

# ***Personalized Transportation and Mobility Aid (PTMA)***

## *Pre-Proposal for Traffic21 Program Funding*

**Principal Investigator:** M. Bernardine Dias

**Co-Investigator:** Balajee Kannan

**Key Personnel:** M. Freddie Dias and Sarah Belousov

### ***Project Summary***

We propose designing, implementing, testing, and deploying a mobile phone-based personalized transportation and mobility aid (PTMA) to advance the effectiveness of intelligent transportation systems and enhance the navigability of the Pittsburgh region. The proposed work utilizes information and communications technology (ICT) to improve mobility by increasing the navigation capability and independence of travelers, decrease energy use by reducing the need for individualized transportation options and enabling more travelers to use public transportation options, and make more efficient use of existing infrastructure by enabling a larger population (especially elderly populations and people with disabilities) to effectively use this infrastructure.

In alignment with the Traffic21 guidelines, the following criteria are satisfied:

- ◆ A first version of the PTMA will be deployed in the Pittsburgh region in the next two years.
- ◆ Traffic21 funding for this project will leverage additional funding from several current projects, and has the potential to leverage funding from further industry, government, and foundation sources in the future. We envision future R&D funding will be generated using the initial work funded by the Traffic21 program.
- ◆ We hope to recruit an interdisciplinary faculty team for some of this work and have identified potential faculty collaborators in industrial design, psychology, human-computer interaction, public policy, and business.
- ◆ Both undergraduate and graduate students will be involved with the project.
- ◆ We have 2 community partners and envision working with additional partners in the future.

Our current community partners, the Western Pennsylvania School for Blind Children and Blind & Vision Rehabilitation Services of Pittsburgh, have informed the needs addressed in the proposed work relating to mobility and transportation. We expect the results from the proposed work to have immediate impact in 2 years, but also inform and benefit from the next generation of ICT applied to transportation infrastructure. Public policy enhancements and commercial opportunities are also likely to benefit from this work, especially in the arena of enhancing independent mobility for people with disabilities. The proposed work will also contribute significantly to the efforts of the Quality of Life Technology group and others to promote the Pittsburgh region as an internationally-recognized location that employs technology to enable independent living for people with disabilities. Finally, the proposed work, while benefitting elderly and disabled populations, will also be useful to the population at large and help promote Pittsburgh as a smart technology region.

## ***Addressed Problems and Desired Results***

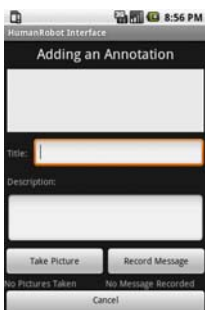
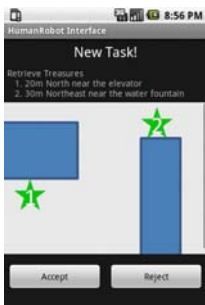
The primary problems addressed by the proposed work are as follows:

- ◆ The lack of easily accessible comprehensive assistance for travelers in the Pittsburgh region
- ◆ The lack of cheap and comprehensive navigational aids to enable independence of travelers with vision impairments and other disabilities which leads to the need for specialized assisted transportation systems for people with special needs
- ◆ The lack of user friendly navigational aids for deaf-blind travelers
- ◆ The lack of a comprehensive and easily accessible navigation system that can be customized for individual needs to allow a variety of travelers to navigate the Pittsburgh region and utilize the existing transportation and ICT infrastructure more effectively

The proposed work envisions a customizable digital assistant, accessible via a smart mobile phone that can provide navigational assistance to individuals based on their specific needs. The features of the envisioned PTMA are as follows:



Google Android Phone



Phone Screen Shots

- ◆ Assistance for planning complete journeys, customized to the ability of the traveler, and able to dynamically re-plan
- ◆ Enhanced route planning that takes into account some sensory and mobility constraints
- ◆ Multi-modal interactive interface to allow a variety of users including the visually impaired and deaf-blind users to benefit from the PTMA
- ◆ Effective use of existing infrastructure including GPS, wireless networks, digital maps, Google street view, and the inertial measurement unit on the smart phone for localization
- ◆ Travel planning that uses different modalities of travel (including walking, wheelchairs, bicycles, and public transportation)
- ◆ The ability for individual travelers to enhance the centralized information system by submitting updated information

The proposed work shares some elements with the e-Adept system<sup>1</sup> deployed in Stockholm for increasing pedestrian accessibility for elderly people and people with disabilities. The proposed work builds on our current work, sponsored by the Boeing Company, in effective coordination of human-robot teams. In this work we use the Google Android phone (see images on the left) to allow human team members to interact with the rest of the team. The proposed work also leverages our ongoing work in educational assistive technology, sponsored by the Qatar National Research Fund, which has afforded us the opportunity to work with visually impaired communities around the world. The envisioned PTMA will undoubtedly have significant impact on many people's lives.

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<sup>1</sup> [www.eadept.se](http://www.eadept.se)

## ***Outline of Major Tasks and Rough Timetable***

	<b>Year 1 (2010)</b>	<b>Year 2 (2011)</b>
<b>Spring semester</b>	<ul style="list-style-type: none"> <li>◆ Get IRB approval and conduct in-depth needs assessment with community partners and other categories of travelers</li> <li>◆ Conduct literature review</li> <li>◆ Explore different interface options to the Android mobile phone platform for visually impaired users</li> <li>◆ Begin implementation of basic PTMA framework</li> </ul>	<ul style="list-style-type: none"> <li>◆ Conduct initial user tests with visually impaired travelers</li> <li>◆ Modify implementation based on feedback from user tests with visually impaired travelers</li> <li>◆ Document new ideas for future enhancements of PTMA</li> <li>◆ Update needs assessment document and related work review as needed</li> <li>◆ Submit initial work for publication</li> </ul>
<b>Summer</b>	<ul style="list-style-type: none"> <li>◆ Document, organize, and prioritize assessed needs</li> <li>◆ Design PTMA features that addresses the needs of visually impaired travelers</li> <li>◆ Explore related work</li> <li>◆ Complete implementation of basic PTMA framework</li> <li>◆ Develop an appropriate framework for evaluating the PTMA</li> </ul>	<ul style="list-style-type: none"> <li>◆ Implement enhancements prioritized according to feedback from user tests with general population and with visually impaired travelers</li> <li>◆ Conduct more extensive user tests with a variety of travelers</li> <li>◆ Iterate on user tests and enhancements that address findings from the user tests</li> </ul>
<b>Fall semester</b>	<ul style="list-style-type: none"> <li>◆ Conduct initial user tests with random sample of travelers from general Pittsburgh population using the basic PTMA implementation</li> <li>◆ Enhance implementation of basic PTMA to address results of initial user tests</li> <li>◆ Implement initial version of PTMA that addresses the needs of visually impaired travelers</li> <li>◆ Submit proposals for further funding from other potential funding sources</li> </ul>	<ul style="list-style-type: none"> <li>◆ Complete final testing and deployment of PTMA</li> <li>◆ Explore possibilities for commercialization and other dissemination options for the implemented PTMA</li> <li>◆ Submit completed work on PTMA for publication</li> <li>◆ Submit proposals to relevant funding agencies for further research and development of proposed enhancements</li> </ul>

## ***Project Team***

The initial envisioned project team will be as follows:

- ◆ M. Bernardine Dias, Assistant Research Professor, Robotics Institute
- ◆ Balajee Kannan, Research Engineer, rCommerce Lab, Robotics Institute
- ◆ M. Freddie Dias, Research Engineer, rCommerce Lab and TechBridgeWorld research group, Robotics Institute
- ◆ Sarah Belousov, Project Manager, TechBridgeWorld research group, Robotics Institute
- ◆ Ermine Teves, Project Assistant, TechBridgeWorld research group, Robotics Institute
- ◆ Nisarg Kothari, Undergraduate Student, Electrical and Computer Engineering (applying to the 5<sup>th</sup>-year Masters program in Robotics)
- ◆ Victor Marmol, Undergraduate Student, Computer Science
- ◆ Hend Geddawy, 5<sup>th</sup>-year Masters Student, Computer Science (fully funded by Qatar Science Leadership Program)

## ***Cost Estimate***

	<b>Year 1 (2010)</b>	<b>Year 2 (2011)</b>
<b>Personnel</b> Estimated partial salary coverage for 1 faculty member (\$10,000), 2 staff members (\$30,000), 1 graduate student (\$10,000), and 1 or 2 undergraduate students (\$10,000). Estimates for year 2 were increased by 5%.	US\$ 60,000	US\$ 63,000
<b>Equipment</b> (Estimated cost of purchasing 5 more mobile phones for field testing)	-	US\$ 2,000
<b>Travel</b> (Estimated cost of travel and participation in a national conference)	US\$ 1,500	US\$ 1,500
<b>Miscellaneous</b>	US\$ 500	US\$ 500
<b>Total</b>	<b>US\$ 62,000</b>	<b>US\$ 67,000</b>

## ***Community Partners***

We have initiated conversations with two leading organizations dedicated to working with individuals with disabilities in the Pittsburgh region. Both organizations have confirmed their interest in collaborating with us on the proposed work. We have included a letter confirming the partnership with one organization as an appendix to this proposal. The second community

partner confirmed their partnership verbally and will submit a letter indicating their intent to partner in the next few days. Both of these organizations possess valuable expertise in helping us to understand the needs and challenges of individuals with disabilities which will be essential for the success of this project.

The Western Pennsylvania School for Blind Children (WPSBC) is a one-of-a-kind educational facility committed to training visually impaired students with additional disabilities. Founded more than 120 years ago, no other agency in the western half of the Commonwealth is better equipped to care for and educate blind children with severe concomitant disabilities than WPSBC. The majority of their students have cognitive and ambulatory challenges and their unique facility and programming are tailored for boys and girls who require distinct educational and supportive services to realize their full potential. The curriculum emphasizes the acquisition of life skills. The Blind & Vision Rehabilitation Services of Pittsburgh (BVRS) is a private, non-profit, United Way agency located in Homestead, Pennsylvania that believes in independence through rehabilitation. For nearly 100 years, BVRS of Pittsburgh has empowered people who are blind, deaf blind or vision impaired to become independent. Experienced and talented instructors, many of whom are blind or vision impaired themselves, provide instruction in essential areas and the organization is heralded by experts in the vision field as one of the top rehabilitation centers in the United States. In the Pittsburgh region they especially provide a variety of services to U.S. military combat veterans.<sup>2</sup>

### ***Potential Sources of Financial Support and Future R&D Funding***

We will be leveraging several other sources of current funding for the proposed work including a gift of five Android mobile phones from Google, ongoing Boeing-funded work, Qatar Science Leadership Program funding for one of the graduate students, and a grant from the Qatar National Research Fund (QNRF) for enhancing assistive technology for educating visually impaired people.

Further potential sources of funding for this work could come from a partnership with the Quality of Life Technology group, submitting a Google research proposal, future NSF and QNRF submissions, local foundation support, and philanthropic gifts from well wishers.

There are many ways to expand this work in the future. Some potential ideas are:

- ◆ Using vision for enhancing GPS-based navigation to provide finer-resolution guidance for visually impaired users to navigate to correct doorways, enable indoor navigation, enable safe crossing of streets, etc.
- ◆ Adapting public policy to allow appropriate mapping of indoor spaces so they are navigable by visually impaired people
- ◆ Enabling added independence for deaf-blind travelers by allowing them to communicate directly with the mass transportation system via the PTMA
- ◆ Enable shopping at malls and advertising for visually impaired people
- ◆ Wheelchair mobility improvement

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<sup>2</sup> [www.wpsbc.org](http://www.wpsbc.org) and [www.blindvr.org](http://www.blindvr.org)

## **Appendix: Letter from Community Partner**



WESTERN  
PENNSYLVANIA  
**SCHOOL**  
FOR BLIND  
CHILDREN

201 North Bellefield Avenue  
Pittsburgh, Pennsylvania  
15213-1499  
(412) 621-0100  
(412) 681-1736 Fax  
[www.wpsbc.org](http://www.wpsbc.org)

November 25, 2009

Todd S. Reeves  
Executive Director and  
Superintendent

To Whom It May Concern:

I am writing to verify my organization's interest in participating with Carnegie Mellon University's research projects led by faculty member Dr. M. Bernardine Dias' research groups related to addressing the needs and challenges of individuals who are blind or visually impaired. In my role at the Western Pennsylvania School for Blind Children, I am in a position to facilitate access to our administrators, staff, teachers, alumni, and students (and their parents to seek permission for their children's participation). Given that our School's current Strategic Plan highlights vibrant partnerships with institutions of higher education and research centers, our interest in partnering with CMU in these efforts is keen.

I encourage you to support this proposed project and look forward to our collaboration with Dr. Dias and her research groups.

Sincerely,

Todd S. Reeves  
Superintendent and Executive Director  
Western Pennsylvania School for Blind Children  
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