Evaluating Child-Robot Interaction in Public Environments

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1 Project Description

Research and commercial robots have infiltrated homes, hospitals and schools, becoming attractive and proving impactful for children's healthcare, therapy, edutainment, and other applications. The focus of this work is to investigate a little explored issue of how children's perception of the robot changes with age, and thus to create such a robot to adapt to these differences. In particular, this research investigates the impact of gender typing on children interactions with a humanoid NAO robot. To this end, a series of experiments were conducted with children aged between 5 and 12 years old at primary schools in Dublin. The results suggest that children relate differently towards robot's perceived gender across age and gender groups and support the trends in gender development in child-robot interaction.

In order to dynamically adapt to children's age and gender, a perception module was developed utilizing the Microsoft Kinect and a collected depth dataset of 3D body metrics of 428 children aged between 5 and 18 years old. This module is able to successfully determine children's gender with 99% accuracy and estimate children's age with an mean error of only 0.94 years. Additionally, a pretend play testbed was designed in order to address the challenges of evaluating child-robot interaction by exploiting the advantages of ubiquitous robotics and ambient intelligence of multimodal, multi-sensory perception. The pretend play testbed performed successfully at the "Imaginosity" children's museum where a humanoid NAO robot was able to dynamically adapt its gender by changing its synthesized gendered voice to match child's perceived gender. By analyzing the free play of children, the results confirm the hypotheses of gender typing within child-robot interaction. These findings are important to consider when designing robotic applications for children in order to increase robot's perceived likeability, acceptance and engagement.

2 Methods and Challenges

To shed light on the impact of child development tendency of gender typing within child-robot interaction, a large-scale study was conducted, inviting 107 children aged between 5 and 12 years old to interact with the robot over three

sessions one week apart. The robot's gendered voice was manipulated in two experimental conditions to either genuine child male or female synthesized voice. Children's choice of the robot's gender for the third encounter was then assessed. The results support the hypothesis of robot gender typing for younger children (aged less than 8 years old). However older children (9-12 years old) did not elicit gender typing in their interactions with the social robot. In contrast to children's choice, the results from subjective and behavioural measures (facial expressions, eye gaze, words spoken) adopted during the study did not support the hypothesis. This large-scale experiment provides invaluable insights into how challenging child-centered research is in terms of a well-known questionnaire's ceiling effect and extremely time-consuming video coding process.

3 Solution

Pre-existing approaches to the generation of robust and fully autonomous social robotic platform for public environments are based on the idea of a standalone robot, in which sensor input or feedback output have to substituted by WoZ control. That is, they do not consider the advantage of ubiquitous robotics and ambient intelligence of multimodal, multi-sensory perception. This work achieves social autonomy of human-robot interaction by effective integration of ubiquitous sensory knowledge into action selection resulting in a robust and fully autonomous interaction engine of the proposed testbed. This testbed has been extensively exercised in a number of public demonstrations at perceptually challenging environments and has proven to be a reliable, robust and an effective robotic system. The unprecedented quality of social autonomy as achieved by the proposed testbed thus advances the state-of-the-art by providing a more flexible and natural way to realize and evaluate HRI.

Child-robot interaction community experiences a need to develop methods that can be used to evaluate and benchmark the quality of child-robot interaction in a safe, ethical, and reliable way. This research sought to address these challenges by automating child-centered qualitative evaluation. Based on the implemented testbed and its ubiquitous perception modality, the automation of coding of qualitative and qualitative measures is achieved. The work continued with the observational study in uncontrolled natural settings of children's pretend play center, Imaginosity, with children aged between 3 and 9 years old. By autonomously perceiving child's activity with the pretend play set, the NAO robot is able to sense the interaction phase and respond accordingly. The duration of the interaction, proximity from the robot, and engagement with the pretend play furniture were automatically logged in and, when compared to manual coding of these data, performed efficiently. Finally, there is no need to record videos of interactions since the required data is logged in a text file for future processing. This work contributes with its experimental paradigm in which automating objective, subjective, and behavioral measures address the challenges of evaluating the social and cognitive outcomes of child-robot interaction.