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PRODUCT ASSEMBLY PLANNING USING AI TECHNOLOGIES

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ABSTRACT

Assembly connects product components to ensure the product functions in operations. An effective assembly plan can improve manufacturing productivity and save maintenance cost in the product life time. Planning for product assembly has been widely discussed in academia and industry. Although different methods and solutions have been proposed for product assembly planning, most of them only consider the product assembly in processing sequences without including operations of positioning and fastening components and space accessibility. Design for assembly is mainly for feasible structures of product assembly in the product design stage. Robotic systems are used in product assembly operations, but they are only applied in some specific applications such as the mass production of automobile assemblies.

This talk introduces problems and methods in product assembly planning. Artificial Intelligent (AI) technologies are discussed to search the optimal solution. Different AI methods are compared for product assembly planning considering the operation sequence, fastener operation, space accessibility and tool feasibility. For example, although Artificial Neural Networks (ANNs) can automatically learn and generalize solutions without explicit programming, it is difficult to build an ANNs model for guiding an evolutionary search with various amounts and types of product data as it requires large volumes of quality training datasets. Reinforcement learning (RL) learns things like humans and animals in a reward-orientated process from interactions with environments. RL uses trial-and-error to maximize the reward. Data sets for RL training provide only indications to guide the system to search actions. RL is expected to be able to "observe" data, analyze data and generate knowledge to assist with the knowledge generation and minimum information requirements in product assembly planning and operations.

Therefore, a RL method is introduced to enable automatic assembly operations for improving efficiency and accuracy of the product assembly. A representation method of the product assembly is proposed to build the RL model. The automatic assembly of product operations is planned by RL agents. Constraints of assembly operations are considered to develop searching strategies of the maximum reward for the optimal solution of assembly operations. Different actions and reward settings are searched to find the best action and reward to achieve the shortest time for component connections in product assembly. The solution evaluation and industrial applications are also introduced.

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