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OpenSCAD Batch Exporter: Automating Parametric Design Workflows for Research and Engineering

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Summary

The OpenSCAD Batch Exporter is an open-source tool designed to automate the generation of STL models using parametric designs in OpenSCAD. By leveraging parameter files in CSV or JSON format, the tool simplifies the creation of multiple design variations, making it invaluable for research, prototyping, and engineering. Users can rapidly generate tailored design sets with ease, allowing accelerating and enabling novel workflows for applications such as experimental analysis, mass customization, and combinatorial design testing.

This tool addresses critical pain points in research and engineering workflows, such as the need to manually create or export designs from code-based CAD systems. By offering batch exporting capabilities, it supports efficient testing and analysis, promotes the use of parametric models in low-resource environments, and reduces bandwidth requirements by allowing compact script distribution instead of large 3D model files.

Inspired by community contributions and existing batch exporting tools, this project provides a polished and user-friendly solution, bridging gaps in usability and scalability within the OpenSCAD ecosystem.

Statement of Need

Parametric design tools like OpenSCAD enable researchers and engineers to create highly customizable computational 3D models. However, exporting multiple designs based on varied parameter sets can be time-consuming and error-prone. The OpenSCAD Batch Exporter automates this process, enabling rapid generation of design variants, which is critical for:

1. **Research Applications**:
   - Supports iterative experimental setups, such as those used in agrivoltaics (Pearce, 2021), chemical synthesis (Hou et al., 2021), electronic components (Brooks et al., 2023), scientific hardware (Hietanen et al., 2018; LeSuer et al., 2018), medical devices (Gallup et al., 2020; S. Oberloier et al., 2022; Petsiuk et al., 2020), manufacturing (Beeker et al., 2018) and hardware prototyping (Shane Oberloier & Pearce, 2018).
   - Allows researchers to optimize designs by testing numerous parameter variations without manual intervention.
2. **Mass Customization and Low-Resource Settings**:
   - Facilitates the distribution of compact scripts that can generate large design libraries, reducing storage and bandwidth requirements. This is especially beneficial for researchers in low-resource environments.
   - Promotes distributed manufacturing and parametric design practices (Machado et al., 2019).

3. **Ease of Use**:
   - Provides a straightforward interface for non-experts, allowing users to interact with pre-made parameter sets without coding knowledge.
   - Bridges the gap between OpenSCAD's code-based environment and accessible design workflows for scientific and engineering applications.

This tool significantly extends the usability of OpenSCAD, making it easier for researchers, engineers, educators, and makers to integrate data-driven design into their workflows.

Functionality

The OpenSCAD Batch Exporter allows users to:

- **Batch Export**: Supports exporting STL files in ASCII or binary format using parameter files in CSV or JSON format.
- **Selection Options**: Allows users to target specific parameter sets for export using a flexible selection syntax.
- **Format Conversion**: Includes utilities for converting between CSV and JSON parameter files.
- **Graphical User Interface (GUI)**: Simplifies usage for non-technical users, while retaining a command-line interface for advanced workflows.
- **Cross-Platform Compatibility**: Works on systems where OpenSCAD is installed, leveraging its command-line capabilities.

A command-line interface and an intuitive graphical user interface (GUI) make the tool adaptable for users of varying expertise levels. As illustrated in Figure Figure 1, the OpenSCAD Batch Exporter GUI provides an intuitive interface for configuring batch exports. Users can select the OpenSCAD file, parameter file, and output directory, and specify export settings.

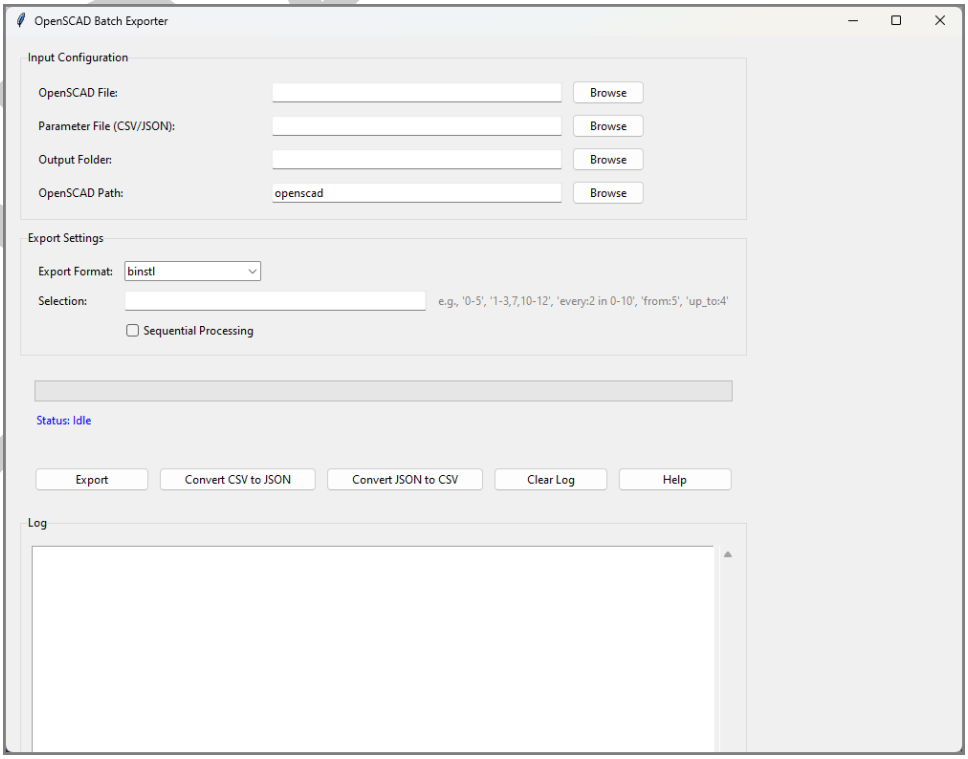

Figure 1: The OpenSCAD Batch Exporter GUI in idle state.

During the export process, users can monitor progress and view logs, as shown in Figure Figure 2.

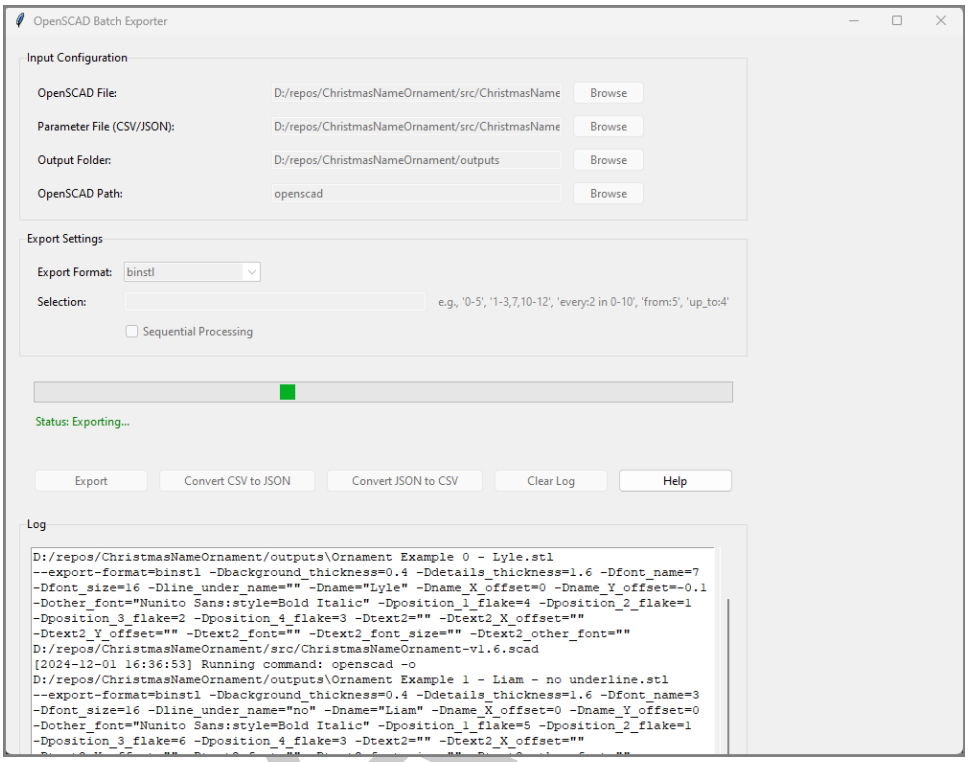

Figure 2: Configuring batch export parameters and monitoring progress in the GUI.

After the batch export completes, the generated STL files can be accessed, exemplified in Figure Figure 3.

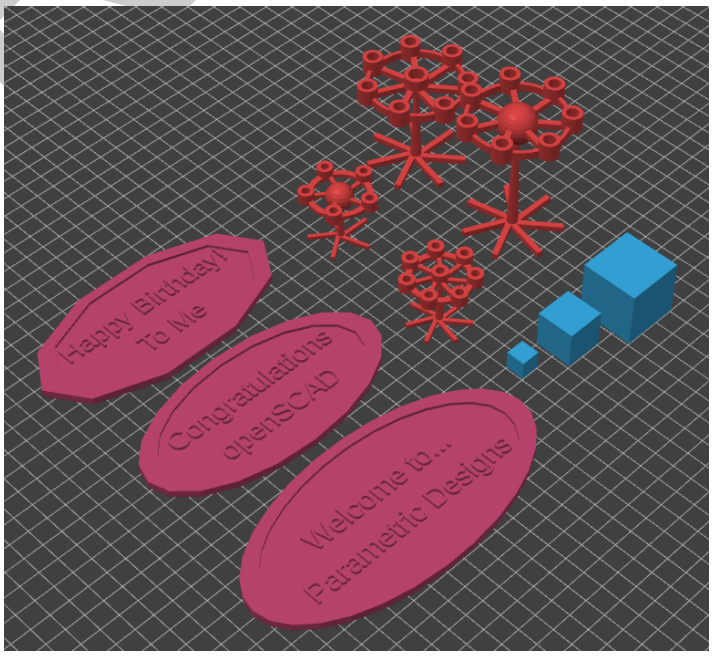

Figure 3: Examples of generated STL outputs from batch exporting.

The OpenSCAD Batch Exporter was validated for large-scale operations using the Gridfinity storage system rebuilt in OpenSCAD (Kenneth, 2024), generating 200 unique models to test performance and reliability under high-demand workloads. The resulting STL models were visualized and analyzed in Blender, as shown in Figure Figure 4.

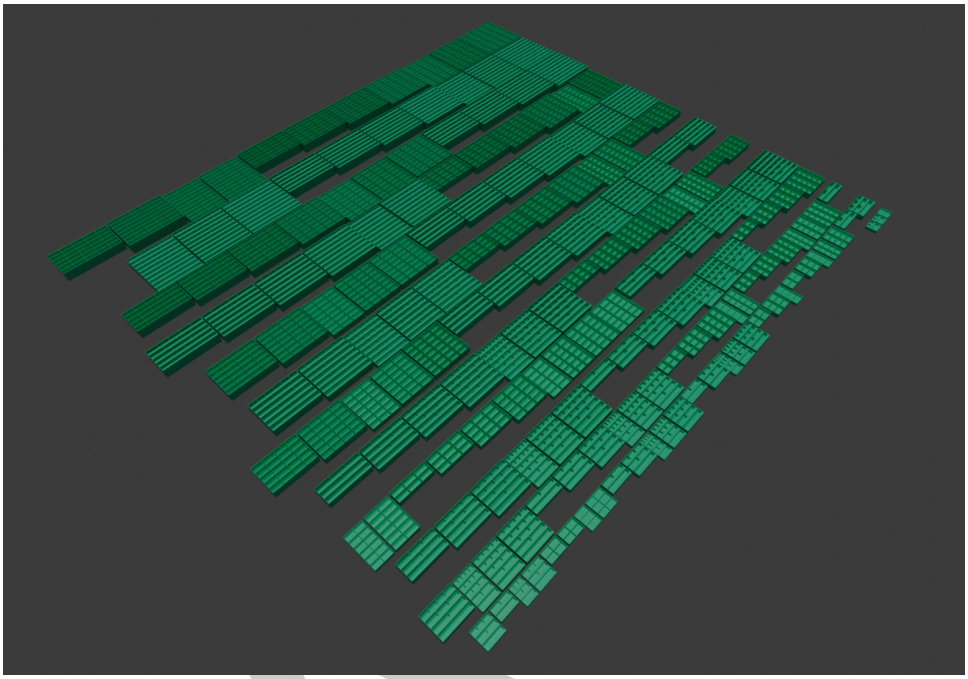

Figure 4: Visualization of 200 Gridfinity models generated using the OpenSCAD Batch Exporter.

This entire development and testing process was conducted using the latest stable release, OpenSCAD 2021.01 (OpenSCAD, 2021).

Related Work

This tool builds on efforts by the OpenSCAD community to streamline batch exporting ("Multi File Export," 2020; "Using Batch Files and OpenSCAD to Generate STL's," 2018). It integrates and improves upon existing approaches, notably:

- OpenSCAD Batch Export STL
- OpenSCAD Bulk Export

Unlike prior methods and tools, the presented OpenSCAD Batch Exporter offers a complete and user-friendly package, with added functionality for parametric design workflows, broader compatibility, and robust documentation. It is currently being used for an ongoing research project called SnapTessSCAD (Brooks, 2024), a complex OpenSCAD-based design program for computational design of 3D-printable interlocking connectors, validating the robustness and utility of the OpenSCAD Batch Exporter program.

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References

Beeker, L. Y., Pringle, A. M., & Pearce, J. M. (2018). Open-source parametric 3-D printed slot die system for thin film semiconductor processing. *Additive Manufacturing*, *20*, 90–100. https://doi.org/10.1016/j.addma.2017.12.004

Brooks, C. K. (2024). Uwo-fast/SnapTessSCAD. In *GitHub*. https://github.com/uwo-fast/SnapTessSCAD

Brooks, C. K., Peplinski, J. E., & Pearce, J. M. (2023). Overcoming Chip Shortages: Low-Cost Open-Source Parametric 3-D Printable Solderless SOIC to DIP Breakout Adapters. *Inventions*, *8*(2), 61. https://doi.org/10.3390/inventions8020061

Gallup, N., Pringle, A. M., Oberloier, S., Tanikella, N. G., & Pearce, J. M. (2020). Parametric nasopharyngeal swab for sampling COVID-19 and other respiratory viruses: Open source design, SLA 3-D printing and UV curing system. *HardwareX*, *8*. https://doi.org/10.1016/j.ohx.2020.e00135

Hietanen, I., Heikkinen, I. T. S., Savin, H., & Pearce, J. M. (2018). Approaches to open source 3-D printable probe positioners and micromanipulators for probe stations. *HardwareX*, *4*. https://doi.org/10.1016/j.ohx.2018.e00042

Hou, W., Bubliauskas, A., Kitson, P. J., Francoia, J.-P., Powell-Davies, H., Gutierrez, J. M. P., Frei, P., Manzano, J. S., & Cronin, L. (2021). Automatic Generation of 3D-Printed Reactionware for Chemical Synthesis Digitization using ChemSCAD. *ACS Central Science*, *7*(2), 212–218. https://doi.org/10.1021/acscentsci.0c01354

Kenneth. (2024). *Kennetek/gridfinity-rebuilt-openscad*. https://github.com/kennetek/gridfinity-rebuilt-openscad

LeSuer, R. J., Osgood, K. L., Stelnicki, K. E., & Mendez, J. L. (2018). OMIS: The Open Millifluidic Inquiry System for small scale chemical synthesis and analysis. *HardwareX*, *4*. https://doi.org/10.1016/j.ohx.2018.e00038

Machado, F., Malpica, N., & Borromeo, S. (2019). Parametric CAD modeling for open source scientific hardware: Comparing OpenSCAD and FreeCAD Python scripts. *PLOS ONE*, *14*(12), e0225795. https://doi.org/10.1371/journal.pone.0225795

Multi File export. (2020). In *GitHub*. https://github.com/openscad/openscad/wiki/Multi-File-export

Oberloier, S., Gallup, N., & Pearce, J. M. (2022). Overcoming supply disruptions during pandemics by utilizing found hardware for open source gentle ventilation. *HardwareX*, *11*. https://doi.org/10.1016/j.ohx.2021.e00255

Oberloier, Shane, & Pearce, J. M. (2018). General Design Procedure for Free and Open-Source Hardware for Scientific Equipment. *Designs*, *2*(1), 2. https://doi.org/10.3390/designs2010002

OpenSCAD. (2021). *Openscad/openscad*. openscad. https://github.com/openscad/openscad

Pearce, J. M. (2021). Parametric Open Source Cold-Frame Agrivoltaic Systems. *Inventions*, *6*(4), 71. https://doi.org/10.3390/inventions6040071

Petsiuk, A., Tanikella, N. G., Dertinger, S., Pringle, A., Oberloier, S., & Pearce, J. M. (2020). Partially RepRapable automated open source bag valve mask-based ventilator. *HardwareX*, *8*. https://doi.org/10.1016/j.ohx.2020.e00131

Using batch files and OpenSCAD to generate STL's. (2018). In *3D Printing Forum - Pinshape*. https://forums.pinshape.com/t/using-batch-files-and-openscad-to-generate-stls/2157