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Collision-Aware Assembly Planning.

Report Topic

The title of the report is germane to the topic chosen. However, Collision-Aware Assembly Planning can be vague without previous knowledge about what Assembly Planning can mean so something in the lines of "Collision-Aware approaches to Manufacturing Assembly Planning" would have been optimal since it provides applicable information before reading the report. The abstract of the report provides clear goals tried to achieve in the report and provides the reader with the information about the project, which is the inclusion of collision-aware end effector tool to a robotic arm manipulator to upgrade the present approach to assembly process in manufacturing.

Motivation

The report begins with the motivation behind the team's work on choosing the topic of assembly planning. Their idea is quite novel to the present day approaches and amplifies the importance of manufacturing assembly process in a country's economy highlights the significance of the topic they have chosen. They also provide the information about the current process of using a precedence graphs and how they feel that augmenting collision aware process into the existing system. There is also a statement about the team's approach to assembly planning, which includes motion planning and collision aware part sequence planning allows them to prove that certain tasks in the current system of a relationship precedence graph inadmissible. The team elaborated their approach of improving the assembly planning by combining a traditional manipulator motion planning to a collision-aware part sequence planning. Certain goals were stated in this section where they stated that the plans are generated through the algorithm they have worked on accounts for collisions in an on going assembly progress. There are also details about implementation of their designed algorithm on an OMPL (The Open Motion Planning Library) simulation of an assembling simple LEGO model to prove their concept.

Theoretical and Research Perspectives

A good assembly-planning algorithm can definitely increase the efficiency and quality by decreasing the cost time of the whole product manufacturing process. This is really important as the production demand changes rapidly in the present day market. The Assembly Sequence Planning (ASP) has been noted as a very important step in present day manufacturing processes and the report deals with identifying the present day researches on this topic. The report provides adequacies of research articles, which deal with different forms of ASP such as geometric constraints, automated assembly process planning (AAPP) and grasp planning. The paper provides the perfect platform to allow understand what are the current research arenas in respect to Assembly-Planning. Further, clearly allowing the reader to understand the importance of their topic choice, which is augmenting the precedence graph with collision-aware end effector tool to trim inadmissible tasks in the precedence graph making the manufacturing more efficient. However improvements can be definitely made as the explanations on the researches

provided assume certain level of knowledge from the reader. Elaboration of the topics would have been better as the reader can understand better. Also a section which includes the motivation of the usage/improvement of current theoretical and research perspective would have been better as it can allow the reader to understand the real intuition behind the usage.

Theoretical and Research Applications

To achieve the set goal of removing the inadmissible tasks in the precedence graph, the team has implemented some of the research works. The classical planning algorithm used to obtain the actions performed by the end effector tool/robot arm is done through an implementation of partially ordered planning. The report discusses a Partially Ordered Planning to be a method, which produces generalized steps, such as translation of the end effector, rotation of the part and usage of a sensor or a tool. They have utilized this Partially Ordered Planning mechanism to get a list of actions, which can be implemented by the robot arm. However to account for the collisions a total-order plan is derived from the partially ordered plan using classical planning. The algorithm the team has provided for the classical planning part of the assignment uses an extra variable to detect whether the grasping at a certain position would effect the collision of the already placed assembled product. Finally the team has evaluated the classical planner by implementing a LEGO simulation model using a Flexible Collision Library in the motion planner. The classical planner results a fully ordered set of actions to be taken with an index of the grasp type at the end of each action to take care of collision. This implementation of theoretical and research methods to simulate the hypothesis in the report can adequately justify their presentation.

Technical Aspects and Experimental Evidence

The report provides a collection of existing research techniques in the field of Assembly Planning and implemented a few of the techniques, which help the team to achieve their goal of improving the present day assembly-planning. The experiment conducted in the report is a simulation of an arm with a collision- aware end effector tool assembling a LEGO model. The report has provided their experimental procedure of simulation by producing a collection of actions produced by a classical planner and then running it using an existing motion planner OMPL. The evidence of the experimental success is sufficient in the report as multiple screenshots of the KUKA KR5sixxR650WP arm with SCHUNK PG70 gripper simulation executing the list of actions created by the classical planner. Also the report provides the code repositories and videos showing the simulation of the experiment. Even though there is enough technical information to confirm the correctness of the experiment, cross validation using different models and the performance of the code inclusion would have added better feedback about the improvement in general. Usage of different motion planners other than OMPL such as SBPL (Search-Based Planning Lab) would have been better as the results could be compared for a better context. Overall I felt like the report is sufficient in terms of results, however different evaluation metrics to identify the efficiency of the assembly planning could have been introduced to get a better context of the progress made by this report.

Things Learned

This report does not really reflect about what have been learned about Assembly Sequence Planning over the process of development. A brief description about the potential future plans was provided, however the conclusion could have been expanded to relate and reflect about the learning through the process of this research project.

Document Analysis

Organization

The report is very well organized in terms of logically providing information about the project. From the introduction to the conclusion the report was written in a funnel approach of introducing the reader with a large problem and provided the approach they have taken to solve the problem. The report does a great job of providing different approaches used to solve the problem stated in the beginning and then clearly state the path taken to solve the problem and ends it with relevant evidence and results. The organization of the paper is done very well, however there lacks a certain level of connection between the different sections, to be specific section II and III can be improved by relating the reasoning and effect on each other.

Readability

The report has done a good job in terms of the readability. Other than lacking certain elaborations in section II, the report does a decent job of conveying the importance of the approach taken by the team. There are no grammar related errors, which affected the report's readability. I personally would have preferred an APA format of citing research articles, where the author is credited instead of having a [#]. Other than these minor changes, the report is quite well done.

Abstract

The abstract of the report has a very concise summary of the entire report. It contains the main idea developed in the report with the result of a successful simulation. However a sentence in the beginning giving the importance of Assembly Planning would have been perfect as it would have been cohesive in terms of a quick summary of the report. The abstract clearly summarizes the entire report and set a great scope for the rest of the report.

Introduction

Introduction/Motivation section was very well developed and provided a great overview of the project. It introduced the reader to the topic in a very efficient manner by catching the reader's attention. The problem of improving the efficiency of Assembly Planning is clearly stated and highlighted, therefore allowing the report to give the prospective

solution by adding Collision Awareness. The related works section helps the reader to get background information about the current research going on in the field of Assembly Planning.

Figures and Screenshots

The figures provide a clear evidence of the experiment conducted. The figures are placed in strategic places to get the attention of the reader and imbue a sense of anticipation while reading the report. On page 4 the figures could have been arranged better, in the left column. The captions of the figures do a sufficient job of being explanatory because they have the information stated in a very brief sense. Since the positioning of the figure is optimal the user has an understanding about the figure and the caption provides better feedback.

Conclusion

The conclusion is very concise and to the point. The significance and the summary of the project have been provided with enough information about the results. It also provides the path to be taken to develop this project even further. However the conclusion lacks the reflection of the things learned overall.

Bibliography/Reference

The report has ideal amount of references listed that helped develop the project. The team has done an admirable job researching on approaches of Assembly Planning before providing a solution, which was reflected in the report's Related Work section.

Comments

The report has done a great job in providing a problem and solution in the scant timeline provided. The research topic of Assembly Planning is quite interesting as it is a very good implementation of robots in the real world. The research done by the team is commendable as it provides a reader with no previous understanding of Assembly Planning know the importance of it. The objectives were clearly stated and the report was developed logically to complement the motivation behind it. There are a few things which can be further developed, such as elaboration of the current research perspectives of Assembly Planning, motivation behind the intuition of using Collision-Awareness, secondary plans to implement if something fails (i.e. planners), cross validation with different motion planners and finally better evaluation metrics measuring the performance of the Assembly Planner. I personally think the evaluation could have been better and the results could have included statistical information backing the improvement or comparative results. Overall, the team has done a great job and it was enjoyable reading the report.