**Appendix**

Table 1 Possible non-contact interactions corresponding to map operations.

|  |  |  |  |
| --- | --- | --- | --- |
| Map operation | Non-contact type | Specific way | Demonstration in Table 2 |
| Map zoom-in | Eye tracking control | The left eye open, the right eye closed. | Num. 1 |
| The left eye closed, the right eye open. | Num. 2 |
| The left eye blinks on the "Zoom-in" button. | Num. 3 |
| The right eye blinks on the "Zoom-in" button. | Num. 4 |
| Both eyes blink on the "Zoom-in" button. | Num. 5 |
| Voice control | Say "Map zoom-in". | Num. 6 |
| Head movement control | Nod up | Num. 7 |
| Nod down | Num. 8 |
| Move left | Num. 9 |
| Move right | Num. 10 |
| Expression control | Recognize "smile" expression | Num. 11 |
| Map zoom-out | Eye tracking control | The left eye open, the right eye closed. | Num. 1 |
| The left eye closed, the right eye open. | Num. 2 |
| The left eye blinks on the "Zoom-out" button. | Num. 3 |
| The right eye blinks on the "Zoom-out" button. | Num. 4 |
| Both eyes blink on the "Zoom-out" button. | Num. 5 |
| Voice control | Say "Map zoom-out". | Num. 6 |
| Head movement control | Nod up | Num. 7 |
| Nod down | Num. 8 |
| Move left | Num. 9 |
| Move right | Num. 10 |
| Expression control | Recognize "smile" expression | Num. 11 |
| Map pan | Eye tracking control | Gazing at a target with the left eye automatically sets the location as the center of the map display. | Num. 12 |
| Gazing at a target with the right eye automatically sets the location as the center of the map display. | Num. 13 |
| Gazing at a target with both eyes automatically sets the location as the center of the map display. | Num. 14 |
| The left eye blinks on the map compass "up/down/left/right" button. | Num. 3 |
| The right eye blinks on the map compass "up/down/left/right" button. | Num. 4 |
| Double eyes blink on the map compass "up/down/left/right" button. | Num. 5 |
| Voice control | Say "move up/down/left/right". | Num. 6 |
| Head movement control | Nod up | Num. 7 |
| Nod down | Num. 8 |
| Move left | Num. 9 |
| Move right | Num. 10 |
| Expression control | Recognize "smile" expression | Num. 11 |
| Map toggle | Eye tracking control | The left eye blinks on the "satellite" button to toggle. | Num. 3 |
| The right eye blinks on the "satellite" button to toggle. | Num. 4 |
| Double eyes blink on the "satellite" button to toggle. | Num. 5 |
| Voice control | Say "Map toggle". | Num. 6 |
| Head movement control | Nod up | Num. 7 |
| Nod down | Num. 8 |
| Move left | Num. 9 |
| Move right | Num. 10 |
| Expression control | Recognize "smile" expression | Num. 11 |
| Location search | Eye tracking control | After the left eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | Num. 3 |
| After the right eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | Num. 4 |
| After blinking both eyes on the text box to bring up the virtual keyboard, blinking both eyes on the letters of the virtual keyboard to realize the phonetic character blinking input. | Num. 5 |
| Voice control | Say "search" & the name of the location you are looking for. | Num. 6 |
| Route planning - Interface open | Eye tracking control | The left eye blinks on the "Route" button. | Num. 3 |
| The right eye blinks on the "Route" button. | Num. 4 |
| Double eyes blink the "Route" button. | Num. 5 |
| Voice control | Say "Route". | Num. 6 |
| Head movement control | Nod up | Num. 7 |
| Nod down | Num. 8 |
| Move left right | Num. 9 |
| Move right | Num. 10 |
| Expression control | Recognize "smile" expression | Num. 11 |
| Route planning - Location entry | Eye tracking control | The left eye gazes at the target location, after the function menu pops up, double eyes blink to set the start point or end point. | Num. 12 |
| The right eye gazes at the target location, after the function menu pops up, double eyes blink to set the start point or end point. | Num. 13 |
| Double eyes gaze at the target location, after the function menu pops up, double eyes blink to set the start point or end point. | Num. 14 |
| After the left eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | Num. 3 |
| After the right eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | Num. 4 |
| After blinking both eyes on the text box to bring up the virtual keyboard, blinking both eyes on the letters of the virtual keyboard to realize the phonetic character blinking input. | Num. 5 |
| Voice control | Say "start" & start point or "end" & end point. | Num. 6 |
| Route planning - Navigation method selection | Eye tracking control | The left eye blinks on the "drive"/"bus"/"walk" button. | Num. 3 |
| The right eye blinks on "drive"/"bus"/"walk" button. | Num. 4 |
| The double eyes blink on the "drive"/"bus"/"walk" button. | Num. 5 |
| Voice control | Say the corresponding mode of navigation, e.g. "drive"/"bus"/"walk". | Num. 6 |

Table 2 Typical non-contact operation demonstration in Table 1.

|  |  |
| --- | --- |
| Number | Demonstration |
| 1 | 卡通人物  描述已自动生成 |
| 2 | 卡通人物  描述已自动生成 |
| 3 |  |
| 4 |  |
| 5 | 卡通人物  描述已自动生成 |
| 6 | 卡通人物  描述已自动生成 |
| 7 | 卡通人物  描述已自动生成 |
| 8 | 卡通人物  描述已自动生成 |
| 9 | 卡通人物  描述已自动生成 |
| 10 | 图形用户界面  描述已自动生成 |
| 11 | 图形用户界面, 应用程序  描述已自动生成 |
| 12 | 人的脸被修图的玩具  中度可信度描述已自动生成 |
| 13 | 卡通人物  描述已自动生成 |
| 14 |  |

Table 3 Expert pre-assessment of non-contact approach selection and score results - Map zoom-in (The composite score is calculated by equation (1), and will not be repeated later.)

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | The left eye open, the right eye closed. | 45.16% | 3.77 |
| The left eye closed, the right eye open. | 5.23% |
| The left eye blinks on the "Zoom-in" button. | 0 |
| The right eye blinks on the "Zoom-in" button. | 0 |
| Both eyes blink on the "Zoom-in" button. | 22.58% |
| Others | 0 |
| Not recommended | 22.58% |
| Voice control | Say "Map zoom-in". | 70.97% | 3.03 |
| Others | 3.23% |
| Not recommended | 25.81% |
| Head movement control | Nod up and down | 25.81% | 1.68 |
| Move left and right | 16.13% |
| Others | 0 |
| Not recommended | 61.29% |
| Expression control | Recognize "smile" expression | 25.81% | 0.77 |
| Others | 3.23% |
| Not recommended | 74.19% |

Table 4 Results of the Friedman test for expert pre-assessment options - Map zoom-in

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Control method | Sample size | 25th percentile | Upper quartile | 75th percentile | Statistic | P | Cohen's f |
| Eye tracking control | 31 | 1 | 1 | 1 | 26.522 | 0.000\*\* | 0.252 |
| Voice control | 31 | 2 | 2 | 2 |
| Head movement control | 31 | 2.5 | 3 | 3 |
| Expression control | 31 | 1.5 | 4 | 4 |
| Note: \*\* and \* represent 1% and 5% significance levels, respectively. | | | | | | | |

Table 5 Expert pre-assessment of non-contact approach selection and score results - Map zoom-out

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | The left eye open, the right eye closed. | 19.03% | 3.68 |
| The left eye closed, the right eye open. | 54.84% |
| The left eye blinks on the "Zoom-out" button. | 0 |
| The right eye blinks on the "Zoom-out" button. | 0 |
| Both eyes blink on the "Zoom-out" button. | 29.03% |
| Other | 0 |
| Not recommended | 22.58% |
| Voice control | Say "Map zoom-out". | 77.42% | 2.94 |
| Other | 0 |
| Not recommended | 22.58% |
| Head movement control | Nod up and down | 9.68% | 1.61 |
| Move left and right | 22.58% |
| Others | 0 |
| Not recommended | 70.97% |
| Expression control | Recognize "smile" expression | 25.81% | 0.77 |
| Others | 9.68% |
| Not recommended | 67.74% |

Table 6 Results of the Friedman test for expert pre-assessment options - Map zoom-out

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Control method | Sample size | 25th percentile | Upper quartile | 75th percentile | Statistic | P | Cohen's f |
| Eye tracking control | 31 | 1 | 1 | 1 | 23.847 | 0.000\*\* | 0.217 |
| Voice control | 31 | 2 | 2 | 2 |
| Head movement control | 31 | 1.5 | 3 | 3 |
| Expression control | 31 | 0 | 4 | 4 |
| Note: \*\* and \* represent 1% and 5% significance levels, respectively. | | | | | | | |

Table 7 Expert pre-assessment of non-contact approach selection and score results - Map pan

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | Gazing at a target with the left eye automatically sets the location as the center of the map display. | 7.34% | 3.74 |
| Gazing at a target with the right eye automatically sets the location as the center of the map display. | 5.56% |
| Gazing at a target with both eyes automatically sets the location as the center of the map display. | 74.19% |
| The left eye blinks on the map compass "up/down/left/right" button. | 0 |
| The right eye blinks on the map compass "up/down/left/right" button. | 0 |
| Double eyes blink on the map compass "up/down/left/right" button. | 9.68% |
| Other | 0 |
| Not recommended | 22.58% |
| Voice control | Say "Move up/down/left/right". | 77.42% | 3.06 |
| Other | 0 |
| Not recommended | 22.58% |
| Head movement control | Nod up/down | 22.58% | 1.61 |
| Move left/right | 32.26% |
| Others | 0 |
| Not recommended | 51.61% |
| Expression control | Recognize "smile" expression | 16.13% | 0.87 |
| Others | 3.23% |
| Not recommended | 80.65% |

Table 8 Results of the Friedman test for expert pre-assessment options -Map pan

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Control method | Sample size | 25th percentile | Upper quartile | 75th percentile | Statistic | P | Cohen's f |
| Eye tracking control | 31 | 1 | 1 | 1 | 37.266 | 0.000\*\* | 0.353 |
| Voice control | 31 | 2 | 2 | 2 |
| Head movement control | 31 | 3 | 3 | 3 |
| Expression control | 31 | 3 | 4 | 4 |
| Note: \*\* and \* represent 1% and 5% significance levels, respectively. | | | | | | | |

Table 9 Expert pre-assessment of non-contact approach selection and score results -Map toggle

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | The left eye blinks on the "satellite" button to toggle. | 19.35% | 3.55 |
| The right eye blinks on the "satellite" button to toggle. | 6.45% |
| Double eyes blink on the "satellite" button to toggle. | 64.52% |
| Other | 0 |
| Not recommended | 22.58% |
| Voice control | Say "Map toggle" | 80.56% | 3.23 |
| Other | 3.23% |
| Not recommended | 19.35% |
| Head movement control | Nod up and down | 25.81% | 1.65 |
| Move left and right | 19.35% |
| Others | 0 |
| Not recommended | 61.29% |
| Expression control | Recognize "smile" expression | 22.58% | 0.84 |
| Others | 0 |
| Not recommended | 77.42% |

Table 10 Results of the Friedman test for expert pre-assessment options – Map toggle

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Control method | Sample size | 25th percentile | Upper quartile | 75th percentile | Statistic | P | Cohen's f |
| Eye tracking control | 31 | 1 | 1 | 2 | 28.555 | 0.000\*\* | 0.276 |
| Voice control | 31 | 1 | 2 | 2 |
| Head movement control | 31 | 3 | 3 | 3 |
| Expression control | 31 | 1 | 4 | 4 |
| Note: \*\* and \* represent 1% and 5% significance levels, respectively. | | | | | | | |

Table 11 Expert pre-assessment of non-contact approach selection and score results - Location search

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | After the left eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | 0 | 1.23 |
| After the right eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | 0 |
| After blinking both eyes on the text box to bring up the virtual keyboard, blinking both eyes on the letters of the virtual keyboard to realize the phonetic character blinking input. | 58.06% |
| Others | 0 |
| Not recommended | 41.94% |
| Voice control | Say "search" & the name of the location you are looking for. | 80.65% | 1.62 |
| Others | 0 |
| Not recommended | 19.35% |

Table 12 Expert pre-assessment of non-contact approach selection and score results - Route planning - Interface open

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | The left eye blinks on the "Route" button.. | 9.68% | 3.58 |
| The right eye blinks on the "Route" button. | 9.68% |
| Double eyes blink the "Route" button. | 67.74% |
| Other | 0 |
| Not recommended | 22.58% |
| Voice control | Say "Route" | 83.87% | 3.13 |
| Other | 0 |
| Not recommended | 16.13% |
| Head movement control | Nod up and down | 19.35% | 1.52 |
| Move left and right | 12.90% |
| Others | 0 |
| Not recommended | 67.74% |
| Expression control | Recognize "smile" expression | 25.81% | 0.81 |
| Others | 0 |
| Not recommended | 74.19% |

Table 13 Expert pre-assessment selection of Friedman test results - Route planning Interface open

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Control method | Sample size | 25th percentile | Upper quartile | 75th percentile | Statistic | P | Cohen's f |
| Eye tracking control | 31 | 1 | 1 | 2 | 33.531 | 0.000\*\* | 0.31 |
| Voice control | 31 | 1 | 2 | 2 |
| Head movement control | 31 | 3 | 3 | 3 |
| Expression control | 31 | 3.5 | 4 | 4 |
| Note: \*\* and \* represent 1% and 5% significance levels, respectively. | | | | | | | |

Table 14 Expert pre-assessment of non-contact approach selection and score results - Route planning - Location entry

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | The left eye gazes at the target location, after the function menu pops up, double eyes blink to set the start point or end point. | 16.13% | 1.26 |
| The right eye gazes at the target location, after the function menu pops up, double eyes blink to set the start point or end point. | 6.45% |
| Double eyes gaze at the target location, after the function menu pops up, double eyes blink to set the start point or end point. | 35.48% |
| After the left eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | 0 |
| After the right eye blinks on the text box to bring up the virtual keyboard, both eyes blink on the letters of the virtual keyboard to realize the pinyin text blink input. | 0 |
| After blinking both eyes on the text box to bring up the virtual keyboard, blinking both eyes on the letters of the virtual keyboard to realize the phonetic character blinking input. | 54.84% |
| Others | 0 |
| Not recommended | 25.81% |
| Voice control | Say "start" & start point or "end" & end point. | 83.87% | 1.65 |
| Others | 3.23% |
| Not recommended | 16.13% |

Table 15 Expert pre-assessment of non-contact approach selection and score results - Route planning - Navigation method selection

|  |  |  |  |
| --- | --- | --- | --- |
| Non-contact type | Specific way | Selection ratio | Score |
| Eye tracking control | The left eye blinks on the "drive"/"bus"/"walk" button. | 16.13% | 1.48 |
| The right eye blinks on "drive"/"bus"/"walk" button. | 6.45% |
| Double eyes blink on the "drive"/"bus"/"walk" button. | 74.19% |
| Others | 0 |
| Not recommended | 19.35% |
| Voice control | Say the corresponding mode of navigation, e.g. "drive"/"bus"/"walk". | 80.65% | 1.42 |
| Other | 3.23% |
| Not recommended | 19.35% |