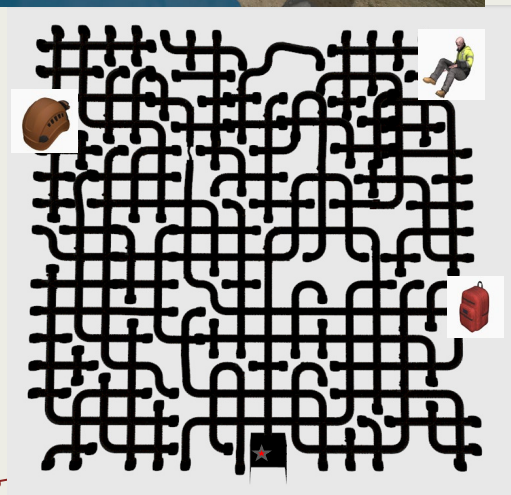
TIP: Levels

- Extensively used in DARPA Subterranean Challenge

TIP: Lower physics update rate

- 1ms -> 2 or 4ms step size





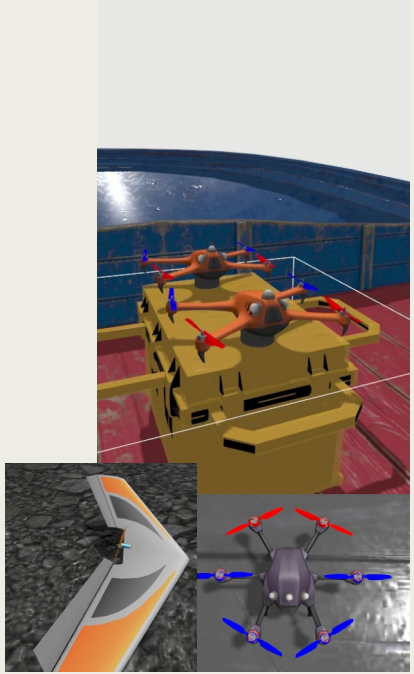
Expensive dynamic objects

Expensive dynamic models with many joints, meshes, etc

- Disable / enable them as needed

TIP: Make models static / dynamic

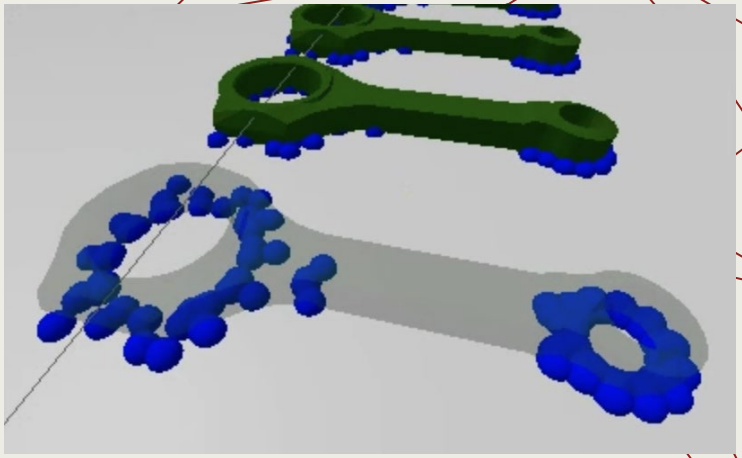
- Unfortunately no easy API
- Set static
  - Create empty static model
  - Create detachable joint with the static model
- Set dynamic
  - Detach joint
  - Delete static model



MBZIRC: Deactivate drones (out of bounds / battery)

Ionic demo world
25% -> 99 % RTF

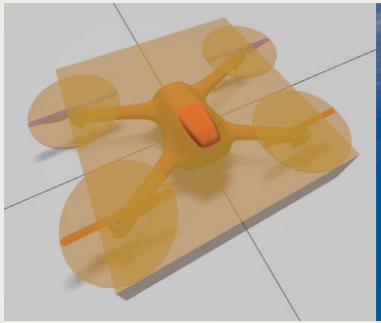
Complex meshes

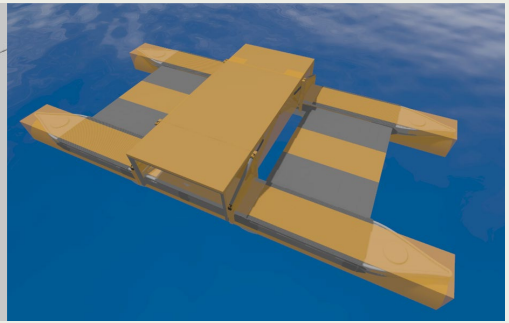


Dynamic meshes are expensive to simulate

- Collision detection phase:
  - Different algorithms used for meshes
  - Mesh-to-mesh collision is most expensive
- Can potentially generate many contact points

TIP: Use simple primitive shapes or optimized colliders!

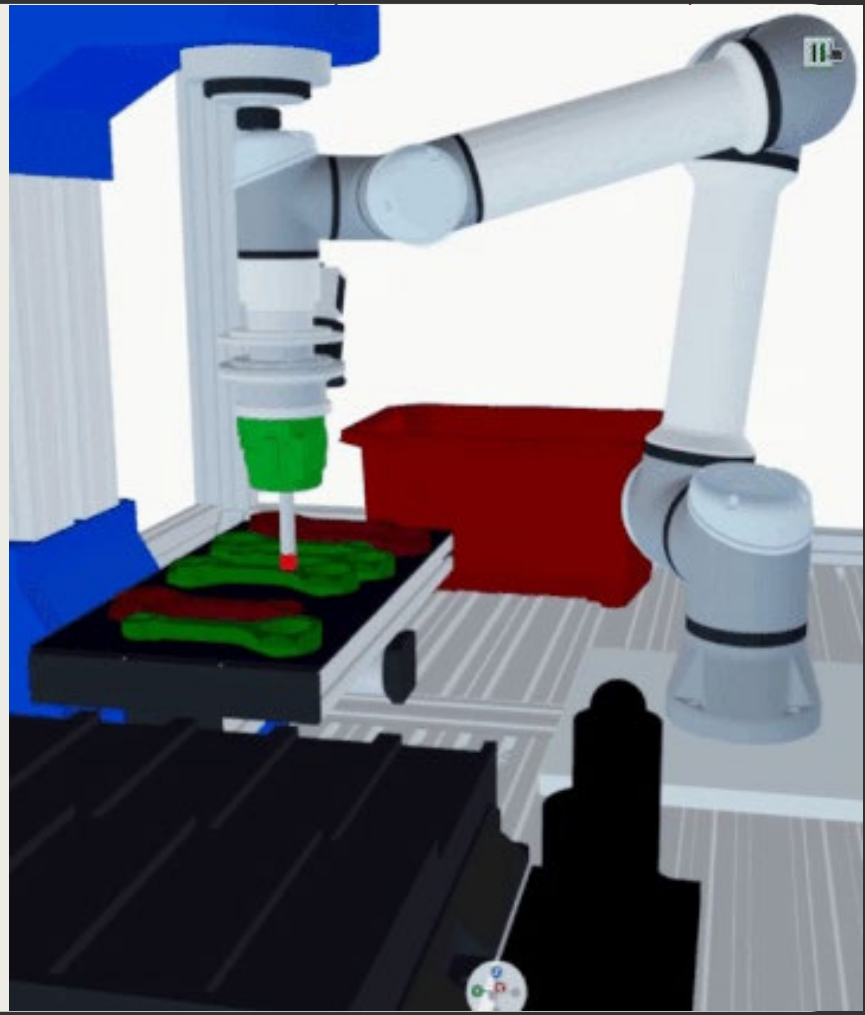




Applications that need meshes

Example: Precise pick and place application

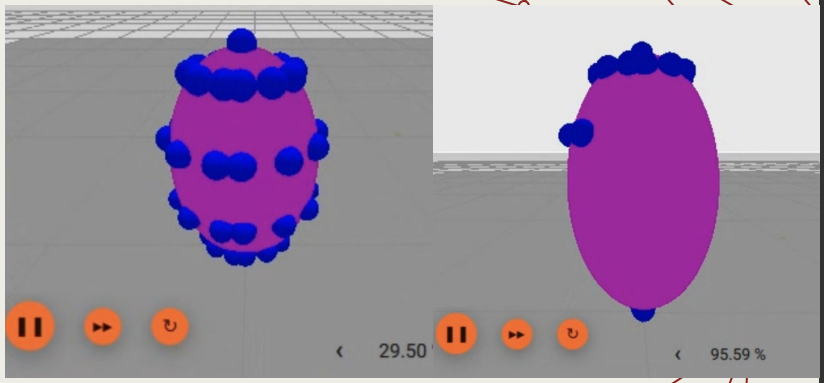
- Needs high fidelity concave mesh



New Gazebo Features

Limit max no. of contacts between collision pairs

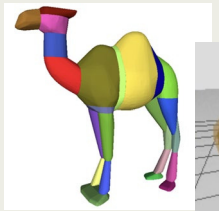
```
<max_contacts>20</max_contacts>
```

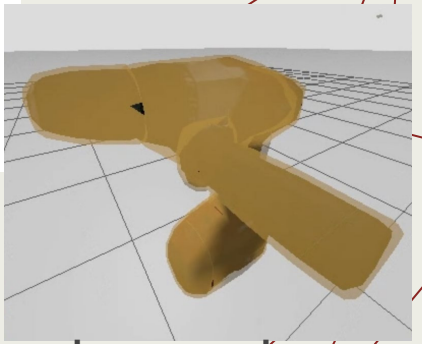


Collision mesh optimization

- Convex hull & Convex Decomposition
  - V-HACD https://github.com/kmammou/v-hacd

```
<mesh optimization="convex_decomposition">
```





Drill: convex decomposed mesh collision

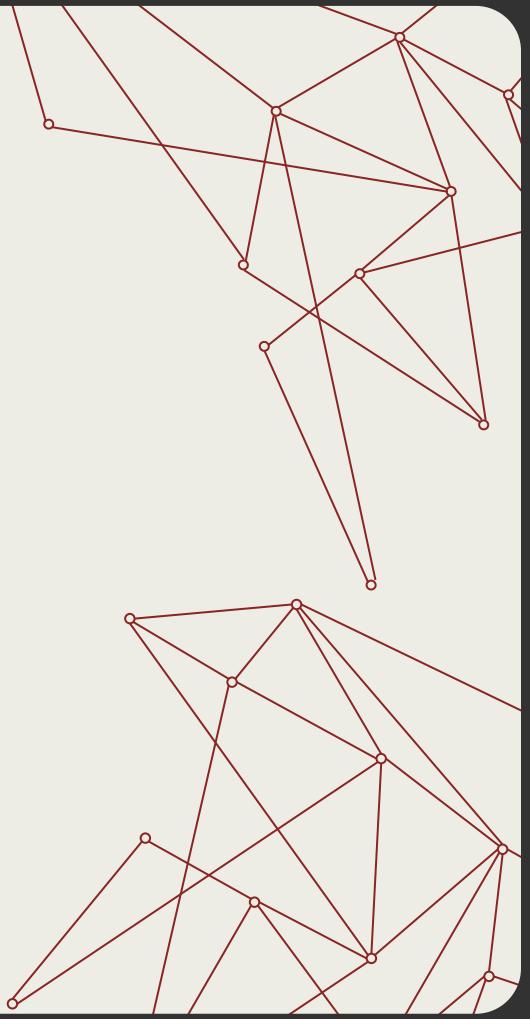
Improvements to **bullet-featherstone** physics plugin

- Convex hull shape representation
- Auto-deactivation
  - Ionic demo world **15% -> 99%**
- WIP: Kinematic mode (experimental)

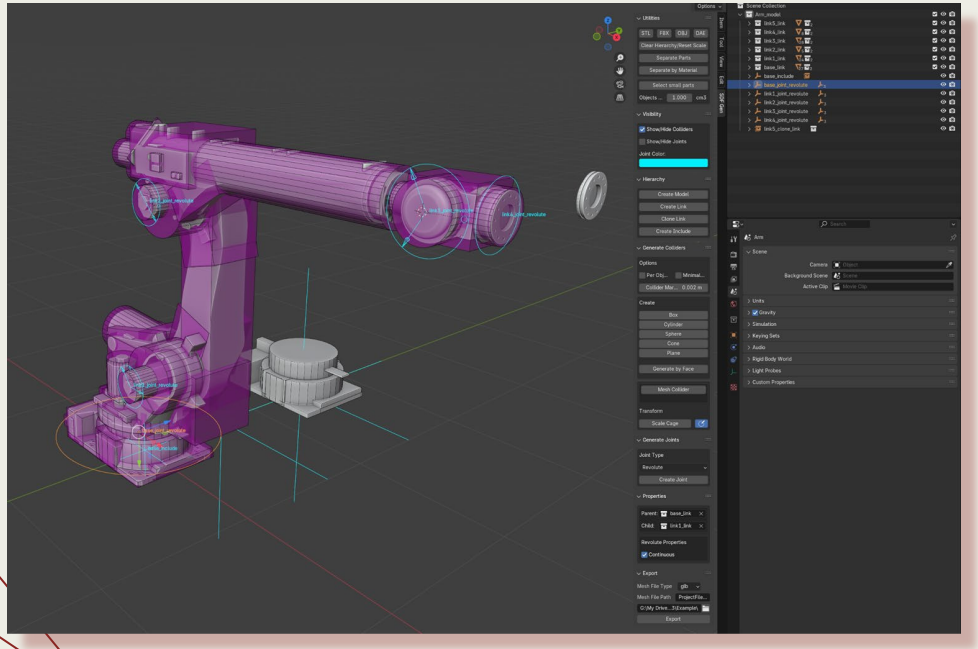
SDFGen

An addon for Blender

Building meshes for simulation FAST



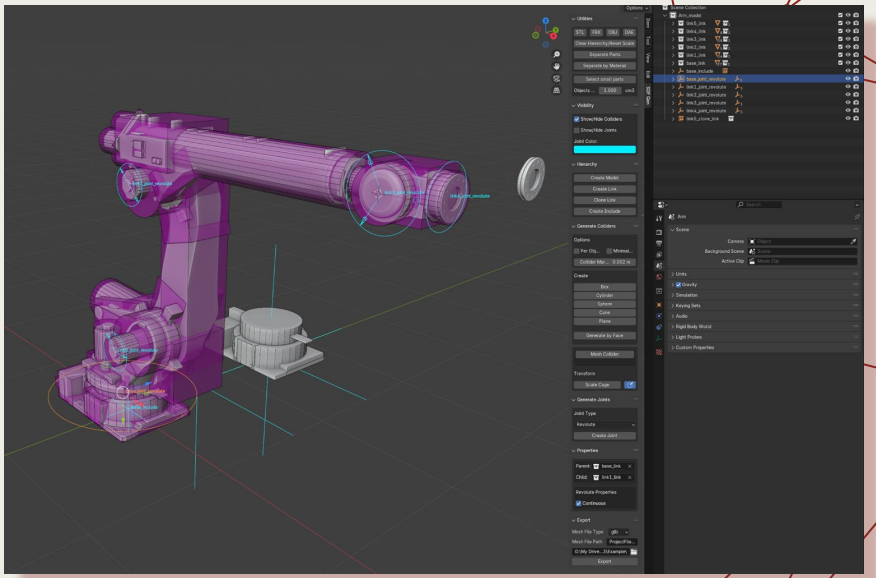
What is **SDFGen?**



Capabilities of **SDFGen**

What can SDFGen do?

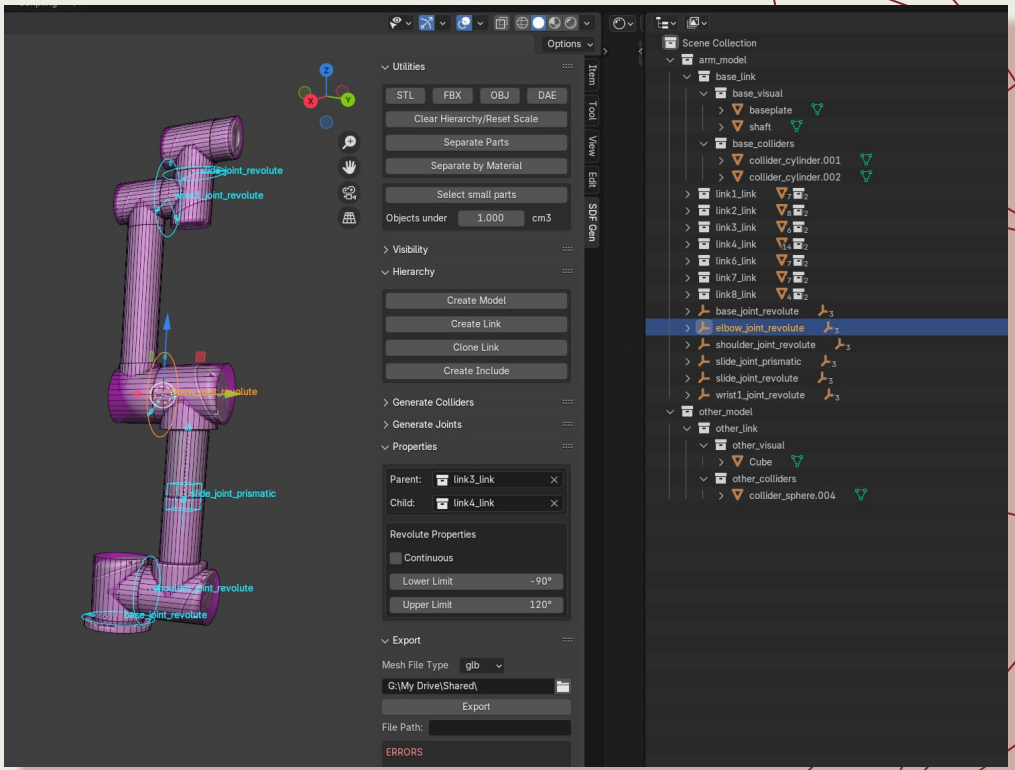
- Mesh processing
- Model, link, and visual generation
- Support for multiple models
- Joint creation and visualization
- Exporting of SDF files
- Inertial properties generation
- Collider generation
- Model instancing via include tags
- Link cloning
- Mesh optimization



https://github.com/cole-bsmr/SDFGen

Hierarchy setup

- Matches SDF hierarchy
- Item properties are in one place
- Separate scenes for separate models
- Meshes, inertia, collisions, etc calculated at export



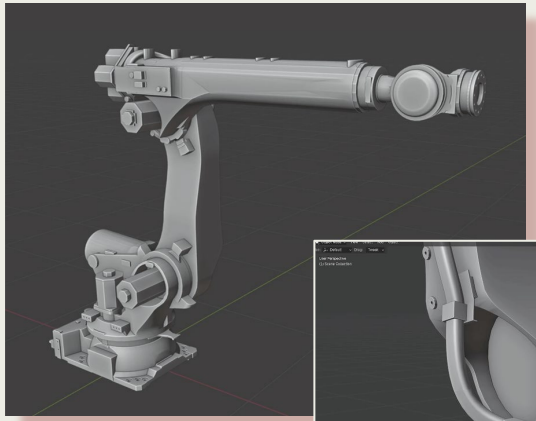
Creating collisions

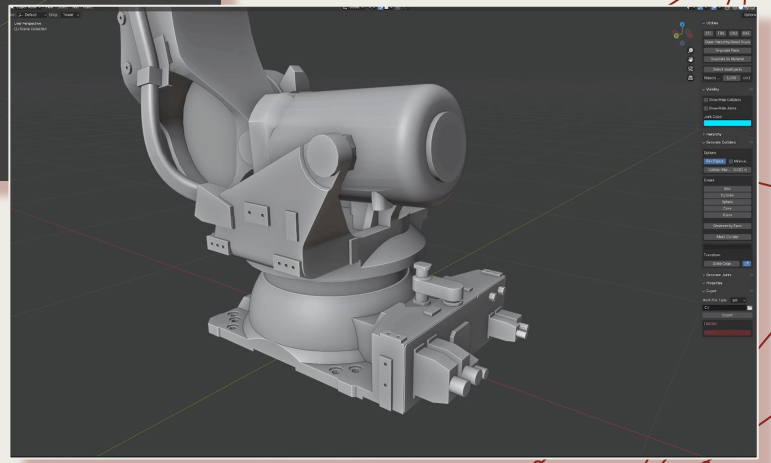
Using SDFGen

Creating collisions in **SDFGen**

Workflow and features:

- Mesh processing
- Outliner setup
- Collider types
- Creation settings
- Mesh collider generation
- SDF Generation

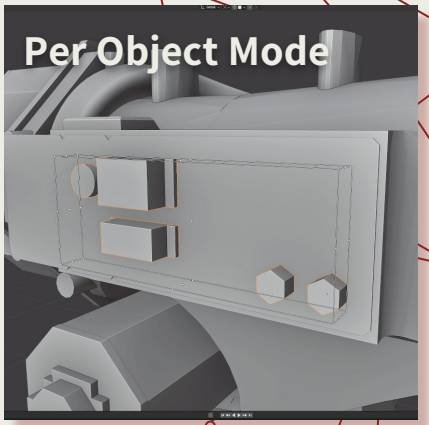


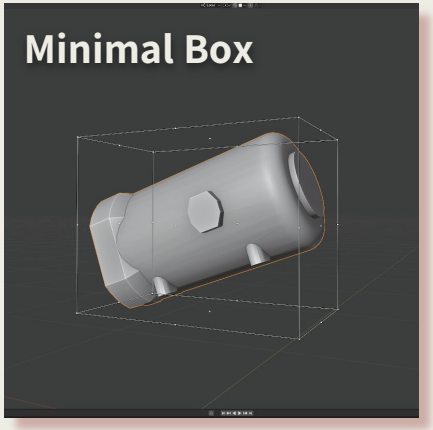


Collision creation options

Collision creation features:

- Minimal box
- Generating colliders by flat faces
- Multiple selection options
- Safety margin

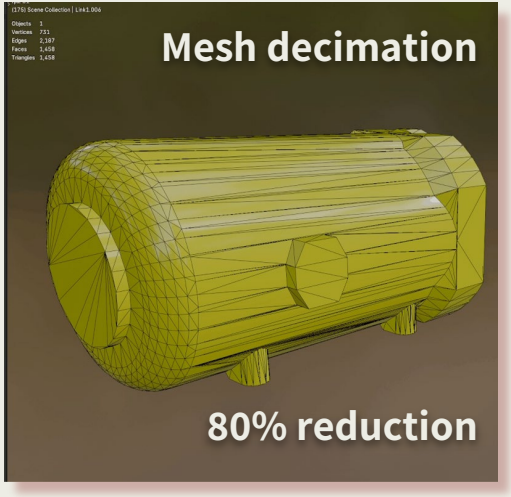


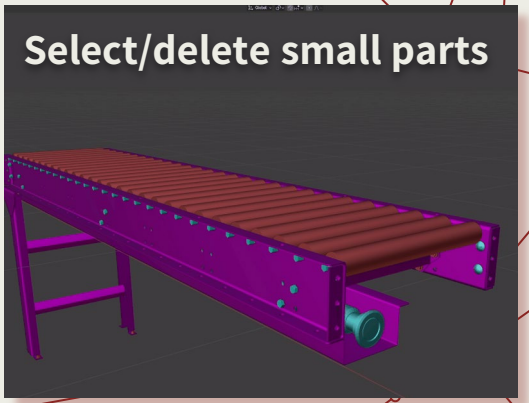


Mesh **optimization**

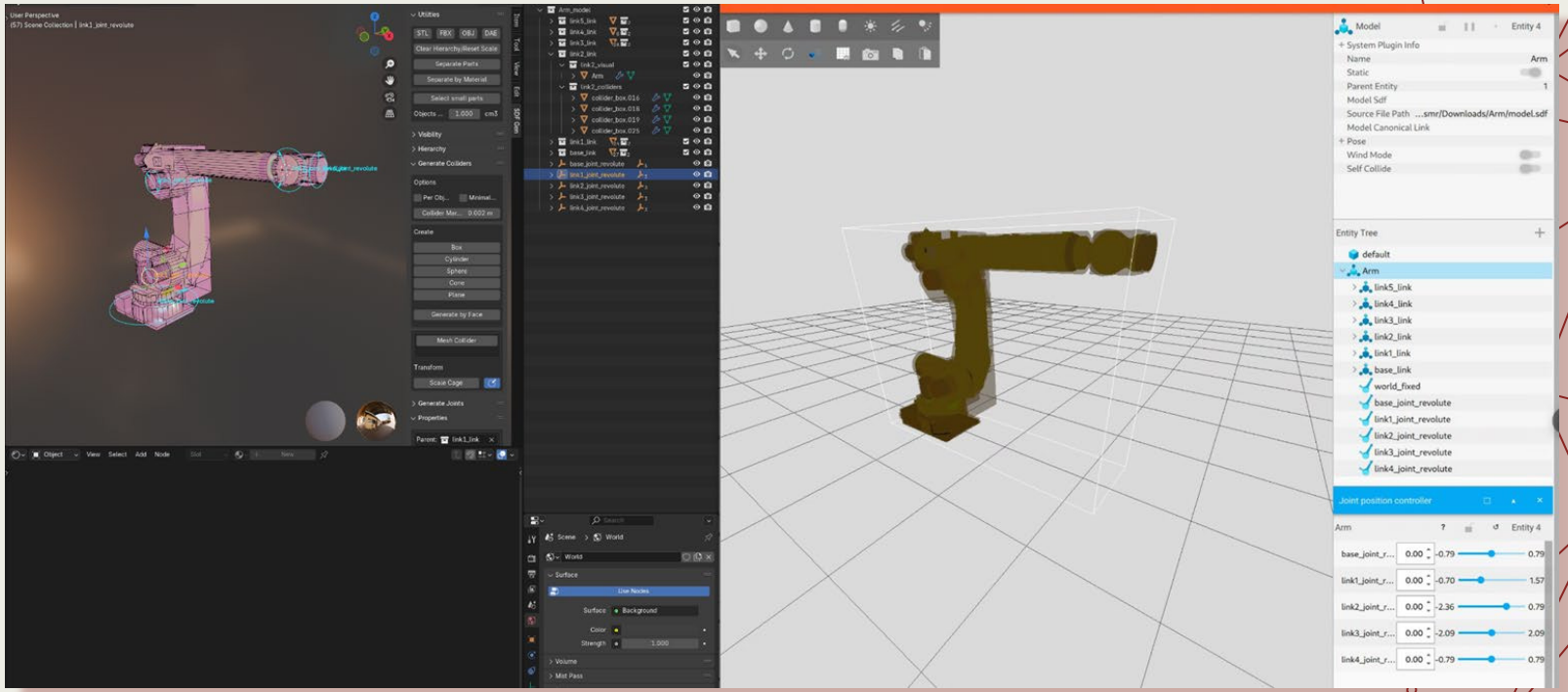
Mesh optimization features:

- Decimation for polygon reduction
- Select and delete parts by size



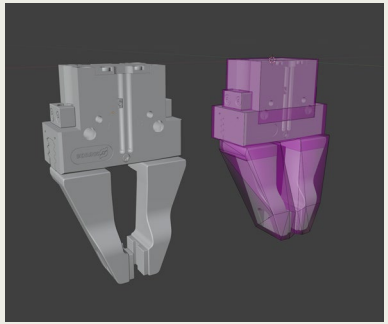


SDFGen to Gazebo

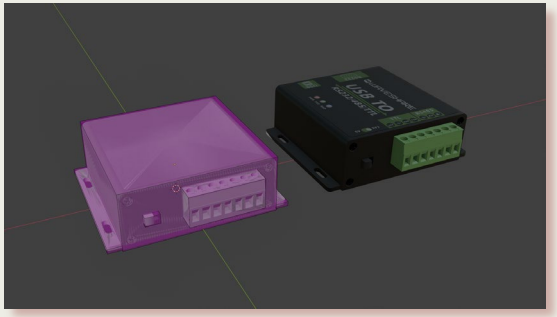


Examples

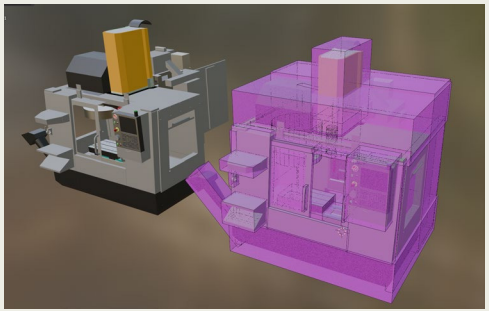
CAD Object



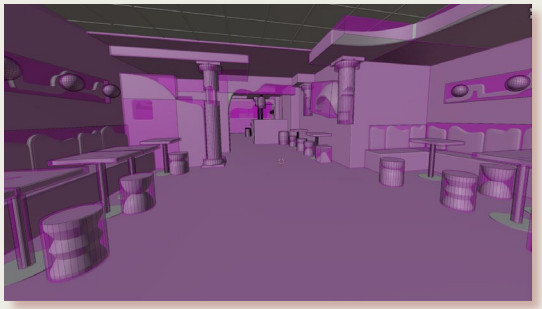
Mesh object



Workcell

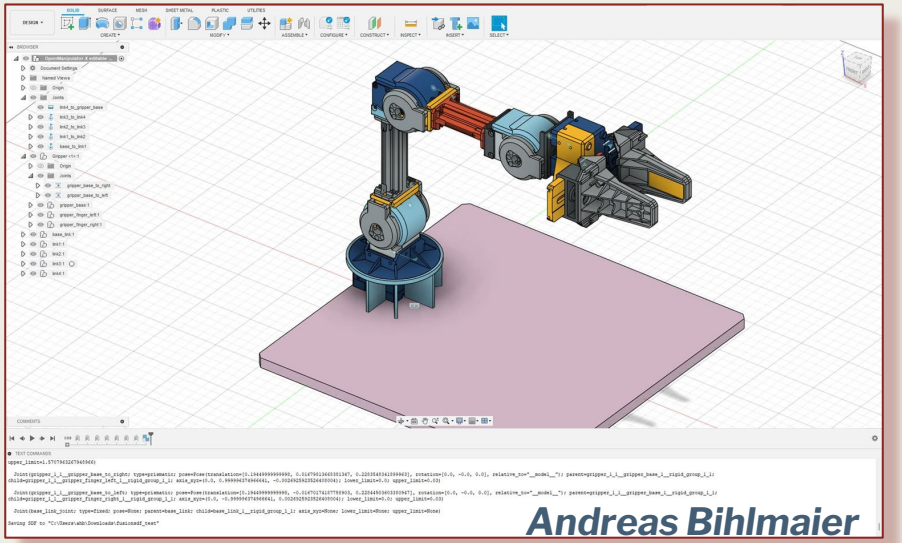


Environment



Fusion**SDF**

https://github.com/andreasBihlmaier/FusionSDF



Questions?

SDFGen

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