LekBot
– A natural-language robot for children with communicative disabilities

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1. Introduction

Children with communicative disabilities, for instance disabilities resulting from cerebral palsy or autism, have few opportunities to play independently and to interact on equal terms with children without communicative disabilities. One way in which this can be achieved is through a robot that is controlled by the child herself, on her own or together with other children. Internationally, there are a number of research projects that involve robots for children, including quite a few directed towards children with autism and other disabilities (Robins et al., 2008; Saldien et al., 2006; Kozima et al. 2007; Lee et al. 2008; Arent & Wnuk, 2007). However, none of these seem to involve communication through natural language in any form.

The LekBot project is a VINNOVA-funded collaboration between the University of Gothenburg, Talkamatic and DART. Acapela supports the project by providing their Acapela Multimedia TTS free of charge. LekBot started in March 2010 and runs until the end of 2011. The aim of LekBot is the development of a robot that uses current state-of-the-art technology to provide children, whether with or without communicative disabilities, with a toy that is easy and fun to use, and that involves natural language dialogue.

2. Communication and play

When playing with the LekBot robot, the child communicates by pressing buttons on a touch screen. The selected option is verbalised using a text-to-speech synthesiser, which acts as the child's voice. The robot communicates through its actions and linguistically also using a TTS. The precise characteristics, functionality and dialogical capabilities of the LekBot robot are to be determined during the course of the project. LekBot's predecessor, TRIK, was capable of drawing various objects on a sheet of paper on the floor (Ljunglöf et al., 2009), whereas LekBot will move around more freely, engaging with various objects in the room, and also include certain social and "physiological" capabilities, such as greet the user or indicate that it is tired or hungry.

At the time of writing, the current incarnation of LekBot can be told to go forward, go backwards or turn, and then carries out appropriate movements. When it goes forward and comes upon something that cannot be moved, such as a wall, it stops and variously exclaims "Oops!" ("Hoppsan!"), "Ouch!" ("Aj!") or "Wow!" ("Oj!"). If the user has not asked the robot to do anything during a specified amount of time – currently 20 seconds – the robot becomes bored, yawns, and starts to move around randomly for a while. This basic version of the robot thus allows the child to take some initiative, but can also take the initiative on its own.

3. System description

The heart of the LekBot system is the information-state based GoDiS dialogue manager (Larsson, 2002). The robot is built using Lego Mindstorms NXT, and currently includes a sensor for distance.

The child's communicative device is a communication board in the form of a touch screen that displays various symbols. Bliss symbols and Symbolstix are used for different children in the project. Acapelas's Swedish voices are used for the TTS, with different voices for the robot and for the user, that is, the child. Two sets of loudspeakers are used, one for the child's voice and one placed on the robot. The communication between computer and robot is via Bluetooth, rendering the use of an ASR superfluous. This means that "speech recognition" is always perfect, and that the natural language dialogue is there for the benefit of the child.

4. XP and user evaluations

LekBot development is done using Extreme Programming (Beck, 2005). XP practice involves programming in pairs, test-driven development and code refactoring, and of particular importance to the project, short iterations with frequent releases to the users.

During the first few months of the project, DART (a communication and computer resource centre for people with disabilities, and one of the three partners in the LekBot project) have acted in the interests of the users, specifying demands on the system and ranking proposed alternatives in the system's functionality.

The first release involving actual users is planned for October 2010. This will involve three pre-school children with cerebral palsy, and testing will take place at their respective daycare centres. The experiences of children and staff using LekBot will feed back into the development, and several such user evaluations during the project will help determine the robot's functionality and communicative behaviour. Each iteration will give priority to the development most beneficial to users.

5. Intonation and external events

Two areas of theoretical as well as practical interest in

the LekBot project, are intonation and external events. Both of these involve the extension of current dialogue models used by GoDiS. In the case of intonation, the TTS default pattern may need to be modified in order to render utterances as clear as possible, bearing in mind that erroneous or unclear intonation may pose a great challenge to children with cognitive disabilities. Models for improved intonation typically need to take dialogue context into account, as is explored for information-state models by Ericsson (2005).

External events concern the robot's movements through a changing environment. The system will need to handle external events coming from the robot, such as information that the robot is about to or has just hit an object. Such external events may lead to dialogue between the child and the robot, determining how the robot should handle the new situation.

6. Expected results

At the end of the project, a fully functional LekBot demonstrator will have been developed, which outwardly includes a communication board, a robot and a speech and symbol-based dialogue system. This demonstrator should be fun and user-friendly for children with communicative disabilities, encouraging children with disabilities to interact on their own with the robot, as well as together with a friend, and in both cases learning interactional skills through play. The demonstrator should also be easy to set up and control for day-care centre staff and other adults such as parents, and run in a robust way.

7. References

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