A Study of Spatial Exploration Patterns of Children

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Abstract

Cognitive development in children is based on exploration, part of which involves exploration of, and interaction with, the surrounding environment. There is an intuition that children with developmental delays like autism explore space in their surrounding environment using different motion patterns when compared to typically developing children. We propose to develop algorithms that can automatically track children in video and extract models of their exploratory motion, to enable measurement, mining, and quantitative analysis of the patterns of a child's exploratory behavior during unstructured, "free-play".

Motivation

- Cognitive development in children is based on exploration, part of which involves exploration of the surrounding environment.
- There is an intuition that children with developmental delays like autism explore using different motion patterns when compared to typically developing children.

Preliminary Proof of Concept

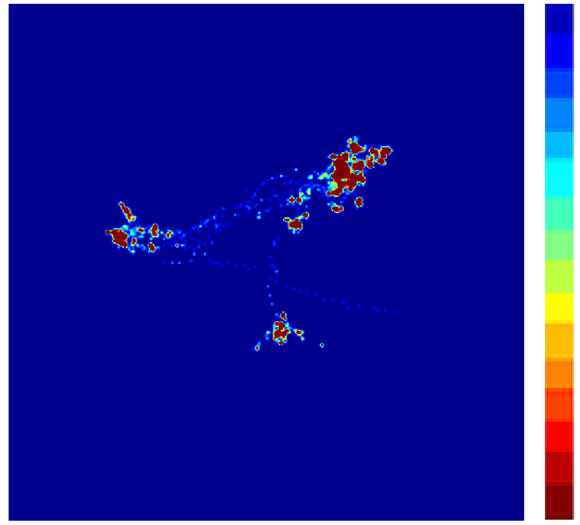
Video Setting

Environment explored by child

Track Map

Child's trajectory of exploration

Heat Map



Red: frequently explored, Blue: rarely explored

Motion Patterns of Interest

In discussions with psychologists, Prof. Matthew Goodwin (NEU) and Prof. Helen Tager-Flusberg (BU), we identified a number of potentially useful features for quantitative analysis of exploratory behavior in children of 2-3 years of age:

- Repetitive exploration patterns
- How much children approach/pose to their anchor (parent)
- Time spent stationary vs. moving
- How much space is explored
- Speed and sharpness of trajectories
- Time spent touching wall

Overview of Preliminary Study

We are given monocular, overhead video of a child engaged in free-play.

The tracking-by-detection method of [2] is used to track the child across time to produce:

1. a track map showing the child's trajectory of exploration, and
2. a heat map of locations she has explored in the room with color corresponding to the amount of time spent at specific locations.

From these two simple models, we can infer places where the child had spent most of her exploration time, how she chose to explore, and how frequently she approaches her parent.

Future work will include extracting models of exploratory behavior that help us analyze the full set of interesting motion patterns identified in our discussions with the domain experts (psychologists).

Related Work

Work on automated video-based analysis of children's exploratory behavior has been limited to [1], where analysis of motion patterns of 40 ASD children indicated that adaptive social communication skills decreased with increases in percent time spent away from the parent and increased latency to approach parent.

[1] Ira L Cohen, Judith M Gardner, Bernard Z Karmel, Soh-Yule Kim. *Rating scale measures are associated with Noldus EthoVision-XT video tracking of behaviors of children on the autism spectrum*. Molecular Autism. 5:15, 2014.

[2] Qinxun Bai, Zheng Wu, Stan Sclaroff, Margrit Betke and Camille Monnier. *Randomized Ensemble Tracking.* In Proc. of IEEE International Conference on Computer Vision (ICCV), 2013