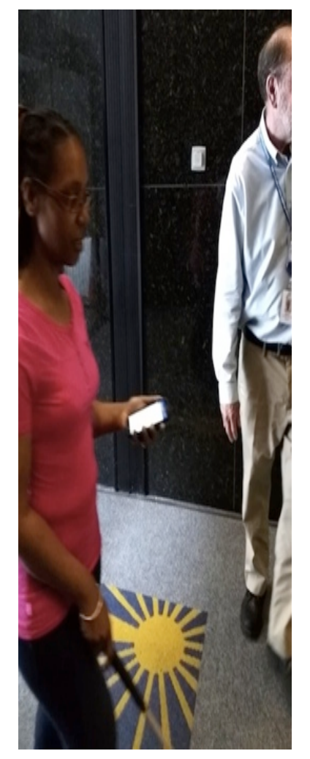
ASSIST: Assistive Sensor Solutions for Independent and Safe Travel of Blind and Visually Impaired People +

Zhigang Zhu[1*], Vishnu Nair[1], Greg Olmschenk[1], William H. Seiple[2]
[1]*The City University of New York, USA;* [2]*Lighthouse Guild, USA*
*Email: zzhu@ccny.cuny.edu

Presented at the IJCAI Workshop on
AI for Social Good, January 8th, 2021

SAT-Hub: AI, Machine Learning and IOTs for Social Good



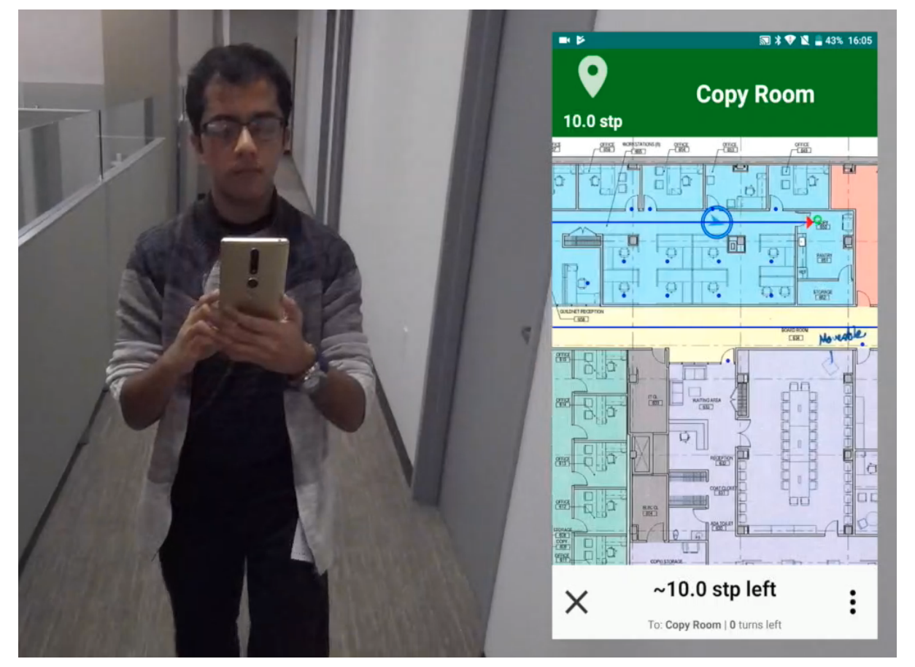
Tests with 40 + BVI & ASD Users:
IRB Informed Consent: Ethics & Privacy

ASSIST Indoor Navigation Test Lighthouse Guild (2018)
Usability: 11 BVIs , 5 with ASD; Performance: 6 BVI and 11 Blind-folded

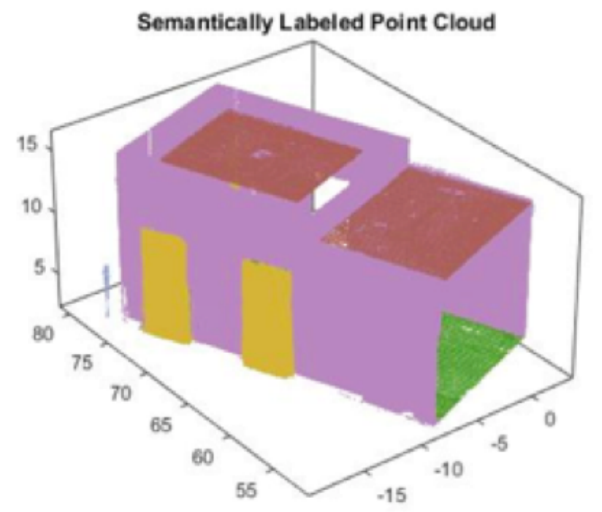
Assistive Focus Groups with ASD Goodwill NYNJ (2019)
All participants used public transportation for all or most trips; 22 Individuals in ASSIST App & VR, then a focus group

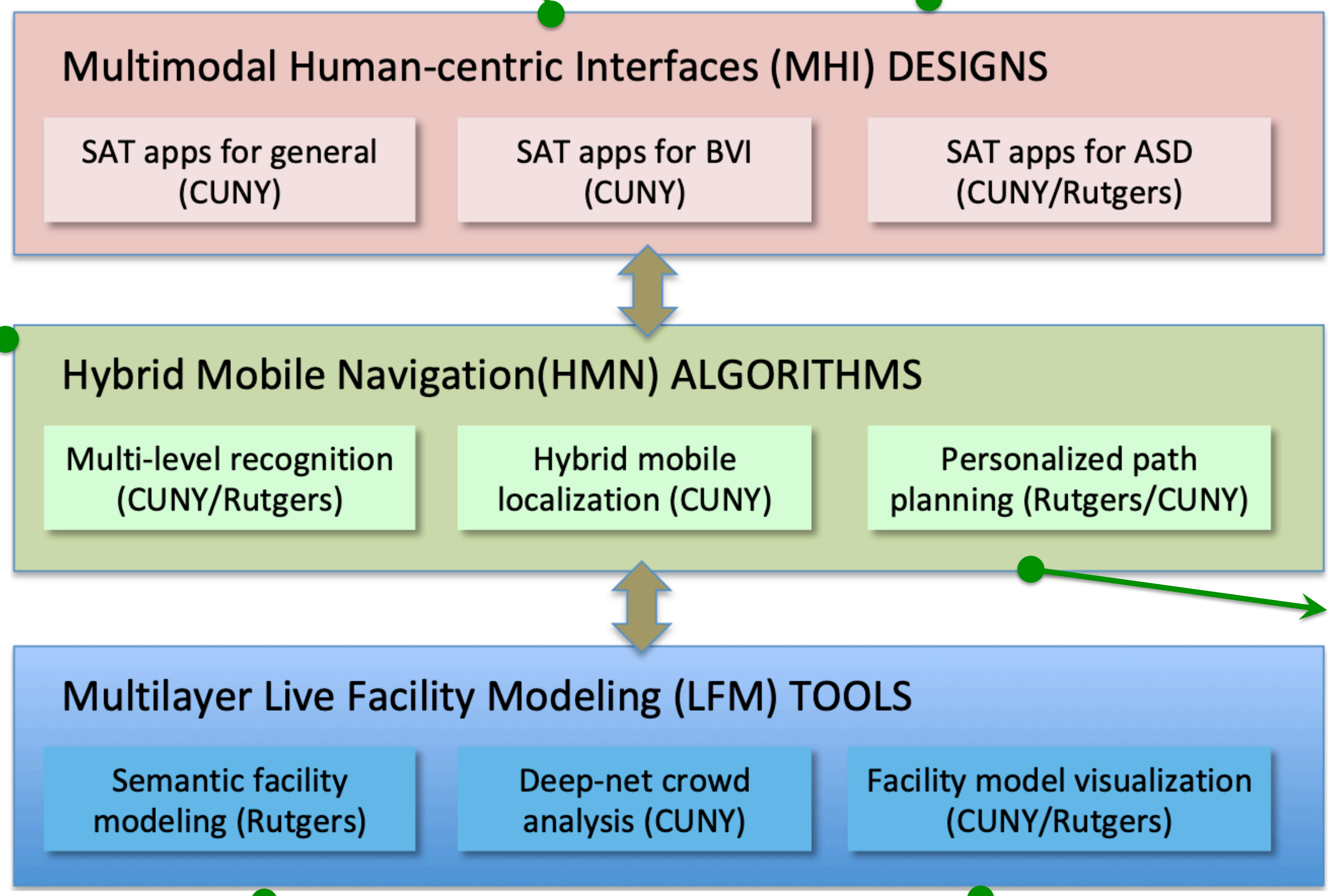
ASSIST Navigation Apps:
- **Accurate positioning**
- **Multimodal & personalized interfaces**
- **Android and iOS phone based apps**

Privacy, Inclusive, Unobtrusive, Diversity:
- **User location tracking not saved or shared**
- **Universal designs for various groups of users**
- **Mobile devices without attracting attention**
- **Increasing job opps with neurodiversity**



ASSIST (with Tango):
https://youtu.be/Hq1EYS9Jncg
iASSIST (with ARKit):
https://youtu.be/iH1LZ-HAjWs





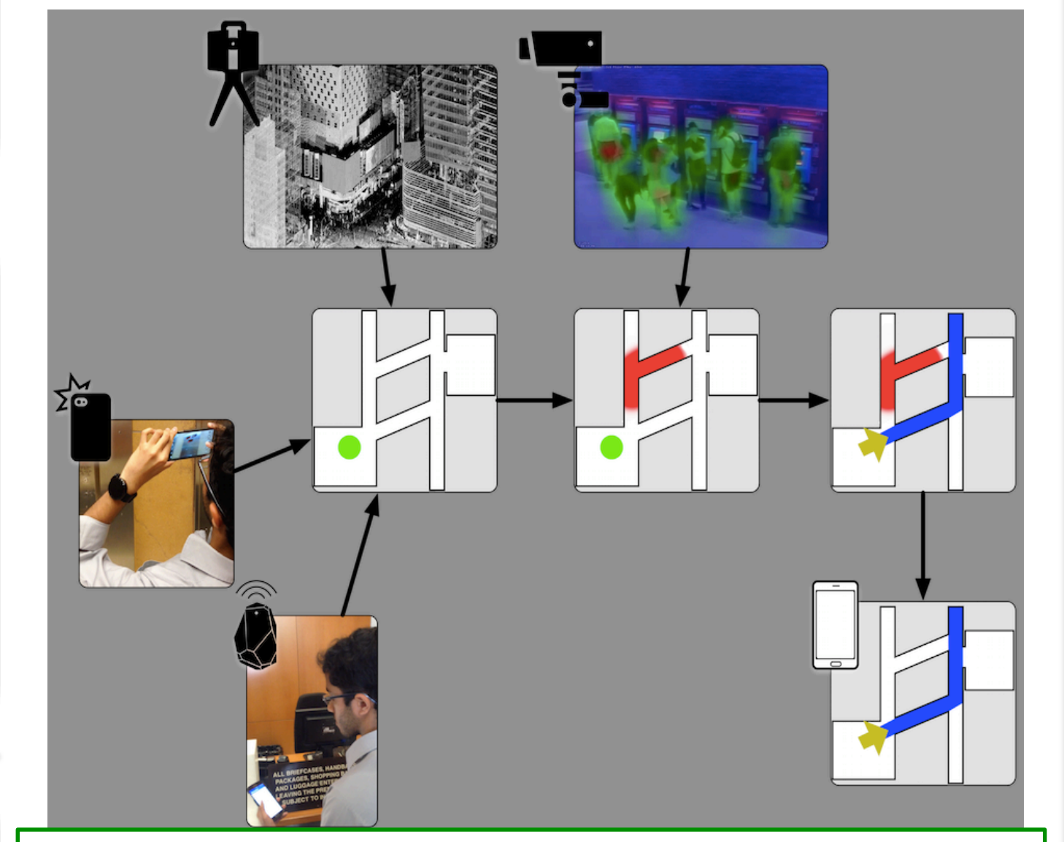
Multimodal Human-centric Interfaces (MHI) DESIGNS
- SAT apps for general (CUNY)
- SAT apps for BVI (CUNY)
- SAT apps for ASD (CUNY/Rutgers)

Hybrid Mobile Navigation(HMN) ALGORITHMS
- Multi-level recognition (CUNY/Rutgers)
- Hybrid mobile localization (CUNY)
- Personalized path planning (Rutgers/CUNY)

Multilayer Live Facility Modeling (LFM) TOOLS
- Semantic facility modeling (Rutgers)
- Deep-net crowd analysis (CUNY)
- Facility model visualization (CUNY/Rutgers)

GCNN for 3D Segmentation:
- **Self-supervised learning for semantic features w/ ContrastNet & ClusterNet**
- **Making use of large unlabeled 3D data**

Big Data Divide & AI Bias:
- **Human data labeling has bias**
- **Self-supervised only uses data**
- **Semantic labeling are for services**



Hybrid & Personalized Nav:
- **BLE+vision: robustness & accuracy**
- **Android Tango & iOS ARkit platforms**
- **Personalized route planning**

ADA.gov, Diversity & Privacy:
- **ADA Compliance – new regulations?**
- **Diversity in schools and workplaces**
- **Tracking without privacy concerns**

SAT-Hub Demo Video:
https://youtu.be/KXZnxyA30KM

Semantic Facility Modeling:
- **LiDAR for high-fidelity 3D facility models**
- **Hi-res omnidirectional images -> any views**
- **Multi-layers with semantics and activities**

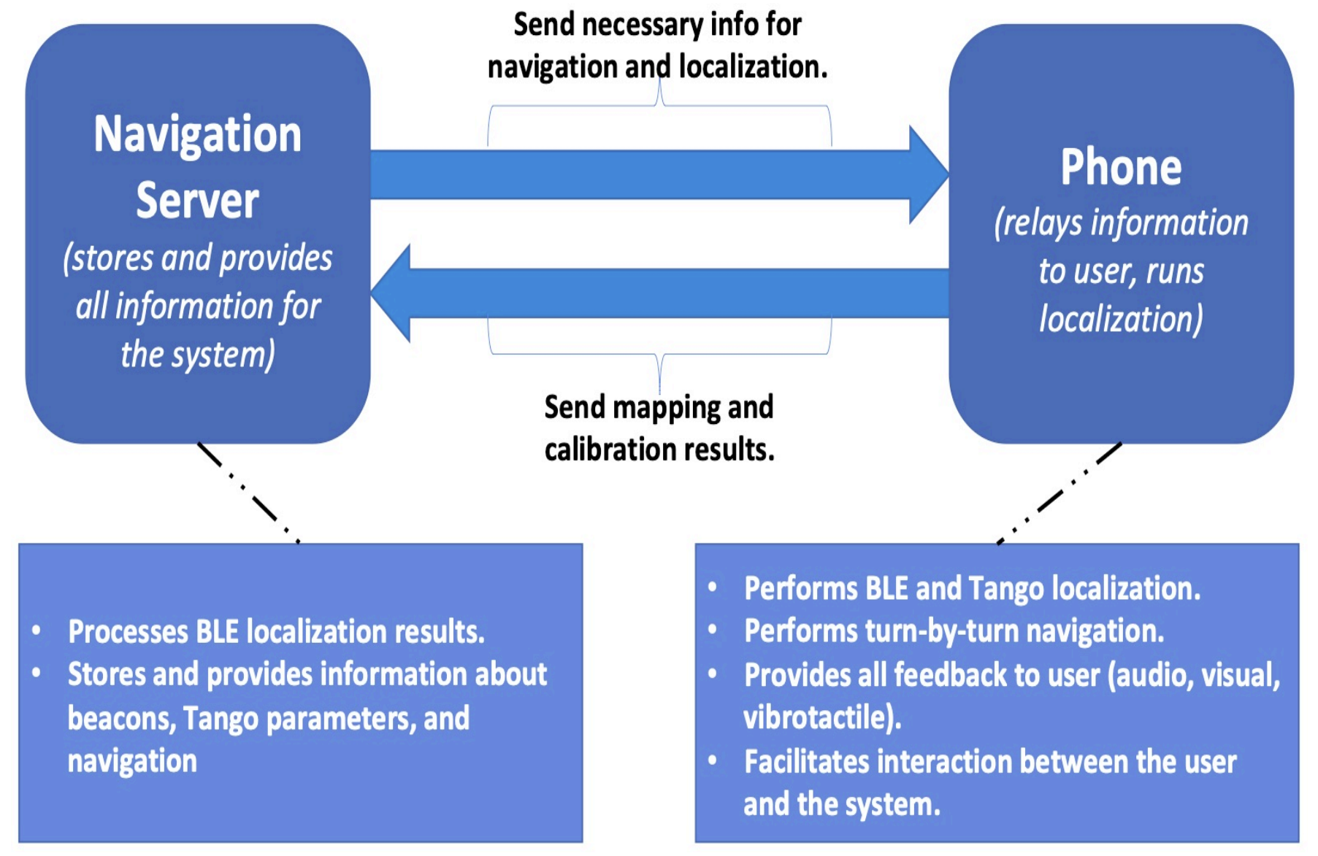
Big Data Divide in 3D & Viz:
- **Traditionally 3D &VR only for sighted**
- **Proposed 3D for services of BVI and ASD**
- **Closing the gap in the big data divide**

Crowd Analysis w/ CNN+GAN:
- **Training models with less labeled data**
- **Generalizable to other cameras**
- **Semi-supervised multi-target regression**

Privacy w/ Surveillance Cameras:
- **Using existing public cameras**
- **Processed in the frontend**
- **Individual identities not saved or shared**

ASSIST: Senors & System, Multimodal Interface and User Evaluation

ASSIST's Client-Server Structure



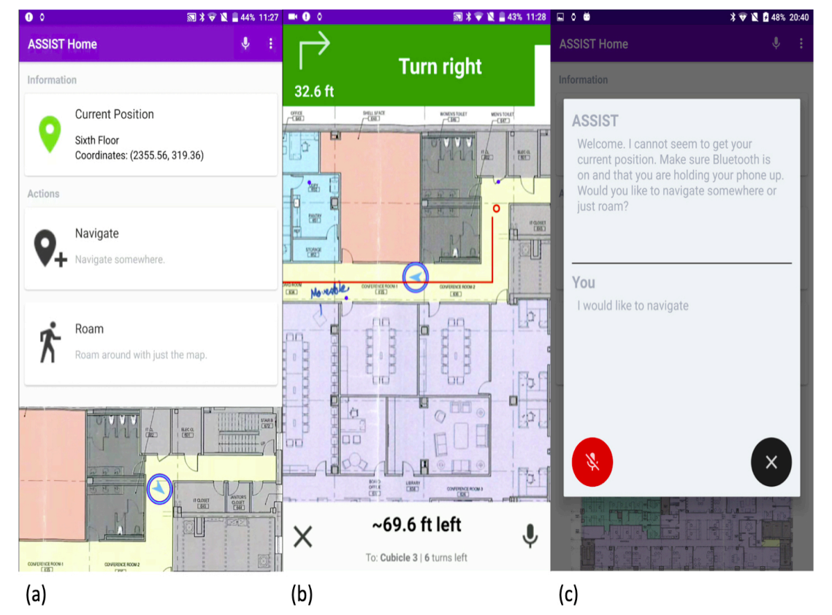
Send necessary info for navigation and localization.

Send mapping and calibration results.

Navigation Server *(stores and provides all information for the system)*
- Processes BLE localization results.
- Stores and provides information about beacons, Tango parameters, and navigation

Phone *(relays information to user, runs localization)*
- Performs BLE and Tango localization.
- Performs turn-by-turn navigation.
- Provides all feedback to user (audio, visual, vibrotactile).
- Facilitates interaction between the user and the system.

User-Centric Navigation Experience: Interfaces and Levels of Interaction



(a) home screen, (b) navigation interface, (c) voice engine interface.

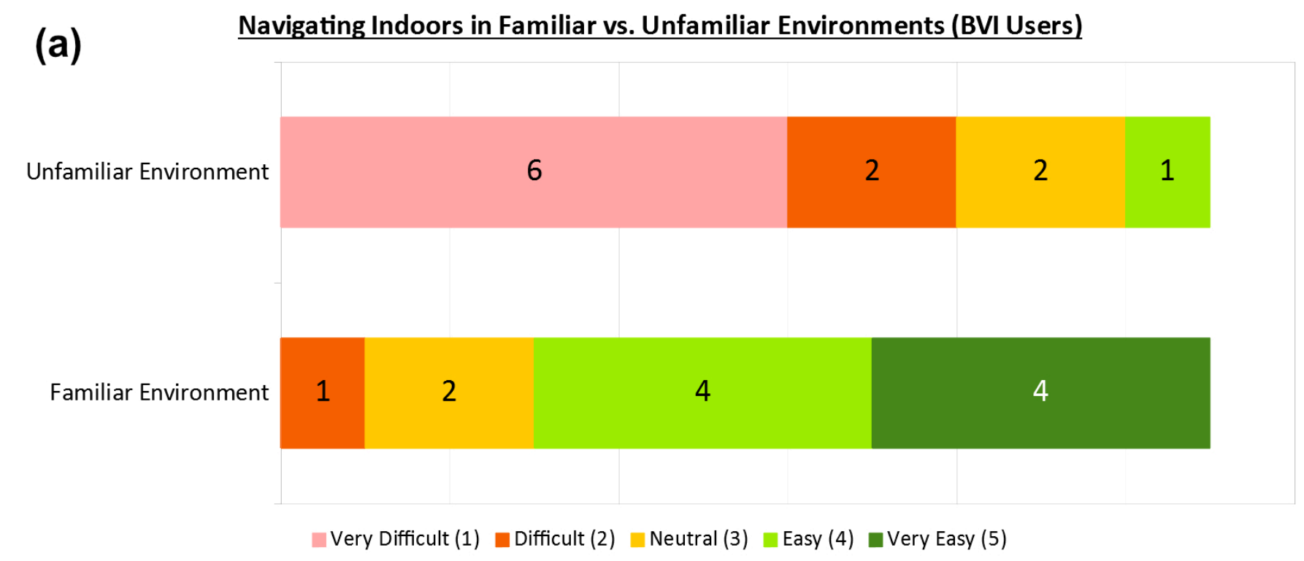
Interface Features	Minimal	Medium	Maximal
Speech announcements of all major instructions	X	X	X
Flashing of icons at major points		X	
Changing of colors on-screen		X	
Obstacle announcements		X	X
Haptic feedback (total)		X	X
Haptics: Single burst before major alerts/instructions		X	
Haptics: Continuous bursts before and at instruction point			X
Veering correction			X

User Evaluation: Usability Study

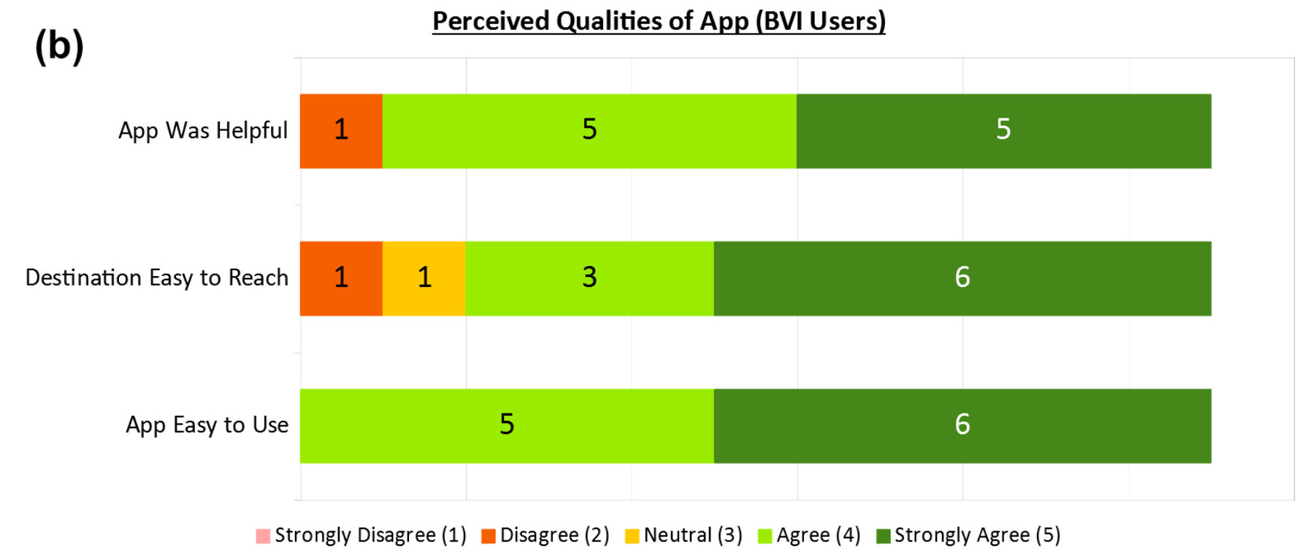
Paths taken by participants during usability studies

No.	BVI Class	Age	M/F
1	Legal blindness	55+	Male
2	Total blindness	35-44	Male
3	Legal blindness	55+	Male
4	Total blindness	55+	Male
5	Total blindness	55+	Female
6	Total blindness	45-54	Female
7	Total blindness	25-34	Male
8	Legal blindness	55+	Female
9	Total blindness	55+	Male
10	Total blindness	55+	Female
11	Legal blindness	55+	Male

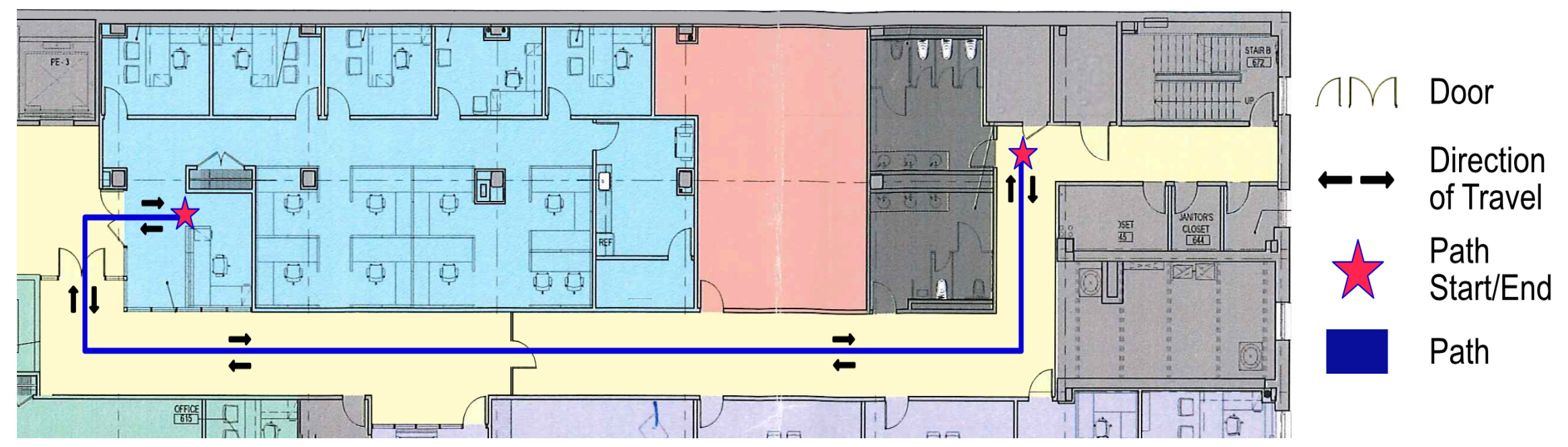
(a)



(b)



User Evaluation: Performance Study



Condition	BVI		Blindfolded	
	Time (s)	Events	Time (s)	Events
A *(aid + no app)*	84.4	1.5	111.8	1.8
B *(aid + app)*	78.5	0.3	101.6	0.5
C *(after "training")*	77.2	0.7	119.6	2.0

Conclusions and Discussions

- The app was generally very well received by all subjects, and the performance study showed that the app reduced their navigation errors.
- Although recruiting blindfolded users was not ideal for the performance study, we observed some similarities and obvious differences when comparing them with blind and visually impaired users.
- We believe that an accurate system is needed, at least in a dense, metropolitan area like NYC
- Our studies have shown that the design and execution of usability studies is paramount to the successful development of such an app.
- Developing a real-time, reliable, low- or no-cost, user-centric app needs not only the appropriate technologies in research and development, but also related policies and new ADA compliance for buildings and facilities and market mechanisms to provide incentives to industry.

This work is supported by NSF via awards #CNS-1737533 & #IIP-1827505, Bentley Systems, Inc., and ODNI IC CAE at Rutgers (#HHM402-19-1-0003 & #HHM402-18-1-0007).

+ Excerpt of Nair, V., Olmschenk, G., Seiple, W. H. & Zhu, Z. (2020): ASSIST: Evaluating the usability and performance of an indoor navigation assistant for blind and visually impaired people, *Assistive Technology*, DOI: 10.1080/10400435.2020.1809553