



A CONSTRAINT-BASED METHODOLOGY FOR PRODUCT DESIGN WITH VIRTUAL REALITY

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ABSTRACT—This paper presents a constraint-based methodology for product design with advanced virtual reality technologies. A hierarchically structured and constraint-based data model is developed to support product design from features to parts and further to assemblies in a VR environment. Product design in the VR environment is performed in an intuitive manner through precise constraint-based manipulations. Constraint-based manipulations are accompanied with automatic constraint recognition and precise constraint satisfaction to establish constraints between objects, and are further realized by allowable motions for precise 3D interactions in the VR environment. The allowable motions are represented as a mathematical matrix and derived from constraints between objects by constraint solving. A procedure-based degrees-of-freedom combination approach is presented for 3D constraint solving. A rule-based constraint recognition engine is developed for both constraint-based manipulations and implicitly incorporating constraints into the VR environment. An intuitive method is presented for recognizing pairs of mating features between assembly components. Examples are presented to demonstrate the efficacy of the proposed methodology.

Key Words: virtual reality, product design, model representation, constraint-based manipulation, allowable motions, constraint recognition and constraint solving