

# Work in Progress - Description of a Service Learning Project to Design Assistive Technologies to Aid the Visually-Impaired in India

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**Abstract** - Cultural practices in India that dictate that individuals remove their footwear before entering homes and places of worship creates a challenge for visually-impaired people in identifying and collecting their footwear as they leave. This paper describes an interdisciplinary service-learning project, involving students in Electrical & Computer Engineering (ECE) and the Mechanical Engineering (ME) programs, whose goal is to design and develop assistive technologies to help ameliorate this situation. The paper outlines the relevant technological issues in this project, and discusses how this research might be incorporated into the existing pedagogical structure of both programs.

**Index Terms** - Assistive technologies, interdisciplinary project, service learning, social entrepreneurship.

## INTRODUCTION

It is common practice for people in India to remove their footwear when entering public places such as offices, places of worship, classrooms, etc and even private residences of family and friends. A typical instance of this practice is shown in Figure 1, from which it is evident that the process of independently recovering one's footwear when leaving such places can be a tremendous challenge for a visually impaired person. It often requires feeling and touching multiple pairs of footwear, sometimes performed on hands and knees, in order to identify one's own pair. Such tactile contact with footwear, besides being unhygienic, is considered to be a socially demeaning practice in India.



Figure 1: Pile of footwear

It is the aim of this project to design prototypical devices that could assist visually impaired individuals in locating their footwear through electronic means. Our goal is to design a device that is integrated into a normal cane and that allows for communication between the cane and complementary devices on a pair of footwear.

While the underlying concept is electrical in nature (based on radio frequency identification technology), significant interdisciplinary challenges associated with the project include the development of a viable product prototype, as well as entrepreneurial aspects of manufacturing the product, which are typical issues encountered in innovation and entrepreneurship programs.

Additionally, the project provides a meaningful and rewarding linkage to the service learning aspects of engineering programs, and fits in with the widely-felt need in engineering disciplines to be seen as gateways to professions that serve society, and that attract diverse talent.

## TECHNOLOGICAL ISSUES

Selection criteria for the technology and the components to be employed in the design of these assistive devices were based on the following four important factors: (1) Maximum detection distance; (2) Low maintenance and cost requirements; (3) Low power consumption; and (4) Minimum size/weight of device attachment.

Based on these factors, we have determined that the optimal technology to use would be a Radio Frequency Identification (RFID) system [1]. Such systems consist of an Interrogator and a small Tag - an electronic circuit embedded within a coil antenna, which can be permanently mounted to an article or location - that communicate with each other using radio frequency signals. The Tag comes in two formats: active tags which require a power source, or passive tags which radiate the signal power that they receive from the Interrogator. Each Tag has a unique identifying number (ID) which can be read and uniquely identified by the Interrogator. The Interrogators are radio frequency transceivers which activate tags within their range and decode the resultant tag ID, reporting information regarding the Tag through appropriate signals.

The Tags are durable, low cost devices which can be designed to be easily taped or inserted into the sole or sidewall of sandals and slippers by a visually-impaired

individual. By fitting multiple pairs of footwear with Tags and associating them with the same Interrogator at the time of use, we provide individuals with the ability to select their footwear of choice in real-time according to their needs.

A critical issue in establishing the maximum detection distance is the orientation of the antenna coil planes of both the Interrogator and Tag. The maximum RF energy is radiated and received perpendicular to the plane of the antenna coil [2]. However, this optimal alignment cannot be guaranteed when the Tags are embedded in a randomly oriented pile of shoes. Consequently, the Interrogator would have to be aligned at various angles during a search to enable the Tag to be “spotted” (see Figure 2).

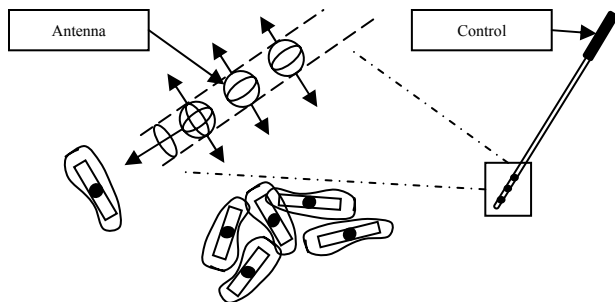


Figure 2: Maximizing detection distance through antenna design

This problem can be overcome by using a set of omnidirectional antennas distributed along the axis of the Visual Assistance Device (VAD) used to hold the Interrogator. A unidirectional antenna is added at the end of the VAD to allow for precise location of the Tag after general localization. We anticipate that detection can be first achieved from a distance of about 3 feet; precise location is then established through the use of distance-modulated vibration, and possible additional audio feedback.

**PEDAGOGICAL STRUCTURE**

As a Catholic university, service-learning in an urban context has been an integral aspect of UDM’s mission, and hence is an important component of engineering programs at the university. Many different courses across the engineering curriculum have integrated such projects into their pedagogical structure. For example, the ECE program is designing an interactive display for visitors at the Detroit Science Center, and the ME program has worked on adapting wheelchairs and cribs for disabled parents [3]. We find that this project fits well with such a mission, while also providing an excellent research context for advanced undergraduate and graduate students in ECE and ME.

Initially, the project will serve as the research topic for a Master’s thesis in ECE. We expect that students within the ECE program could then modify and adapt the basic design developed through the thesis to create laboratory prototypes as part of their coursework in a Digital Logic or Embedded Systems course. Subsequently, students within the ME program could investigate product prototypes within an ME Design course.

Recently, an Innovation & Entrepreneurship curriculum has been launched at the University [4], which emphasizes social entrepreneurship and the use of case studies in instructional pedagogy. We believe that this project can serve as an excellent example for students in this program to study the process by which a social need serves as a catalyst for a technological innovation, which could then drive an entrepreneurial collaboration between universities and industry to bring such a product to consumers in need. The cultural aspects of this project will also help students appreciate the concept that technology works best when tailored to the particular social context in which it operates.

**SUMMARY**

This paper outlines relevant technological and pedagogical issues in a design project to aid the visually-impaired community in India. Research validating the basic concept and establishing the parameters for a product prototype are expected to be completed by the middle of summer. These aspects of the project, as well as planned future developments will be presented at the conference.

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**REFERENCES**

[1] Dobkin, D., “The RF in RFID: Passive UHF RFID in Practice”, Newnes, Elsevier Inc., 2008.  
 [2] Lee, Y., “Antenna Circuit design for RFID Applications”, Microchip Application Notes AN710, accessed March 23, 2009. <http://ww1.microchip.com/downloads/en/AppNotes/00710c.pdf>.  
 [3] Rayess, N.E. and Kleinke, D.K., "Faces on Design: A Partnership between Clients, Students and Community Volunteers", accepted for publication in the Proceedings of the ASSE 2009 Annual Conference and Exposition, Austin, TX, 2009.  
 [4] UDM Entrepreneurship Curriculum, <http://www.udmercy.edu/stay-connected/news-events/newsletters/ces/2007/01/program-updates/entrepreneur.htm>, accessed March 23, 2009.  
 [5] Integrated Systems, <http://integrateindia.com>.

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