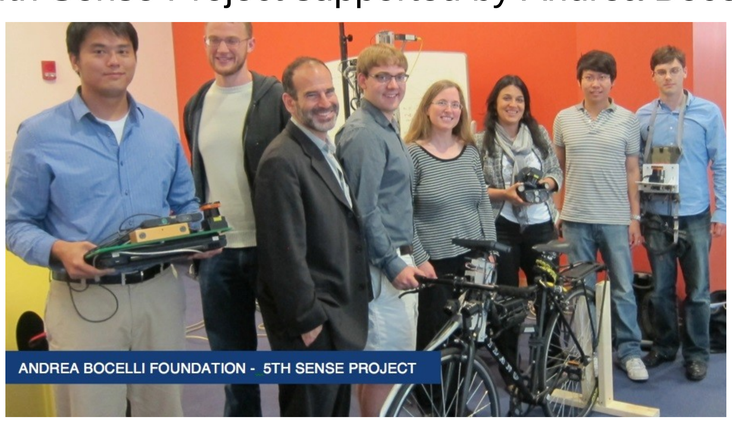
Environmental Text Spotting for the Blind using a Body-worn CPS

Hsueh-Cheng Wang, Rahul Namdev, Chelsea Finn, Peter Yu, and Seth Teller
Robotics, Vision, and Sensor Networks Group
Computer Science and Artificial Intelligence Laboratory (CSAIL), MIT

Motivation

- Environmental text is important in every-day task, but such information is inaccessible to 285 million blind and visually impaired (BVI) people around the world.
- Fifth Sense Project supported by Andrea Bocelli Foundation



MIT Fifth Sense Project: Providing Key Functions of Vision to the Blind and Visually Impaired.

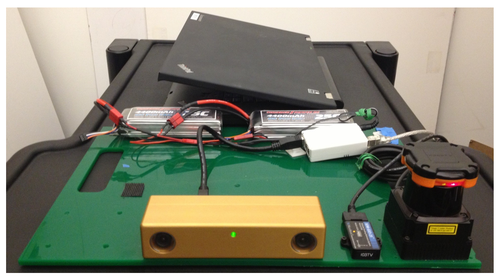
Italian tenor Andrea Bocelli became blind after a childhood accident.

Challenges

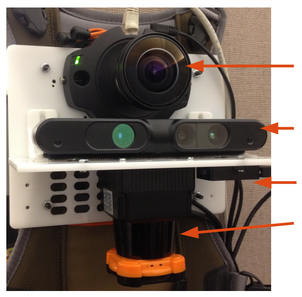
- Unlike scanned documents, scene text only occupies tiny portion of entire field of view (FOV) with high variability
- Decoding is resolution-demanding and computationally intensive
- Similar to classical CPS challenges, a real-time system that allows message passing among computation and physical processes is needed.

Body-worn/Mobile CPS

- As a substitute for the eyes to allow communications among sensory devices, algorithms, and BVI users.
- Using frameworks in robotics and sensor networks (LCM and ROS).



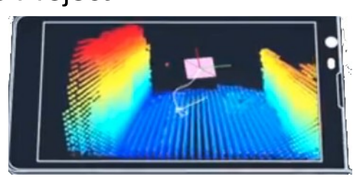
June, 2013

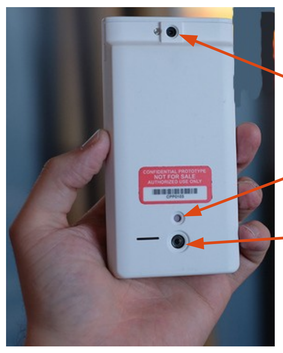


Pan/Tilt/Zoom Camera
Depth Sensor
IMU
LIDAR Laser Scanner

Dec., 2013

Google Tango Project
March, 2014

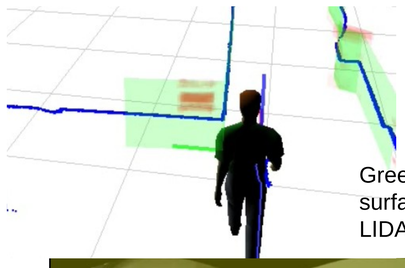




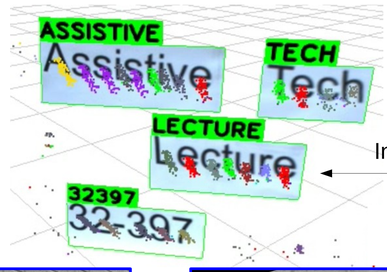
4 MP RGB-IR Camera
Depth Sensor
170º Fisheye Motion Tracking Camera

Text Spotting using SLAM with Feedback Loops

- Incorporate spatial prior on text locations by depth sensors
- Dewarp to remove perspective effects, and Integrate with 3D mapping

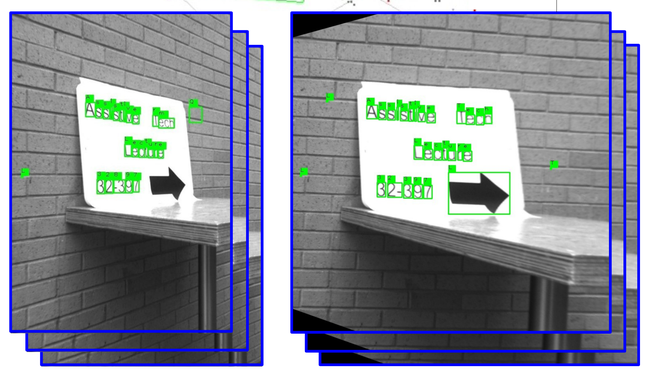


Green: vertical surface found by LIDAR



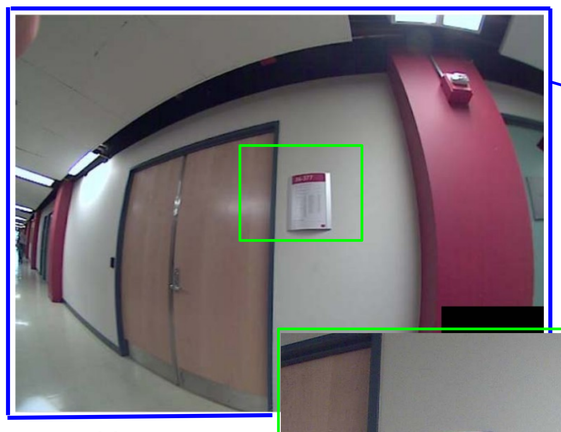
Integration

Translucent yellow: regions excluded due to prior.

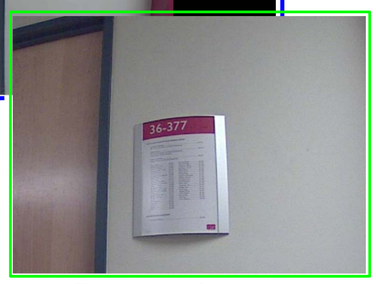


Human-CPS Interaction

- Using an electronic braille, blind users can not only access where text likely occurs in current field of view, but also control the PTZ cameras to foveate the region of their interests.

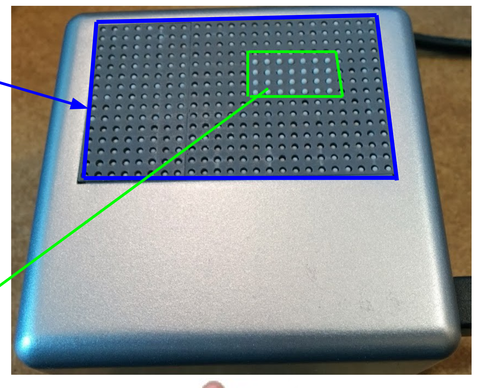


Wide FOV



Foveated Imagery

Text detection algorithm shows where text likely occurs



Users press the pins to zoom in

24 x 15 Braille Display

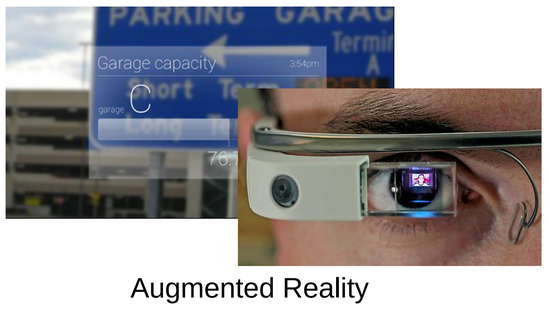
Potential Impact and Future Work

- Our work can lead to many applications, such as health care and augmentation of human capabilities.

Carnegie Robotics Stereo Sensor

Support decision Making in Supermarket

Outdoor Navigation



Augmented Reality