WAND: Walk Around Navigational Device for the Cognitively Impaired

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Abstract
Children with Autism Spectrum Disorders (ASD) face many challenges, particularly with regards to the ability to explore their surroundings like a typical child. This paper presents a device and accompanying application that allows parents of children with ASD to encourage independent walking through restriction of paths in their neighborhood, with security through the devices tracking capabilities. This device not only motivate the child to walk, through games and camera functions, but also aims to build social skills through interactions in their neighborhood.

Keywords
Walking, Fitness, Health, Autism, Cognitive Disabilities, Navigation

ACM Classification Keywords
H.5.2 User Interfaces (D2.2, H.1.2, I.3.6) Subjects: Graphical User Interfaces (GUI), Input Devices and Strategies, Prototyping, User-Centered Design.

General Terms
Design, Human Factors, Performance

Introduction
Walking, in any amount and at any pace, expends energy. Walking is a natural activity and the only sustained dynamic aerobic exercise that is common to everyone except for the seriously disabled or very frail.

No special skills or equipment are required [1]. Walking is a simple way to live a healthy life, can be done at any location, works multiple parts of the body, and is a naturally social activity [2].

For children with Autism Spectrum Disorders (ASD) such as Asperger's syndrome, Rett's syndrome, and Autism, walking is particularly important. It is an effective means of addressing many of the physical, cognitive, and social impairments of the disorder.

Due to fewer opportunities to engage in structured physical activity, unusual dietary patterns, and increased sedentary behaviors such as television viewing, children with ASD have an increased risk of being overweight. Rosser and Frey report less time spent in moderate activity in children with ASD compared to children without [3]. Because of this, whereas the overall prevalence rate of obesity is 16%, 19% of children with ASD are overweight [4]. Dynamic aerobic exercise, as in walking, enhances a multitude of bodily processes that are inherent in skeletal muscle activity, including the metabolism of high-density lipoproteins and insulin/glucose dynamics [1]. When done regularly, walking can be an effective weight management strategy for sufferers of ASD.

Walking is also one of the most effective treatments for the cognitive aspects of ASD [5]. The benefits of light exercise for individuals with ASD are well documented. Exercise can help increase coordination, visual tracking, and mental processing, improve attention span, increase fine motor skills, and decrease stereotypic (self-stimulatory) behaviors, hyperactivity, aggression, self-injury, and destructiveness [6,5]. Taken together, these address the broad range of cognitive symptoms associated with ASD, which the American Psychological Association identifies as lack of spontaneous play, repeated and restricted patterns of behavior, and decreased attention [7].

Social impairment is also a major component of ASD. This includes limitations in the ability to share attention with peers, engage in imaginative play with others, and develop effective relationships [8,9]. Walking can encourage successful social engagement in two ways. First, though a single etiology of ASD ignores the diversity of those who are classified as having the disorder [8], it is apparent that many of their relational difficulties are a result of their cognitive impairment. For example, difficulty in following the attention of peers, problems in engaging in cooperative play due to misunderstanding social cues, and increased likelihood of aggressive behaviors means that children with ASD are unlikely to develop meaningful relationships. Walking, by improving many of the cognitive deficits of ASD, can help those with the disorder engage appropriately with peers.

Secondly, walking allows those with ASD to explore their social environment. Walking can help them integrate themselves through engagement in similar activities. Simply co-locating children with ASD with full-functioning children is not enough to promote social inclusion [10]. Walking, however, by bringing children in close proximity and demanding joint effort and coordination on the part of children with ASD, can increase social interaction and social play [11].

It is unfortunate, then, that one of the most underutilized treatments for individuals with ASD is walking [5]. While walking is a common leisure activity

for healthy children, it poses unique challenges for individuals with ASD. Typical children have no special challenges in going for a walk in their neighborhood. They know their neighborhood, know where their parents allow them, and can remember the way home. If a problem arises, they can communicate their needs. They are naturally curious, and walking allows them to explore their surroundings while meeting their neighbors. Sufferers of ASD, however, have a difficult time processing multiple areas of sensory input simultaneously and can thus find walking in new areas to be overwhelming [12]. A limited ability to communicate verbally means that caretakers of those with ASD cannot allow them to walk without their direct supervision.

"*I'm currently in tears right now. My 12 yr old son with Asperger's ran off yesterday […]. Just 1/2 hour ago, I got a call from child protective services because his school reported me (they have reported me 2 previous times, all unfounded) for not 'providing proper supervision.' […] I am so sick and tired of this. What can/should I do???*" [13].

As captured in this quote, the cognitive impairment of children with ASD does not severely limit their physical mobility. Children with ASD thus have a strong desire to imitate their peers and gain a sense of independence, but are limited by concerned caretakers and issues of safety. It is apparent, then, that there is need for a means of mediating the needs of exercise, social interaction, and autonomy of sufferers of ASD with their caretaker's concerns of safety and security.

figure 1: prototype WAND device with stylus and map of home area.

Problem Identification

The need for an application that targets the most common disadvantage of ASD, social interaction, can be done in conjunction with the task of walking. A city, and specifically neighborhoods, can educate individuals about the life that surrounds them and people in it; socialization can happen simply by taking a walk in the environment [14].

Toys or applications for children with ASD are usually done on individual basis due to sensory preference, interests and personality. Sensory processing difficulties are common with Autistic children. Each child is unique and may have an aversion or depravity in different areas. By incorporating controls which allow the parent to turn off or on aspects, such as sound, vibration, videos, and color to allow broader appeal to children and not create sensory aversion [15].

It is an appropriate time in our society due to the larger numbers of individuals being diagnosed with Autism Spectrum Disorders to introduce a device that helps with their integration into the community.

Envisioned Solution

The proposed device and application, WAND: Walk Around Navigation Device, is assistive technology that attempts to enhance or improve the functioning and lives of children afflicted by ASD and their parents. With the larger goal of walking for fitness, the device and programming teaches socialization, with neighbors and friends, by fostering independence through following routes during walking and having tasks of photographing and exploring their neighborhood.

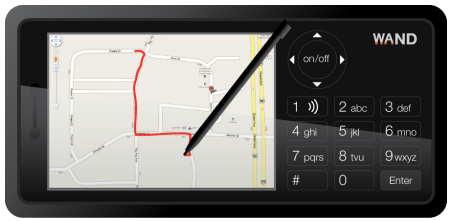

figure 2: Parent can choose the paths on amps of their neighborhood that are ok for a child to walk along.

figure 3: Using GPRS the device can detect and alert the parent when their child is off the path.

Utilizing the ideation of GPS technology, GPRS connectivity, and alarm systems, the device would be handheld with a touch screen and stylus, acting as a wand. It would need to be heavy duty, small enough to be portable, similar to iPhone, with simplified controls, and a long battery life. The package would include two devices, one child oriented, the other a home base for the parent, also portable. Both devices would be programmable by the parent. Children and adults with ASD generally have an affinity for technology, making assistive technology ideal for them, particularly in areas such as health and social interaction.

Parents can choose the paths on maps of their neighborhood that are acceptable for a child to walk along. Due to the level of involvement these parents have with their children, it is not unreasonable for this customization by the parent at onset. The paths allow a child to role-play the situation first and see boundaries on map system before completing the walk. These maps and paths teach the proximity of the area that he child is allowed to walk from the home base.

Children can walk with their parents or separate, the distance allowed from the home base to be determined by parent. Using GPRS, which has unlimited distance range, it allows transferring of data from the child's device to the parent's device, and vice versa, with no cords [16]. Vibrations and noise as negative reinforcement can occur for when the child has strayed too far to alert them and to alert parents if a child goes out of the programmed area.

When a parent is in the house and a child playing in the yard and goes out of their allowed range, WAND would alert the parent and remind the child. It also serves for safety of children who walk alone. Parents will know when a child walks too far, which route they take, and where they are by the GPRS system. Therefore parents will be more comfortable having their children walk or play alone because it is not difficult to find them by WAND and children gain independence.

The inclusion of a camera on the device can serve two purposes. The photograph serve as a visual diary, or breadcrumbs, of where the child went and storing those images allows reminders of what can be seen on that specific route. A picture is worth a thousand words and children with ASD who have difficulty with verbalization can use the camera as a tool for communication with those they meet or with their family. Also, the device can ask the children to take pictures of things along the way and compliance results in reinforcement by unlocking games to play.

Interest and motivation can be created through rewards on the device. Completion of walks, determined by the GPRS, or the taking of photos will unlock games the child can play. The games can be adjusted by the parent, turning on or off sound, color vibrancy, etc.

Due to autistic children's limited ability to interpret symbols of things as representational of reality, the application can be likened to augmented reality rather than virtual reality; the imagery and maps would be realistic, akin to Google Earth images but more simplified, with a layer of highlighting for allowed paths [17]. The design must be consistent, graphics based, not textually heavy, repetitive for memory enhancement, include no or limited time constraints,

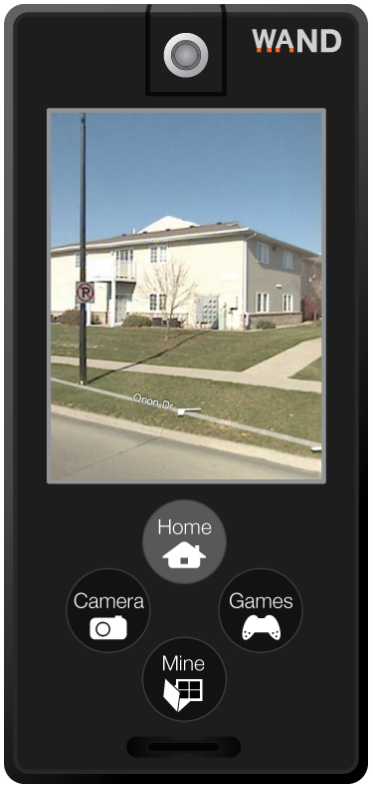

figure 4: The camera allows the child to take pictures of things in their neighborhood. The icons for the location can be seen in this image.

and demonstrations. Using the clearest language and pairing graphics with text will allow the users more

comprehension and keeping navigation consistent will benefit the users. Sensory-based accommodations can be made to address an individual child's processing needs and controlled levels can benefit arousal, alertness and attention level of autistic children [12].

Screens of Application
The following are the interfaces that would be implemented within WAND:

- On and off options for sensory settings
- Choosing location of neighborhood
- Map of neighborhood for setting walk limitations
- Map of neighborhood with walk options
- Photo capture
- Photo viewing
- Games

Icons of Application
The following are the icons that would be implemented for selecting options:

- Home
- Camera
- Games
- Personal Folder

Remaining physically fit is important for these individuals and WAND would remind them of the task at hand, track progress, and be a tracking device for parents in both traditional and emergency situations.

Future Work

While this product is targeted specifically at children and young adults with Autism Spectrum Disorders, its ability to trigger memory cues and provide a GPS of known routes could prove effective for persons with the cognitive disability of Alzheimer's. Alzheimer's is a progression of dementia from forgetfulness to total disability. The changes in lifestyle due to the illness represent a loss of independence and are a difficult transition for the individuals suffering from the disease [18]. WAND has the potentiality to prolong independence for those persons afflicted while giving some peace of mind and tracking capabilities to caregivers and family members.

Insufficient time for an IRB proposal and approval limited our ability to test a prototyped application with parents and children afflicted with ASD. However, the browsing of blogs and support networks devoted to care of autistic and Alzheimer persons reveals the real need for products which aim to do exactly what the WAND application proposes: motivate movement and social interaction while providing caregivers with means of security of the individual's whereabouts. The next step would be testing paper prototypes and revising the application based on testing.

Conclusion

We followed a user-centered design process and created an application that has multiple functions for the intended users, beyond the immediate goal of walking; because of that, we are confident that the application will be successful as it covers a myriad of capabilities. This application represents the merging of walking for health, social inclusion, and independence skill building in a technology that can be tailored to

individual needs, for those suffering from an Autism Spectrum Disorder, with possibilities for typical children and individuals with Alzheimer's.

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