Graphical Instruction for A Garment Folding Robot

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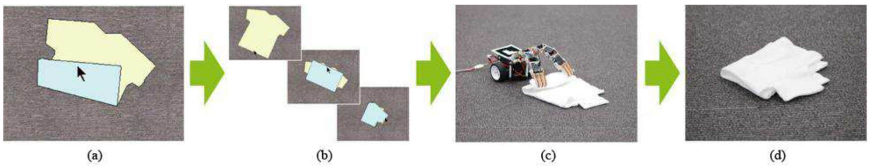

Figure 1: *Teaching how to fold a T-shirt by means of graphical editing. The user folds the T-shirt on the computer via simple dragging operations (a, b). The robot then performs the task in the real world (c, d).*

1 Introduction

This project proposes to use interactive graphical editing interface for an end user to give instructions to intelligent robots to complete a real world object manipulation task. Natural language is often considered as an ideal communication method for robots, but it not intuitive at specifying tasks that require visual (geometry) information. Learning from demonstration can be useful, but it is not easy to generalize a provided example into a working program. Our approach is to provide a specialized graphical editor that abstracts the target task and to have the user specify how to complete the task by performing simple editing operations (clicking and dragging). We show the effectiveness of our approach by building and testing an example application based on this concept, which is a graphical editor for teaching garment folding to a robot. This example shows that our approach is particularly effective for an end user to configure the robot behavior to satisfy their own needs, which cannot be covered by a single, pre-programmed solution for general audience.

2 Exposition

We propose to use custom-made graphical editor to give instructions to the robot. The system provides a graphical representation that abstracts the essence of target task and the user edits the graphical representation using direct manipulation (click and drag) (Figure1). This approach is much more effective than using a natural language for tasks that involves visual information and is much more reliable than having the system inferring the procedure from a demonstration. We envision that our approach makes intelligent robots much more accessible for end users than they are now.

We introduce an example prototype system to demonstrate the effectiveness of the proposed approach, which is garment folding. In garment folding, the user first captures the shape of a given garment into a computer and folds the captured virtual garment on the computer by simple click and drag operations. The resulting operation sequence is then transferred to a real folding robot and the robot performs the task according to the instruction. The system continuously monitors the progress of the folding process using a ceiling mounted camera and sends appropriate control commands to the robot by comparing the current real world configuration and the configurations in the virtual folding procedure.

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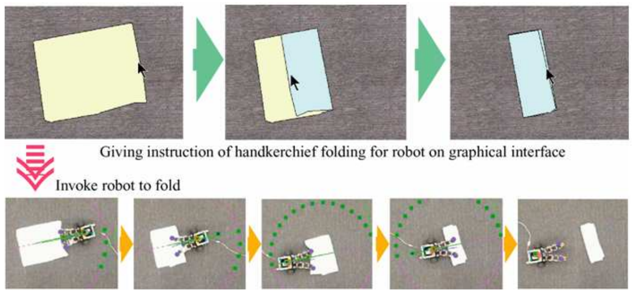

Figure 2: *The result of giving folding instruction for handkerchief and T-shirt.*

3 Conclusion

Our contribution is summarized as follows. 1) We propose to use interactive graphical editing as a communication method for the user to teach how to perform a task. This method has various advantages over typical methods such as conventional programming, natural languages, and programming by demonstration. 2) We describe a working prototype system that shows the feasibility of the concept. Although it is crude prototype, implementation detail will be useful for implementing more robust practical system in the future. 3) The main technical contribution is in the way we design the graphical interaction. It is not literal simulation of the target task or completely abstract geometric editing. It appropriately abstracts the essence of the target task providing easy control while hiding the low-level control system details.

Teaching is fun and watching the result of successful teaching is a fulfilling experience. The success of our experiment shows that this applies not only to people and pets, but also to robots. The user feels more intimacy and confidence with robots that follow his or her instruction than those works without user intervention at all. Previous as-automatic-as-possible approach to robot control lacks this point of view, which we believe that is one of the reasons behind limited adoption of robot technology in daily life. We hope that our work inspires more work in this direction.

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