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Project Summary

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Overview: This proposal is for a scientific research and development career program that will result in a System for Assisted Navigation of Dynamic and ComplEx Environments (SANDEE) and will help the PI to develop professionally as a researcher, a teacher, a mentor, and an assistive technology practitioner. The system is expected to significantly increase navigation effectiveness for the visually impaired in dynamic and complex indoor and outdoor environments. The specific goals are 1) to develop new localization, orientation, and wayfinding algorithms; 2) to develop new sensor fusion algorithms; 3) to design lightweight wearable wayfinding toolkits for the visually impaired; 4) to design multi-modal communication interfaces; 5) to test the technology on the target population of visually impaired users; and 6) to mentor and train young scientists in assistive technology research. The proposed research will build upon and advance previous research efforts in assisted navigation. Critical aspects of navigation effectiveness will be systematically evaluated through longitudinal user studies.

Intellectual Merit: This project will significantly advance our understanding of localization, orientation, and wayfinding, audio representation of environments, sensor fusion, multi-modal user interfaces, and pervasive computing. Current navigation technologies can be quite error-prone and inflexible due to their tendency to rely on one type of sensor. Here, it is claimed that in many environments exploiting a broad range of sensor types leads to superior navigation effectiveness. Current navigation technologies require that the user commit to a specific communication model. However, this project will show that multi-modal communication interfaces reduce the user's navigation-related cognitive load and allow her to add intelligence to the system dynamically. Existing navigation technologies for the visually impaired rely on body sensors or sensors embedded in the environment. However, this project will demonstrate that, in unfamiliar indoor environments, better navigation effectiveness and user satisfaction are achieved through the use of mobile robotic guides. These views entail a wealth of open research questions ranging from sensor fusion models for localization, orientation, and wayfinding to audio representation of objects and events in the environment. Particularly challenging tasks are the design and implementation of robust localization, orientation, and wayfinding algorithms that integrate information from multiple sensors, the design and development of multi-modal communication interfaces, and the evaluation of the human ability to learn and adjust critical aspects of the system and to use the system on a continuous basis.

Broader Impact: This project will have a significant impact in three areas: outreach, education, and scientific advancement. First, the proposed research is itself an outreach activity insomuch as its objective is to develop a new assistive technology for the visually impaired. Individuals with vision loss will be included in this project at all stages both as researchers and as participants in longitudinal evaluation studies. The project plan contains additional outreach activities such as public awareness lectures at community centers, a conference workshop, and demonstrations at assistive technology shows. Second, by involving both undergraduate and graduate students in research activities, this project will produce new researchers interested in assistive technology and universal access. Research findings will be integrated into the university coursework, thereby increasing the number of students exposed to such critical assistive technology issues as localization, orientation, and wayfinding, multi-modal user interfaces, environment representation, and robot-assisted navigation. Finally, due to the interdisciplinary nature of this research, scientific papers and posters will be published and presented at a range of conferences. SANDEE will be demonstrated at an assistive technology show in Year 3. A workshop dedicated to assisted navigation will be organized in Year 5. All software and hardware innovations resulting from this research will be documented and, in the case of software, distributed over the Internet to the target population, the scientific community, and the general public.