ELEMENTS OF AGILITY IN MANUFACTURING

by

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Abstract

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Smaller lot sizes, shorter times to market, and lower manufacturing costs are typical requirements of a modern manufacturing facility. Under such constraints, agile manufacturing systems are desirable. Elements of such a system include multiple robots, flexible parts feeders, modular conveyors, and machine vision.

Flexible feeders enable a workcell to rapidly switch between different assemblies by eliminating the need for part-specific feed mechanisms. A flexible feeder, consisting of multiple conveyors to singulate parts, a vision system for pose determination, and a robot for part retrieval, was designed, implemented, and incorporated into an agile workcell. The system was shown to feed a wide variety of parts with little physical alteration at rates of up to 30 parts per minute. A new metric to describe feeder throughput was developed and a statistical analysis of feeder test results was conducted.

In most assemblies there are operations which cannot easily be performed by a robot. In such cases, a method of encapsulating assembly-specific hardware to enable rapid changeover is required. Such a method may be constructed using homogeneous transforms (also called tool offsets), however, the transforms must be

defined correctly or reconfigurability will be difficult. Transforms are divided into two categories: those that describe the workcell and those that describe the assembly-specific hardware. To determine the utility of this approach, transforms for an example task were determined at one workcell and shown to be functional at a second workcell.

The design of the robotic end effectors and the parts used in each assembly are important to ensure a productive, error-free system. Appropriate gripper design can accommodate the additional sources of error in an agile workcell, such as those inherent in vision calibration and in robots. Proper parts design can improve flexible feeding (stable rest configurations consistent with assembly and features that enable simple vision recognition) and increase the reliability of assembly actions. Therefore, guidelines have been established to assist in the intelligent design of grippers and parts. Many gripper designs are examined and the redesign of an example assembly is performed to demonstrate the application of the guidelines.

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