

ACCESSIBLE MAP INFORMATION. Map information can be presented as auditory verbal messages. An example is the use of Talking Signs® Remote Infrared Audible Signage (http://www.geog.ucsb.edu/~marstonj/DIS/CH2_4.html) to provide information about the immediate environment. The Talking Signs continuously transmit messages encoded as IR signals, which are picked up and decoded by the pedestrian's handheld receiver and converted to audio speech [25]. The fixed messages generated by Talking Signs are not designed to provide wayfinding information between arbitrary locations in a complex space.

A more recent development is the ClickAndGo Wayfinding system of narrative maps [26]. The advantage of the ClickandGo narrative mapping service is that the maps (comprised of verbal descriptions and high-contrast print and symbols) are designed by O&M professionals and customized to each facility. Because they are designed explicitly for BVI users, each map contains wayfinding information that would not be present on traditional maps, e.g., descriptions of changes in floor texture, salient sounds, or other nonvisual landmarks, as well as detailed verbal descriptions of key routes and layout geometry. When combined with a beacon system, the maps also allow for real-time positioning. ClickandGo is a commercial service with a proven track record, including contracts to provide narrative maps in transportation venues such as the Washington Metropolitan Area Transit Authority and the New York City Department of Transportation. Use of such a system in airports would be a natural extension to other transportation hubs and would support the goal of having a consistent and seamless interface available to BVI travelers.

With the increasing importance of graphical communication in our society, some research has focused on development of new tactile, vibrotactile, and haptic methods for conveying graphical information including in maps. For a review of the pros and cons of some of these approaches, see O'Modhrain et al. [27].

There are several relatively straightforward technologies for preparing tactile maps, including the use of braille embossers. One limitation of tactile maps is that the density of graphical information is typically low compared with corresponding visual maps. This means that a tactile map of a large and complex space, such as an airport, would either be very large or contain only a small subset of the information in a printed map of the same physical size. In principle, however, tactile maps of selected portions of an airport (e.g., from a specific gate to baggage claim) could be made available to BVI passengers prior to travel either in hard copy or as downloads to a braille embosser. Research is needed to determine the practical value and limitations of hardcopy tactile maps for airport wayfinding.

Vibro-audio maps, discussed earlier, represent another promising wayfinding solution for use in airports. Key advantages of this interface are that the maps are based on commercially available smartphones that many BVI people already own; incorporate multimodal information including haptics, audio, and gestures; and can use existing data sources to provide BVI travelers with either real-time information (assuming a positioning system such as iBeacons, or can be used in an offline prejourney mode).

AUDITORY BEACONS. The BVI traveler often relies on the sense of sound to locate targeted elements within an indoor environment. For instance, to exit a restaurant or store, it is common