

Baby Gym For Robots: A New Platform For Testing Developmental Learning Algorithms

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Abstract

This extended abstract describes a new platform for robotic manipulation research that was inspired by some of the first toys that human infants learn to manipulate. It summarizes the results of our existing research on pressing buttons and formulates some ideas for future work.

Motivation and Inspiration



Figure 1: My son in his *Baby Gym*.

When my son was growing up I noticed that it took him almost 5 months to learn how to press a button reliably on one of his toys. The toy had a number of buttons, sliders, levers, and knobs that could be manipulated (see Figure 1). These toys come in many varieties and in recent years some toy manufacturers have started to call them *Baby Gyms*. Initially my son was more interested in exploring the plastic casing of the button instead of the button itself. He had to learn *what* the button looks like and *how* and *where* to press it. This learning process started when he was 4.5 months old and continued until he was 9 months old. Once he had mastered this skill, however, he knew how to detect other buttons around the house. Furthermore, he knew that these devices are for pushing and he knew how to push them. Light switches, keyboard keys and microwave buttons were now intuitively obvious to him as they were in the same equivalence class with that first button. Similar developmental sequences were observed for a number of other devices present in the baby gym.

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Learning to Press Buttons

The devices found in baby gyms – buttons, sliders, levers, wheels, and knobs – are widely used in human environments. Buttons alone are present in virtually every gadget that humans have ever created. Robots operating in human environments would have to know not only how to navigate without hitting any obstacles, but also how to operate these devices by actively touching and manipulating them. Otherwise these robots would not be very useful.

These manipulation tasks are still challenging for robots yet one-year-old infants can perform them quite easily. This suggests that the exploration methods that infants use may hold the key to solving such tasks with robots. These methods rely on exploratory behaviors such as pushing, scratching, and nudging, which can be quite powerful when combined with multimodal perceptual change-detection functions. One key advantage of the baby gym platform is that it offers a nice way to have multiple reproducible experiments.

These observations motivated a pilot study to test if a robot can learn to press buttons in a similar way (Sukhoy et al. 2010; Sukhoy and Stoytchev 2010). That is, to test if a robot can learn both *where* and *how* to press buttons from its own experience without prior knowledge of what buttons look like. We built an experimental fixture similar to a baby gym (see Figure 2) that contained multiple doorbell buttons. The results showed that the robot was indeed able to learn to press buttons autonomously. Furthermore, the robot simultaneously learned a visual model for what a button looks like and was able to use it to detect novel buttons.

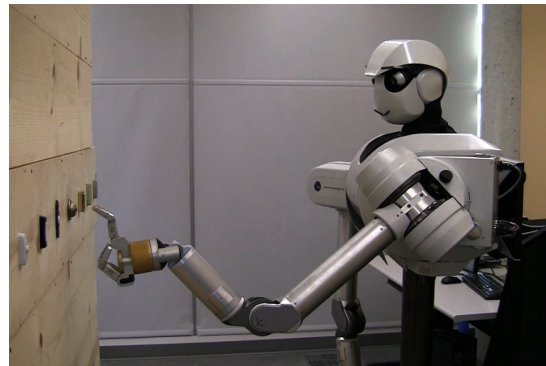


Figure 2: The experimental fixture with doorbell buttons inspired by my son's baby gym.



Figure 3: Mapping between the baby gym toys and other similar devices around my house.

Future Work

Figure 3 shows examples of different objects from my house that are similar to the toys in my son’s baby gym. My son was able to manipulate all of these devices before he was 18 months old. Some of them he was able to manipulate with appropriate behaviors after seeing them for the first time. Others were more challenging for him but he reverted back to exploring them with exploratory behaviors and soon figured out how to manipulate them. Future work could test if the robot could do the same. For each of the devices we plan to present a number of instances on a fixture. After the robot is trained with these instances it will be presented with at least 3 instances of tasks that can be derived from them. We expect the robot to be able to detect a novel instance of that widget and be able to manipulate it appropriately without having to explore it extensively.

Because certain devices can only be manipulated in certain ways, it may also be possible to build a taxonomy of these devices, which links them based on the similarity of the motor acts required to manipulate them. The similarity metric can then be used to predict what manipulations skills the robot should apply to a novel device that is visually similar to an already explored one. In our previous work we

have demonstrated that a robot can use sensorimotor similarities between objects to form object categories (Griffith et al. 2010) and even to find the odd-one-out in a set of objects (Sinapov and Stoytchev 2010). These methods could be extended to the domain of articulated devices.

References

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