Vom CAD Modell zur robot_description (URDF/SDF) ohne all das ‹XML/›

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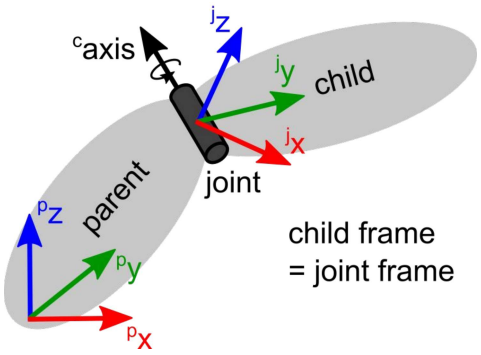
Slides

Robot description formats (URDF/SDF)
and
CAD data

Robot descriptions - of Links and Joints



- **Model**: Collection of links and joints

- **Links**:
  - Pose
  - Visual geometry
    - Primitives or meshes
    - Color and texture
  - Collision geometry (primites or meshes)
  - Mass and inertia
  - Contact dynamics (friction and damping)

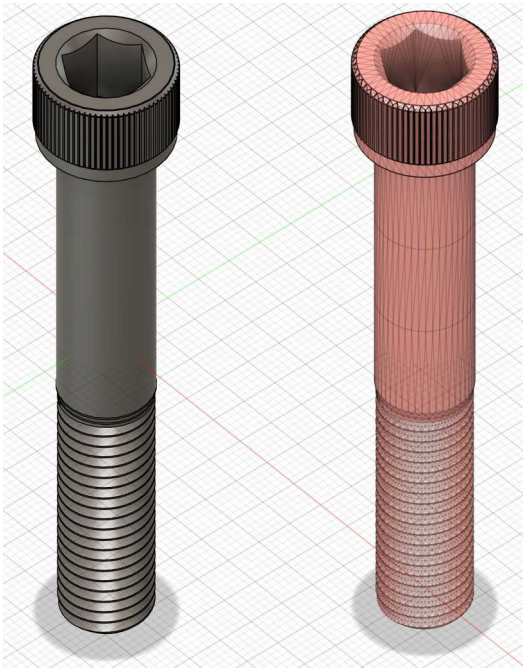
- **Joints**:
  - Pose
  - Parent link and child link
  - Type (fixed, revolute, prismatic)
  - Axis
  - Limits
  - Joint dynamics (friction and damping)

CAD data - of Components and Occurrences[1]

More details in this ROSCon 2024 talk

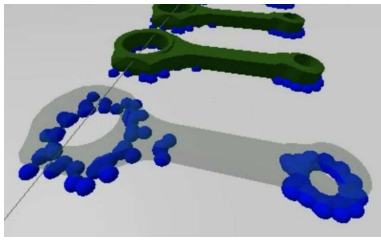
Main differences

- Geometry representation: B-Rep vs Meshes
- Hierarchy of components and occurrences
- Physical material and appearance
- Implicit and missing joints
- Many more details than in typical URDF/SDF, e.g. fasteners



Considerations for conversion

- Simulation performance ⚠️
  - Mesh size (#triangles), esp. for collision (-> #contacts!)
  - Convex collision meshes
  - Geometric primitives instead of meshes, esp. for collision
  - Inertia ratios
  - #Joints, esp. non-fixed
- Natural coordinate systems and joint axis and origins
- Naming conventions



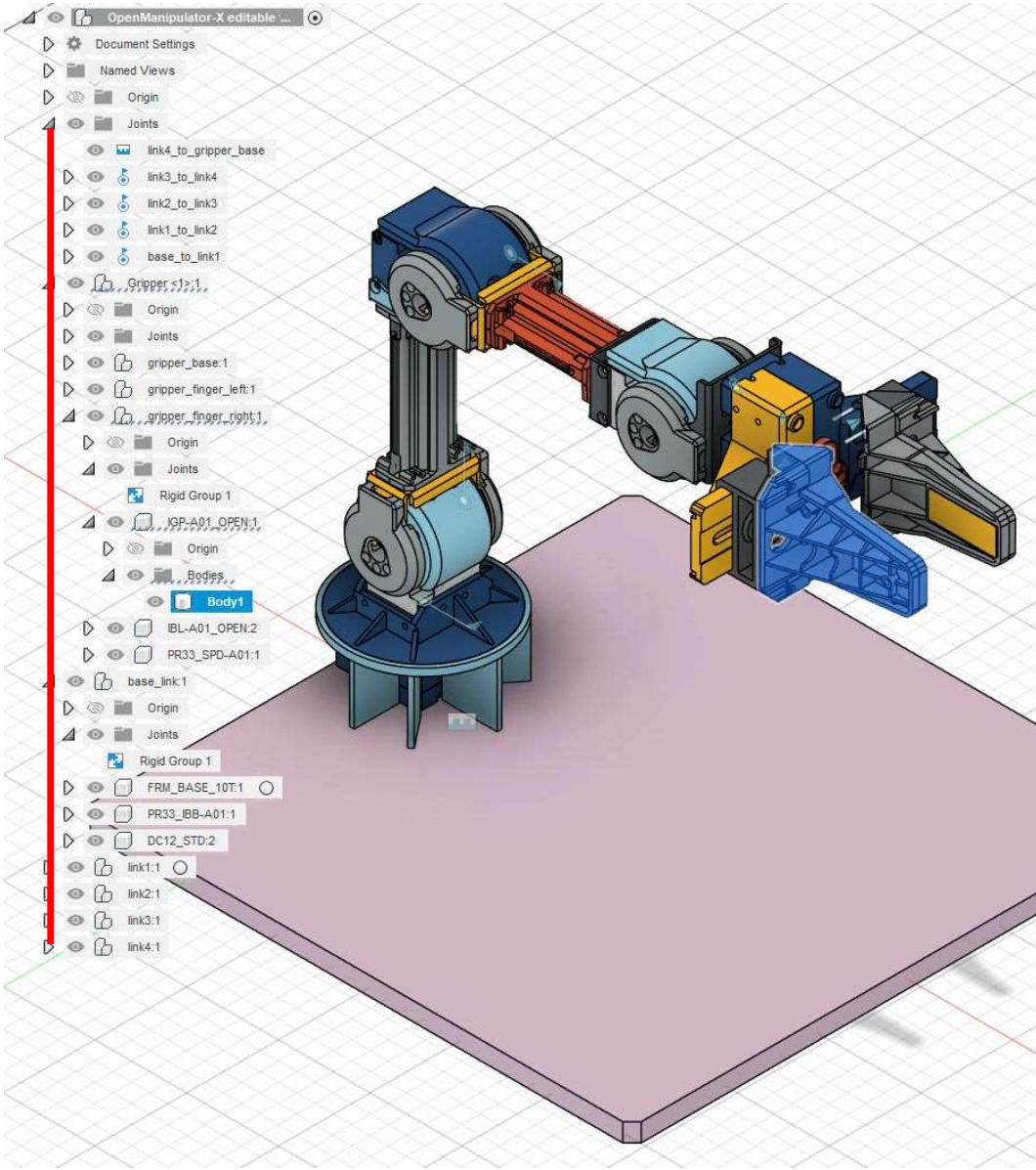
[1] Using Fusion 360 terminology

FusionSDF
Fusion 360 to SDF

FusionSDF

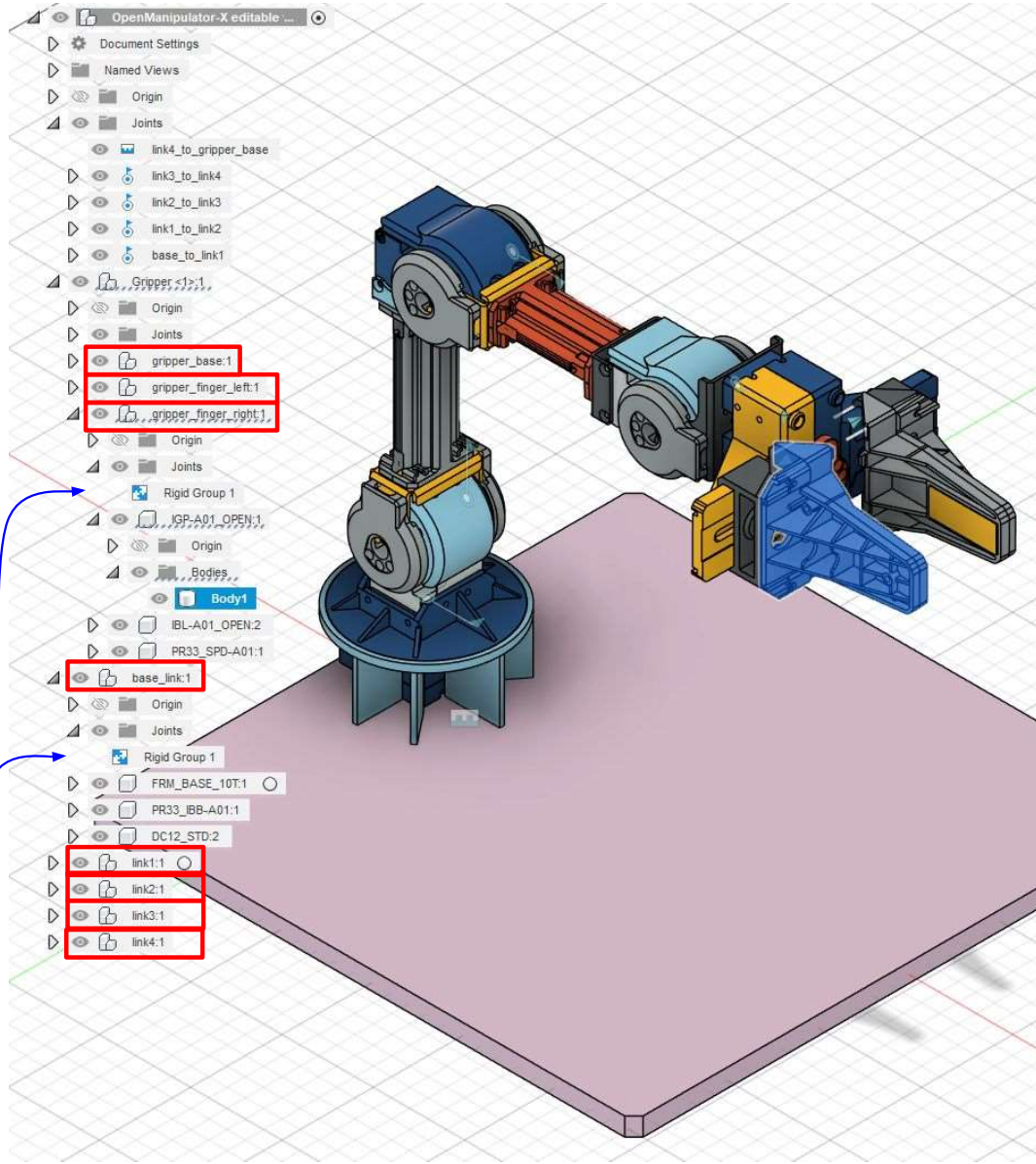
- **Conventions**:
  - The top level component only consists of components and joints.
  - Every link is a component.
  - Each rigid group corresponds to a single link

  - [To be valid as ROS robot_description, using SDFormat URDF, all components must be linked by joints to form a tree structure. This implies there must be only one root link, i.e. one link that is not a child of any joint.]



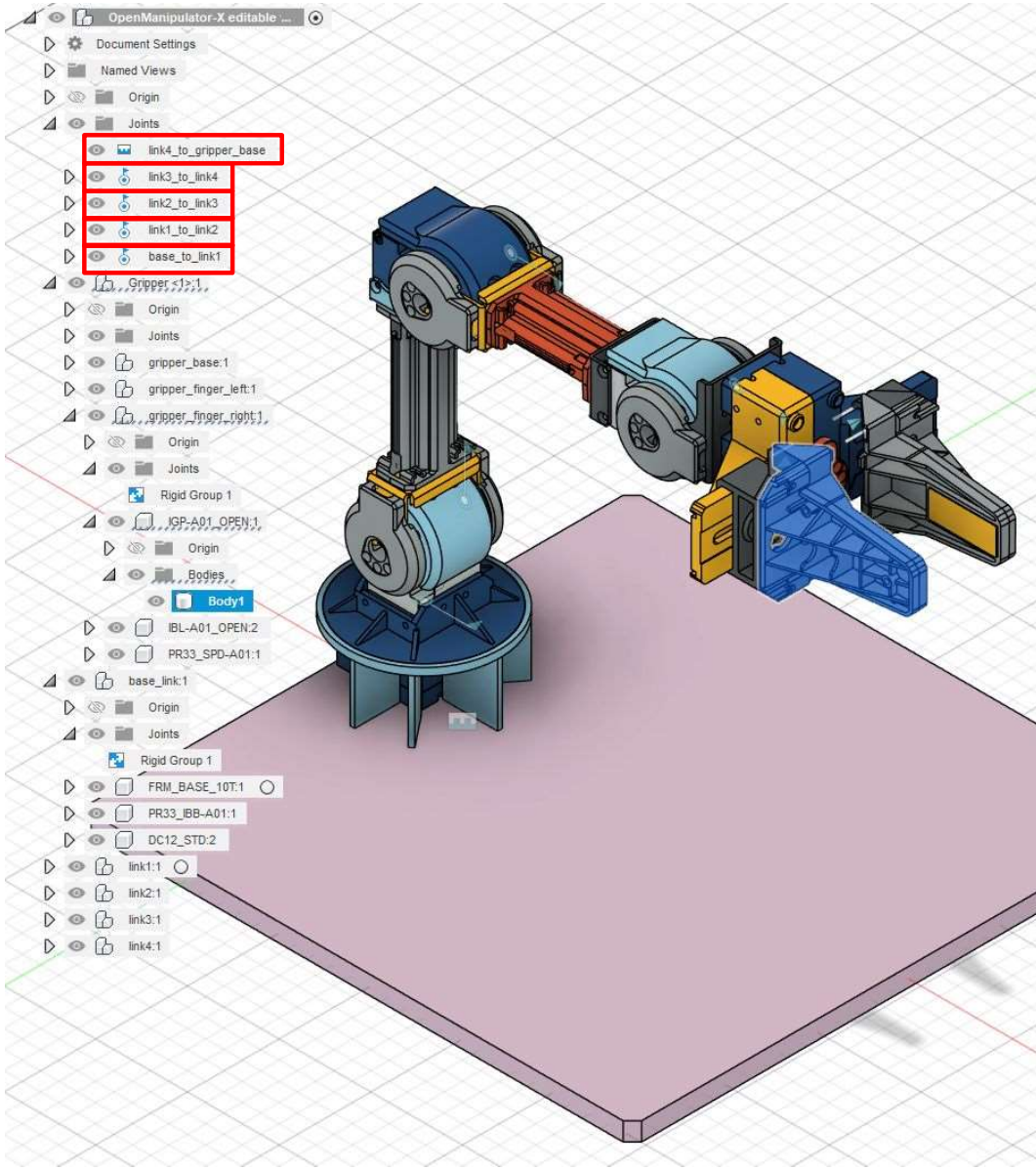
FusionSDF

- **<link>**s:
  - Pose
  - Visual geometry
    - Export all bodies as meshes, each becoming <visual>s on the link
    - Optional post-processing via sdfopt or SDFGen
  - Collision geometry
    - Calculate oriented minimum bounding box, each becoming <collision>s on the link
      - Option to use mesh instead
  - Mass and inertia
    - Use physical material to calculate mass and moments of inertia
  - Combine everything held together by a rigid group into a single <link>

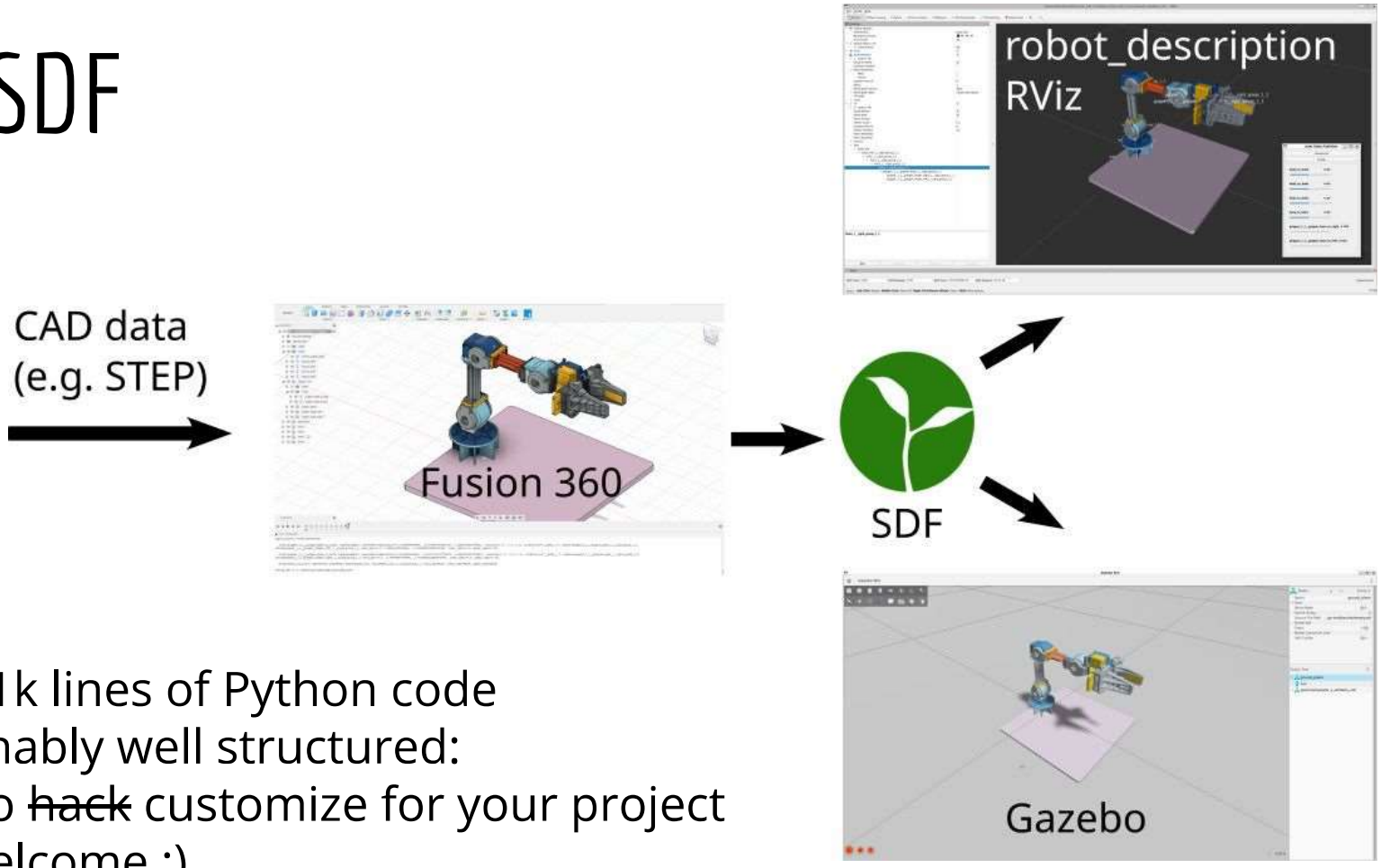


FusionSDF

- **<joint>**s:
  - Pose
  - Parent link and child link
    - Resolve joints to subcomponents deeper in the hierarchy
  - Type (fixed, revolute, prismatic)
    - Straightforward correspondence for simple joint types
  - Axis
  - Limits



FusionSDF



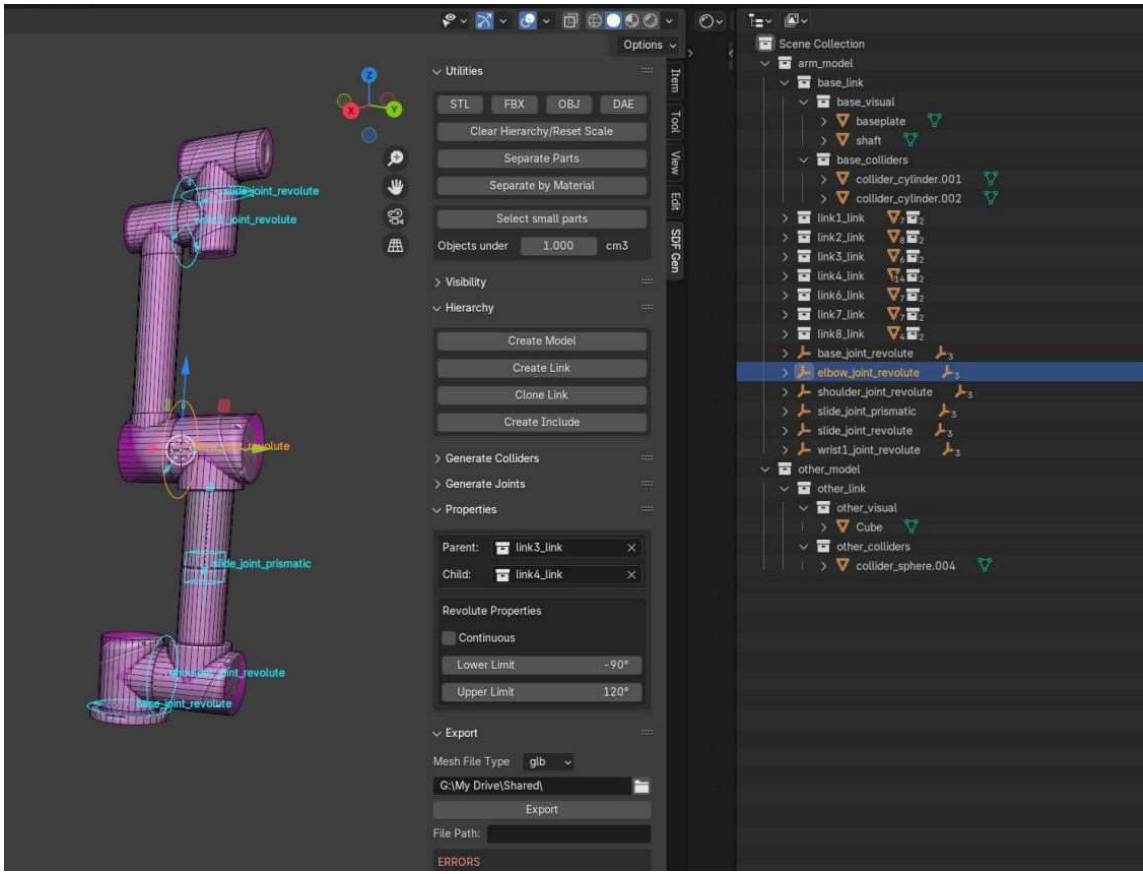
Less than 1k lines of Python code
and reasonably well structured:

- Easy to ~~hack~~ customize for your project
- PRs welcome :)

SDFGen
(CAD to meshes to) Blender to SDF

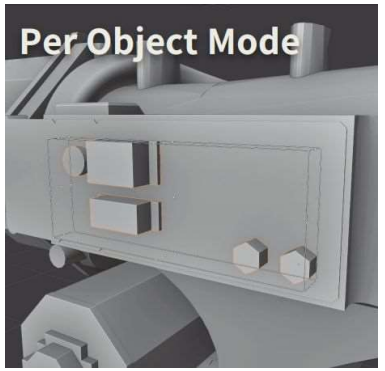
SDFGen features

- 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

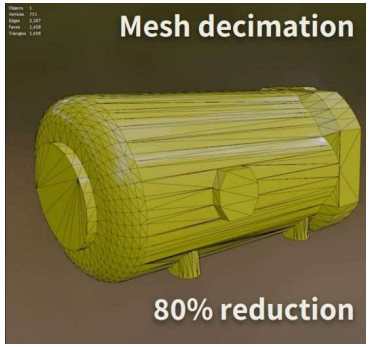


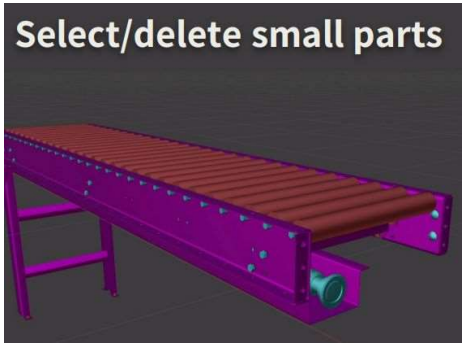
SDFGen collider creation & optimization workflows

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



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





Other tools

CAD Exporters

- Blender URDF Exporter
- CREO Parametric URDF Exporter
- FreeCAD ROS Workbench
- RobotCAD (FreeCAD OVERCROSS)
- Freecad to Gazebo Exporter
- Fusion 360 URDF Exporter
- FusionSDF: Fusion 360 to SDF exporter
- OnShape URDF Exporter
- SolidWorks URDF Exporter
- ExportURDF Library (Fusion360, OnShape, Solidworks)
- RoboForge Project (freemium / paid tooling)

Other URDF Export and Conversion Tools

- Gazebo SDFormat to URDF Parser
- SDF to URDF Converter in Python
- URDF to Webots Simulator Format
- The Blender Robotics Tools respository includes a number of useful tools, including a tool to export URDF files from Blender.
- CoppeliaSim URDF Exporter
- Isaac Sim URDF Exporter

Viewing URDF & SDF Files

- Examples of Common URDF Launch Files
- Web Viewer for URDF Files: GitHub Repo & Live Website
- View SDF Models in RViz
- Jupyterlab URDF Viewer

View SDF in RViz

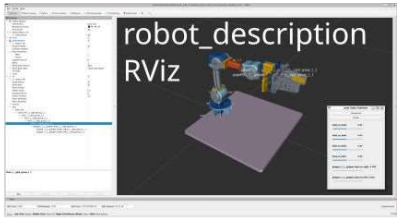
https://docs.ros.org/en/jazzy/Tutorials/Intermediate/URDF/Exporting-an-URDF-File.html

Write less URDF/SDF XML,
enjoy using ROS more!

Thanks!

FusionSDF

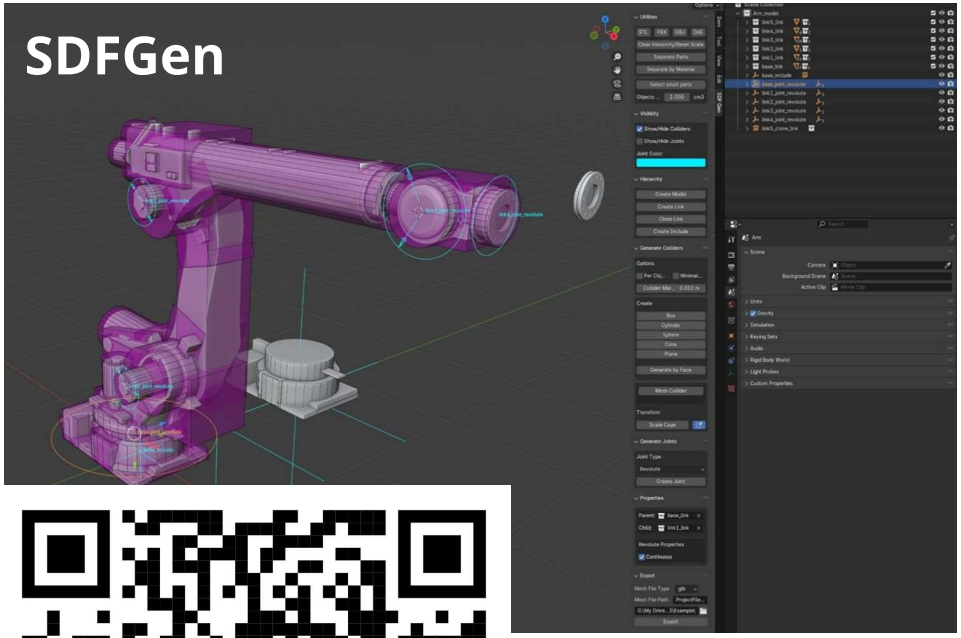
CAD data
(e.g. STEP)



SDF

https://github.com/andreasBihlmaier/FusionSDF

SDFGen



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