

# Enhancing Urban Navigation for Blind Travelers with a Smart Phone Aid that Benefits from a Network of Trusted Sources

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# OUTLINE

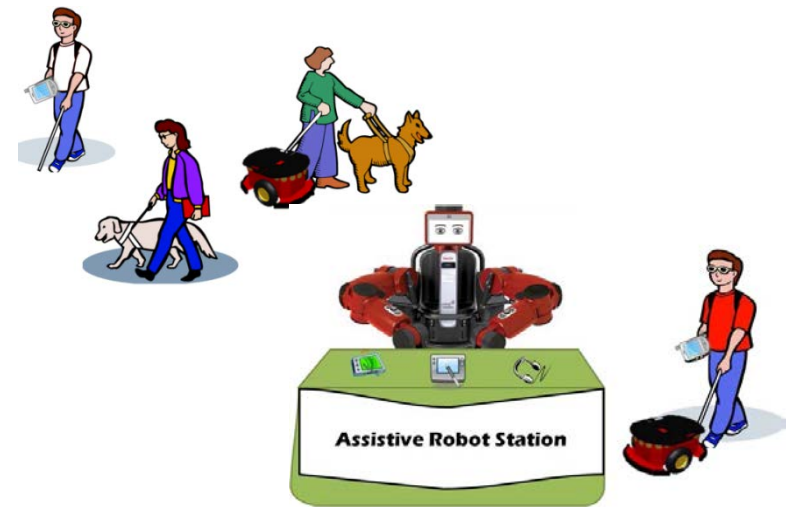
- ❑ MOTIVATION
- ❑ RELATED WORK
- ❑ RESEARCH GOAL
- ❑ PROPOSED SOLUTION
- ❑ SUMMARY AND FUTURE WORK

# MOTIVATION

- ❑ 285 million people are visually impaired in the world
- ❑ Dynamic changes in unfamiliar environments can make safe and independent urban navigation a challenge
- ❑ Smart cities could potentially enhance the safety and independence during navigation
- ❑ Smartphones are likely to be the primary modality



*Blind adult interacting with smartphone-based navigation app*



*Illustration of blind travelers in future smart cities*

# RELATED WORK

- ❑ White Cane
- ❑ Dog Guide
- ❑ Smart Phone-based Navigation Tools
  - ❑ NavPal Indoor App
  - ❑ BlindSquare, Ariadne, Loadstone, etc
- ❑ Crowdsourcing Approaches
  - ❑ VizWiz
  - ❑ Tiramisu
  - ❑ Blind Leading the Blind

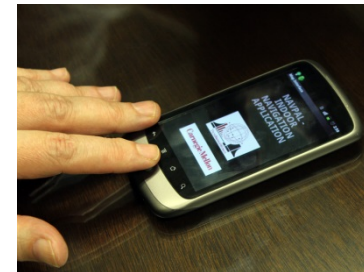
## ISSUES:

- ❑ Not point-to-point navigation
- ❑ Inflexible to deal with dynamic changes
- ❑ Hard to discern if the information is trustworthy



This Image from \*

*Strategies blind travelers utilize to navigate*



*NavPal*



*Tiramisu*



BlindSquare

*BlindSqure*

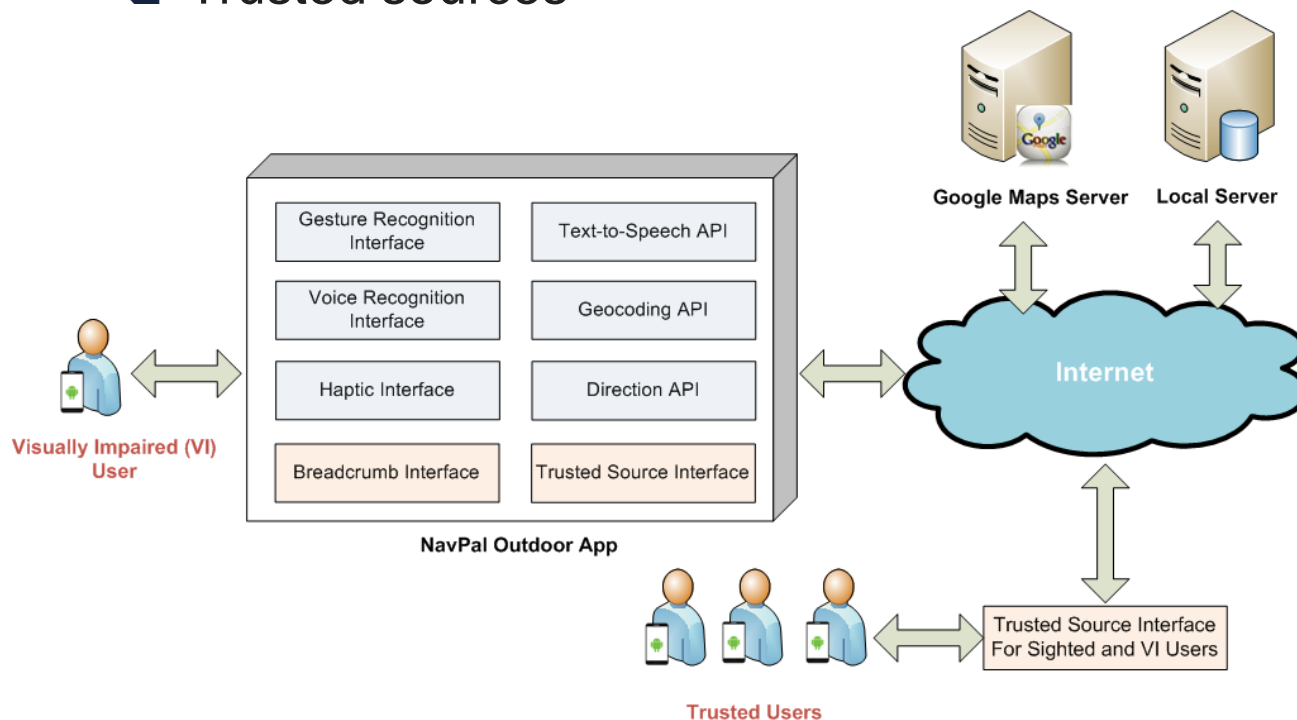


*VizWiz*

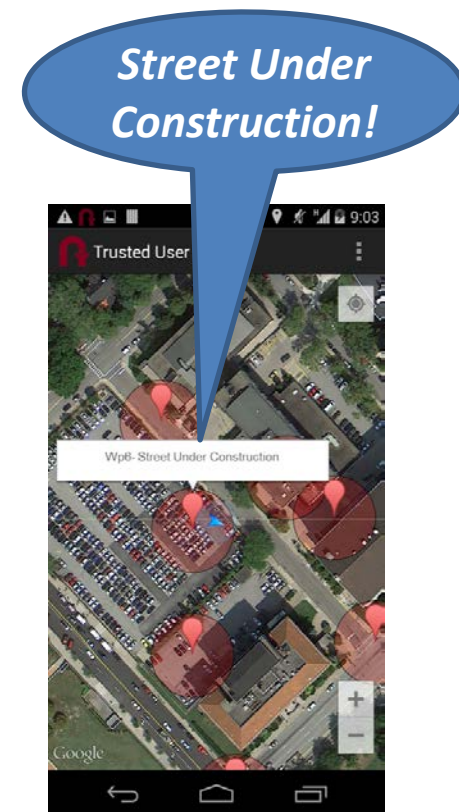
\* Image source: <http://www.dailymail.co.uk/news/article-1043529/Pensioner-lose-guide-dog-walking-slowly.html>

# RESEARCH GOAL

- ❑ Introduce a mechanism for blind travelers to enhance the performance of a smartphone-based navigation tool by
  - ❑ Breadcrumb annotations
  - ❑ Trusted sources



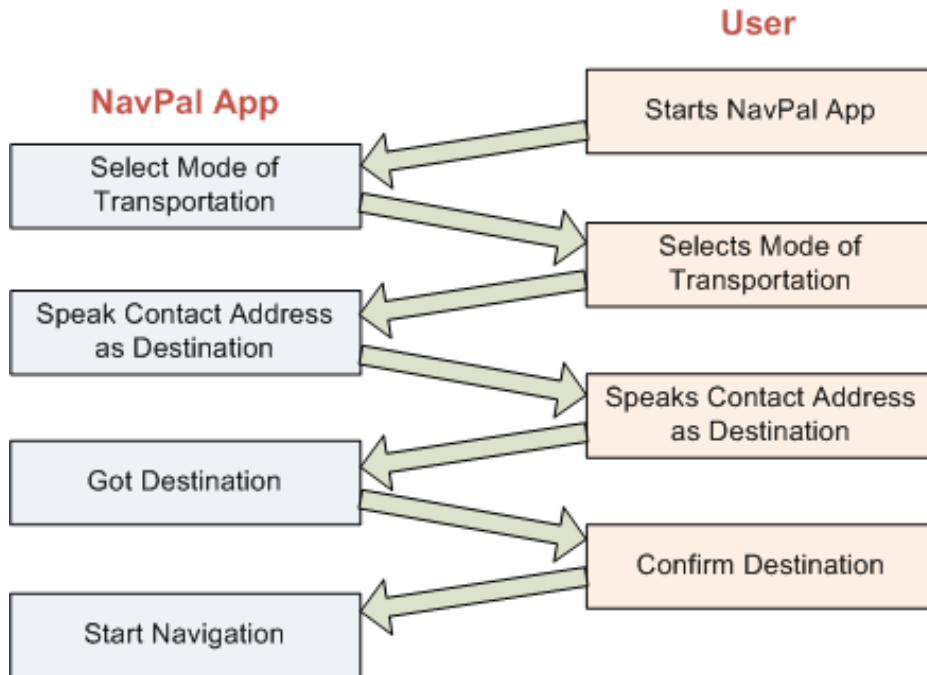
*System Architecture of the NavPal outdoor app*



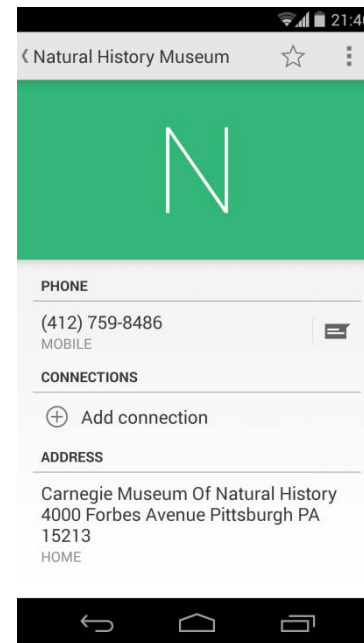
*Example of useful annotation added*



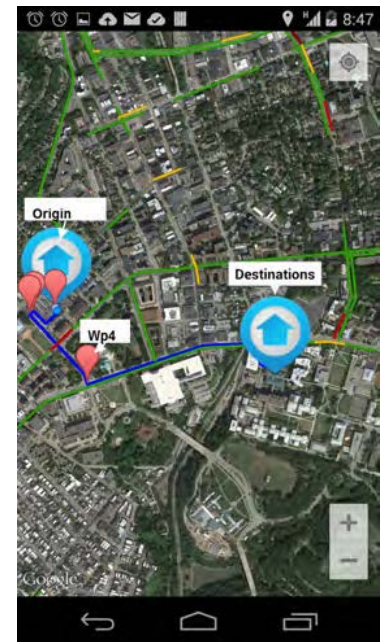
# NAVPAL OUTDOOR APP



*Interactions between the NavPal outdoor app and the user*



*Contact name and address*



*Snapshot of NavPal outdoor app*

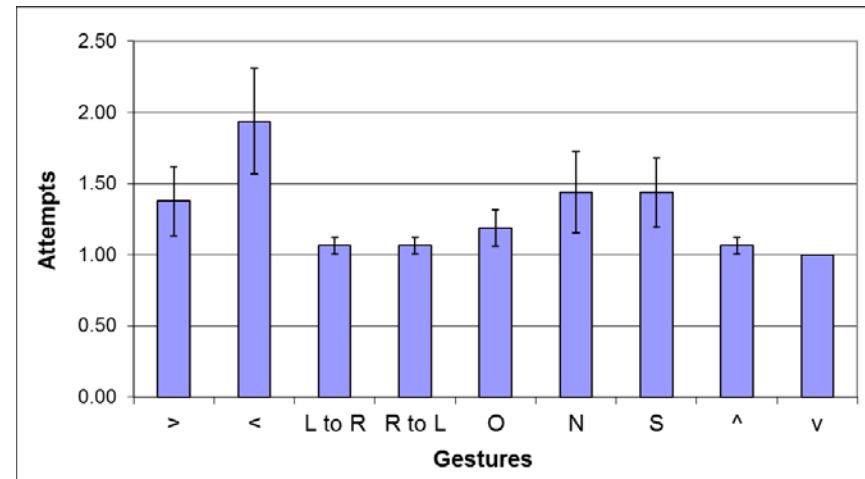
# ITERATIVE DESIGN

- ❑ Conducted with 4 participants (3 blind; 1 visually impaired)
- ❑ Input via on-screen gestures



*Gesture drawn  
on the screen*

Gestures: >, <, swipe right, swipe left, O, N, S, ^, v



*Summarized results form gesture testing*

## RESULTS

Troublesome gesture: <, N, S, and >

Performed correctly: *swipe right, swipe left, ^, v, O*

Preferred directional swiping with one or two fingers

# ITERATIVE DESIGN

## ❑ Overall accessibility of interface

- Input the transportation medium
- Speak the contact name
- Use gestures
- Speak an address location
- Navigate on the map by gestures

Participant	Attempt1	Attempt2	Attempt3
	(a) - (c)		(d),(e)
P1	3/3	3/3	2/2
P2	1/3	2/3	2/2
P3	2/3	3/3	2/2
P4	0/3	2/3	-
Average	1.5/3	2.5/3	2/2

*Usability studies on the NavPal outdoor app*

## ❑ Feedback

- Speech recognition
- Voice instruction
- Gesture instruction
- Overall performance

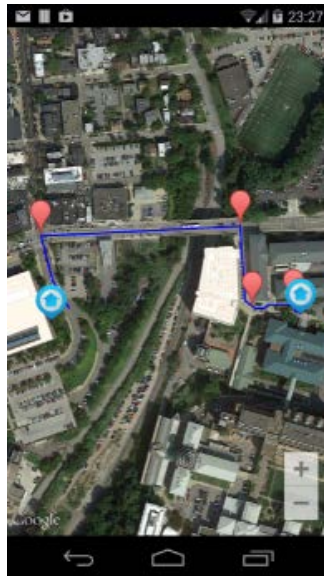
Participant /Item	(a) Speech	(b) Voice	(c) Gesture	(d) Overall
P1	5/5	4/5	5/5	9/10
P2	5/5	3/5	5/5	8/10
P3	4/5	4/5	5/5	9/10
P4	2/5	4/5	4/5	6/10
Average	4/5	3.75/5	4.75/5	8/10

*User score on the NavPal Outdoor app*

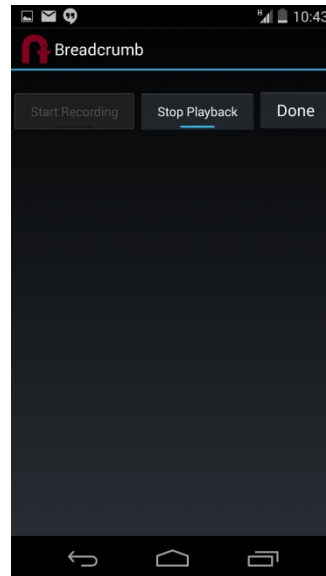


# BREADCRUMBS APPROACH

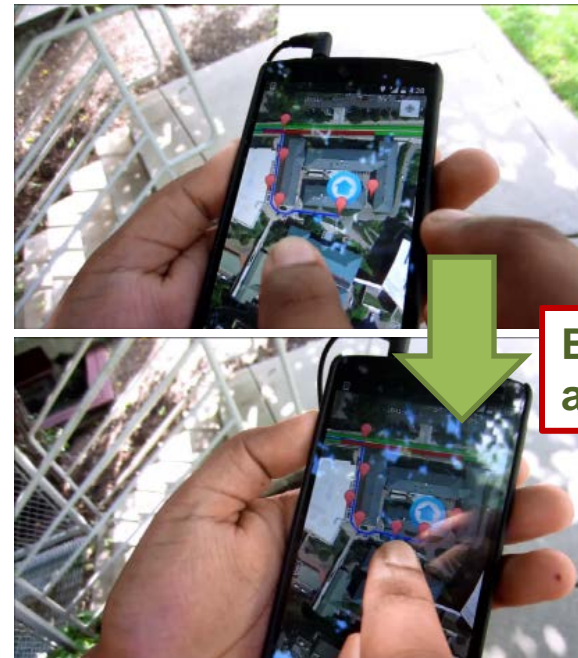
- ❑ Concept – Visually impaired travelers are able to
  - ❑ Annotate their routes on maps
  - ❑ Record other information that will be useful for future trips to the same location
  - ❑ Share this customized information with others who may find it useful



*Snapshot of NavPal outdoor app*



*Breadcrumbs Interface*



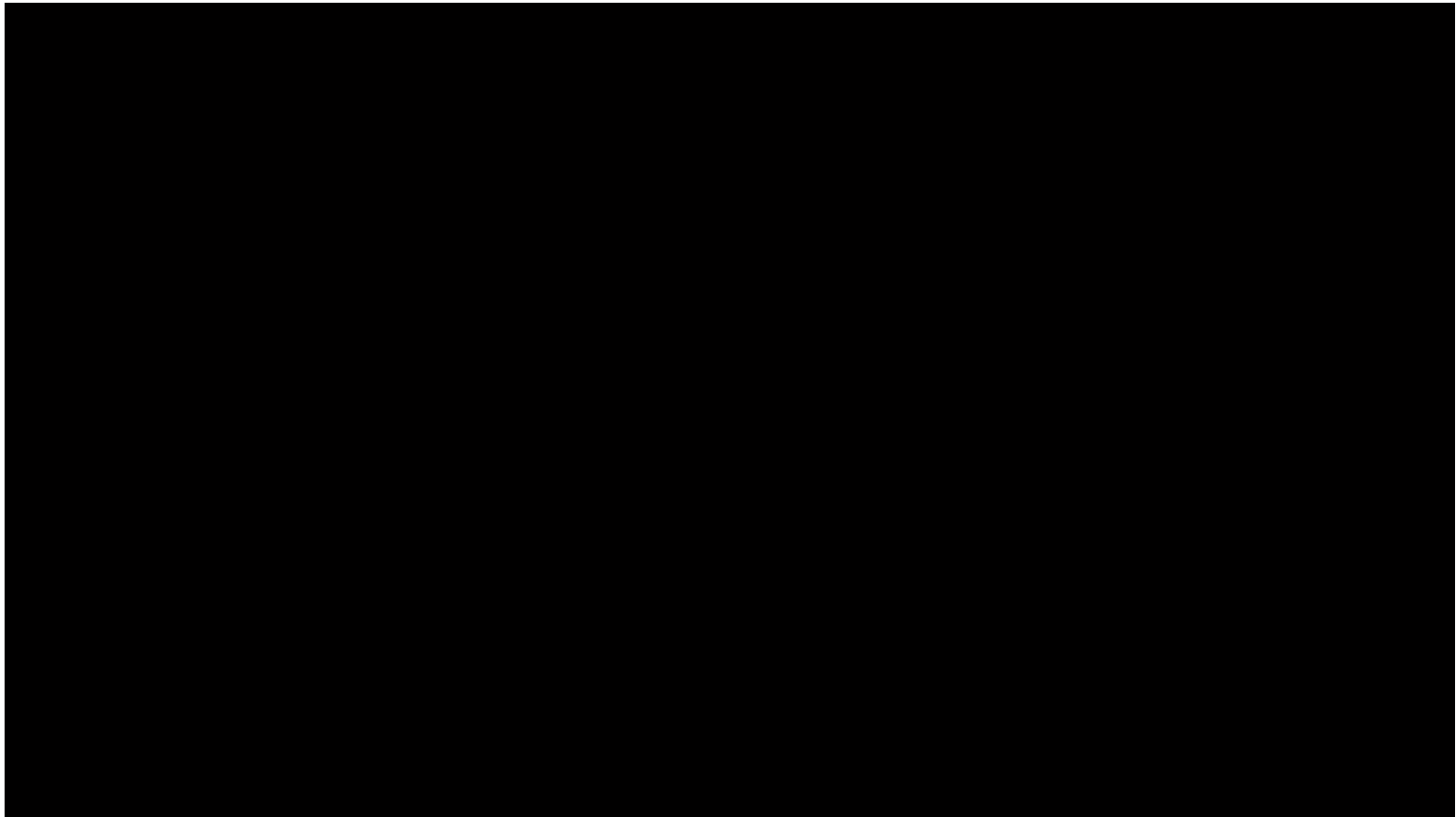
*Original map*

**Breadcrumbs  
annotation added**

*Updated map*

# BREADCRUMBS APPROACH

- Demo – Use-case scenario for breadcrumbs\* ([Link](#))

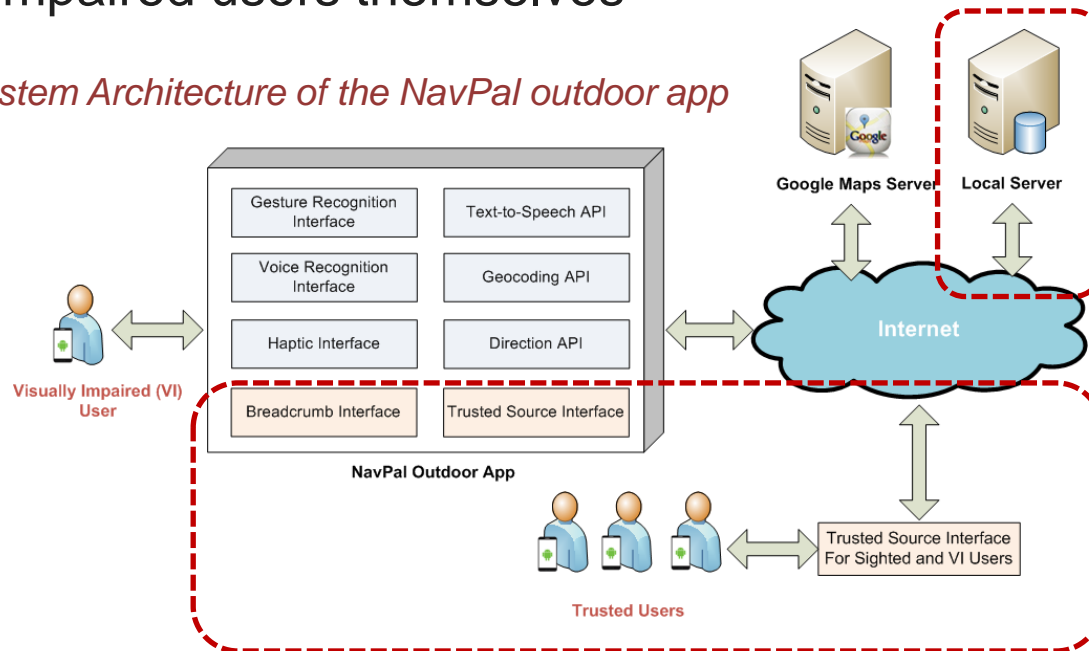


\* A full video is available at: <https://www.youtube.com/watch?v=h8qs86OEzxo>

# A NETWORK OF TRUSTED SOURCES

- ❑ Concept - Trusted individuals can share their observation on the dynamic change in the environment with blind travelers via the connected network like Internet
- ❑ Trusted individuals could be government officers, property managers, O&M experts, friends of the visually impaired traveler, or visually impaired users themselves

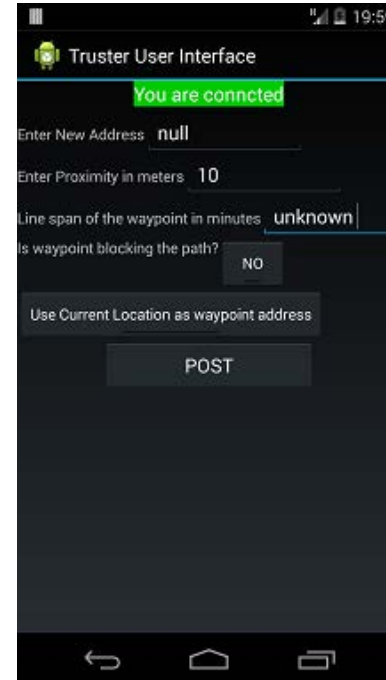
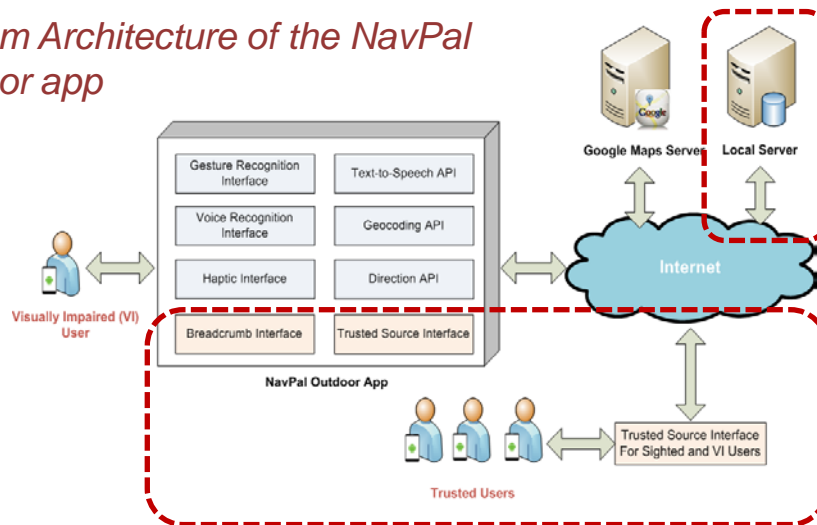
*System Architecture of the NavPal outdoor app*



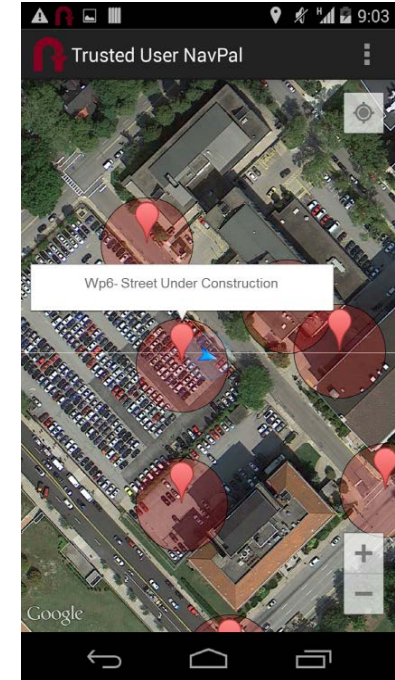
# A NETWORK OF TRUSTED SOURCES

- ❑ Trusted individual can select different attributes of the Point-of-Interest (POI). For example,
  - ❑ Is this POI blocking the path of the user?
  - ❑ What is a proximity to this POI?
  - ❑ Life span of the POI
- ❑ Users can designate trusted sources
  - ❑ Contact name and address

*System Architecture of the NavPal outdoor app*



*Trusted user interface for sighted users*



*Example of trusted sources added*



# A NETWORK OF TRUSTED SOURCES

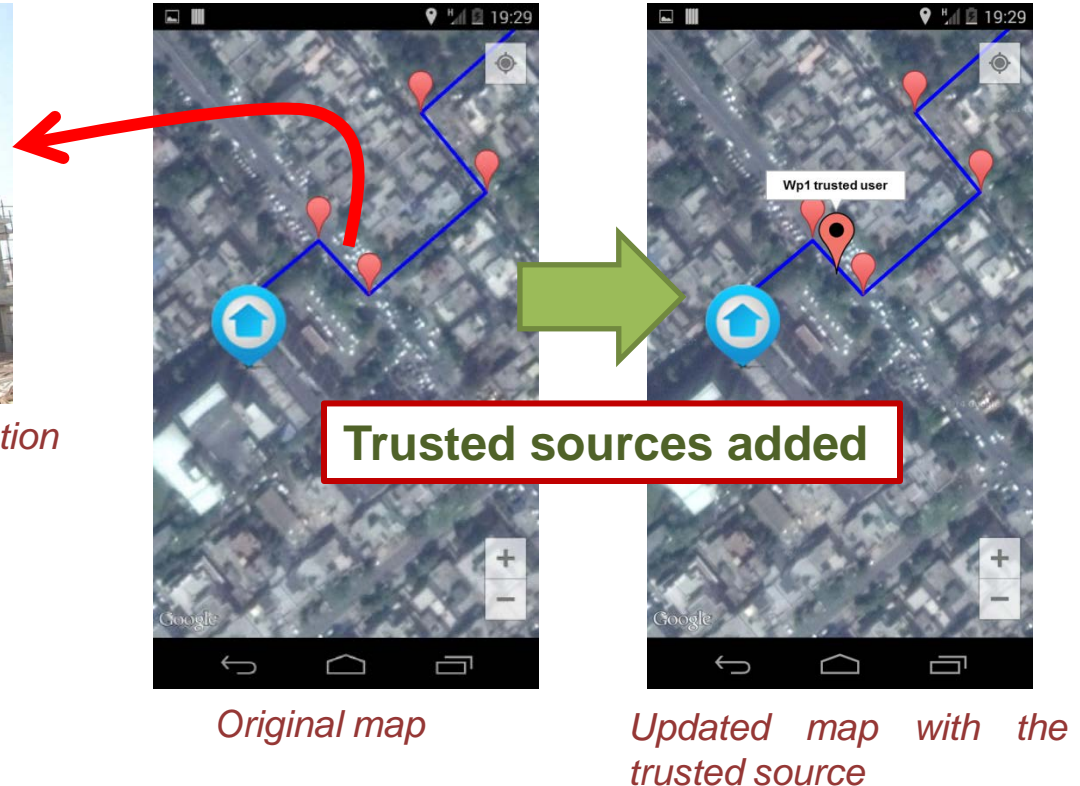
- Use-case scenario for a network of trusted sources



*Unexpected situation – house under construction*



*Debris over the sidewalk*



NavPal app says **“Bricks are in front, please be careful!”**

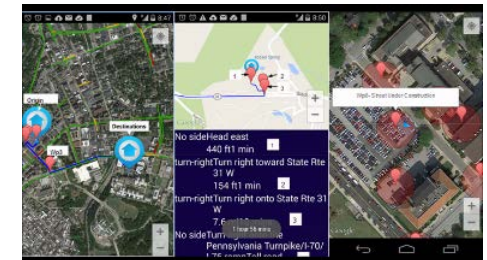
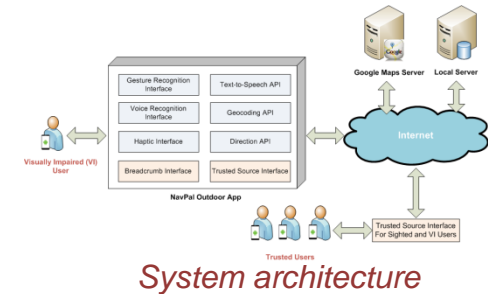
# SUMMARY AND FUTURE WORK

## □ Summary

- Proposed a mechanism of Trusted Sources and Breadcrumb Annotation
- Developed prototype of a smartphone-based navigation tool
- Implemented the key functions

## □ Future work

- Remove the dependence of the Google servers
  - Only provides 8 way-points per route
  - provides information about the shortest route in the navigation
- Currently working with Open Street Maps (OSM)



*Smartphone-based navigation tool*



*Implementation of Breadcrumb annotation*



# ACKNOWLEDGMENTS

- ❑ This work was funded by
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- ❑ We thank
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  - ❑ The participants in the user studies that informed this work
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Blind & Vision Rehabilitation  
Services of Pittsburgh



WESTERN  
PENNSYLVANIA  
SCHOOL  
FOR BLIND  
CHILDREN

# Questions?

**NavPal Project Website**

[www.cs.cmu.edu/~navpal](http://www.cs.cmu.edu/~navpal)