3D Manufacturing Primitive CAD-Based Object Recognition

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ABSTRACT

This paper describes a 3-D recognition system for objects designed with a manufacturing primitive-based CAD. Within the recognition system, objects are modelled as organized compositions of instantiated manufacturing primitives. Since these primitives have a higher semantic level than the traditional entities used in object modeling (surfaces, edges, and so on), the burden of recognition is shifted from matching the scene to the objects database to matching the scene to the primitives database, which is usually significantly smaller. Consequently, set up time is reduced while recognition is faster. The paper reviews our approach to primitive and object modeling, primitive indexing, and pose estimation.

1. Introduction

The growing interest in concurrent engineering and its related areas has made an impact on the philosophy of object recognition for manufacturing. This is so because it has become apparent that vision systems for assembly and inspection can be constructed faster and maintained more efficiently by exploiting the geometry rich CAD models of the parts being manufactured [1, 2].

This paper presents an ongoing research effort to develop a 3-D object recognition system for parts designed with a *manufacturing primitive-based* CAD, a type of CAD system which preserves design intent throughout the different phases of manufacturing, thus reducing costs and lead time [3, 4, 5].

The heart of the approach resides in modeling objects as collections of inter-related manufacturing primitives. This allows the main object recognition task to be broken down into less stringent ones of primitive identification, instantiation, and pose estimation, followed by the actual object model indexing.

In section 2, we present the primitives currently supported by the recognition system, and describe our modeling schemes for both manufacturing primitives and objects. Primitive hypotheses generation is briefly described in Section 3, while verification and geometric instantiation are explained in Section 4. Primitive pose estimation is presented in Section 5. Finally, work-in-progress on part model indexing and pose estimation is presented in Section 6, with conclusions in Section 7.

2. 3D Primitive and Part Modeling

In this research, objects are modeled as set of instantiated manufacturing primitives. This section presents the schemes used to represent both the primitives and the parts constructed with them.

2.1. Manufacturing Primitives

Primitive representation is examined in the context of a reduced set of manufacturing primitives shown in Figure 1.

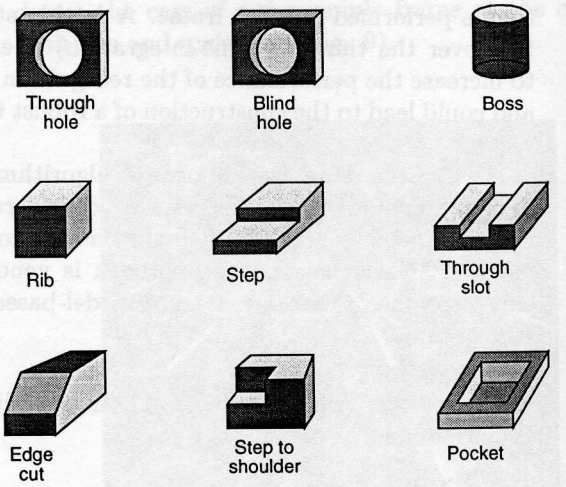

FIGURE 1. The CAD manufacturing primitives.

Nine manufacturing primitives were chosen: through hole, blind hole, boss, rib, through slot, step, step-to-shoulder, pocket, and edge cut. Their variety is sufficient for designing a substantial number of different parts, thus validating recognition methodology; nevertheless, they