When is it better to give up?

Towards Autonomous Action Selection for Robot Assisted ASD Therapy

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ABSTRACT

Robot Assisted Therapy (RAT) for children with ASD has found promising applications. In this paper, we outline an autonomous action selection mechanism to extend current RAT approaches. This will include the ability to revert control of the therapeutic intervention to the supervising therapist. We suggest that in order to maintain the goals of therapy, sometimes it is better if the robot gives up.

Categories and Subject Descriptors: H.1.2 [Models and Principles]: User/Machine System

Keywords: Action selection, ASD, Cognitive Robotics, RAT, Social Robotics.

1. INTRODUCTION

Recent studies estimate that around 1.1% of the population in the UK and also in other European countries have Autism Spectrum Disorders (ASD). These people typically lack social skills normally expected in human interactions. Consequently, therapies have been designed to help children with ASD to improve their social abilities; these therapies can be enhanced by using robots [5].

However, due to the complexity of social interactions involving children, the majority of existing studies use the Wizard of Oz (WoZ) technique, where the robot is not autonomous but controlled by a human. Despite the clear advantages of this method, there are a number of reasons for researchers to move away from it, such as reducing the personnel required to use the robots, or improve the consistency of therapy [3, 6].

The present work is conducted within the DREAM project: a European project which aims to develop new Robot-Enhanced Therapy. We seek to develop the therapy robot's control system to enable supervised autonomous operation. A clinician will set the therapeutic goal for the session, from which the robot should be able to decide by itself which actions to execute, under explicit supervision. Rather than maintaining autonomy, we argue that allowing the robot to revert control to the therapist when appropriate would improve both the interaction and the therapeutic outcome.

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Figure 1: The Aldebaran Nao was selected as the common robot platform, to facilitate consistency and reproducibility.

2. BACKGROUND

Different approaches of Robot Assisted Therapy (RAT) have been explored by researchers in the last two decades. In previous studies robot control was typically achieved in one of two ways: either fully tele-operated using the WoZ method, e.g. [4, 7] or fully autonomous, e.g. [1, 2]. For WoZ control, a hidden, manual manipulation of the robot allows the therapist to obtain exactly the desired behaviour and to adapt to unpredicted events. On the other hand, an autonomous robot requires lower load on a human operator and allows greater repeatability of behaviour, but requires to design a complex controller. As such, only reactive control schemes are used in prior work.

Several attempts have already been made to combine the flexibility offered by the WoZ method and the autonomy and the consistency provided by autonomous operation. However, working with children with ASD presents additional challenges: the infrastructure required to perform the experiments is more extensive, it is hard to gather a population large enough to obtain statistically valid results, therapies take place over long periods of time and, as ASD is a spectrum, the children's behaviour can be more difficult to predict than neurotypical children.

To be able to use a robot as a therapeutic tool, we use a set of interaction scripts that determine the interaction between the child and the robot. These scripts are defined and selected by a therapist according to the goals of the current session and describe a clear, serial interaction where both the robot's and the expected child's actions are specified.

However, as we are working with children with ASD, it is unlikely that the script will be completely adhered to. The robot needs to be able to react to unpredicted actions to either return to the script or find alternate means of continuing the interaction. An autonomous action selection mechanism must therefore be able to cope with unplanned events whilst maintaining the therapeutic goals for the current session. A general description of the context in which the action selection mechanism should operate is presented in Figure 2.

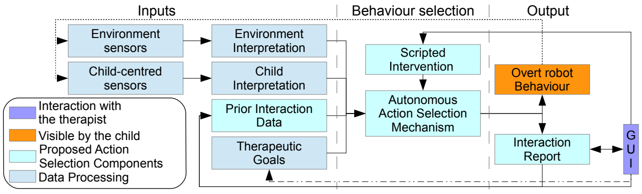

Figure 2: Context for the action selection mechanism.

Despite this, in some cases, the best action to select may be to stop the interaction and request help from the therapist. Contrary to the current approach, where the clinician must detect a problem and stop the interaction themselves, we aim to allow the robot to autonomously decide to refer to a human when this is appropriate.

3. APPROACH AND METHODOLOGY

The requirement for help for the robot may arise for a number of reasons. Firstly, there could be physical danger for the robot or the child. Some movements required by the script could harm the child if he is too close, requiring intervention if automated attempts to prevent collision fail.

Secondly, children could also react strongly to some specific actions, and force the therapist to stop the interaction. The robot could identify these actions and require help if one of them is requested for execution, thereby adjusting its level of autonomy. As the robot will be use in therapies, every action has to be carefully therapy-oriented and some actions could be defined that require approval before each execution.

Finally, the interaction could also fail (e.g. child no longer engages with the robot), where the robot does not have the competencies to pursue the interaction. In this case, therapist intervention would be required. If the therapist and the robot behave consistently in this context, the interaction may be more effective in terms of therapy.

3.1 Action Selection Mechanism

Based on previous studies about action selection in robotics, we have identified two broad approaches which could enable control to revert to the therapist. The first one is using a rule-based mechanism: as soon as a specific state is reached the therapist is consulted. An example is using the child's engagement in the interaction as a homeostatic variable: as soon as the implication goes outside a certain region, the interaction is stopped.

Another possibility is to use a predictive mechanism. Based on its previous interactions with this specific child or also with other children, the robot could have a model of what reaction is expected from its actions, and use it to predict the consequences of stopping the interaction versus continuing with its behaviour.

3.2 Evaluation methodology

To test our approach, we will use our algorithm in real session both with neurotypical children and ones with ASD in three scenarios: turn taking, imitation, and joint attention. If the robot detects a case where it has to revert the control to the therapist, it will broadcast a message describing what action should have been executed and why it stopped. The therapist will have the opportunity to execute the action, select another one, intervene in the interaction, or stop the session. We will use the therapist's action after control reverting and the number of times a therapist has to interrupt the interaction without a robot's prompt to evaluate the efficiency of the action selection mechanism.

4. DISCUSSION

Even when triggered by the robot, an unplanned human intervention in the interaction may have consequences on the child, the robot, and the therapist. For example, allowing autonomous failure detection, the robot can learn about it, and find itself a way to avoid the same state in the future.

Concerning the child, even if the session stops before an important problem, the emotional impact of interrupting the current interaction need to be taken into account. As children are sensitive, it is important to think carefully about the way to communicate the robot's failure to the child. Should the information about the interruption come from the robot? Should the therapist explain to the child what happened to the robot? We have no general solution yet, and the solutions may depend on individual characteristics. These questions have to be addressed based on data from empirical studies and collaboration with therapists.

5. CONCLUSIONS

In this paper we propose an approach to RAT for children with ASD: allowing a robot to voluntarily interrupt the interaction with a child and request help from a therapist. We outlined our motivations for this behaviour and presented possible consequences and questions to be resolved. The proposal is that autonomous action selection supports RAT because it reduces the workload on therapists, and improves its consistency.

6. ACKNOWLEDGMENTS

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7. REFERENCES

[1] K. Dautenhahn. Robots as social actors: Aurora and the case of autism. *Proc. CT99*, (3), 1999.

[2] D. Feil-Seifer and M. Mataric. B3IA: A control architecture for autonomous robot-assisted behavior intervention for children with Autism Spectrum Disorders. *RO-MAN 2008.*, 2008.

[3] L. Riek. Wizard of Oz Studies in HRI: A Systematic Review and New Reporting Guidelines. *Journal of Human-Robot Interaction*, 1(1):119–136, Aug. 2012.

[4] B. Robins, K. Dautenhahn, R. T. Boekhorst, and A. Billard. Robotic assistants in therapy and education of children with autism: can a small humanoid robot help encourage social interaction skills? *Universal Access in the Information Society*, 4(2):105–120, July 2005.

[5] B. Robins, K. Dautenhahn, and P. Dickerson. From Isolation to Communication: A Case Study Evaluation of Robot Assisted Play for Children with Autism with a Minimally Expressive Humanoid Robot. *Conferences on Advances in Computer-Human Interactions*, pages 205–211, Feb. 2009.

[6] S. Thill, C. A. Pop, T. Belpaeme, T. Ziemke, and B. Vanderborght. Robot-assisted therapy for autism spectrum disorders with (partially) autonomous control: Challenges and outlook. *Paladyn*, 3(4):209–217, Apr. 2013.

[7] B. Vanderborght, R. Simut, and J. Saldien. Using the social robot probo as a social story telling agent for children with ASD. *Interaction Studies*, 110(Tager 2001), 2012.