

## Chapter 44

# Potential of Human Tracking in Assistive Technologies for Children With Cognitive Disabilities

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### ABSTRACT

*The development of human tracking systems has had a significant influence over the evolution of Assistive Technologies for aiding children with cognitive disabilities. Techniques that range from radio frequency, Inertial Measurement Units, and Electroencephalography to the Global Positioning System and depth-based vision systems have provided tools for researchers to incorporate indoor and outdoor localization, motion and activity tracking as well as well-being monitoring into their projects. This chapter aims to introduce the latest human tracking options to consider for implementation of future Assistive Technology projects. Some example research work is discussed with emphasis on how human tracking systems can help in gathering the right data. The chapter concludes with a discussion of a proposed hybrid vision-based system for assisting in full-time supervision of children with cognitive disabilities, utilizing the chapter's central theme of sensor fusion application.*

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## **INTRODUCTION**

Children at development ages gain experience by encountering the world and learning lessons mentally through observation and personal trial and error. Often, adult parents and caregivers play a huge role in guiding this learning process while ensuring that the children do not end up injuring themselves in the process. A child with cognitive disabilities, such as Autism Spectrum Disorder (ASD) in particular, struggles with mental tasks that a typically functional peer would have no problems coping with on a daily basis. On the other hand, Cerebral Palsy (CP), yet another form of cognitive disability, affects the child's control over motor functions across the body, resulting in inability to both perform daily routines and fit into social groups without falling behind typically functioning peers.

These conditions present an additional level of difficulty for the adult guardians and aid workers because generally accepted caretaking norms do not apply for the affected children. Children with ASD experience their surroundings with a wide spectrum of sensory sensitivity anomalies, irregular cognitive development and tendency for stereotypy. This usually results in impeded cognitive development, aversion to social interaction, stereotyped and disruptive behavior. CP increases the learning curve for all active and interactive activities, leading the child to similar situations of social disadvantage as those with ASD.

Such added difficulties demand extraordinary attention from caregivers in the form of constant supervision so that they can be in time to intervene whenever an imminent injury or disturbance situation arises. This added attention to gauge and monitor children with cognitive disabilities extend from free play to therapy sessions, traditionally requiring a trained professional to manually observe them for specific nuances that a typically functional child would not exhibit. Such reliance on extra effort and expertise would ultimately drain the human resource for supporting children with cognitive disabilities, evident by the global shortage of their special healthcare facilities. Some form of automated tracking and monitoring technology is needed in order to assist, relieve and augment these social workers and guardians.

Fortunately, there has been significant development of Assistive Technologies in recent years that aim to improve and augment the diagnosis and treatment of cognitive disabilities in children. Most of these implementations take the form of Mechatronic systems consisting of sensor suites and mechanical actuation, as seen in the boom of Assistive Robots for physiotherapy of children with CP. Advancements in sensor technology for human tracking plays an important role in the development of these Mechatronic systems. Crude mechanical triggers and electrodes has since been replaced by haptic, optical, vision-based and embedded systems that open the door to minimally intrusive, real-time feedback of both indoor and outdoor localization, biological signatures, brain activity and much more. The new breadth in sensory feedback provides avenues for understanding and tracking children with cognitive disabilities that were previously unfathomable, such as multimodal portraits of behavior that are composed of motion capture, brain activity pattern, heart-rate reading and gaze tracking in order to create a snapshot of a child while he is engaged in stereotyped head banging. These new avenues of sensory feedback will incite more exploratory and novel Assistive Technologies that help us to better understand the workings of ASD and improve existing augmented treatments.

This chapter focuses on highlighting the role of human tracking sensor technologies in making the Assistive Technologies of today possible. It will introduce the reader to the state of the art of wearable, embedded and vision-based sensing methods that were pursued over the last few years. This introduction is pivotal to helping future researchers identify the sensing options available for developing subsequent Assistive Technologies. This chapter also discusses several existing research efforts in terms of the human

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