An Assistive Technology Autism Support Device

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Autism Support Device

Autism spectrum disorders are neurological conditions characterized by abnormalities in social interactions, communication, and imaginative functioning. It is typically first observed during infancy or early childhood and follows a steady course without remission or relapse. There is no cure for autism, and it is almost certainly, like cancer, many different diseases with many different causes [1]. In addition to interaction, communication, and imaginative functioning difficulties, a large number of individuals with autism experience some form of sensory dysfunction [2]. Sensory dysfunction may be expressed as difficulty in regulating response to sensory input (e.g., over-sensitivity to repetitive sounds, under-sensitivity to painful stimuli) or as difficulty in maintaining attention to stimulation. Autistic individuals often resort to repetitive motions or verbal patterns to seek local coherence in a world that, to them, appears to be horrifyingly random [1]. These sensory dysfunction problems can lead to the symptomatic behaviors of autistic individuals. Spinning, biting, flailing of limbs, and head banging help them to determine where their bodies are in space. They also serve a "sensory modulating" function, allowing patients to regulate their level of anxiety when experiencing sensory stimulation [3].

Because of these problems, a majority of autistic individuals require long-term care and special education services [4]. The cost of a specially structured education program for an autistic child is approximately $30,000 per year [5]. Nationally, the direct cost for the care and education of autistic patients was $35,000,000,000 in 2006 [4]. During adulthood, more than 50% of autistic individuals will require more than eighteen years of Medicaid waiver (or equivalent) services and more than fifteen years of supported work services [6].

The objective of our project is to design an assistive support device (ASD) for autistic individuals with sensory dysfunction and spatial awareness problems, using the concept of localized vibration therapy, to help them better integrate into society. The ASD will be a small, unobtrusive device, which will be externally attached to the wrists or ankles and provide vibration stimulus. Such a device would be utilized to replace conspicuous self-stimulatory behaviors, allowing individuals greater control over anxiety stemming from sensory input. While much work has been done in general pressure and massage techniques for the relaxation and spatial determination of autistic individuals, there is no study or body of work specifically examining if point vibration therapy can be discreetly applied with beneficial results. It is our hope that the ASD will help individuals integrate more easily into school, social situations, and occupations where conspicuous self-stimulatory behaviors are often deemed undesirable.

1.0 Work Scope of Design Project and Schedule

The scope of this design project has many facets. The team began the project with little understanding of autism and its affect on individuals. Therefore, research was a key initial factor to the design. A multi-disciplinary team has been formed, consisting of four mechanical engineering students, two electrical engineering students, and four psychology students. The team defined the ASD system requirements, and a work breakdown structure has been completed. The ASD will consist of a vibration motor, a control system, a battery power and charging system, and a case with fastener for attaching the device to the patient. After analyzing the system's realistic design constraints, taking into consideration factors including health, safety, manufacturability, and economics, the team was able to complete a failure mode effect analysis. The team has just completed an alternate solution analysis wherein they considered multiple methods for implementing the ASD's four subsystems.

The schedule for the remainder of our project is shown in Figure 1. The next significant milestone will be the completion of an ASD virtual prototype. The virtual prototype will consist of written descriptions of how each subsystem works; schematics, drawings, logic diagrams, block diagrams, and programming flowcharts; equations, fundamental principles, and derivations; and all the detailed calculations used in the design. We will then begin the construction of ASD prototype.

Task	Start	End	November	December	January	February	March	April
Virtual Prototype Completed	23-Oct-07	12-Nov-07						
Virtual Prototype Presentation	15-Nov-07	15-Nov-07	Δ					
System Implementation	16-Nov-07	27-Mar-08						
Subsystem 1 - Motor and Control	16-Nov-07	13-Dec-07						
Christmas Break	17-Dec-07	9-Jan-08						
Subsystem 2 - Power and Charging	10-Jan-08	31-Jan-08						
Subsystem 3 - Housing	1-Feb-08	21-Feb-08						
ASD System Integration	22-Feb-08	27-Mar-08						
ASD Prototype Demonstration	27-Mar-08	27-Mar-08					Δ	
System Testing	10-Jan-08	10-Apr-08						
Draft Test Plan	10-Jan-08	17-Jan-07						
Finalize Test Plan	18-Jan-08	26-Feb-08						
Internal Review Board Approval	27-Feb-08	27-Mar-08						
Test ASD Prototype	28-Mar-08	3-Apr-08						
Final Test Report	3-Apr-08	10-Apr-08						
NISH Submission	28-Mar-08	11-Apr-08						Δ

Figure 1. Schedule for the Autism Support Device Development

The construction will proceed through four stages: implement the vibration motor and control subsystem, implement the battery power and charging subsystem, implement the case and fastener subsystem, and integrate ASD subsystems. Following the completion of our ASD prototype, we will test the device against our previously defined system requirements.

Since the vibration source subsystem will impact all other subsystems (see Figure 2), we have started its virtual prototype. Figure 3 shows the integration of the vibration motor and casing. This modular design will allow the vibration source to contact the user's wrist.

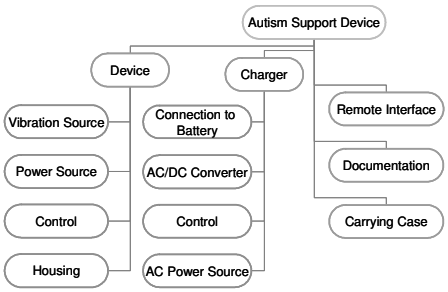

Figure 2. ASD work breakdown structure

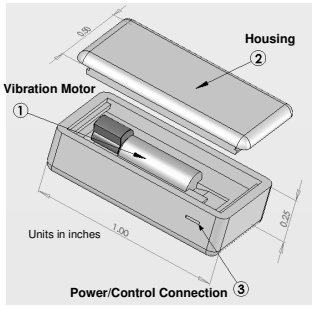

Figure 3. Vibration source design.

2.0 Budget

A brief description of the materials and supplies and their cost estimates is shown in Table 1. Our budget contains sufficient quantities to assemble five ASDs during development and ten ASDs with which we can begin field testing following Internal Review Board approval. If funding allows, we would like to assemble an additional ten ASDs for a broader field test.

3.0 Department Co-Funding

Our College of Engineering has committed to co-fund our development with a matching grant of $650. In addition, our Departments of Mechanical and Electrical and Computer Engineering have each committed to co-fund the development of our ASD project with an as-needed matching grant of $1,000. We are also seeking additional corporate in-kind contributions to allay any additional unexpected hardware or software development costs. If the ASD is awarded first, second, or third prize in the 2007-

Table 1 - Component Description and Budgeted Costs for Autism Support Device

Component	Description	Piece Price	Quantity	Total
PIC18F2550-I/SO	16-bit Microcontroller with USB interface	$4.60	15	$69.00
ECS-327SMO	32.768kHz oscillator clock	$6.74	15	$101.10
BS170	N-channel MOSFET	$0.34	15	$5.10
KHN4NX3AF	3V vibrating motor	$10.00	15	$150.00
MCP73863	Charge management controller	$1.93	15	$28.95
CGA633450B	3.7V 750mAh Li-ion battery	$9.00	15	$135.00
- - -	Assorted resistor and capacitors	$1.00	15	$15.00
ZX40-B-5S-1000	1 meter micro-USB cable	$16.63	15	$249.45
- - -	Printed circuit boards	$33.00	15	$495.00
- - -	Housings and Fasteners	$16.00	15	$240.00
ZX62D-AB-5P8	microUSB Connector	$1.49	15	$22.35
			Total	$1,510.95

2008 NISH National Scholar Award Competition, our College of Engineering will match the award of $10,000, $5,000, or $3,000 given to our institution to continue work on future generation ASDs.

4.0 Project Team

Mallory Gill - Psychology
Heidi Golz - Psychology
Kayla Grutz - Psychology
Caitlin Kaiser - Mechanical Engineering
Debrah Kite - Psychology
Megan Mallette - Electrical Engineering
Megan McGinty - Electrical Engineering
Eric Nielsen - Mechanical Engineering
Jeremiah Ray - Mechanical Engineering
Danielle Woike - Mechanical Engineering

5.0 External Collaboration

We have received confirmation that an external engineering design firm, ESE Incorporated, will assist in the review of our virtual prototype. They have also made themselves available for consultation during the System Implementation phase of our project.

6.0 Supervising Faculty Advisors Contact Information

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7.0 References

[1] C. Wallis, "Inside the Autistic Mind," *Time*, pp. 42-48, May 15, 2006
[2] A. M. Wetherby and B. M. Prizant (ed.), *Autism Spectrum Disorders: A Transactional Developmental Perspective*. Brookes Publishing, Baltimore, 2000.
[3] T. Grandin, *Thinking in Pictures*. Doubleday, New York, Jan. 2006.
[4] M. Ganz, *Understanding Autism: From Basic Neuroscience to Treatment*. CRC Press, Boca Raton, FL, 2006.
[5] Susan Brown, "Autism Surging; Funding Falling," *Northwest Indiana Times*, Nov. 13, 2006.
[6] J. W. Jacobson, J. A. Mulick, G. Green, "Summary: Cost-benefit estimates for early intensive behavioral intervention for young children with autism," *Behavioral Interventions*, vol. 13, pp. 201-226, 1998.