

MagicMark:

A marking menu using 2D direction and 3D depth information

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- 1 Introduction
- 2 MagicMark
- 3 Experiment
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Background

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- Menus are broadly applied to command exploration and selection
 - Input modality
 - Tilt: RapMenu
 - 2D direction: Touchless Circular Menus
 - Depth?
 - Marking Menu
 - Novice mode
 - Expert mode

Our idea

- To extend the selection capability of large screen interaction, we propose MagicMark, a marking menu using 2D direction and 3D depth information

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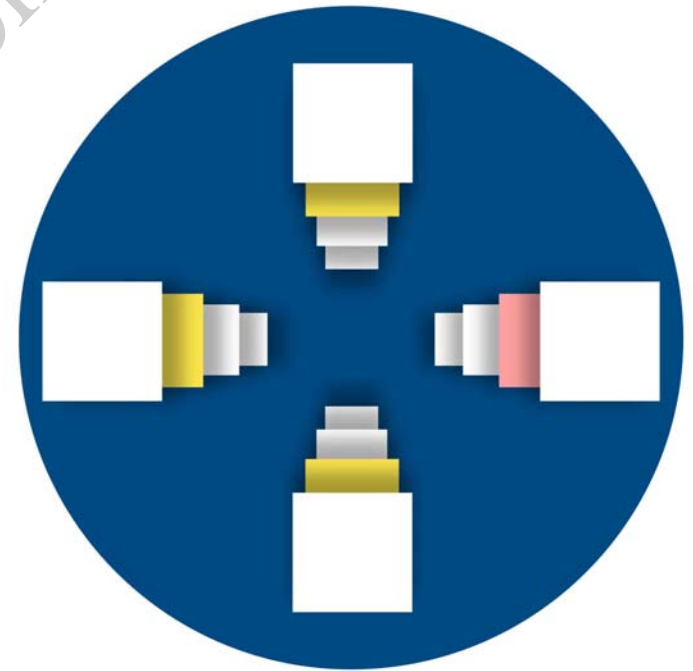
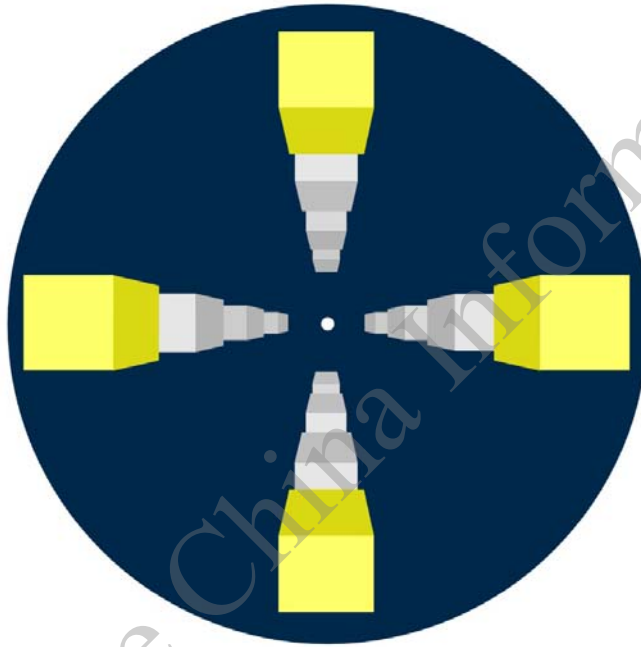
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MagicMark

- menu visualization



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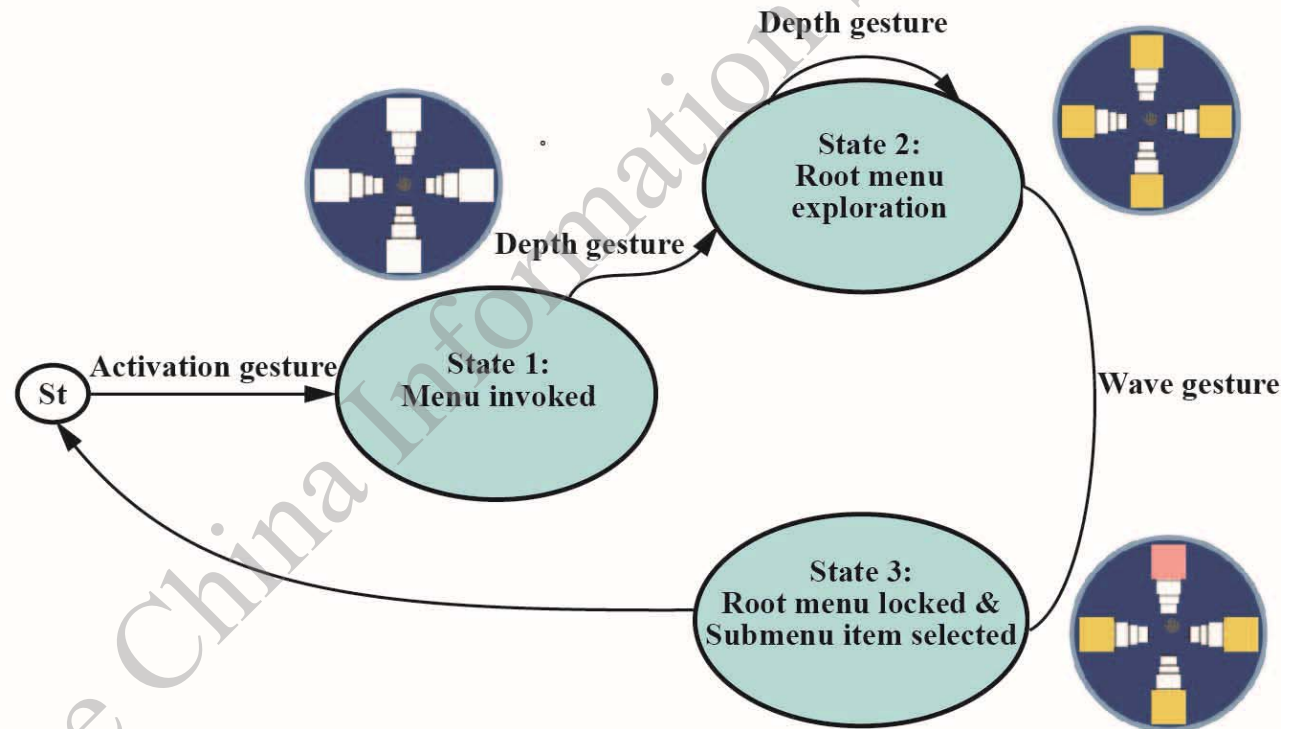
Interaction State Transitions

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Novice mode vs. expert mode.

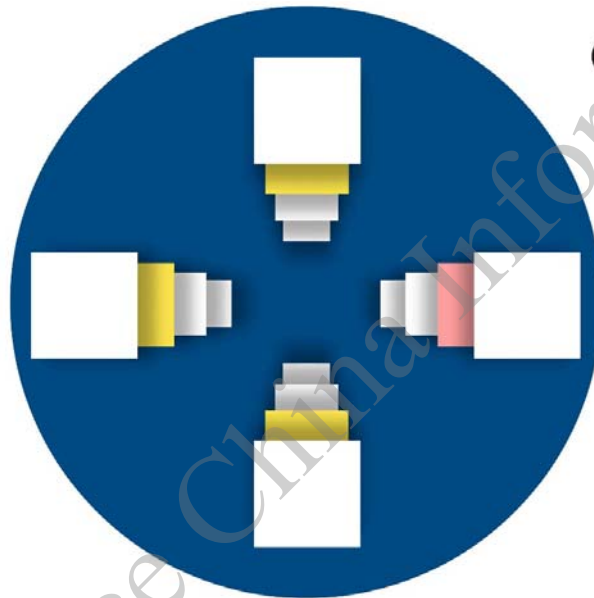
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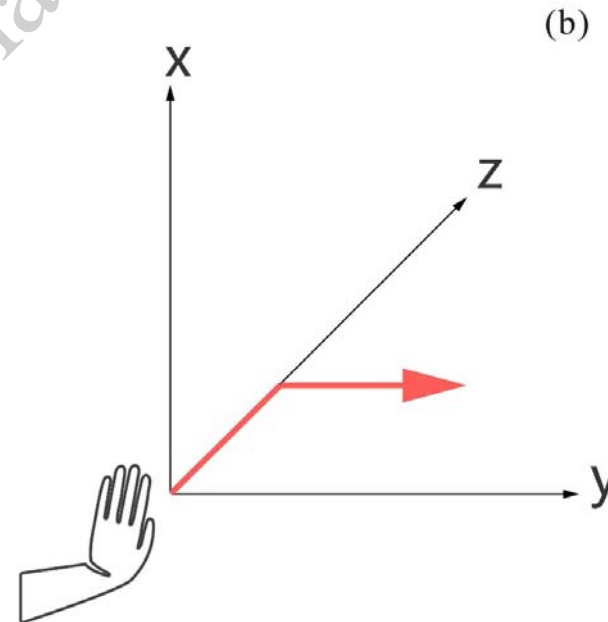
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- MagicMark is a marking menu that includes both novice mode and expert mode.



(a)



(b)

Depth gesture recognition

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- The depth interaction is calculated by the following algorithm. First, a user needs to straighten the dominant arm as far as possible to complete the calibration. As the user fully stretches the arm, the arm length and the calibrated menu depth of MagicMark are calculated according to the following steps:

$$\begin{aligned} \text{armLength} &= Z_{h_{\text{Calibration}}} - Z_{s_{\text{Calibration}}} \\ \text{menuDepth} &= \text{armLength} \end{aligned}$$

where $Z_{h_{\text{Calibration}}}$ and $Z_{s_{\text{Calibration}}}$ are the z-axis value of the user's hand and shoulder, which correspond to skeletal points of Hand and Shoulder Center respectively; armLength is the length of user's arm; menuDepth is the calibrated menu depth of user.

Direction gesture recognition

- Waving gesture is used for converting from the root menu to the submenu. Meanwhile it selects the submenu item based on the direction of the gesture.

An intentional waving gesture is determined when the following conditions are met.

$$\frac{\sum_{i=e_1}^{e_3} |\sqrt{(x_{i+1}-x_i)^2 + (y_{i+1}-y_i)^2}|}{e_3 - e_1} > \text{thresSpeed}_{xOy}$$

$$\frac{\sum_{i=e_1}^{e_3} |z_{i+1} - z_i|}{e_3 - e_1} < \text{thresSpeed}_z$$

If the above conditions are met, the root menu is locked and the submenu is called. At the same time, we calculate the direction of the wave gesture to invoke the command of the corresponding submenu item.

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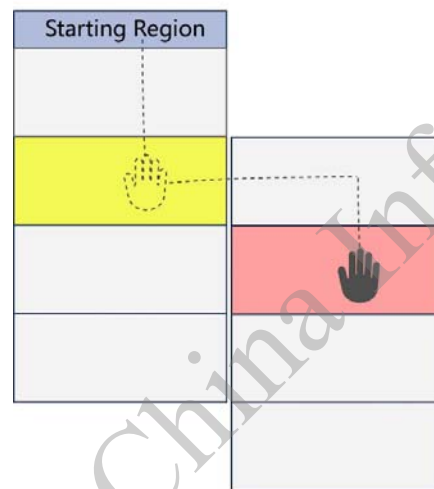
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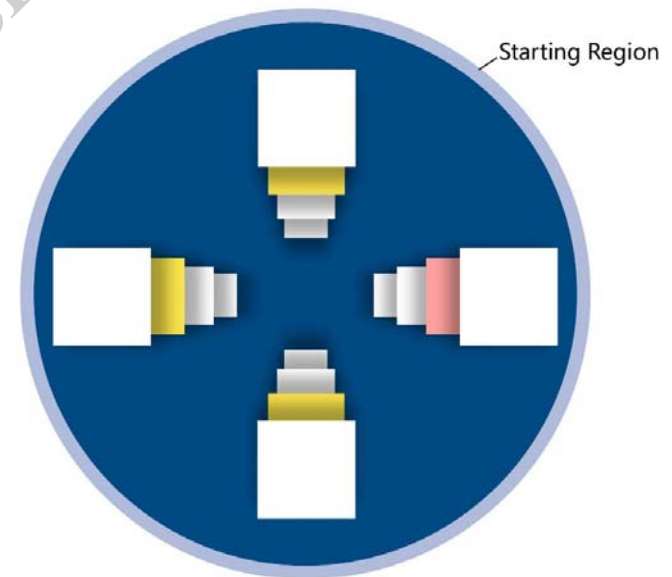
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Experiment

- we conducted an experiment to compare MagicMark and the traditional linear menu.



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Experiment Design

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- 10 subjects, within-subject design
- Participants were requested to complete selection tasks using two menu techniques
- In total, we collected data of 960 trials (16 trials \times 3 repetitions \times 2 menu techniques \times 10 participants)

Measurement

- completion time
- error rate
- questionnaire
 - Speed
 - Error prone
 - Comfortable to use
 - Easy to learn

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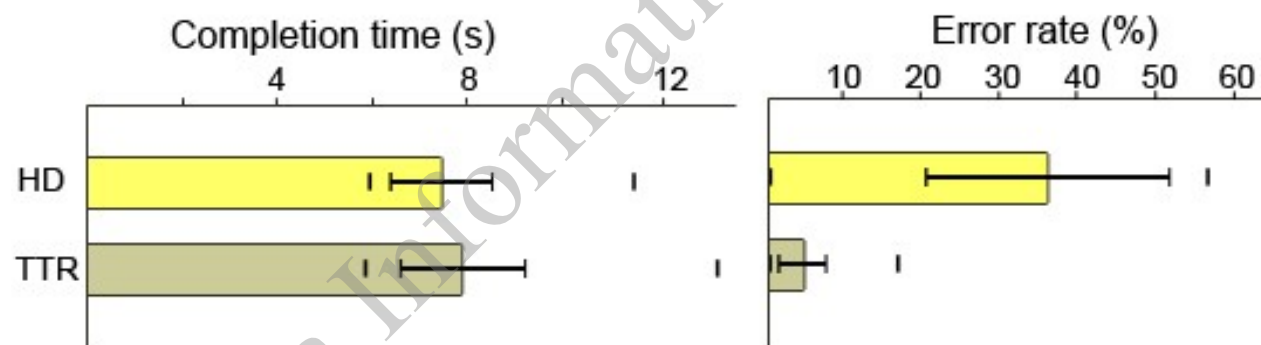
Result

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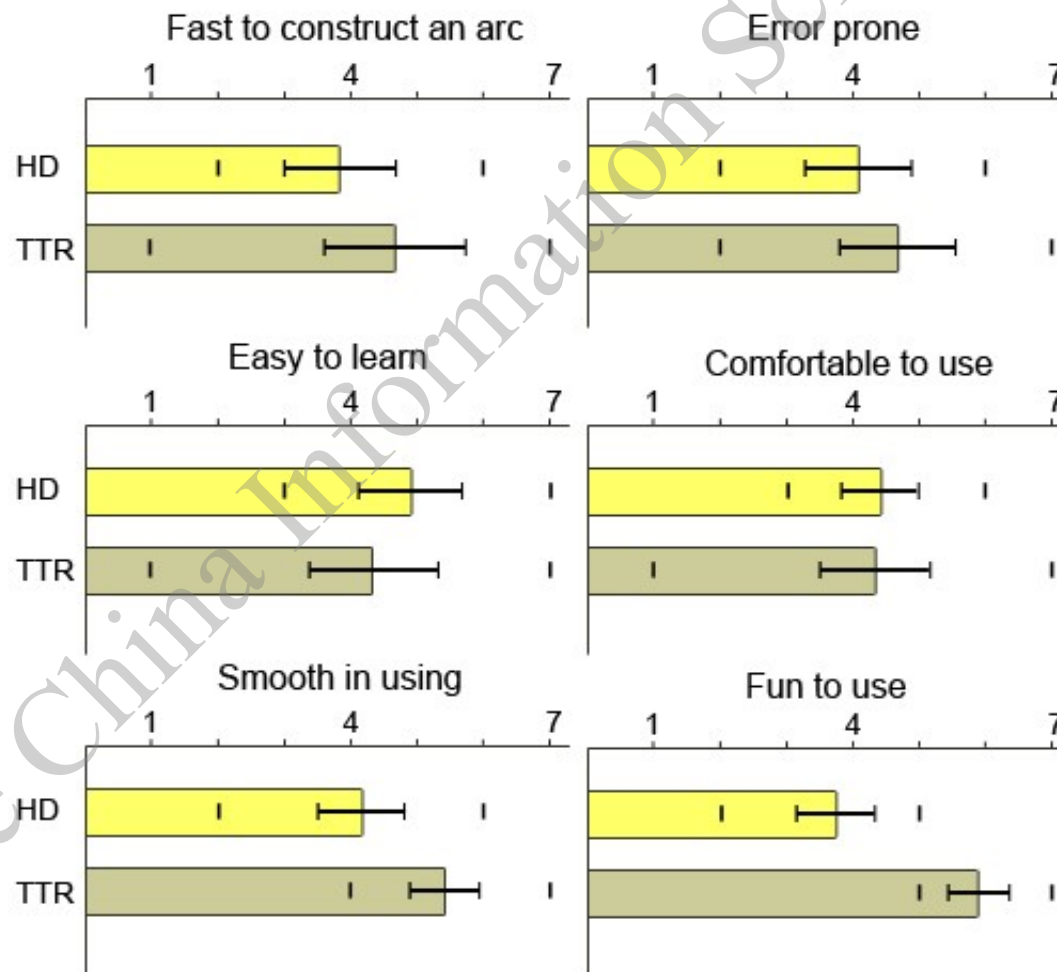
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Result

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Discussion

- Results of the experiment demonstrate that MagicMark can significantly reduce the selection time comparing to the traditional linear menu without sacrificing accuracy.
 - the particular selection mechanism of the MagicMark
- Error rate vs. Error prone

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Future Work

- Our research can be extended in two ways
 - compare the user performance with different menu item sizes using MagicMark
 - explore the learning effect of MagicMark, especially the transition from novice mode to expert mode

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Thank You!

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