Detection of Symmetry and Primary Axes in Support of Proactive Design for Assembly

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ABSTRACT

Assembly-oriented CAD has long been accepted as a necessary development from the current component-focused solid modelling systems. It is proposed that such an environment should incorporate assembly sequence generation and Design for Assembly (DFA) analyses to assist the designer, including some automatic inference to facilitate ease of use.

The key to enabling the various assembly analyses lies in interrogation of the CAD model and this poses some interesting challenges in the field of geometric reasoning. Statistics from case studies show that the identification of symmetry and primary axes is fundamental to many of the required geometric reasoning algorithms which have been identified. In particular, the determination of the major and minor axes of each component is necessary for the definition and evaluation of manufacturing complexity, feeding, gripping and insertion trajectories. The cross-sectional properties parallel and perpendicular to these primary axes can be used to validate the feasibility of the assembly sequence and for determination of other component attributes. Detection of both exact and partial symmetries associated with these axes can provide a useful means of evaluation of practical assembly issues such as component orientation.

This paper extends the recent review by Martin and Dutta of methods for symmetry detection. However, no pre-existing method suitable for this application is found and so a new technique is proposed which exploits the existence of loops within the CAD model. This entails the comparison of loop areas to discover exact symmetry, partial symmetry and repeated features. A preliminary implementation of this technique is described and in conclusion the benefits and problems associated with it are discussed.

Keywords: DFA, Symmetry, Assembly-Oriented CAD, Geometric Reasoning, Design Methodology