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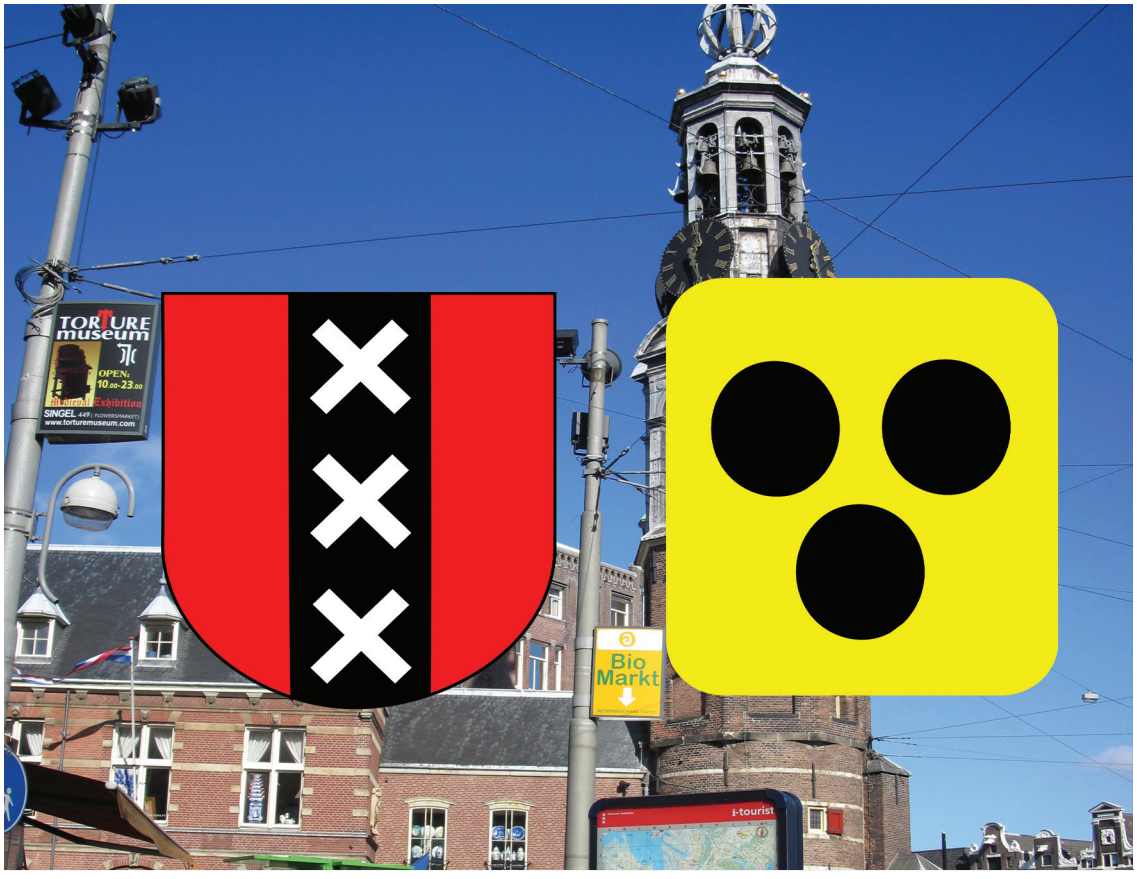
Verlichten

by Lily Bui



SENSEable CITY LAB, MIT

PROJECT DESCRIPTION

Imagine for a moment that you are blind.

The usual visual cues that a sighted person would rely on to navigate a space -- street signs, the image of oncoming cars, the painted borders of crosswalks -- are unavailable to you. Though a vast majority of visually-impaired people live in urban environments, many are prevented from efficiently traveling in cities, especially true in unfamiliar areas. In the Netherlands, there are 311,000 people with vision impairment, approximately 2% of the entire population. There are also an estimated 30 million visually impaired people in all of Europe. The Dutch national government is aware of this gap and is working to address it; for instance, they have inducted a "right to sight" campaign called VISION 2020 to raise public awareness about avoidable vision impairment. Still, the visually impaired are often an overlooked part of the urban population with regard to urban planning and design.

At the same time, Amsterdam is currently struggling with issues of overcrowding in its major historical and downtown districts. Tourists flood commercial areas, deterring local residents from spending time or money there. Many report seeking alternative commuting routes to avoid crowds altogether.

While sighted pedestrians can determine whether a space is crowded or not simply by looking, visually impaired pedestrians who cannot see or cannot see well must discern crowdedness through other sensory cues, such as sound. To further complicate the scenario, the future of mobility in Amsterdam is certain to involve more electric vehicles and cyclists on the road, so auditory cues that help blind and visually-impaired pedestrians orient themselves to the road will become less available. The same problem arises in parks and open public spaces that can be crowded without necessarily being noisy. The need for urban design solutions that are cognizant of sensory limitations of the visually impaired is clear in the statistics as well as in our site visit to Amsterdam. In interviews and meetings with city planners emerged an articulation of the desire to design for social inclusion, to create spaces that enable and encourage socialization between different groups of people.

Problems of access and overcrowding provoke the question: how might we leverage existing technologies to help visually impaired pedestrians navigate overcrowded spaces? The solution may lay in public lighting.

Public lighting, one of Amsterdam's major areas of investigation, is a ubiquitous form of infrastructure distributed throughout the city. While there are a number of projects that have launched to explore different use cases for exploiting light's form -- for instance, an "on-demand" lighting system called Tvilight designed by Delft University of Technology in which the street lights would only glow fully in the presence of a person, bicycle, or car -- not much has been done to maximize on the lighting infrastructure's pervasiveness in urban space.

Though a vast majority of visually-impaired people live in urban environments, many are prevented from efficiently traveling in cities, especially true in unfamiliar areas.

Right:Urban light pole in downtown Amsterdam.

The proposed "Verlichten" project involves maximizing on the ubiquity of urban lighting infrastructure as a location-based sensing platform to help visually impaired pedestrians safely navigate Amsterdam's crowded spaces.

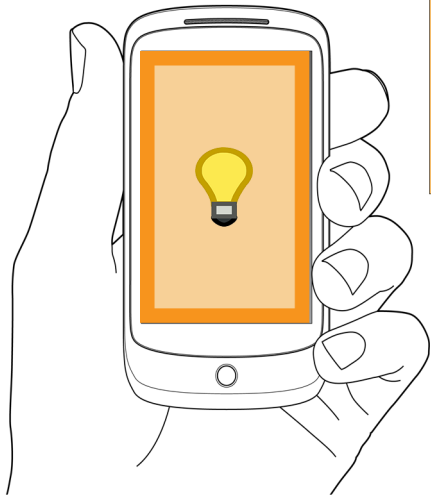
It uses 360 cameras deployed across the network of lighting infrastructure in order to monitor pedestrian, cyclist, and vehicle traffic on the sidewalk and road. The lighting infrastructure becomes a sensing platform wherein each pole's camera locally senses its surroundings for people and vehicle traffic; generates data from low-resolution images; and relays the information to a mobile platform that can be used by visually impaired pedestrians. The system is responsive to the pedestrian's location, creating a "safety bubble" around them, and it also pairs with smart phones and smart canes to convey information about potential hazards.

Because visually impaired pedestrians cannot see the screens of their smart phones, auditory and verbal features help with navigating the interface. The mobile platform is "speaks" to the pedestrian in real time as s/he proceeds along the commute, communicating information about oncoming pedestrian, cycling, or vehicle traffic. Visually impaired pedestrians can access this audio by way of smartphone or a smart cane. The pedestrian can make decisions about whether or not to continue on the path or to change routes and seek a less crowded path. The platform will be aware of the pedestrian's location at all times as s/he enters the sensing radius of each light pole and communicate information about the pedestrian's immediate vicinity.

The data that this platform generates can reveal meaningful patterns of mobility of the visually impaired urban population. It can also be used toward mapping the crowdedness of sidewalks and roads in public spaces over time. One can imagine this data being used toward urban planning applications as well as everyday use by pedestrians who simply want to plan commuting routes based on foot traffic in certain areas. Local residents who would like more information about crowding in Amsterdam as well as tourists visiting from outside of the city can benefit from the data this platform generates.

Verlichten in Dutch means "to illuminate," which can be read two different ways -- both to irradiate a surface or to make something known and bring forth knowledge. The Verlichten platform employs the lighting structure to act as eyes on the street for those who cannot see.

As Amsterdam forges a path into a digitally-oriented future, a "design for all" approach in addressing overcrowding in the city ensures that this future will be one accessible to underserved populations as well as the general populi.



"Oncoming traffic is heavy."

The cane is a natural interface for the visually impaired pedestrian.

Above: Visually impaired pedestrians can use a mobile app to interface with the Verlichten sensing platform.

PERSONAL INTERACTION

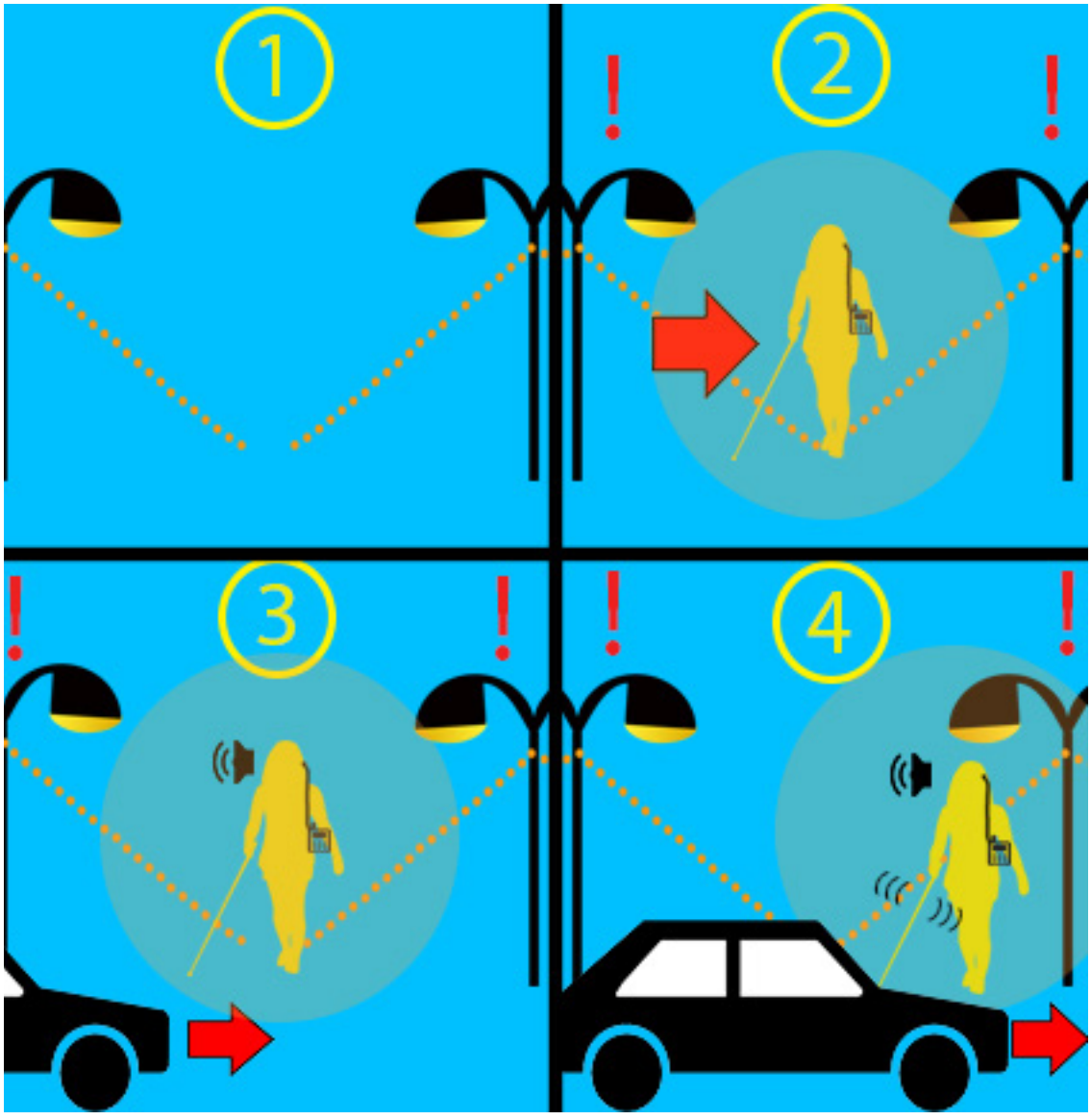
The Verlichten project addresses the gaps in existing technologies for the visually impaired. Within this system, even in the absence of a human guide, visually impaired pedestrians can use a mobile app enabled with voiceover to access information about pedestrian traffic.

At the beginning of a commute, the visually impaired pedestrian would open up the mobile app and leave it running. Along the commute, the Verlichten sensing platform will track where the pedestrian is in relation to the sensing grid. In especially crowded areas, the app will "speak" to the pedestrian in order to alert him or her about pedestrians, cyclists, or vehicles in the vicinity. For example, at a busy intersection, the app will tell the pedestrian if cars are approaching. In parks, which can be crowded yet relatively quiet, the app will tell pedestrians when cyclists or other pedestrians are nearby. The visually impaired pedestrian can then make decisions in real time about whether or how to alter his or her route. At the end of the commute, the pedestrian would simply close the app. Paired with a smart cane, the mobile app would also prompt the cane to play a vibratory signal in the direction of the hazard as an ancillary warning of obstructions. The cane is a natural interface for the visually impaired pedestrian; a vibratory signal makes use of an object that the pedestrian is already using to convey information.

Thus, when the pedestrian is walking in the city, the sensing platform deployed on the lighting system serves as the "eyes on the street" for those who are visually impaired.

While electronic aids for visually impaired pedestrians do exist, It is important to keep in mind that even a combination of non-visual sensory input will give a visually-impaired person an insufficient perception of space. Current electronic audio-based guides to cities require extensive training to use and are not consistent in design nor are they reliable. that place-based apps do not provide real-time feedback about space. Critiques of current smartphone apps for the visually impaired are directed mostly at the fact that place-based apps do not provide real-time feedback about space.

Interviews with individuals who have worked with visually impaired communities or are visually impaired themselves reveal some details about what information blind/visually impaired pedestrians expect on the street. The cognitive load that visually impaired pedestriaisn must pay acute attention to -- street names, where the street is in relation to the sidewalk, number of lanes in the street, direction of traffic, when to cross the street, whether they are on the left or right sidewalk, nearby buildings and traffic light, etc. -- is further complicated by having to navigate crowds of people, on top of also having to navigate nonhuman obstacles.



Above: A pedestrian constantly has a "safety bubble" around them, which activates nearby camera sensors. When potential hazards are present, the Verlichten platform communicates this to the pedestrian through audio on the mobile app.

The platform can also be synced with smart canes, which can vibrate as an ancillary alert to the pedestrian.

URBAN INTERACTION

Amsterdam currently has accessible crosswalks that generate a sound audibly faster when it is safe for pedestrians to cross and more slowly when it is not. However, codified systems for visually impaired pedestrians are neither ubiquitous nor consistent in the Netherlands. In recent years, a "smart light" system has been installed at Hoekenrodeplein, a plaza in front of the Amsterdam ArenA, in order to experiment with how to use programmable lighting systems paired with sensors that detect pedestrians walking through the plaza and dim or brighten lights along their trajectory. This is one of the first steps toward using lighting as a sensing platform that could potentially be maximized for other sensing cases.

a "safety bubble" for visually impaired pedestrians

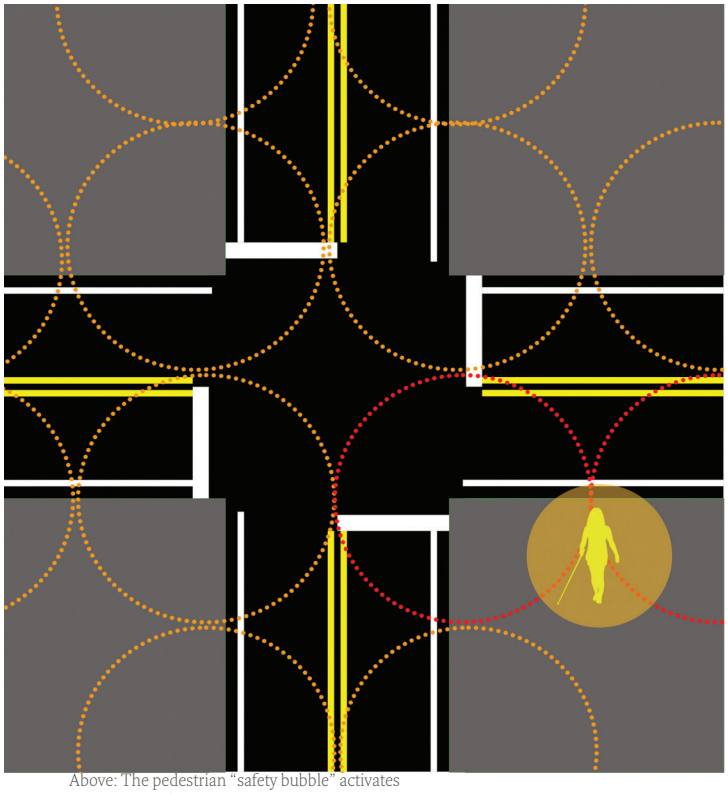
The Verlichten system would not only enable tracking types of crowds in real time; it would also allow for better accessibility of sidewalks for visually impaired pedestrians throughout the city. In effect, it creates a "safety bubble" for visually impaired pedestrians, providing a moe secure way to navigate unfamiliar spaces.

Instead of having to rely only on cues in the built environment, Verlichten gives real-time feedback about the immediate environment via a more ubiquitous interface, a mobile phone and a cane.

The data that the Verlichten platform would collect data about the crowdedness of urban areas, which can potentially be repurposed toward urban mapping and planning as well as for similar crowd apps for the sighted population.

This initial design is specifically for the Knowledge Mile, an area in Amsterdam slated for development into an innovation district by 2018. It spans the length of Wibautstraat on the southeastern side of the city. Unlike downtown Amsterdam, the Knowledge Mile has wider sidewalks and can take a longer amount of time for pedestrians to walk from one block to the next. Most visually impaired people live and travel in such environments, making it an ideal test site. Each light will be "aware" of its vicinity and be able to relay that information to individuals with the companion mobile app or a smart cane.

Left: The Knowledge Mile is slated to be Amsterdam's new innovation district by 2018.

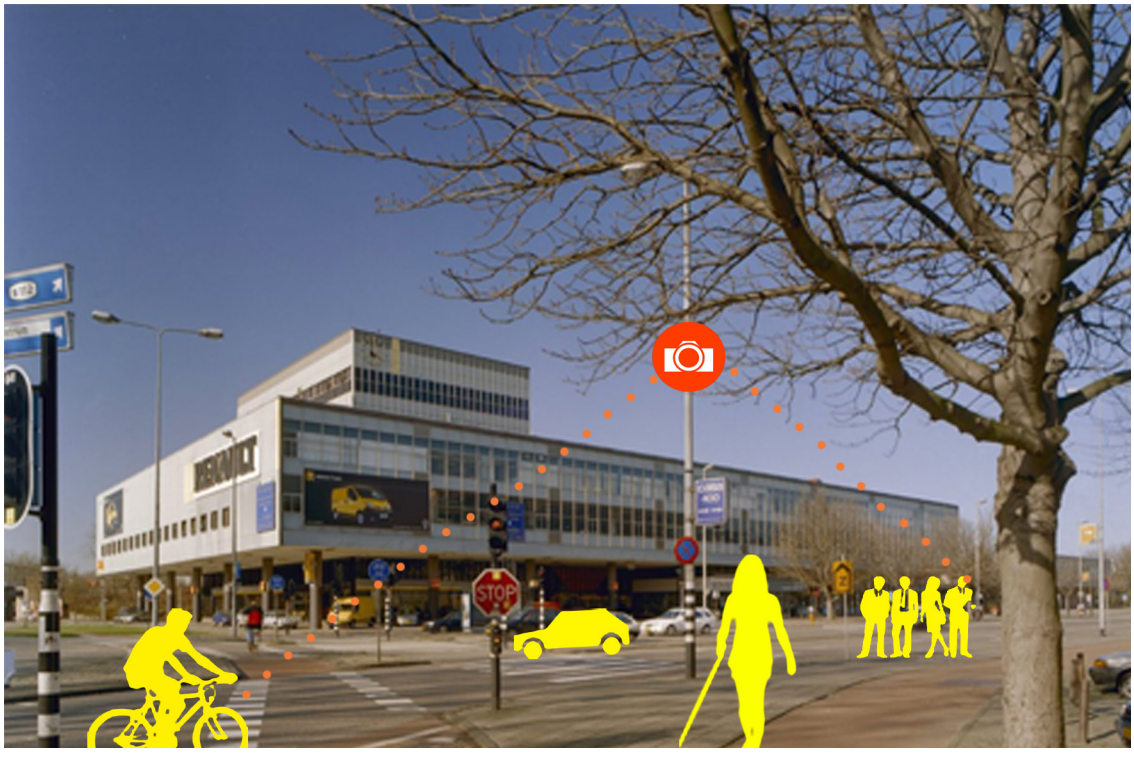


active camera range

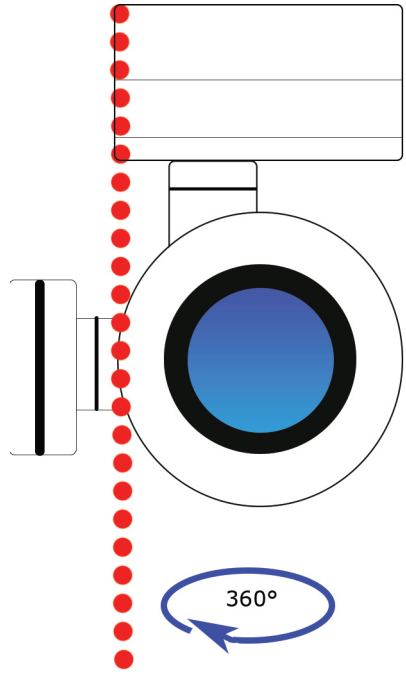
camera range

Above: The pedestrian "safety bubble" activates the network of cameras the pedestrian moves through it.

Below: The Verlichten cameras detect pedestrians, cyclists, and vehicle traffic within the camera's radius.



TECHNOLOGY INTERACTION



This system relies on these core components in order to function: a 360 camera mounted on a light pole whose image radius serves as a geofence; smartphone GPS; 3G to relay local information from the camera sensor to the phone; and Bluetooth technology that can pair a smart phone with a smart cane.

The 360 camera sensors are mounted on light poles distributed throughout the city. The cameras gather low-resolution images between 20 and 60 fps throughout short intervals. In a cloud server, an algorithm analyzes the images and parses them for an approximation of pedestrian and vehicle traffic within the area. The data are exported as a string and published to an API, then also archived.

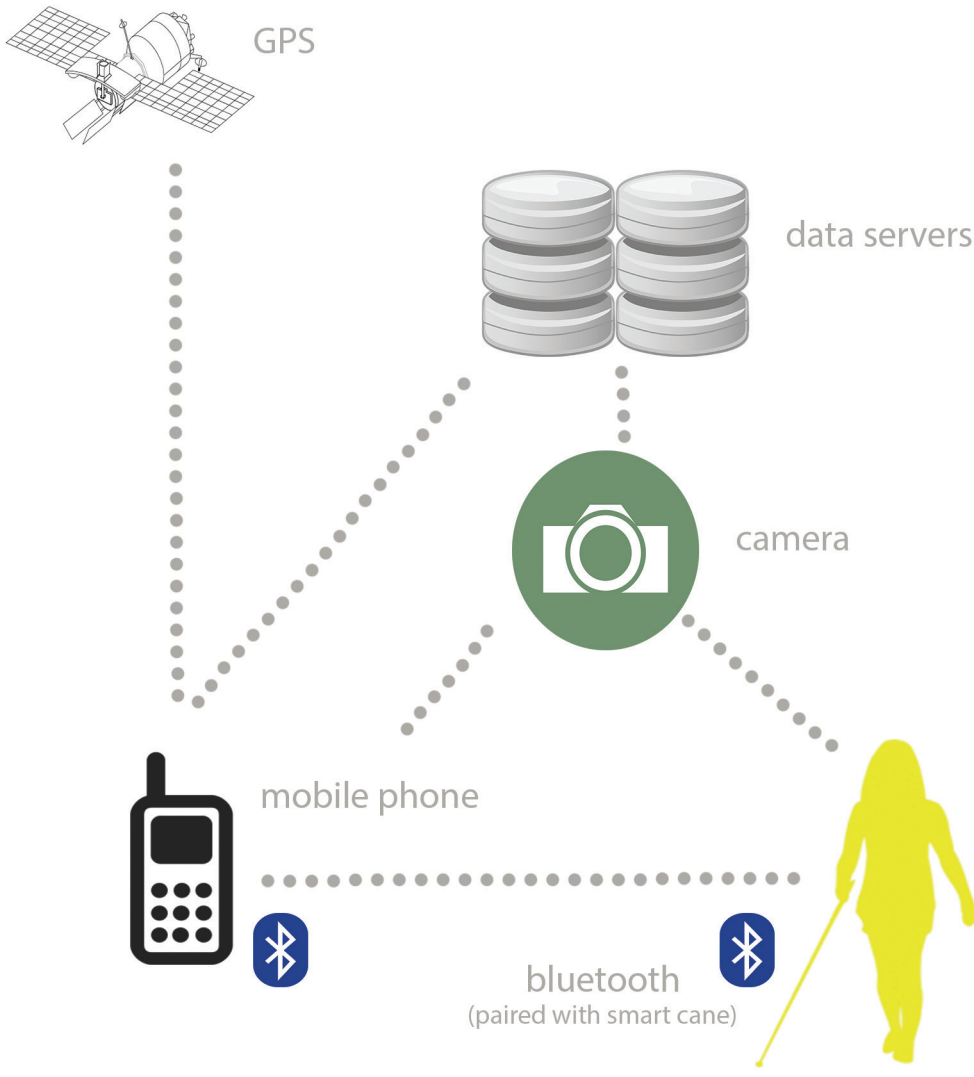
Smartphone GPS locates the user and also generates a 300-meter "safety bubble" or geofence around the user. This safety bubble activates all camera sensors in its vicinity, allowing for on-demand image processing as opposed to leaving the system running perpetually.

The cameras are connected in a mesh network and can thus be responsive to each other. For example, if an oncoming vehicle is approaching a crosswalk where the visually impaired pedestrian is situated, the mesh network will be able to sense and anticipate oncoming traffic, then broadcast warning message to the pedestrian before they cross the street over a 3G network. The warning message will be delivered in the form of audio on a smartphone. If the pedestrian has a smartcane, it can be paired with a mobile phone through Bluetooth. Whenever the mobile phone receives a warning message, the smart cane will simultaneously vibrate to serve as an ancillary warning. Smart canes containing an internal compass can also be programmed to vibrate in the general direction of the threat.

Because the analyzed data is extracted from the image file, there is no need to save the image file itself. To ensure the privacy of pedestrians on the street, the images are discarded immediately after the software analyzes the image and renders the data. Ultimately, the data collected and archived by the platform can be used to better understand mobility patterns of the visually impaired; identify potentially hazardous areas for visually impaired pedestrians; and contribute to knowledge about the makeup of crowds across the city.

Above: A low-resolution 360 camera is mounted on lighting infrastructure, providing for ubiquitous crowd sensing.

Right: How the technological components interact with each other.



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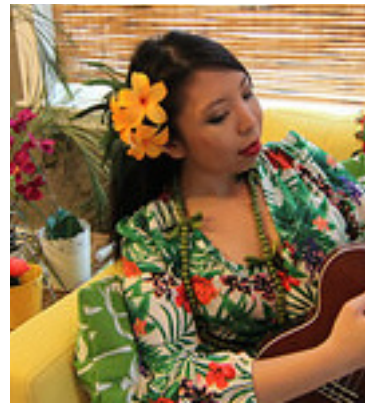

LILY BUI

Lily Bui is a masters student in MIT's Comparative Media Studies program. Her research focuses on the use and representation of sensor data in urban contexts. She is also a research assistant at ArchiMedia, a writing and rhetoric lab that explores various aspects of science communications. Previously, she worked as a STEM Story Project Associate at the Public Radio Exchange (PRX) and the Executive Editor at SciStarter, PLOS CitizenSci, and Discover Magazine's Citizen Science Salon. In past lives, she helped produce the radio show Re:sound for the Third Coast International Audio Festival out of WBEZ Chicago; worked on Capitol Hill in Washington, D.C.; served in AmeriCorps in Montgomery County, Maryland; worked for a New York Times bestselling ghostwriter; and performed as a touring musician.