Human-Robot Interaction System for Non-Expert Users to Create and Debug Robot Behaviors Using Visual Programming

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Abstract

This dissertation proposes a robot behavior creator, a robot simulator, and debugging features to focus on developing a Human-Robot Interaction system for non-expert users. As a problematic consequence of an aging society with increasing labor shortage, there is a need for service robots to efficiently support work in many places, such as convenience stores. Especially for non-expert users (e.g., shop staff) who do not understand a robotic system, it is challenging for them to create desired robot behaviors. This requires a tool to enable non-expert users to create and fix issues in robot behavior programs.

The proposed system provides a robot behavior creator that allows non-expert users to use drag-and-drop composition for creating the robot behavior programs and testing them in a simulated environment. It consists of two features: (i) a graphical user interface using Behavior Trees; and (ii) a robot simulator. The results with ten subjects show that non-expert users can create and fix robot behaviors based on the given situations. According to the System Usability Scale (SUS), the proposed system has a good usability level.

The proposed system also provides four debugging features: (i) breakpoints; (ii) monitor node execution; (iii) log node status; and (iv) show robot status variables; for the robot behavior programming. These features allow non-expert users to identify and fix issues in the system. The experimental results show that 14 non-expert users could not utilize the breakpoints. Based on the interview with non-expert users, the concept of breakpoints is not easy to understand and use for creating a program. According to the SUS, the proposed system has a high marginal usability level.

The main contributions of the proposed system are threefold. First, non-expert users can create robot behavior programs without writing a program. Second, non-expert users can visually test the robot in the simulator. Third, non-expert users can debug the robot behavior programs based on the proposed four features.