Pointing at the HUD

GESTURE INTERACTION USING A LEAP MOTION

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Abstract

Head Up Displays (HUDs) have the advantage to be visi- ble in the line of sight of the driver and thus minimize visual distraction. Otherwise, it is not easy to manipulate them since they are virtually positioned behind the windscreen. We used a Leap Motion controller to achieve a gesture controlled HUD. We have conducted a simulator study with two variations of a simplified HUD: one with three segments and one with four segments. We show that the three segment HUD is superior to the four segment HUD in terms of inter- action time and error rate. We provide data on the horizon- tal angle a HUD segment is chosen with the index finger of the right hand when selecting one of the three respectively four segments of the HUD. Our results can inform HUD in- teraction designers on in- terpreting mid-air pointing gestures to achieve higher success rates.

Fig. 1 :Simulated HUD with 3 segments labeled 1 to 3. Currently the user is pointing at element 3 and thus it is highlighted in blue. Ehen the user would move the index finger of the right hand towards the segment it would be selected and highlighted in green.

Fig. 2 : Test setup during the case studies with the driving simulator. Driver selects segment 3 of the 4-segment HUD. Below the 4 segments the to be chosen segment number is displayed.

Fig. 3 : Flattend steering wheel allows gestures to be made above the steering wheel rim.

Prototype

- Goal to highlight and select segments on HUD with mid-air gestures
- Leap Motion to track gesture
- TFT monitor for HUD

2 conditions:

- HUD with 3 elements
- HUD with 4 elements

3-segment HUD:

- HUD segment 1 angle between 180 and 100 degrees
- HUD segment 2 angle between 100 and 80 degrees
- HUD segment 3 angle between 80 and 0 degrees

4-segment HUD:

- HUD segment 1 angle between 180 and 100 degrees
- HUD segment 2 angle between 100 and 95 degrees
- HUD segment 3 angle between 95 and 85 degrees
- HUD segment 3 angle between 85 and 0 degrees

Study Setup

Study environment

- Driving simulator which consists of a wireframe mock-up and OpenDS
- Netbook running eclipse executed the program and simulated the HUD
- Leap Motion placed right behind a Fanatec steering wheel

Study procedure

- In-between subject design with two conditions (3-segment display and 4-segment display)
- Informed consent and demographic questions
- Exploration phase
- Complete two conditions while driving in the simulator
- Conditions were counter balanced

For each condition:

- Select a given segment by pointing at the corresponding segment
- Random segment numbers visualized in window below HUD
- When pointed at, the segment got blue
- Selection by moving the pointing finger slightly forward
- Then head back on steering wheel
- Repeated 15 times for each condition

Results

- 10 right-handed participants (5f, 5m)
- 3-segment HUD was superior to the 4-segment HUD

Average time to select a segment:

- 3-segment HUD: 4 seconds
- 4-segment HUD: 10 seconds

Error rate:

- 3-segment HUD: 18.1%
- 4-segment HUD: 24.8%

Gesture angles:

3-segment HUD

- Segment 1 110.43 degree
- Segment 2 92.54 degree
- Segment 3 75.63 degree

4-segment HUD:

- Segment 1 108.97 degree
- Segment 2 97.29 degree
- Segment 3 88.81 degree
- Segment 4 78.67 degree

Interview and questionnaire:

- Proposed system was intuitive
- Distraction as an issue

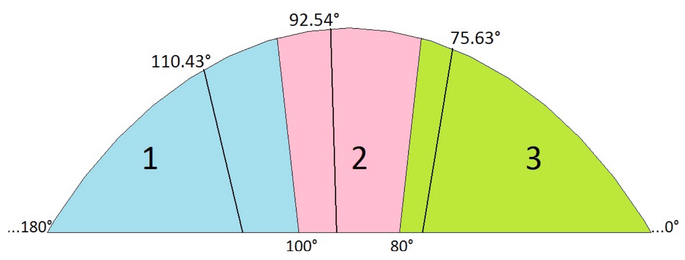

Fig. 4 : Three segments and the angles of the average hit points.

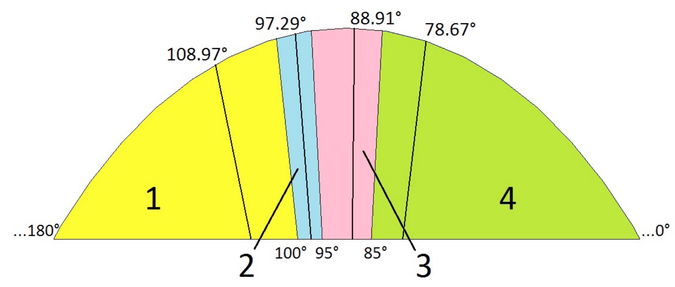

Fig. 5 : Four segments and the angles of the average hit points.

Conclusion

- Segmenting the HUD in three parts is superior to a 4 segment solution in terms of interaction time and error rate
- Drivers tend to hit a target slightly to the right
- A more fragmented HUD would lead to smaller pointing gestures in terms of angle interval

Limitations:

- Simulator setup
- Only 3 and 4 segments
- Not a real HUD (e.g., no see through)
- Position of Leap Motion above and behind the steering wheel

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