Presentation of “Next generation navigation: the importance of context and quality”

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Next generation navigation: the importance of context and quality

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The REGIONAL Project

- UK government funding
- LINK IST Programme
- 1999 – 2002
- Vehicle navigation
- Incorporating landmarks
- Database and HMI

TTEC
Why should systems include landmarks?

- Landmarks are commonly used in current way-finding strategies

- Vehicle Navigation systems that utilise landmarks have been shown to improve:
  - safety
  - acceptability
  - effectiveness
Research rationale

Choose

i.e. What landmarks to use

Use

i.e. When to use them

Present

i.e. How to display them

Advice to industry
Industry Requirements

For database development
- strong business case
- multiple potential uses
- available, accessible, accurate, easily maintainable data
- avoid field visits

For navigation system software
- ‘rules’ for use of landmarks
- ‘proof’ that any approach is the optimum.
- landmarks considered within the ‘big picture’
Study 1 – Context of use

• 36 subjects wrote directions to navigate 3 routes
  – Video of route
  – Cognitive map

• Written directions coded

• Sources of navigation information identified

• Context of use identified
Use of general navigation information
Use within the navigation task

General information category

Frequency counts

- Direction sign (nav)
- Direction sign (object)
- Distance
- Environment
- Junction description
- Junction name/number
- Landmark
- Lane change
- Node geometry
- Path geometry
- Road marking
- Road type
- Street name/number
- Time

Categories: preview, identify, confirm
Information: main or secondary
Information used at Manoeuvre 1

- Direction sign (nav)
- Direction sign (object)
- Distance
- Environment
- Junction description
- Junction name/number
- Landmark
- Lane change
- Node geometry
- Path geometry
- Road marking
- Road type
- Street name/number
- Time

Frequency counts

Information type

- all subs
- cognitive map
- video
Information used at Manoeuvre 9

- Frequency counts for different general info categories.
- Bars represent frequency counts for all subs, cognitive map, and video.

Categories include:
- Direction sign (nav)
- Direction sign (object)
- Distance
- Environment
- Junction description
- Junction name/number
- Landmark
- Lane change
- Node geometry
- Path geometry
- Road marking
- Road type
- Street name/number
- Time

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Information used at Manoeuvre 26

![Bar chart showing frequency counts for different general information categories such as 'Direction sign (nav)', 'Direction sign (object)', 'Distance', 'Environment', 'Junction description', 'Junction name/number', 'Landmark', 'Lane change', 'Node geometry', 'Path geometry', 'Road marking', 'Road type', 'Street name/number', and 'Time'. The chart is color-coded for 'all subs', 'cognitive map', and 'video'.]
Predicting Landmark Value ($V$)

$$V = (0.340) \text{DEGOFINT} + (0.255) \text{USEOFLOC} + (0.134) \text{VISCAR}$$

Where:
- DEGOFINT = Degree of Interaction
- USEOFLOC = Usefulness of Location
- VISCAR = Visual Characteristics

OTHER POTENTIAL FACTORS
- Visual Effort for Scanning*
- Pre-Warning*
- Familiarity
- Ease of Naming
- Influence of Surroundings*
- Similarity of Appearance
- Level of Task Demand*
Study 2 – Effect of Landmark Value

- 48 subjects (3 x 16)
- Good vs Poor vs No Landmarks (verbally)
- Left turn…

[before the pedestrian lights]  [before the phone box]

V=79  V=50

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Number of glances to display

Mean no. of glances - all target manoeuvres

<table>
<thead>
<tr>
<th>Landmark category</th>
<th>Mean no. of glances</th>
</tr>
</thead>
<tbody>
<tr>
<td>good</td>
<td>5.2</td>
</tr>
<tr>
<td>poor</td>
<td>4.5</td>
</tr>
<tr>
<td>none</td>
<td>8.8</td>
</tr>
</tbody>
</table>
Number of glances

Manoeuvre number

Landmark category
- good
- poor
- none

Estimated Marginal Means

0 2 4 6 8 10 12 14
2 4 6 8 10 12 14

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Percentage moving time

- Mean % - all target manoeuvres:
  - none: 16.6%
  - poor: 9.0%
  - good: 10.5%
Percentage moving time

Landmark category
- good
- poor
- none

Manoeuvre number

Estimated Marginal Means

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Approach confidence

1 = low; 2 = medium; 3 = high
Approach confidence

1 = low; 2 = medium; 3 = high
Confidence changes

1 = low;  2 = medium;  3 = high
Driving errors

1 = minor; 5 = serious; 10 = dangerous
Navigation errors

i.e. 25% for poor/none; 10% for good
<table>
<thead>
<tr>
<th></th>
<th>Good landmarks</th>
<th>Poor landmarks</th>
<th>No landmarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of glances</td>
<td>**</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>Glance duration</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>% time looking at display</td>
<td>**</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>Workload</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Driving errors</td>
<td>***</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Navigation errors</td>
<td>***</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Approach confidence</td>
<td>**</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Confidence at Preview 1</td>
<td>**</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Confidence at Preview 2</td>
<td>**</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>Confidence at Final</td>
<td>***</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>Confidence post-manoeuvre</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Study 3 - effect of incorrect information

- 18 participants drove three routes

- 10 traffic lights  \((control \ - \ all \ correct)\)
- 10 pubs  \((no. \ 7 \ - \ wrong \ name)\)
- 10 petrol stations  \((no. \ 7 \ - \ wrong \ name)\)

- Driver confidence at each manoeuvre
  \((1=\text{low}, \ 2=\text{medium}, \ 3=\text{high})\)
Change in confidence levels

Line graph to show the overall confidence levels for the 3 routes

Average Confidence rating

Manoeuvre Number

1 = low; 2 = medium; 3 = high
Main effects on confidence

- Prior to vs post error
  - Traffic lights 2.83
  - Petrol Stations 2.85 to 2.63 (down 0.22)
  - Pubs 2.79 to 2.29 (down 0.50)

- Pre-error confidence range = 2.5 – 3.0
- Manoeuvre at which the error occurred:
  - 2.0 for petrol stations
  - 1.5 for pubs

- Post error, 3 manoeuvres to regain confidence
Did drivers notice (n=16)?

Graph to show how many people noticed the incorrect naming of the landmark

<table>
<thead>
<tr>
<th>Type of landmark</th>
<th>Number of people</th>
</tr>
</thead>
<tbody>
<tr>
<td>Petrol Station</td>
<td>10</td>
</tr>
<tr>
<td>Pub</td>
<td>15</td>
</tr>
</tbody>
</table>
Explanation of findings

• Petrol stations
  – designed to be easily spotted by drivers
  – very different to surrounding objects
  – likely to occur singly

• Pubs
  – pubs are often clustered together
  – there may be other potential manoeuvres nearby
  – difficult to pick out from the surroundings
Future Plans

- Application of results to other areas
  - Pedestrian navigation
  - Location based services

- Information reliability – does the effect differ?

- Context specific information

- Adapting to the user