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

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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
- Administrative Building
- Library
- Airport Terminal
- Hospital Buildings
Outdoor vs Indoor Navigation

Structural Challenges

<table>
<thead>
<tr>
<th>Homogeneous Architecture</th>
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</thead>
<tbody>
<tr>
<td>Lack of Landmarks</td>
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</tbody>
</table>
Challenges of Using Indoor Navigation Apps

Carrying a navigation device is inconvenient

- Too many people

Weakness of the WiFi or RFID Signal

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

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
How the Interface design elements of indoor navigation applications can help people learn about their environment?
How the interface design elements of indoor navigation applications can help people learn the spatial knowledge about their environment?
What is spatial knowledge?
Spatial Knowledge

What is spatial knowledge?

Survey Knowledge
- Topographic Properties of an Environment

Route Knowledge
- Sequential Record Necessary to Move in an Environment
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
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: Current location on the map
- Video Interface: 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

**Relative Location Update**
- Real Time Update

Map Interface with Directional Arrow

Map Interface with Location Marker
Map Interfaces

Directional Arrow
- Turn-by-Turn Update

Relative Location Update
- Real Time Update

Lazy Approach
- Easy to Navigate

Hard Approach
- Facilitate Active Learning

Map Interface with Directional Arrow

Map Interface with Location Marker
Video Interfaces

- **Directional Arrow**
  - Turn-by-Turn Update

- **Relative Location Update**
  - Real Time Update

**Lazy Approach**
- Easy to Navigate

**Hard Approach**
- Facilitate Active Learning

Video Interface with Directional Arrow

Video Interface with Navigation Circle
User Study Design
Study Design

User Study

32 Participants

- 8 Participants
- 8 Participants
- 8 Participants
- 8 Participants
User Study Design

Assisted Navigation Tasks

Tests to measure Incremental Survey Knowledge

Completed 4 Tasks?

Yes → Test to measure Integrated Survey Knowledge

No → Tests to measure Route Knowledge

Completed 3 Tasks?

Yes → End

No
User Study Design

1. Assisted Navigation Tasks
2. Tests to measure Incremental Survey Knowledge
3. Completed 4 Tasks?
   - No
   - Yes
     a. Test to measure Integrated Survey Knowledge
     b. Tests to measure Route Knowledge
4. Completed 3 Tasks?
   - No
   - Yes
     a. Orientation Test
     b. Path Recall Test

End
User Study Design

Assisted Navigation Tasks

Tests to measure Incremental Survey Knowledge

Completed 4 Tasks?

Yes

Test to measure Integrated Survey Knowledge

No

Tests to measure Route Knowledge

Completed 3 Tasks?

Yes

End

No

Orientation Test

Path Recall Test

Floor Plan Recall Test
User Study Design

Assisted Navigation Tasks

Tests to measure Incremental Survey Knowledge

Completed 4 Tasks?

Test to measure Integrated Survey Knowledge

Tests to measure Route Knowledge

Completed 3 Tasks?

End

Orientation Test

Path Recall Test

Floor Plan Recall Test
1. Location Recognition Test
2. Unassisted Navigation Test
Tests to measure Route Knowledge

Location 1: Easiest
Location 2: Harder
Location 3: Hardest
Results
# Results: Time Analysis

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Time Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Task 1</td>
<td>4 min 15 sec</td>
</tr>
<tr>
<td>Task 2</td>
<td>4 min 48 sec</td>
</tr>
<tr>
<td>Task 3</td>
<td>4 min 44 sec</td>
</tr>
<tr>
<td>Task 4</td>
<td>4 min 57 sec</td>
</tr>
</tbody>
</table>
## Results: Time Analysis

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Map with Directional Arrow</th>
<th>Map with Location Marker</th>
<th>Video with Directional Arrow</th>
<th>Video with Navigation Circle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task 1</td>
<td>4 min 15 sec &lt; 5 min 30 sec</td>
<td>4 min 20 sec &lt; 5 min 44 sec</td>
<td>4 min 15 sec</td>
<td>4 min 20 sec</td>
</tr>
<tr>
<td>Task 2</td>
<td>4 min 48 sec</td>
<td>4 min 38 sec</td>
<td>4 min 37 sec</td>
<td>4 min 22 sec</td>
</tr>
<tr>
<td>Task 3</td>
<td>4 min 44 sec</td>
<td>4 min 15 sec</td>
<td>4 min 10 sec</td>
<td>4 min 15 sec</td>
</tr>
<tr>
<td>Task 4</td>
<td>4 min 57 sec</td>
<td>4 min 49 sec</td>
<td>4 min 57 sec</td>
<td>4 min 39 sec</td>
</tr>
</tbody>
</table>

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.
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

FloorPlan Recall Test

- Map: Directional arrow (3.5) vs. Marker/Circle (2.5)
- Video: Directional arrow (2.0) vs. Marker/Circle (2.5)

Avg. Performance Rating

0 1 2 3 4 5
Results: Integrated Survey Knowledge Analysis

Viewing the Map Interface (floor plan) helped participants learn the integrated survey knowledge better.
Results: Route Knowledge Analysis

Location Recognition Test

Unassisted navigation Test
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

Hard Approach

- Easy to Navigate

Directional Arrow

Location Marker

Navigation Circle
Summery of Results

Lazy Approach

Learning Spatial Knowledge

Hard Approach

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Thank You

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