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INVESTIGATION OF DYNAMIC AND CONTROL OF ROBOTS' COOPERATION IN ASSEMBLING PROCESS

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ABSTRACT

Assembling and fitting parts together can be considered as one of the most practical but also challenging process in robotics. Various applications are conceivable such as spatial ones where accessibility is reduced or in construction fields where huge forces have to be dealt with in a meticulous manner. In this paper, the cooperation of two robots during the complete assembling process of two structural parts from the approaching phase to the fitting stage is investigated. In the approaching phase for taking the parts closer, the two large construction parts may collide due to the inertia of motion, causing considerable impact forces even with the slightest relative velocity. This issue presents important control challenges as the effects of this local impact may be transferred throughout the system's frame, affecting all other elements and inducing instability. Finally after connection of these two parts is established, the whole frame is transported to any desired location by cooperative operation of the two robots. Each step requires a particular controller to deal with different system's dynamics that occur during the whole process.

INTRODUCTION

In recent years, robotic activities have found many applications, especially in replacing human beings on tasks considered as very dangerous or expensive. Assembling or putting parts to fit into each other in order to form a whole unit is one of the most applicable and significant robotic activities that involve many complex interactions between sensors and actuators. In addition to the extensive applications in industries for manufacturing multi-components heavy products or in building structures that are combined in situ, the process can also apply to spatial situations. One can address the construction of Large Space Structures[1] such as space telescopes or also the deployment of solar power stations in space, only to enumerate a few. Typically, these structures have very large dimensions and therefore are made of multi components to be assembled once gathered in place. In the past, complete structures were assembled on earth and then sent to space which caused weight and dimension restrictions on them ([1] to [4]). More recently, directly assembling such structures in space has been considered as an alternative to resolve this issue and several studies in this field have been done to realize and consider its feasibility ([5] to [8]). However, interpreting and analyzing different phases of assembling process has not been studied in a systematic way.
An assembling process consists of four different phases:
1. Bringing the individual structures close to each other.
2. Conducting them to superpose at a common hinge.
3. Stabilizing the connected structures against the impact of collision and 4. Transferring the assembled structure to a desired location.

Carrying and handling a structure by two cooperative robots has been extensively studied under different control aspects

[1] - LSS