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13th March 2017

Version

Background

Technology Demonstrator is a major deliverable of the Embedding Design Structures in Engineering Information project, a Design The Future project funded by Engineering and Physical Sciences Research Council (grant reference EP/N005694/1).

Structure Embedding version 4 (StrEmbed-4) is a part of the Technology Demonstrator. This prototype software demonstrates the findings of the project and the feasibility of its implementation for practical use. StrEmbed-4 uses data set of the cases studies defined in the Technology Demonstrator to demonstrate key findings of the project. Alternatively, user data in the form of STEP AP214\* can also be used. STEP AP214 is a popular vendor neutral data exchange format for computer-aided systems. (\*Standard for the Exchange of Product model data Application Protocol 214, ISO 10303-214)

This paper defines a functional specification for StrEmbed-4.

Specification

Open file

1. To read assembly files in STEP AP214 format that are generated by CAD systems. STEP files exported via SolidWorks 2016 were used for testing. Input STEP files are located at ../step\_data/input by default.

**Assembly tree**

1. To visualise graphically an assembly structure in two forms, an assembly tree and a Hasse diagram, entries of the former and the elements of the later are linked.
2. To display an assembly structure as a collapsible tree. Each individual part is an indivisible atom for the purpose of interrogating an assembly structure. A collapsed sub-assembly on the tree is also considered as an indivisible atom as long as it is not expanded.

**Hasse diagram**

1. To display an assembly structure as a Hasse diagram. A shadow hypercube lattice could be shown in the background to represent all possibly assembly structures for a given number of atoms (parts or collapsed sub-assemblies). To show graphically that the Hasse diagram is embedded onto the corresponding hypercube lattice.

**Extraction of information of an assembly structure**

1. To highlight a part or a sub-assembly by moving a cursor over corresponding graphical item in the Hasse diagram. Simultaneously the corresponding part or sub-assembly at the assembly tree will be highlight. It is optional to show information related to a selected entity.
2. To show the feasibility of relating nodes of a Hasse diagram and items of an assembly tree to a pre-processed image that shows the geometries of a product, in this case a robot arm. A potential extension of this approach is to use OpenGL or VRML or equivalent to visualise a product in real-time instead of using a pre-processed image.

**Modification of assembly structure**

1. To modify an assembly tree to support another stage of product life cycle. For example, if an input product structure represents a product as-design, modified assembly structures could represent the product as-built, as-ship, or as-maintain, etc.
2. Specifically, to afford a user interface allowing modification of an assembly structure that operates on the assembly tree. It is anticipated that different product structures are not entirely different from one another, but it could be morphed from one to another with a small number of changes.

**Save file**

1. To save a modified assembly structure as a STEP AP214 which is readable by CAD systems. Output STEP files were imported and tested using using SolidWorks 2016. Output STEP files are saved at ../step\_data/output by default.

**User interface**

1. To afford basic user expectation of a typical pull down menu driven graphical user interface, including open and save files at locations of users’ choices, usage instructions and help, progress indicators and messages if appropriate, graceful exception handling and error messages.