Getting There and Beyond:
Incidental Learning of Spatial Knowledge with Turn-by-Turn Directions and Location Updates in Navigation Interfaces



Sanorita Dey Karrie Karahalios Wai-Tat Fu

University of Illinois at Urbana-Champaign

Navigation with Paper Maps

Navigation Applications

Indoor Navigation Applications

Outdoor vs Indoor Navigation

Outdoor

Reaching to the desired destination following the shortest route

Indoor

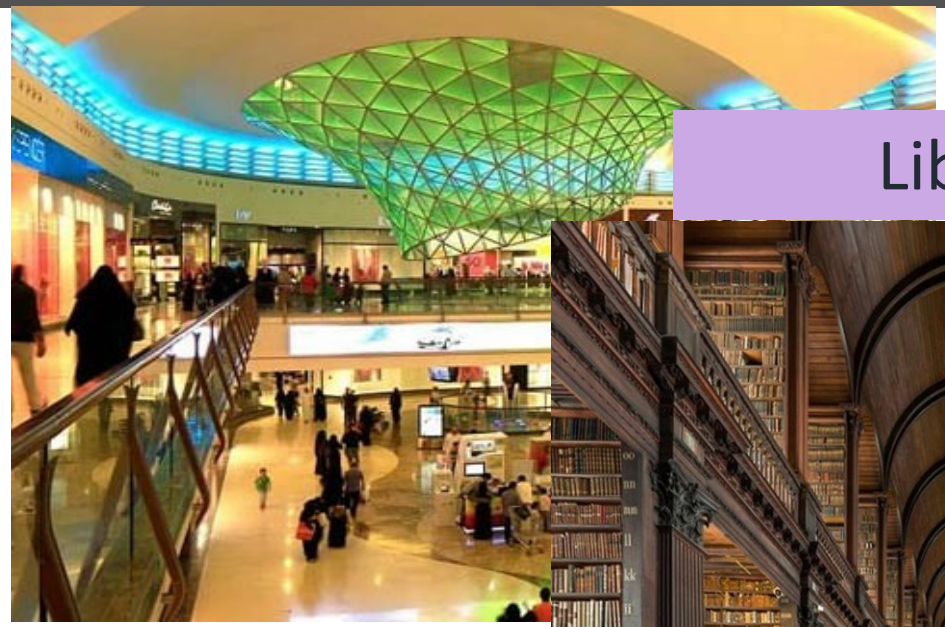
Reaching to the desired destination

+

Explore the environment

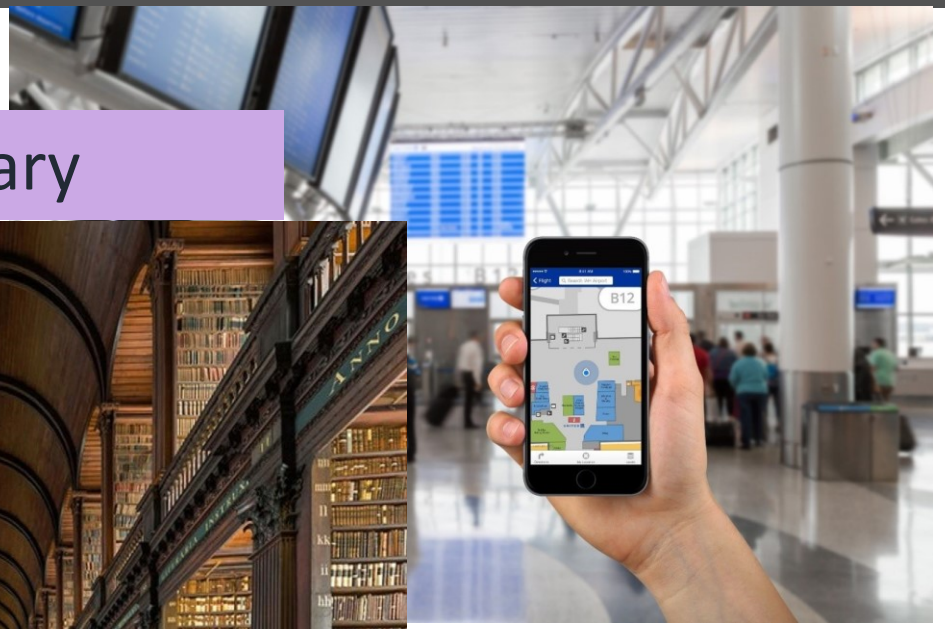
Outdoor vs Indoor Navigation

Shopping Mall



Library

Airport Terminal



Administrative Building

Hospital Buildings

Outdoor vs Indoor Navigation

Structural Challenges

Homogeneous Architecture
Lack of Landmarks

Challenges of Using Indoor Navigation Apps

Carrying a navigation device is inconvenient

Too many people

Weakness of the WiFi or RFID Signal

Low Accuracy

Outdoor vs Indoor Navigation

Frequent or regular visits to a place do not necessarily help people learn about the environment

1. Carlson, Laura A., et al. "Getting lost in buildings." *Current Directions in Psychological Science* 19.5 (2010): 284-289.
2. Peponis, John, Craig Zimring, and Yoon Kyung Choi. "Finding the building in wayfinding." *Environment and behavior* 22.5 (1990): 555-590.
3. Weisman, Jerry. "Evaluating architectural legibility: Way-finding in the built environment." *Environment and behavior*13.2 (1981): 189-204.

Static
“You are Here” Maps

Hard to find those directories when needed

It is challenging to orient with these static maps

Indoor Navigation Applications

Guide people to go from location A to location B

+

Learn about the environment around them incidentally

Indoor Navigation Applications

Guide people to go from location A to location B

+

Learn about the environment around them incidentally

Hypothesis

Not all interface design elements of indoor navigation applications are equally effective for learning about the environment

Research Question

How the Interface design elements of indoor navigation applications can help people learn about their environment?

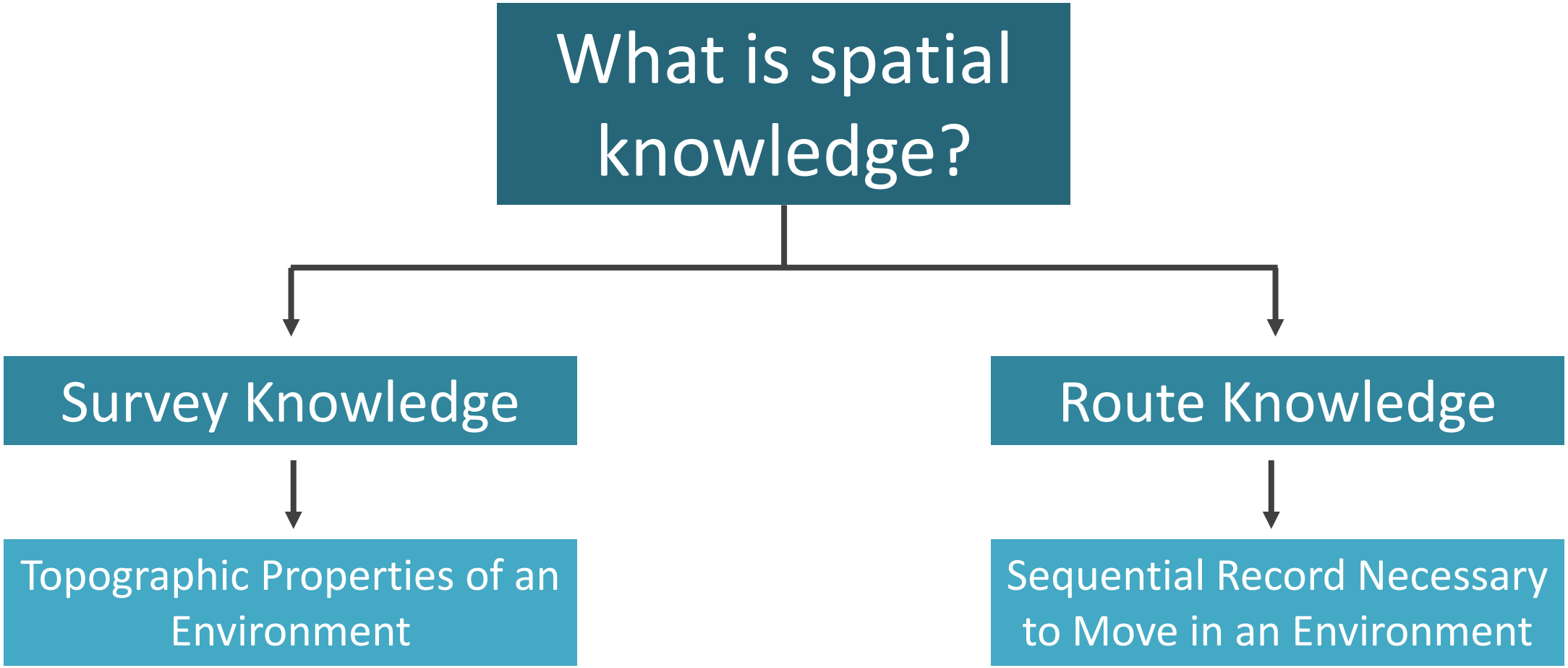
Research Question

How the interface design elements of indoor navigation applications can help people learn the spatial knowledge about their environment?

Spatial Knowledge

What is spatial knowledge?

Spatial Knowledge



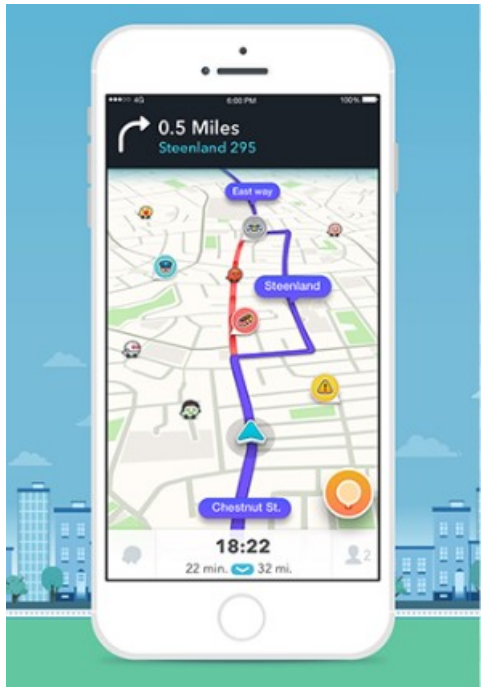
Research Question

How the interface design elements of indoor navigation applications can help people learn **survey and route knowledge** about their environment?

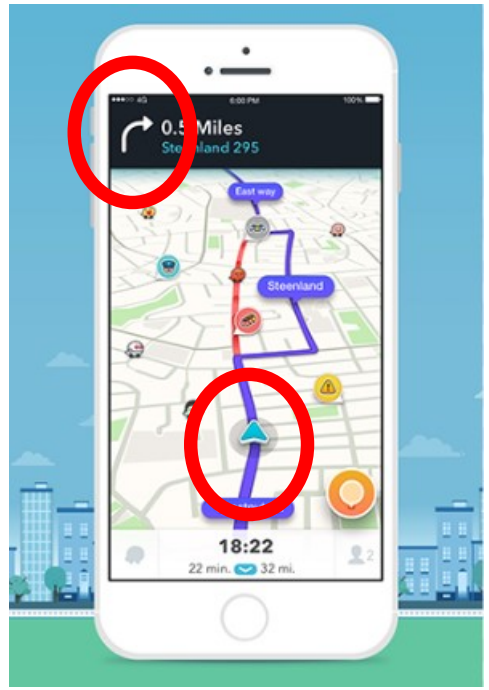
Basic Structure of Navigation Applications

Navigation Applications

Frame of References



Navigation Cues



Research Question

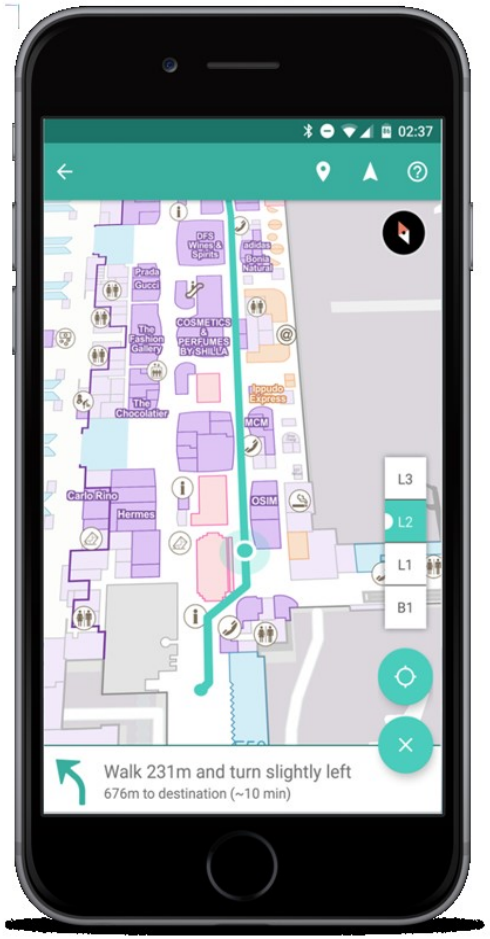
How do the frame of references and navigation cues of indoor navigation applications can help people learn survey and route knowledge about their environment?

Research Question

How do the frame of references and navigation cues of indoor navigation applications can help people learn survey and route knowledge about their environment?

Frame of References

Map Interface



Video Interface

Research Question

How do the frame of references and navigation cues of indoor navigation applications can help people learn survey and route knowledge about their environment?

Navigation Cues

Directional Arrows

Turn Left

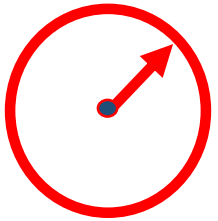
Go Straight

Turn Right

Relative Location Updates

Location Marker

Navigation Circle



Map Interface	Video Interface
Current location on the map	Current direction of the destination

Navigation Cues

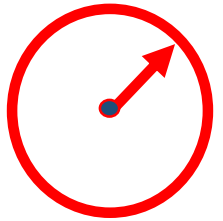
Directional Arrows

Active Processing not Required

Relative Location Updates

Location Marker

Navigation Circle

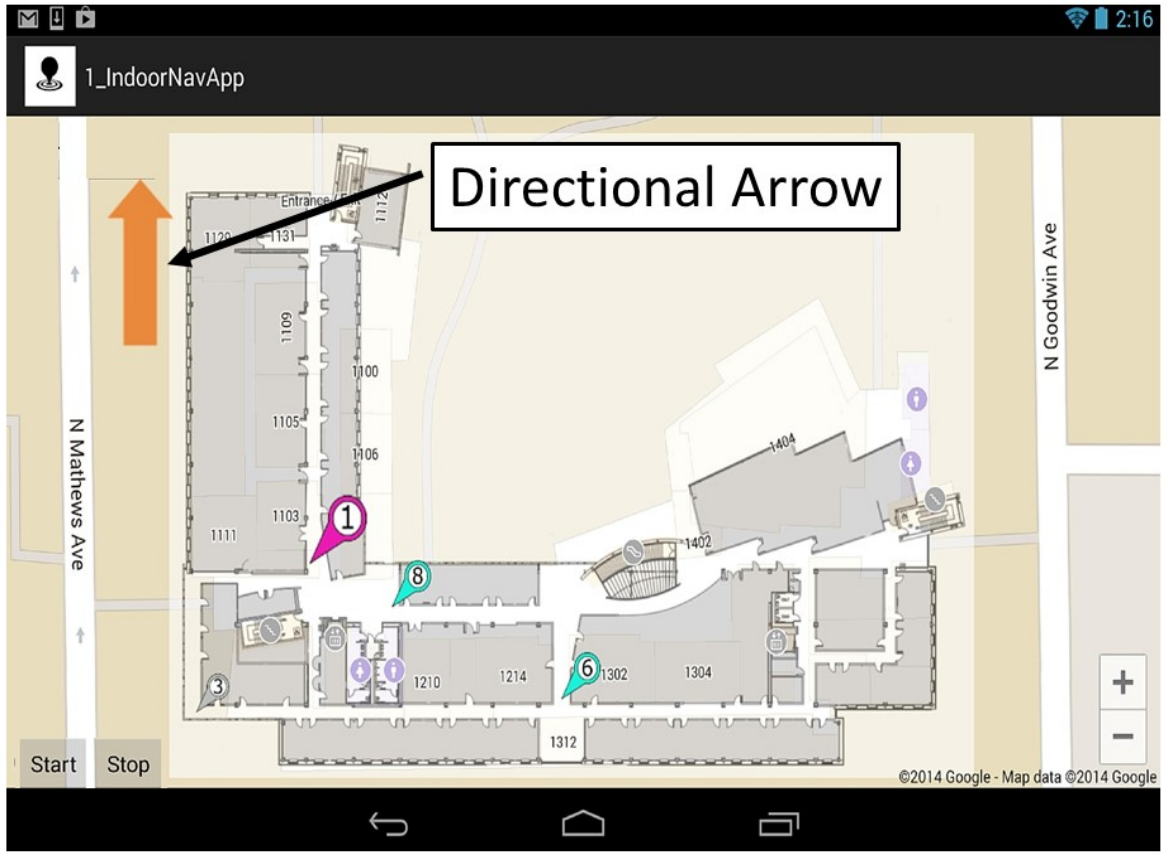


Active Processing Required

Map Interfaces

Directional Arrow

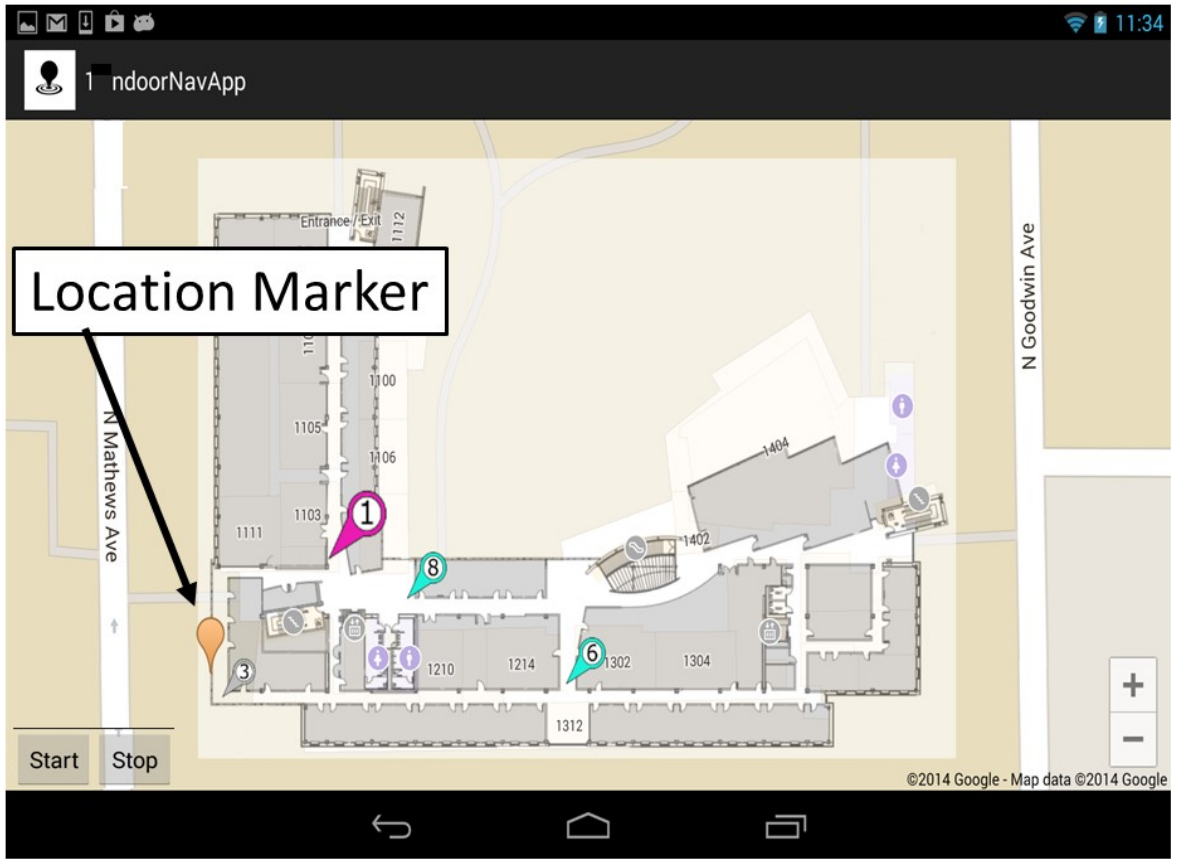
Turn-by-Turn Update



Map Interface with Directional Arrow

Relative Location Update

Real Time Update



Map Interface with Location Marker

Map Interfaces

Directional Arrow

Turn-by-Turn Update

Map Interface with Directional Arrow

Relative Location Update

Real Time Update

Map Interface with Location Marker

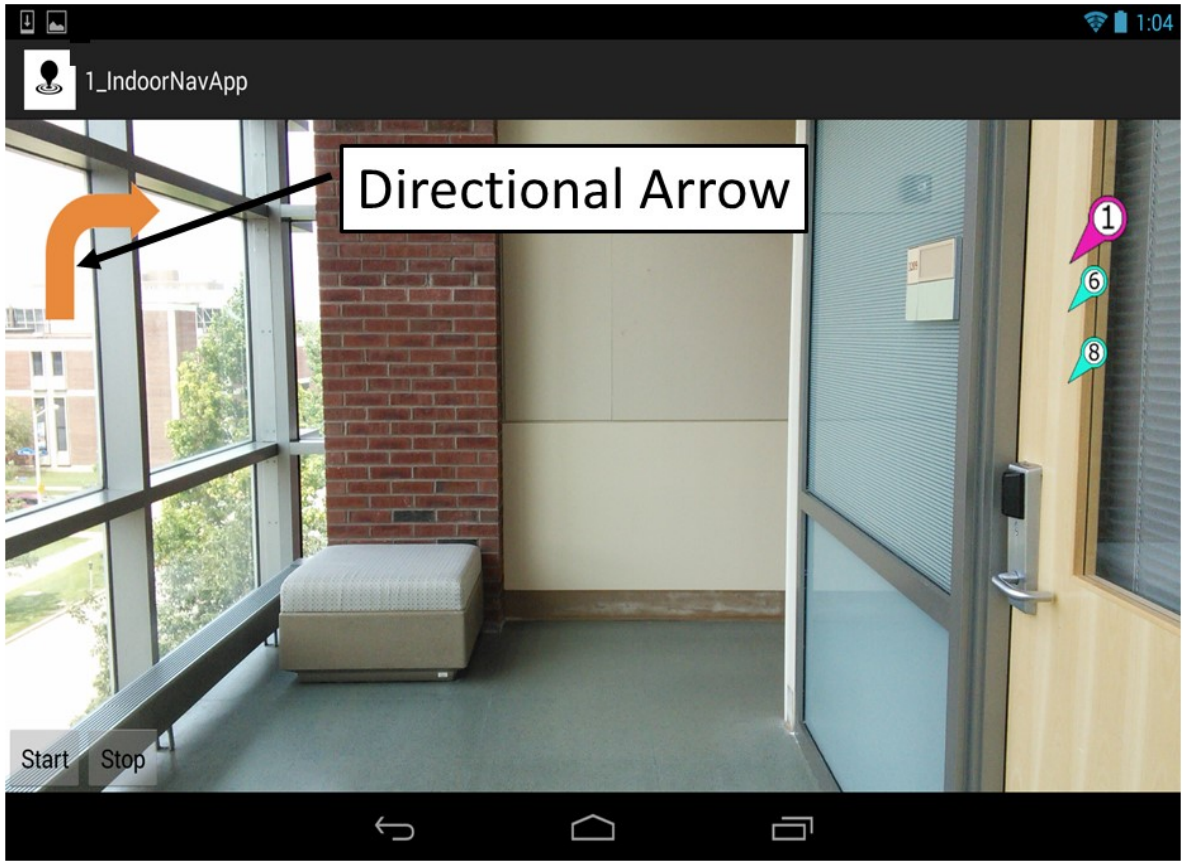
Lazy Approach
Easy to Navigate

Hard Approach
Facilitate Active Learning

Video Interfaces

Directional Arrow

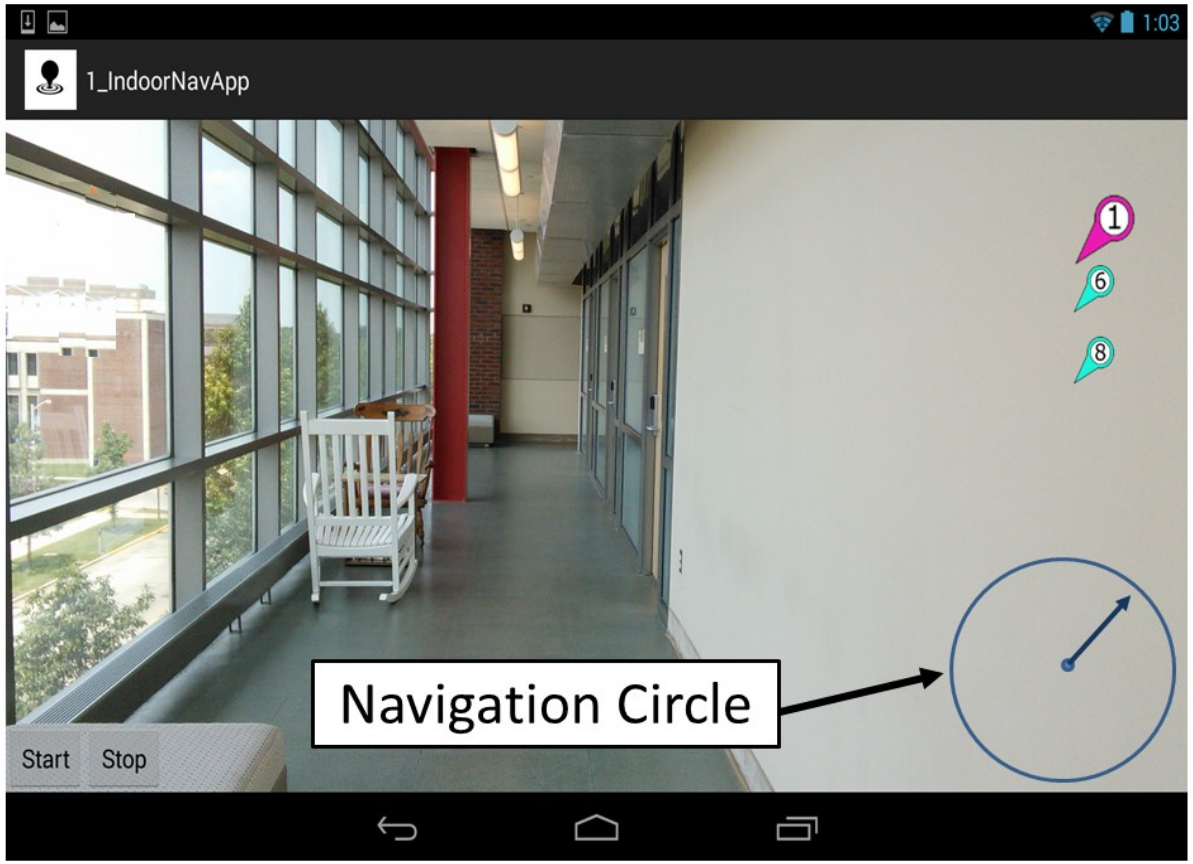
Turn-by-Turn Update



Video Interface with Directional Arrow

Relative Location Update

Real Time Update



Video Interface with Navigation Circle

Video Interfaces

Directional Arrow

Turn-by-Turn Update

Relative Location Update

Real Time Update

Lazy Approach
Easy to Navigate

Video Interface with Directional Arrow

Hard Approach
Facilitate Active Learning

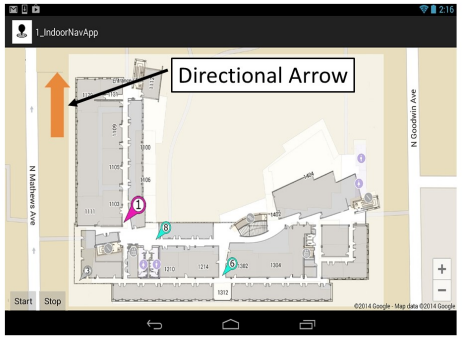
Video Interface with Navigation Circle

User Study Design

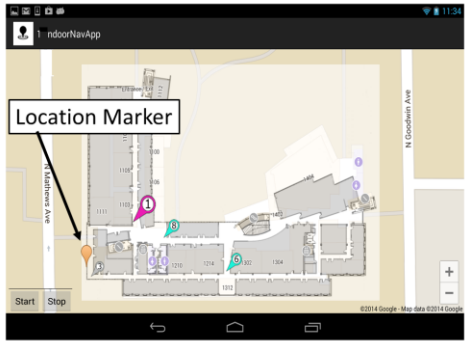
Study Design

User Study

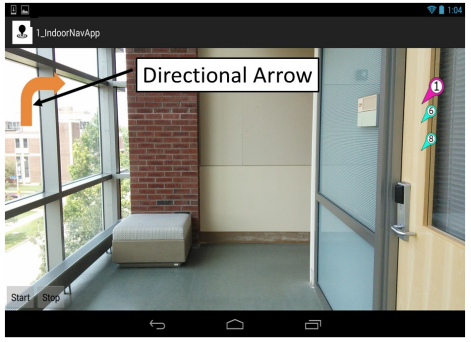
32 Participants



8 Participants



8 Participants



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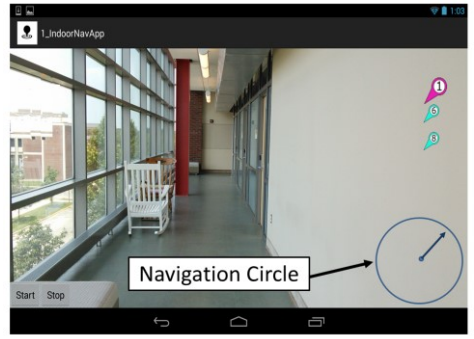
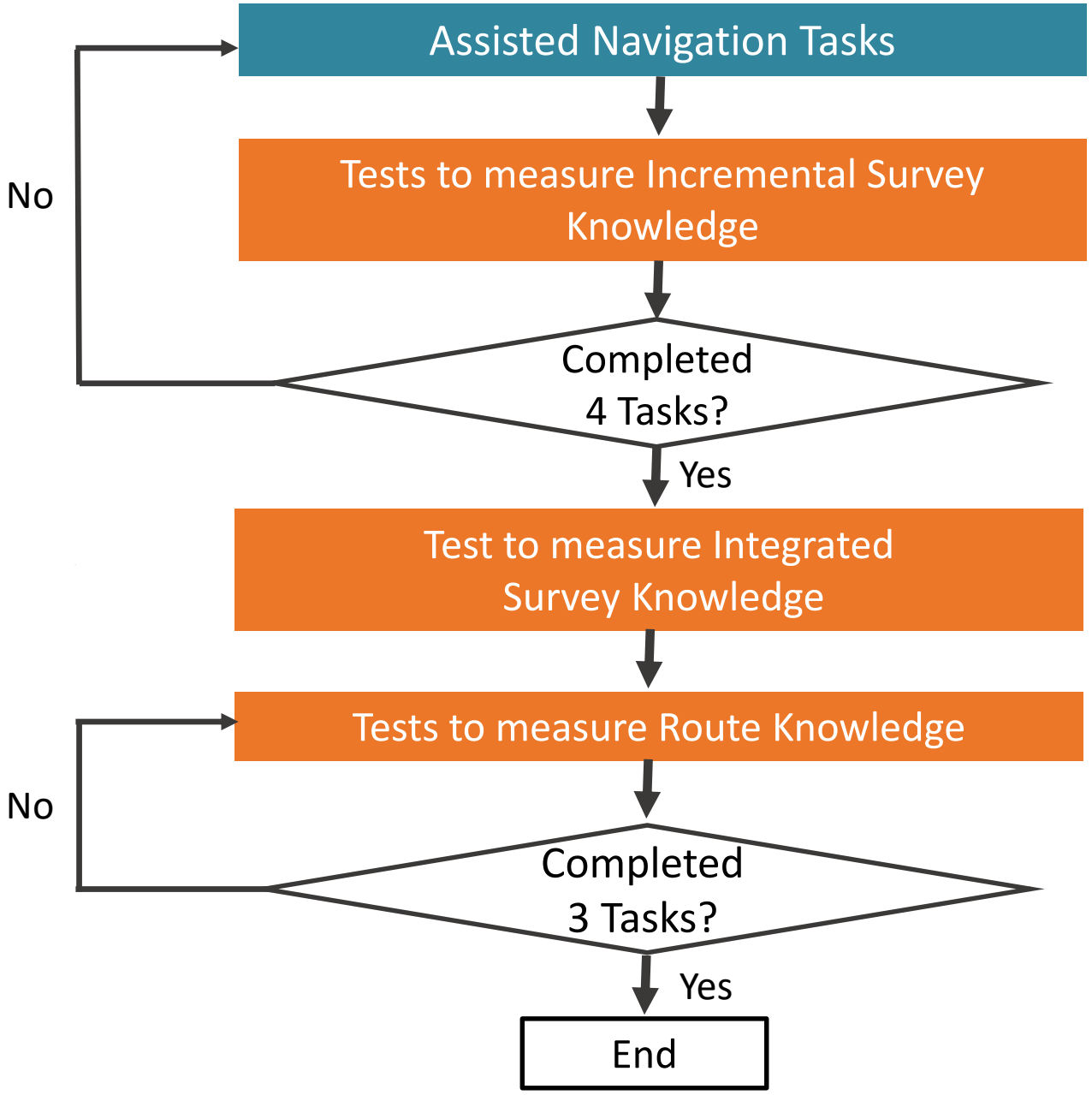
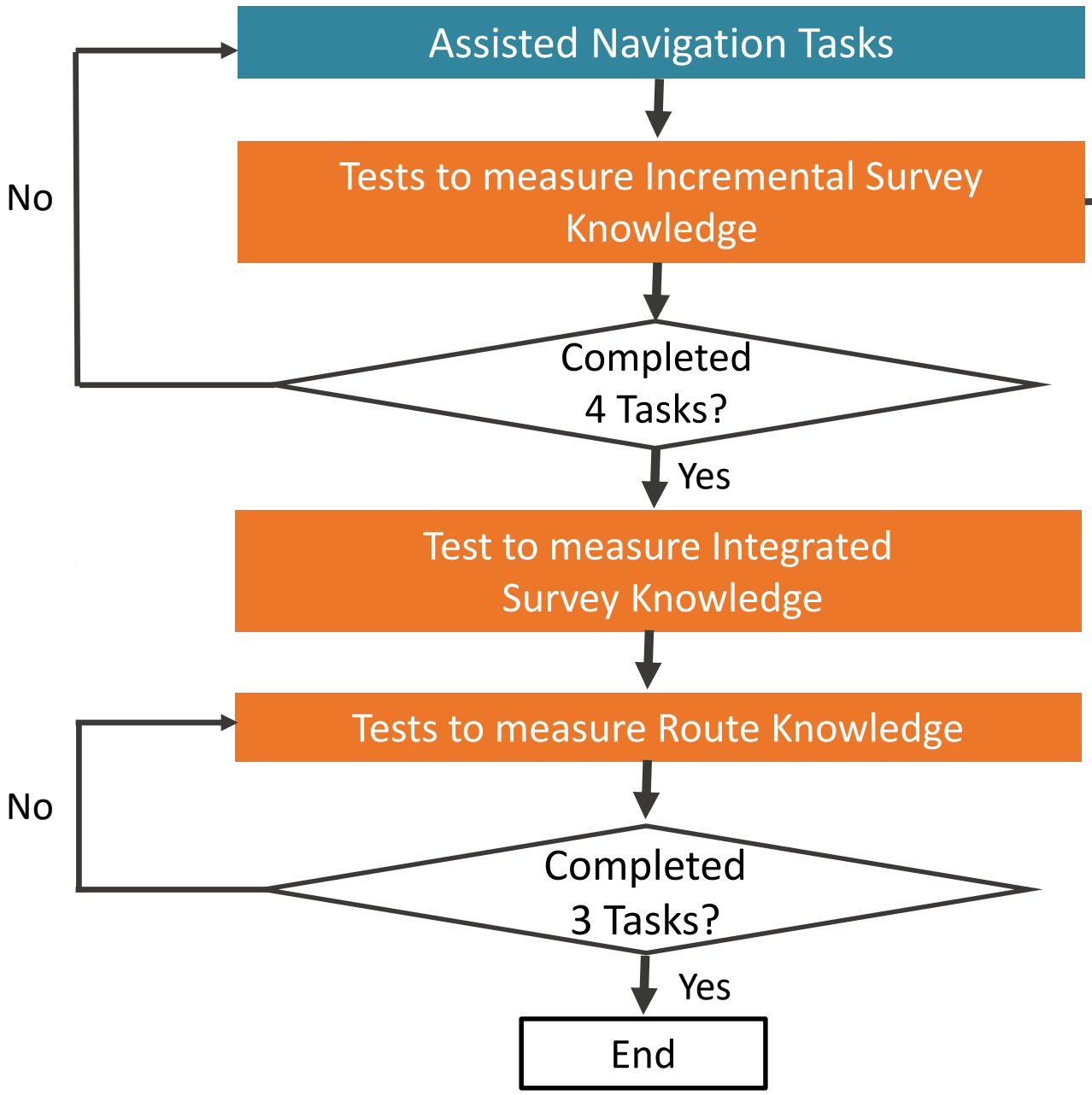


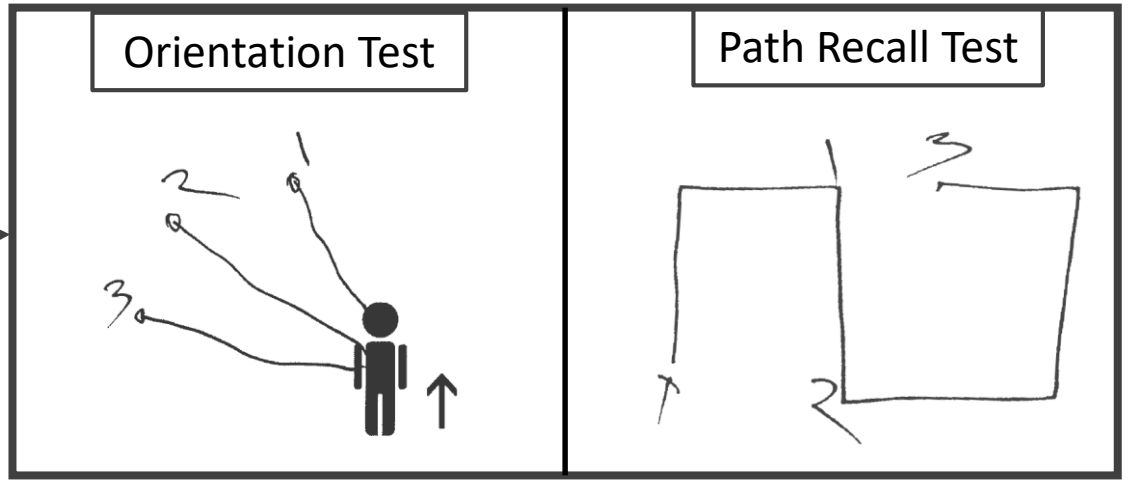
8 Participants

User Study Design



User Study Design





User Study Design

Assisted Navigation Tasks

Tests to measure Incremental Survey Knowledge

Completed 4 Tasks?

No

Yes

Test to measure Integrated Survey Knowledge

Tests to measure Route Knowledge

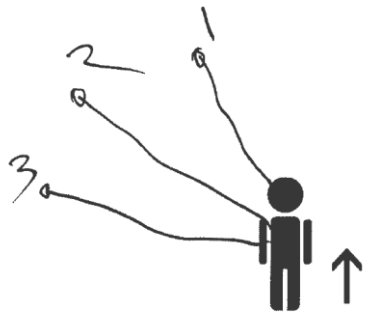
Completed 3 Tasks?

No

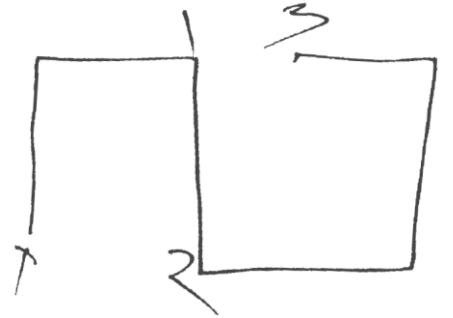
Yes

End

Orientation Test



Path Recall Test



Floor Plan Recall Test

User Study Design

Assisted Navigation Tasks

Tests to measure Incremental Survey Knowledge

Completed 4 Tasks?

No

Yes

Test to measure Integrated Survey Knowledge

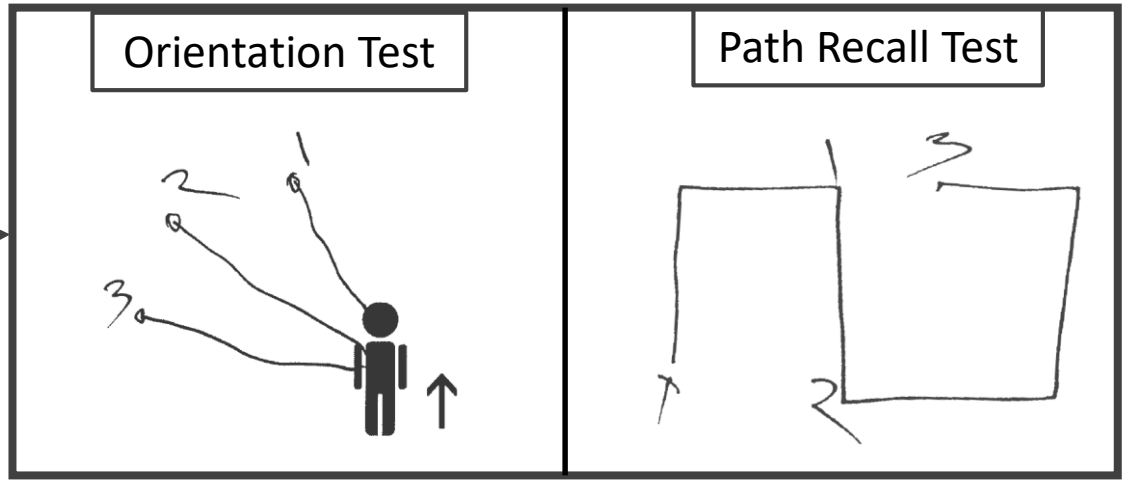
Tests to measure Route Knowledge

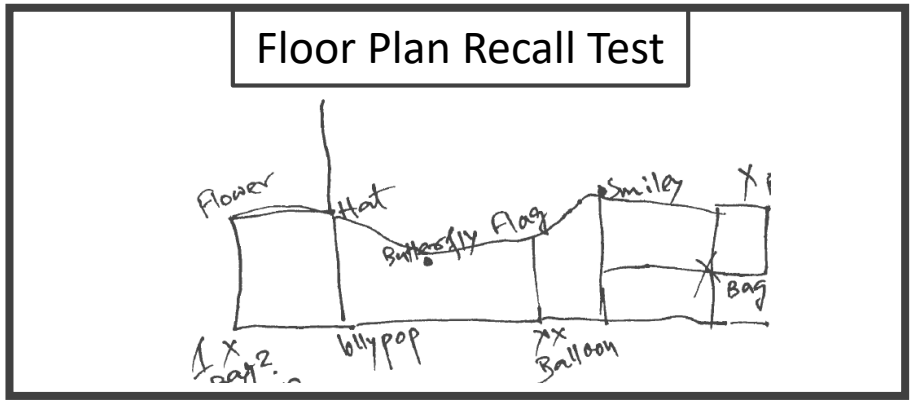
Completed 3 Tasks?

No

Yes

End





User Study Design (cont.)

Tests to measure Route Knowledge

1. Location Recognition Test
2. Unassisted Navigation Test

User Study Design (cont.)

Tests to measure Route Knowledge

Location 1	Location 2	Location 3

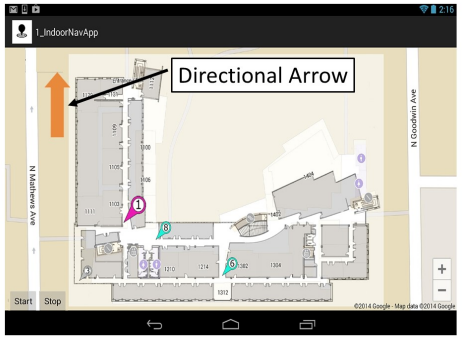
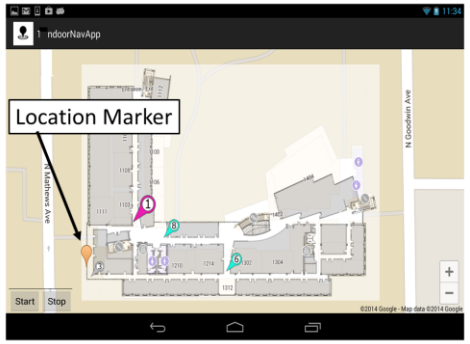
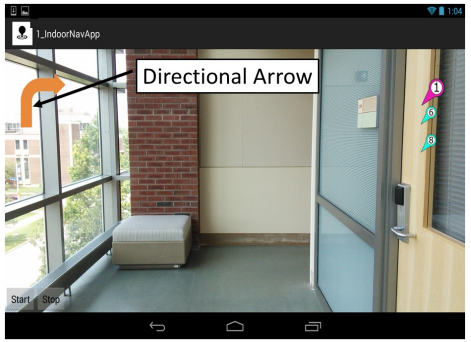
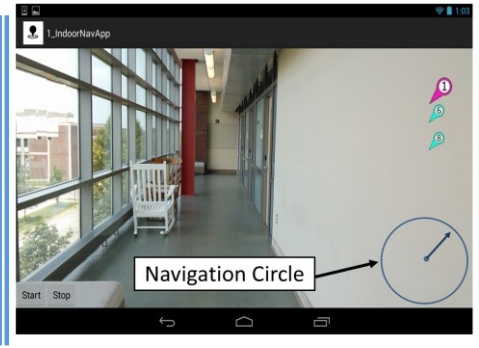
Easiest

Harder

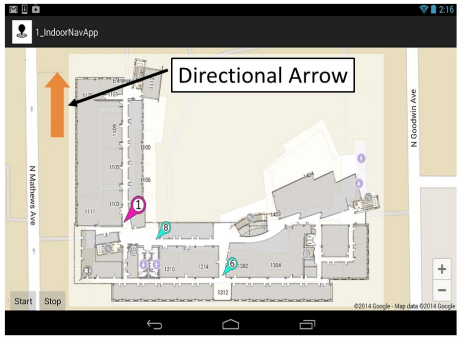
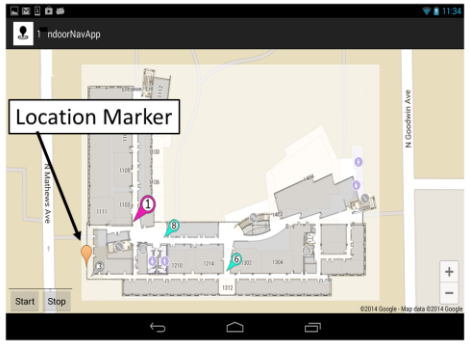
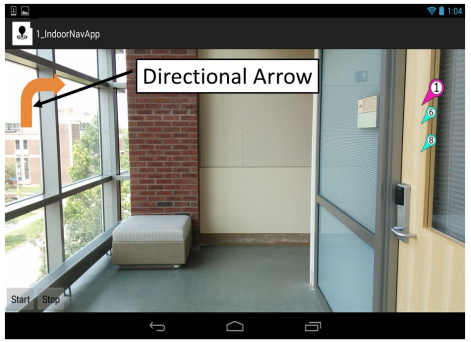
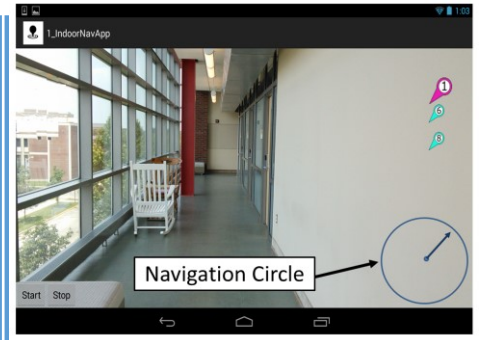
Hardest

Results

Results: Time Analysis

Tasks				
Task 1	4 min 15 sec	5 min 30 sec	4 min 20 sec	5 min 44 sec
Task 2	4 min 48 sec	4 min 38 sec	4 min 37 sec	4 min 22 sec
Task 3	4 min 44 sec	4 min 15 sec	4 min 10 sec	4 min 15 sec
Task 4	4 min 57 sec	4 min 49 sec	4 min 57 sec	4 min 39 sec

Results: Time Analysis

Tasks							
Task 1	4 min 15 sec	<	5 min 30 sec		4 min 20 sec	<	5 min 44 sec
Task 2	4 min 48 sec		4 min 38 sec		4 min 37 sec		4 min 22 sec
Task 3	4 min 44 sec		4 min 15 sec		4 min 10 sec		4 min 15 sec
Task 4	4 min 57 sec		4 min 49 sec		4 min 57 sec		4 min 39 sec

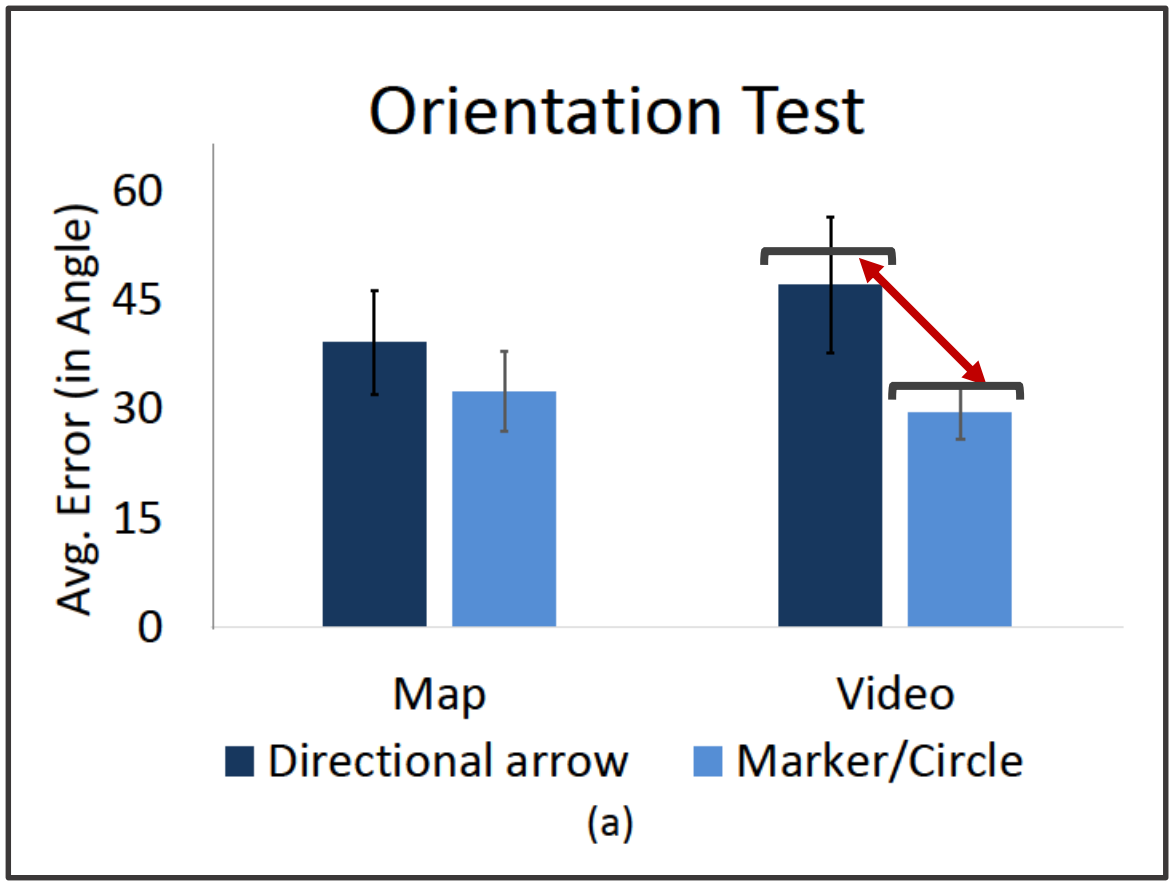
No Difference

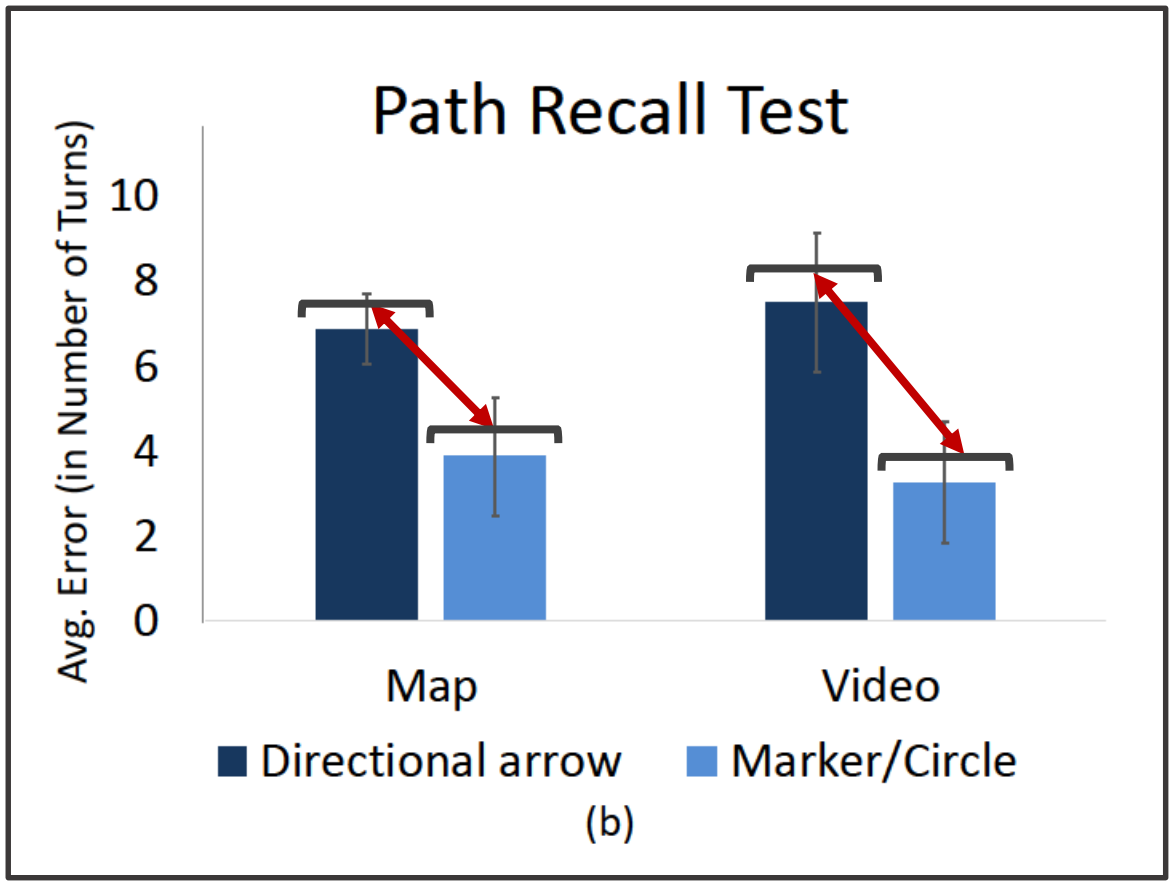
Results: Time Analysis

Active processing of navigation cues was harder for participants

Participants can quickly learn the process

Results: Incremental Survey Knowledge Analysis

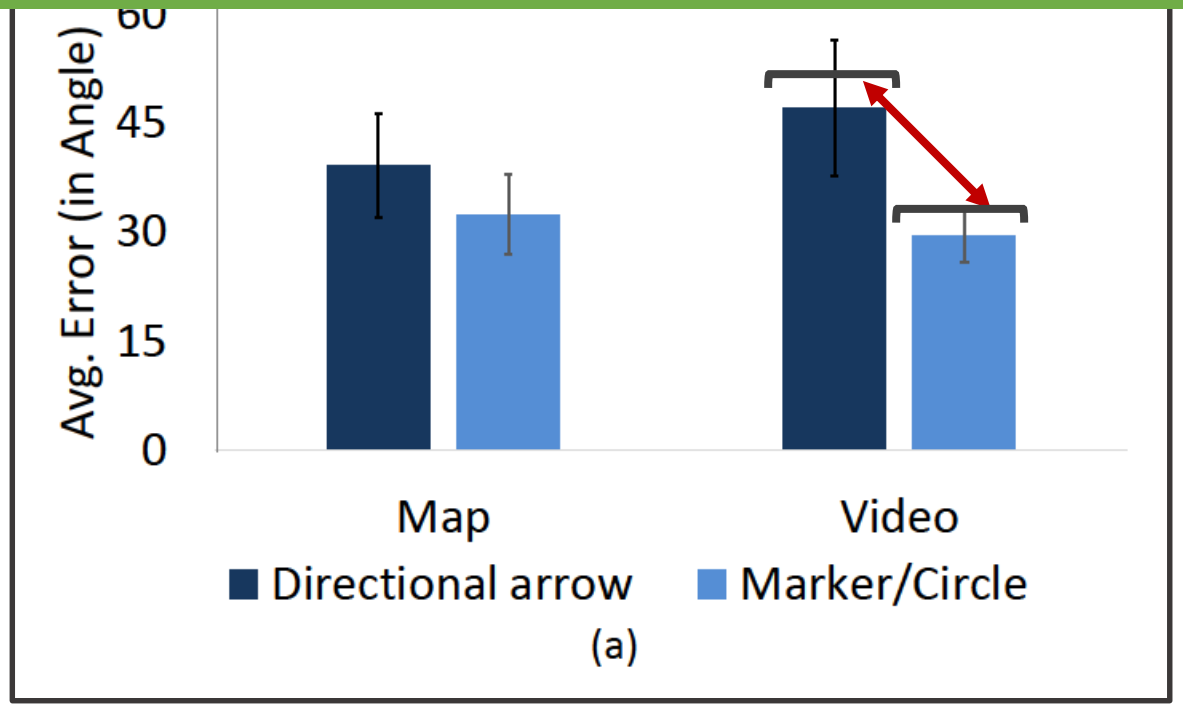


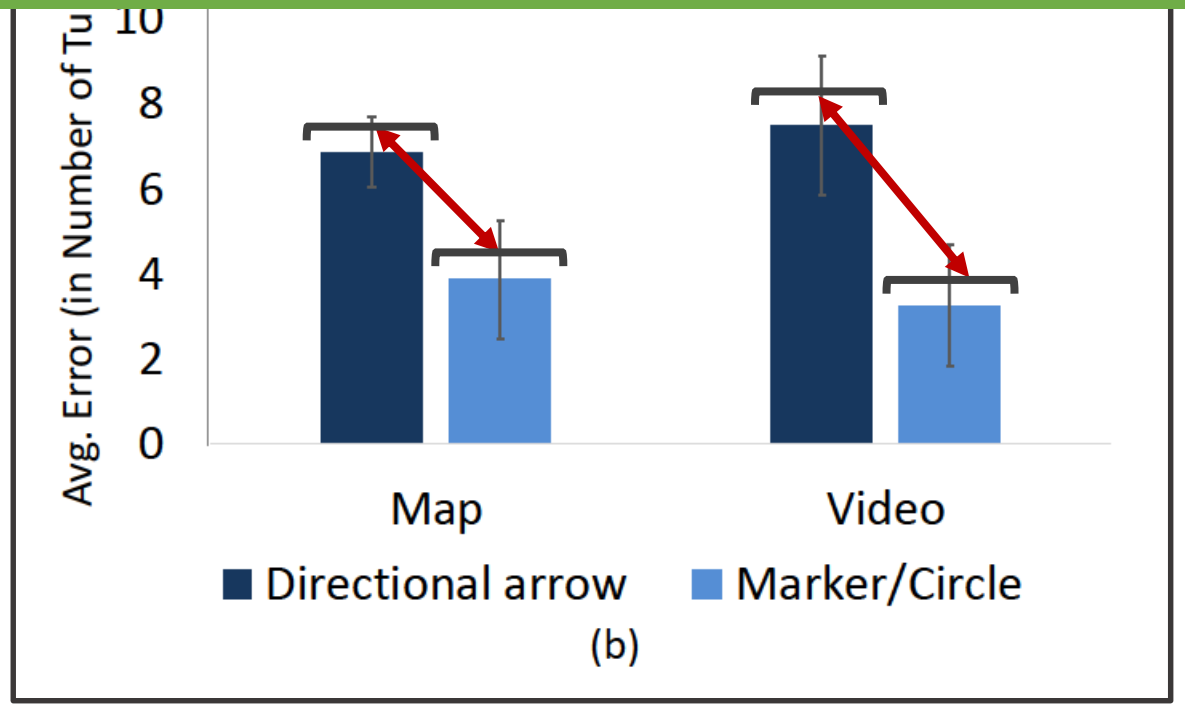


* The lower value is better than the higher value.

Results: Incremental Survey Knowledge Analysis

Active processing of navigation cues helped participants learn survey knowledge incrementally

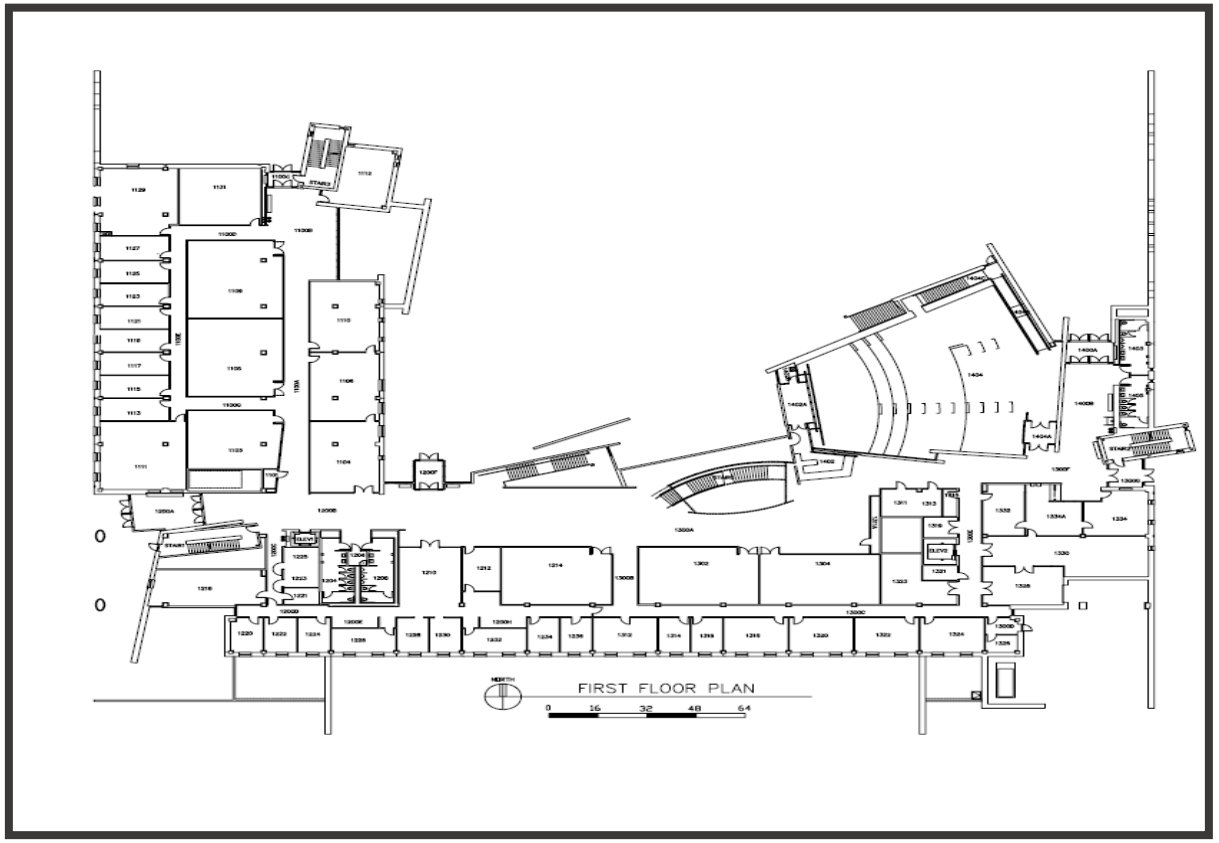




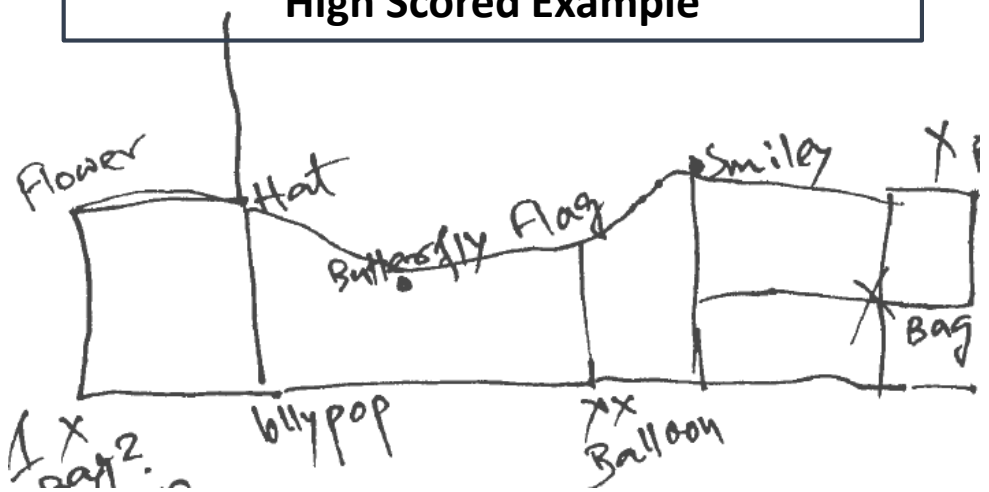
* The lower value is better than the higher value.

Results: Integrated Survey Knowledge Analysis

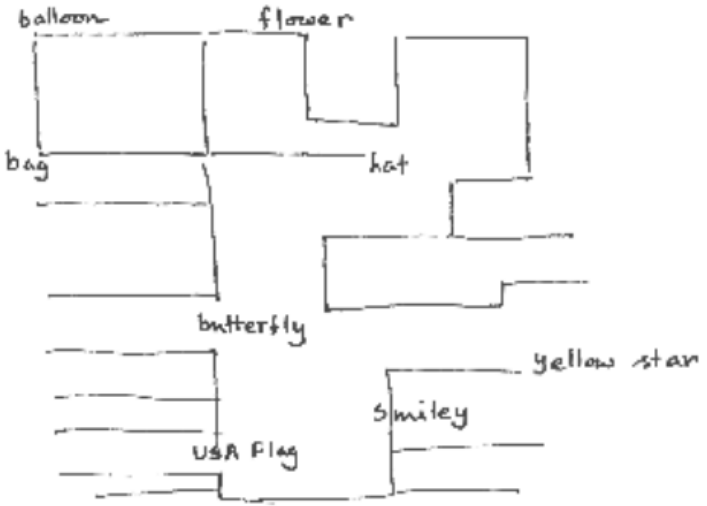
Actual Floorplan



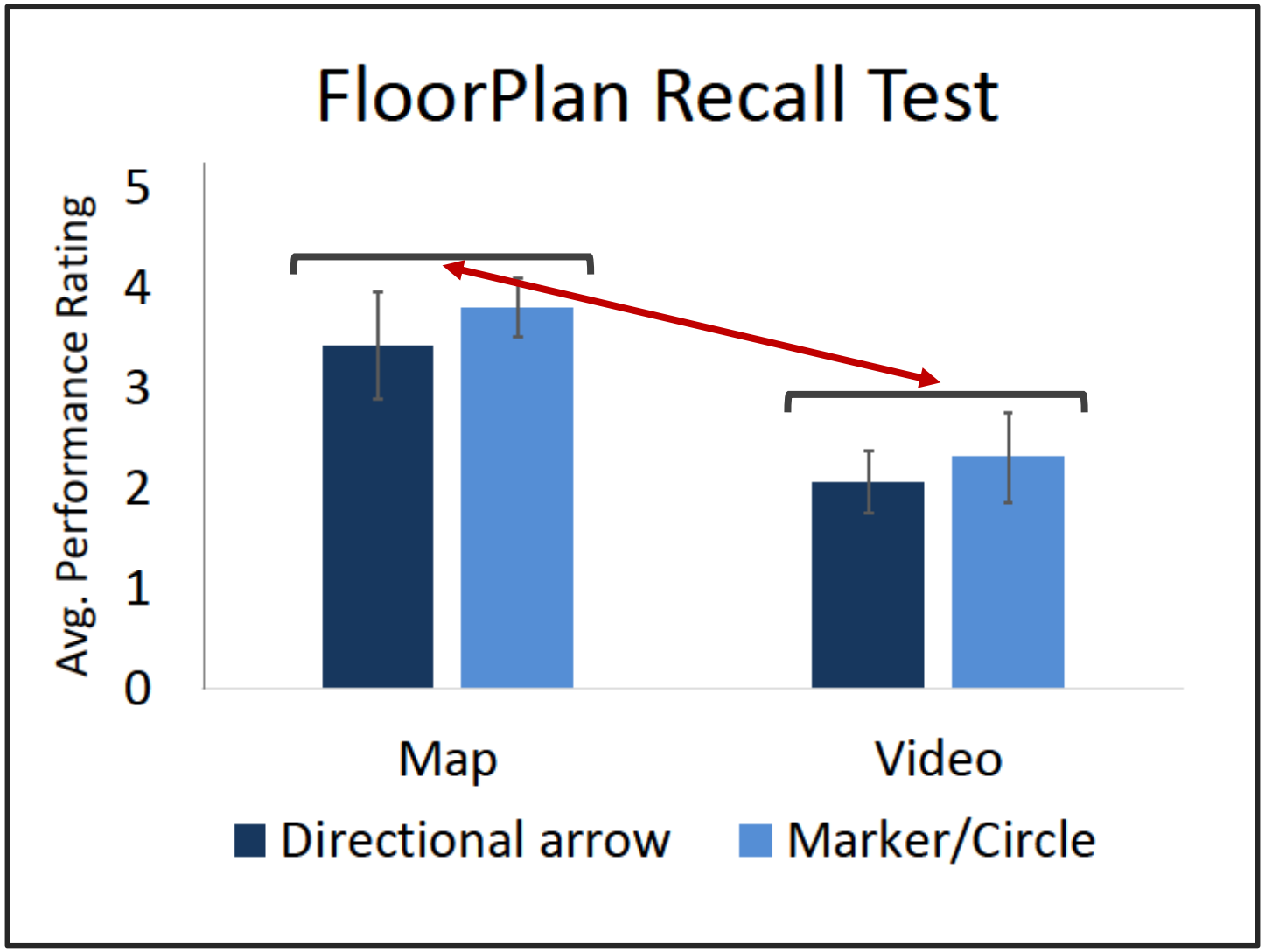
High Scored Example



Low Scored Example

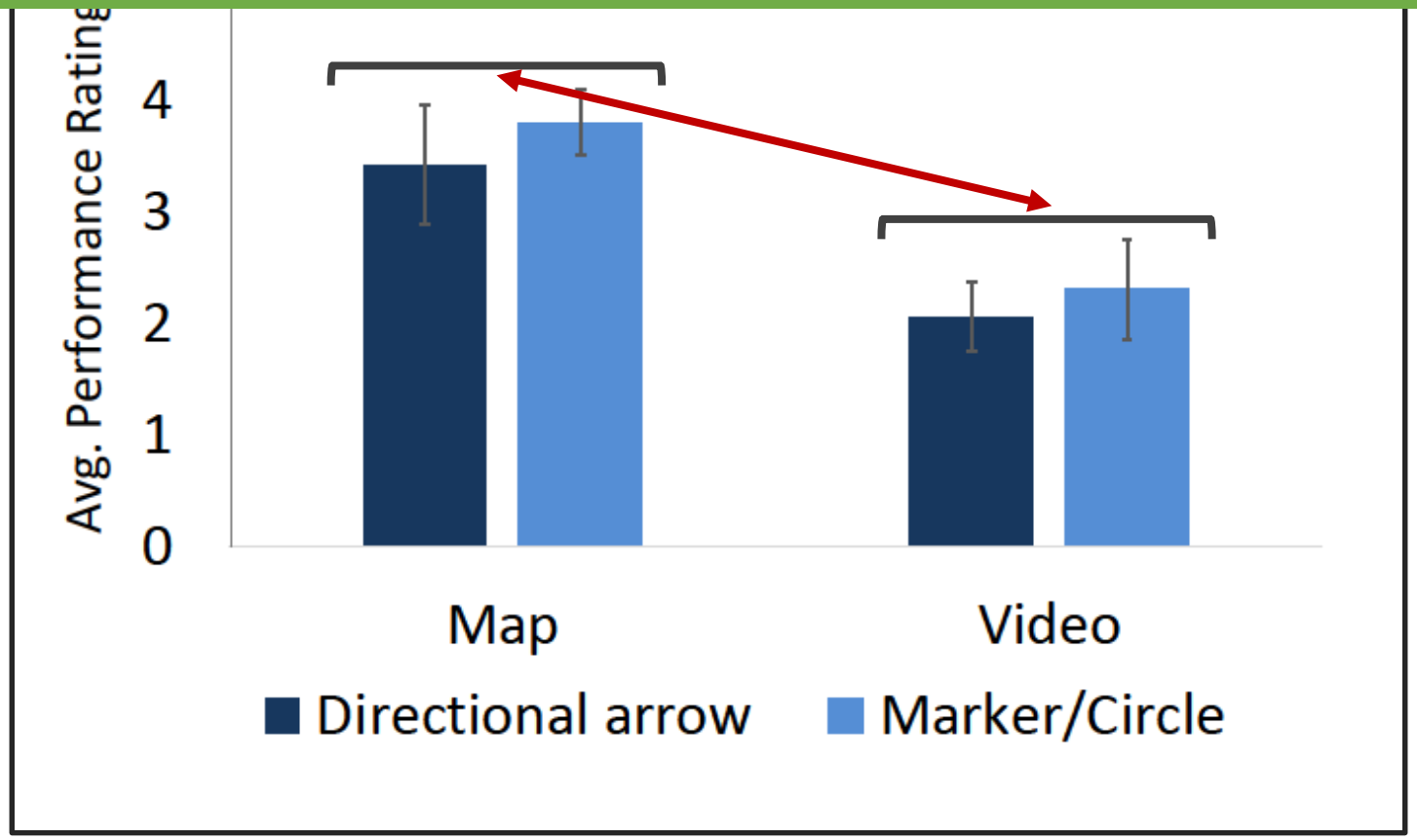


Results: Integrated Survey Knowledge Analysis

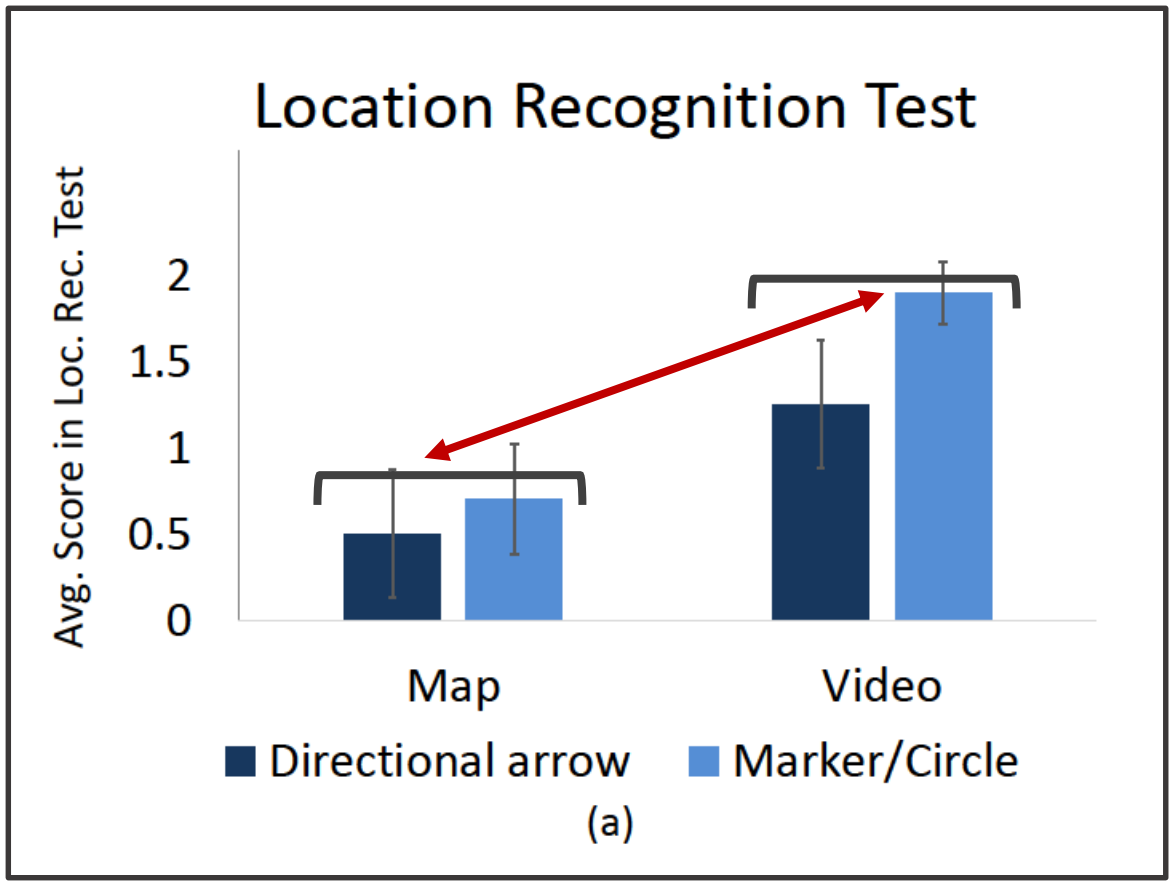


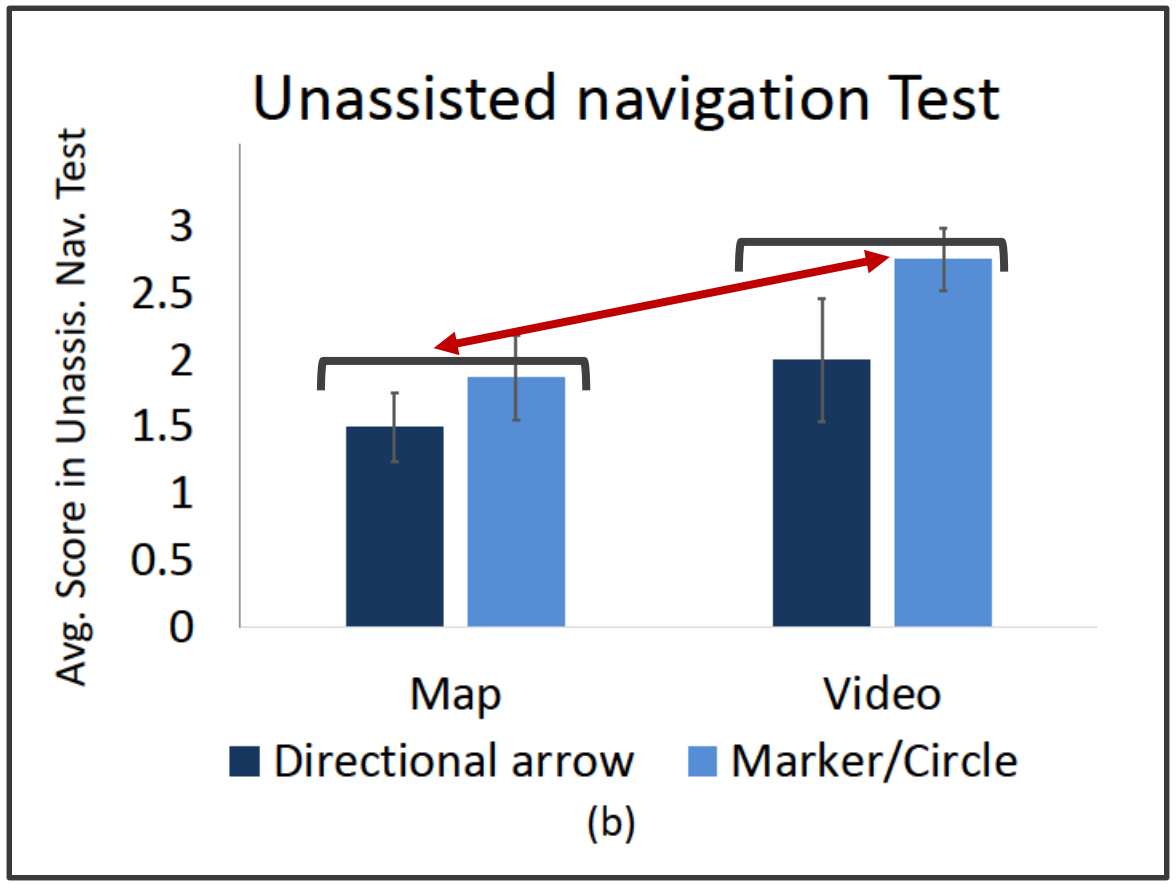
Results: Integrated Survey Knowledge Analysis

Viewing the Map Interface (floor plan) helped participants learn the integrated survey knowledge better



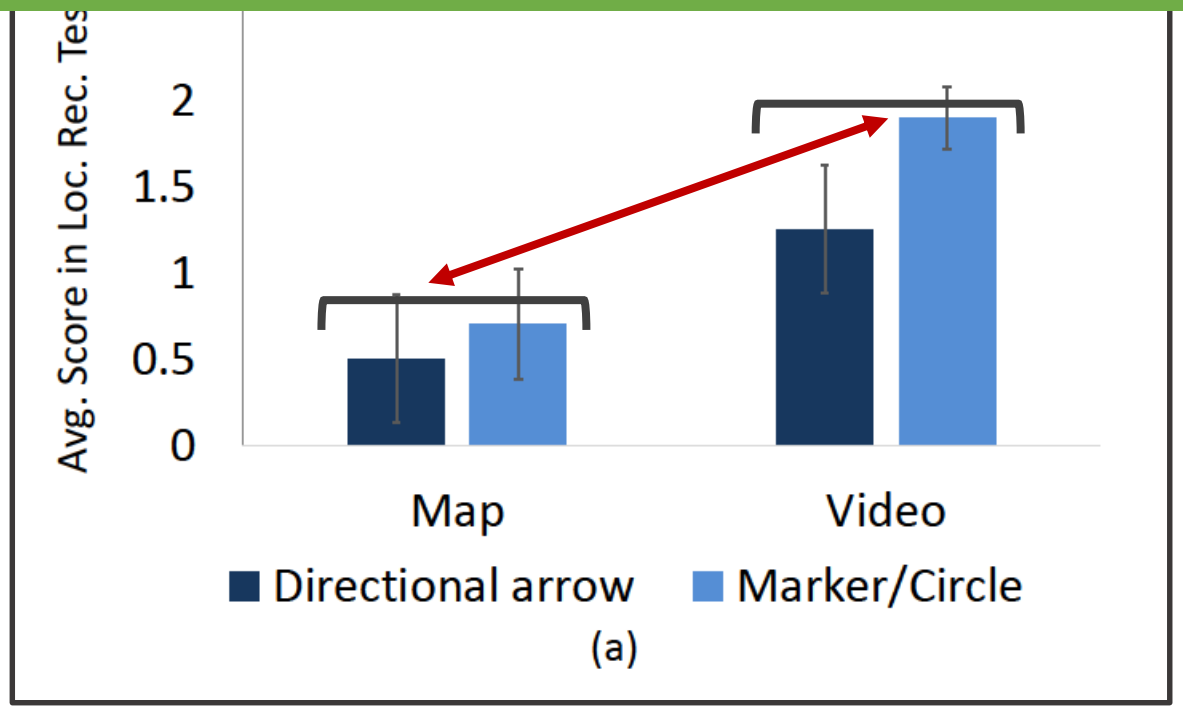
Results: Route Knowledge Analysis

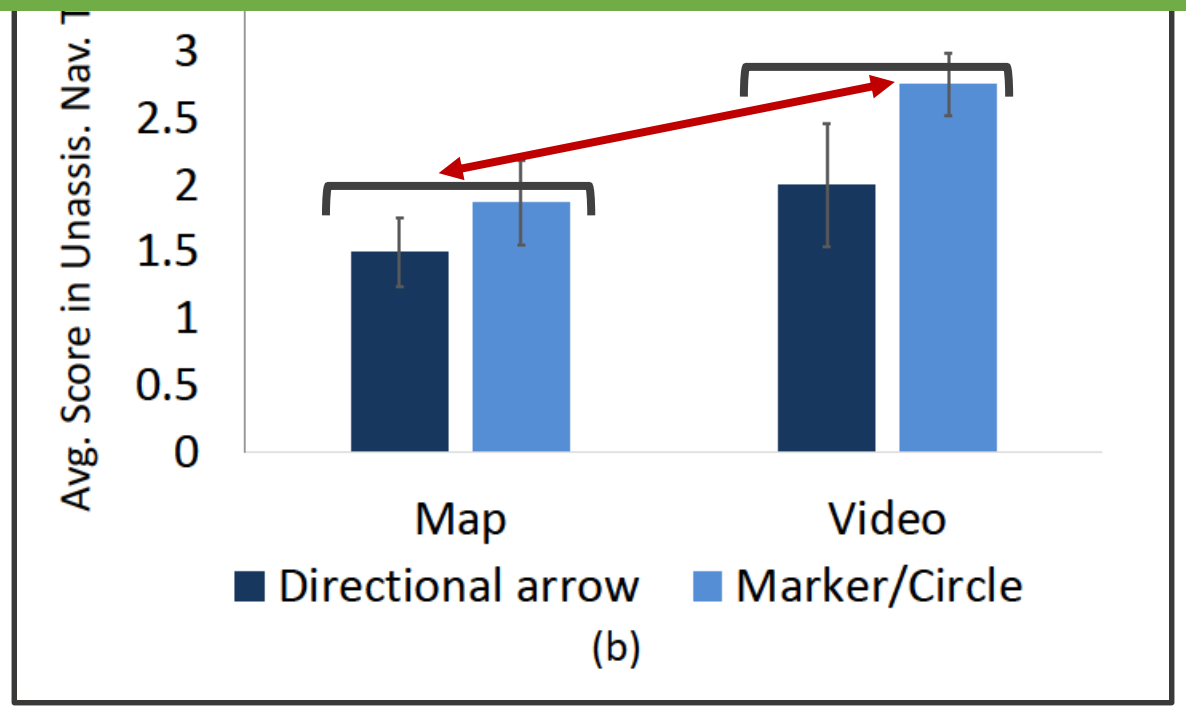




Results: Route Knowledge Analysis

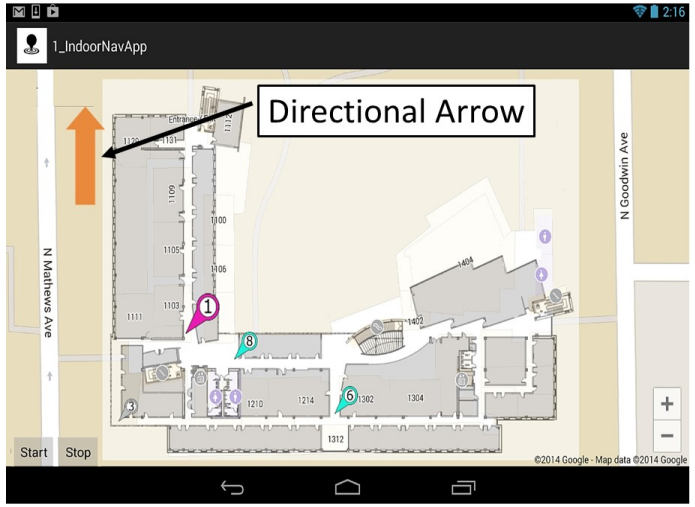
Viewing the Video Interface (live video feed) helped participants learn the route knowledge better

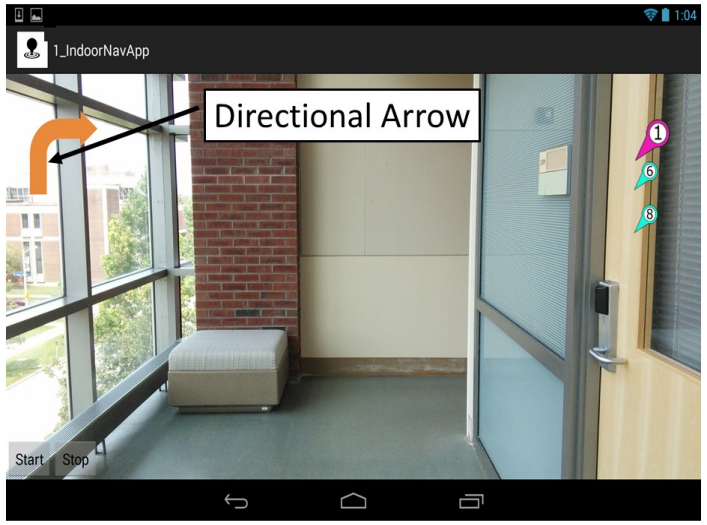




Summery of Results

Lazy Approach





Easy to Navigate

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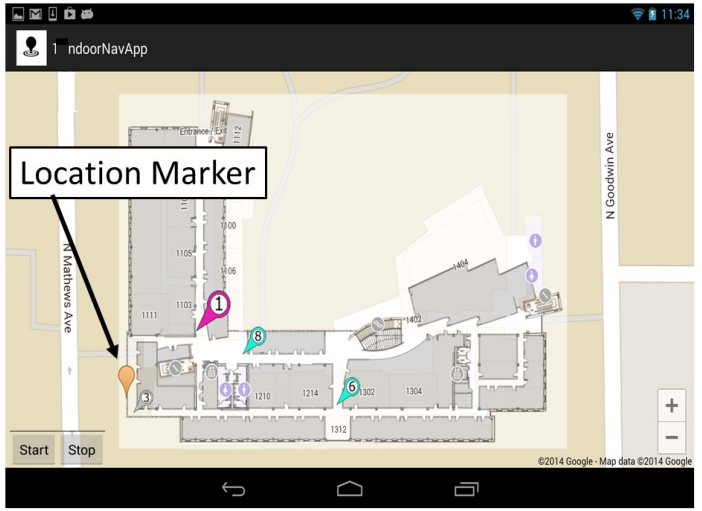
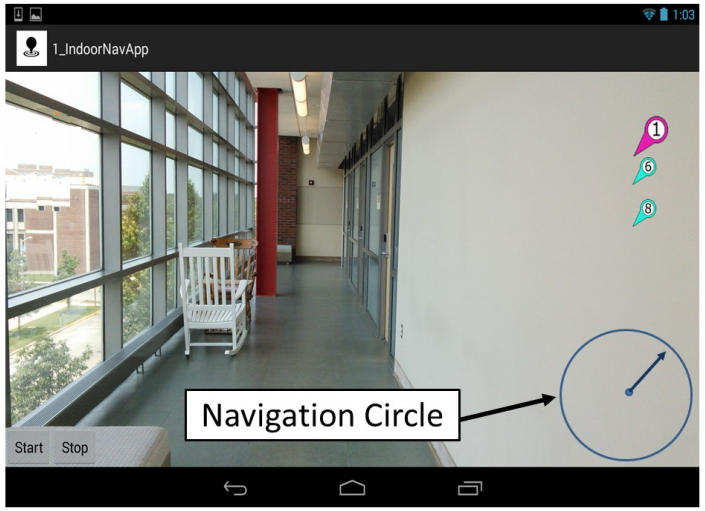
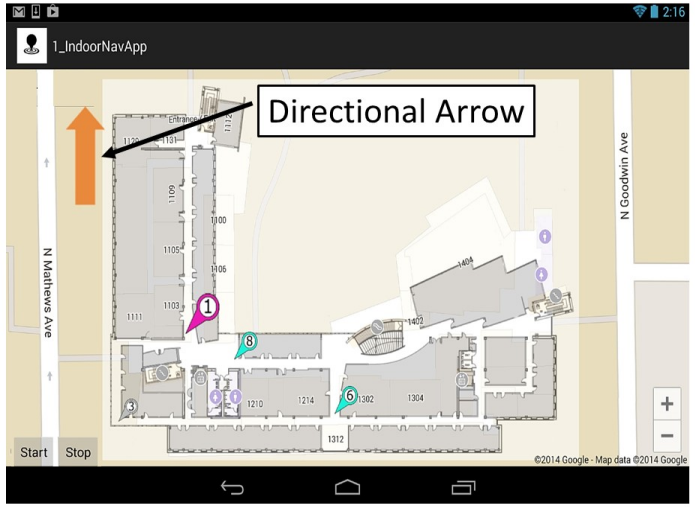
Hard Approach

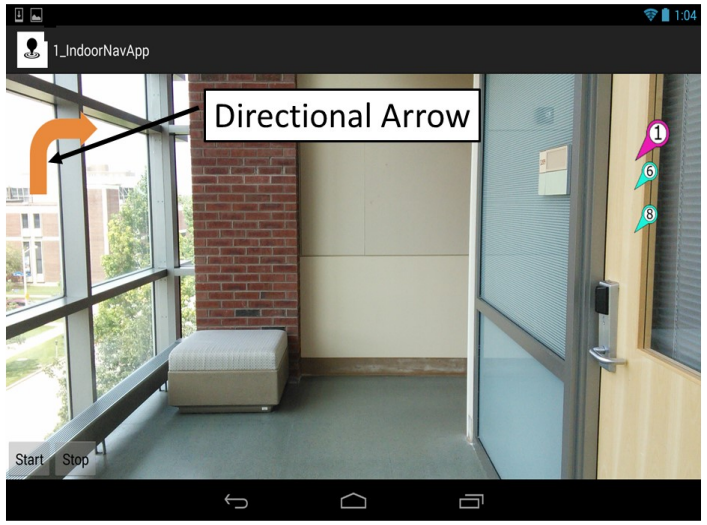




Summery of Results

Lazy Approach





Learning Spatial Knowledge

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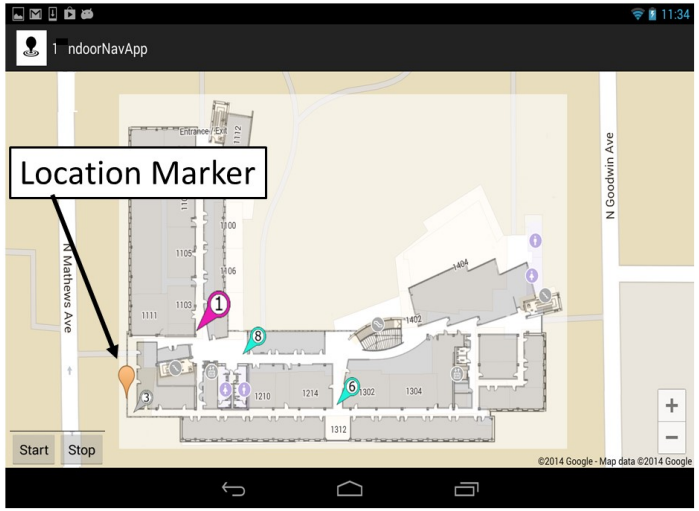
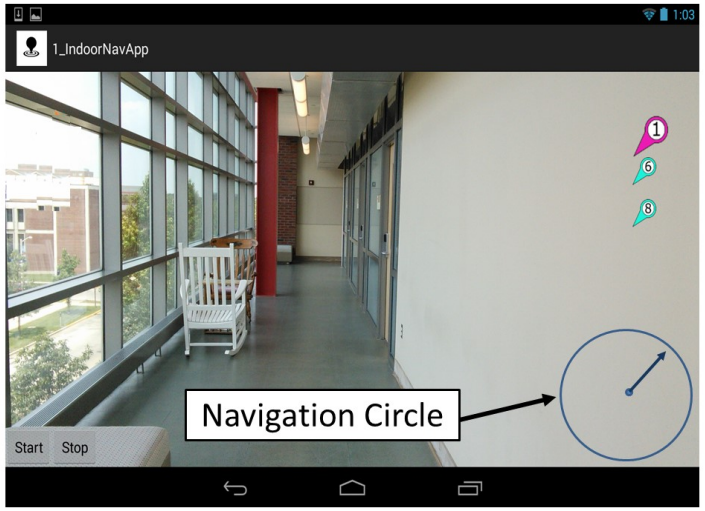
Hard Approach





Thank You

Sanorita Dey

Karrie Karahalios

Wai-Tat Fu

Contact

Email: sdey4@Illinois.edu

Website: http://sdey4.web.engr.illinois.edu

User Study Design