# Advancing Real-time Context-Aware Navigation for the Blind

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**Project Goals:** Advances in emerging technologies in cloud computing, mobile devices, sensors, data analytics, and video processing must help people with different abilities (blindness, hearing impairments) including our senior citizens. My ultimate objective is to provide infrastructure so that blind people are able to play basketball just as any other person. A hearing impaired person should be able to learn in class from the instructor like any one else. People with different abilities should be able to recognize people in a social gathering and attend computer conferences and meetings easily without much burden. I have discussed these ideas with Dr T.V. Raman who is leading the Eyes-Free project at Google, http://www.nytimes.com/2009/01/04/business/04blind.html and my research has been recognized at Purdue.https://www.cs.purdue.edu/homes/bb/focus_award_2017.pdf.

I offered a seminar course titled "Cloud Systems for Blind and Hearing Impaired" https://www.cs.purdue.edu/homes/bb/cs590/. The course was supported by Amazon's generous grant providing access to the Elastic Compute Cloud for each registered student. Students in the class were provided with Android-based smartphones by the Department of Computer Science. Sample of projects continuing research is on following topics.

- *Trust based security for cloud systems:* Development of a trust model and protocol for communication between cloud user and provider
- *Benchmarking of different cloud providers:* Experiments comparing the efficiency of using the Amazon Elastic Compute Cloud vs GoGrid for different tasks
- *A mobile-cloud based pedestrian signal detector*
- *Android application for dollar bill identification:* Processing of the picture of a dollar bill taken by an Android phone's camera in the cloud to determine its value
- *Integration of human resources and cloud systems for persons with blindness*
- *A mobile application for online banking:* Processing of the picture of a credit card taken by an Android phone's camera in the cloud to provide information such as the bank or card number
- *A mobile application for face recognition*

**Challenges:** Independent navigation is becoming a bigger challenge for people with blindness and with the advances in technology, products of which such as hybrid cars (aka quiet cars), it is becoming more difficult to rely on other senses such as hearing for safety. While technology is improving the lives of general public, it is a causing the people with disabilities to fall behind and even puts their lives at risk. Most navigation aids utilizing high technology have high price tags in thousands of dollars. The difficulty of independent navigation in the increasingly complex urban world and the lack of affordable navigation technology cause isolation of the people with blindness or low vision.

**Intellectual Merit:** This effort will advance research in the development of context-awareness tools for people with blindness or low vision by utilizing and advancing knowledge in computer vision, mobile computing, cloud computing, and human-computer interaction. The principle of universal design will be advanced such that the end product will prove useful for a large population and be usable virtually anywhere without requiring any special infrastructure. The key contributions of the proposed research are:

**Multi-function, extensible context-awareness architecture:** Research will be conducted to develop a context-awareness infrastructure using a combination of local and cloud computation resources capable of providing a variety of functionalities. This can lead to an extensible architecture open to many other assistive technology research. Use of cloud computing will contribute to the formation of a large online database of context information for different locations, which can be utilized to avoid repetition of computation or make more accurate estimates about context information.

**Privacy-preserving communication:** Assistive technologies for people with blindness need to address privacy concerns of the users and the people in their immediate surroundings. Research will be conducted for the design of algorithms for privacy-preserving communication between mobile devices and cloud computing resources as well as secure data storage in the cloud.

**Real-time object recognition**: This research will advance research in fast object recognition, which is a major requirement for many real-time applications. It will explore the capabilities and limitations of the recent time-of-flight camera technology to provide guidance on their use in assistive technologies.

**Research tasks include:** Real-time object recognition, Effective interface design, Privacy-preserving communication with remote resources

**Evaluation plans include:** System performance (power consumption, accuracy, resilience) and usability

The design of a self-complete navigation aid for people with blindness or low vision poses challenges in research as follows: (i) develop real-time context-aware navigation technology with adaptable context-awareness in unfamiliar environments (ii) provide a universal design (iii) utilize cloud computing for processing and access to integrated data from various resources for more accurate guidance of information and provide various functionalities on a single handheld mobile device. The last challenge with using cloud computing to provide guidance to the blind users is the concern about privacy. We are currently investigating privacy issues in cloud computing to develop privacy-preserving techniques for communication between the mobile and cloud platforms as well as secure data storage in the cloud.

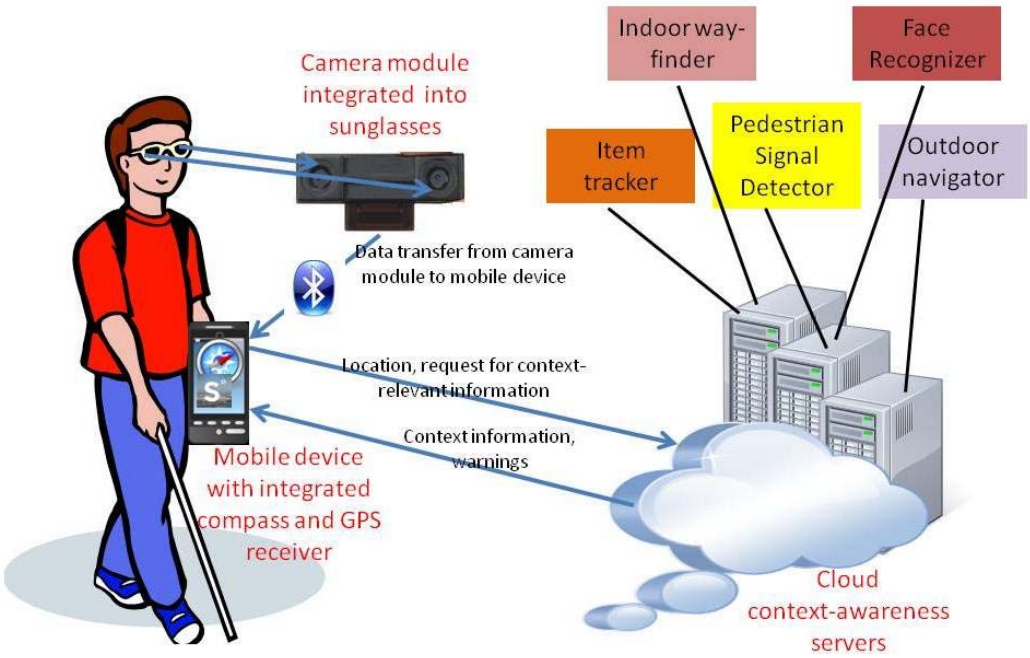


**Figure 1. Broad View of the Proposed System Architecture**

The details pertaining to each of the main architecture components can be presented during our presentation.

**Budget:** We request support for a Ph.D graduate student to design and develop an affordable, easy-to-use and extensible system for real-time navigation guidance to people with blindness or low vision. She will conduct research to reduce the barriers such as cumbersomeness, reliance on a particular infrastructure, high price, limited capabilities, and need for specialized hardware.