Evaluating Pointing Performance in 2D and 3D

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- Motivation and describe your project.

A user's physical gesture by moving an input device allows the computer to interact with on the screen. A common input device is a mouse and a common gesture to select objects at two-dimensional is pointing, point and click has been thoroughly investigated.

However, it is complicated pointing at three-dimensional due to 3D systems. For example, pointing at far objects are smaller than near ones because of perspective. Therefore, measuring a performance of pointing devices in 3D systems involves different tasks and difficulties.

To evaluate the performance in 2D and 3D systems, two input devices (mouse and VR headset) use with Fitts' law. A standardized pointing task ISO 9241-9 (Figure 1) sets to evaluate target pointing. The spherical shape is used for the target in different sizes and distances from each other respectively to a pointing. The target circles place on a 2D vertical plane and render on a 3D environment, but in which targets are rendered by ray casting.

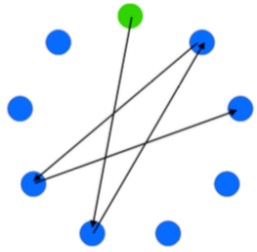

Figure 1. ISO 9241-9

The experiment focus on quantitative results, selection time, error rate and throughput, and the data is automatically logged to evaluate the performance. In the test environment, there are 9 circular targets in a round layout. Each target is respectively changed its size and distance with several task using pointing devices. When using a mouse, the cursor is controlled by the mouse's x and y coordinates. In using a VR headset, the cursor is fixed in the center of the field of view and controlled by the user's perspective.

- Describe the technology.

Fitts' Law

Fitts' law is a model for rapid, aimed movements in human-computer interaction and ergonomics. This law predicts that the time to move a target is a function of the ratio between the distance to the target and the width of the target.

$$\text{MT} = a + b \cdot \text{ID}, \qquad \text{where ID} = \log_2\left(\frac{A}{W} + 1\right)$$

The movement time (MT) is the regression line equation on the index of difficulty (ID) where a and b are determined via linear regression for a given technique. ID is based on the distance to the target (A) and the width of the target (W).

As per the ISO 9241-9 standard, effective ID (ID_e) is used to calculate throughput as:

$$ID_e = \log_2\left(\frac{A_e}{W_e} + 1\right), \qquad \text{where } W_e = 4.133 \times SD_x$$

A_e is the effective distance to the target and W_e is the effective width of the target. The accuracy adjustment is done by calculating SD_x.

$$\text{TP} = \frac{ID_e}{MT}$$

The use of throughput (TP) is a dependent variable.

- Describe the deliverables

The experiment is conducted with an Intel Core i5-6600 quad core processor, a Radeon RX580, and 16GM of RAM, running Microsoft Windows 10. I will be a participant either used a mouse or VR headset depending on the experimental condition. The test environment is created in Unreal Engine.

- Write a paragraph where you make me imagine how will be the end project.

Future work will be the test environment is when the target is selected by devices, the targets' color is changed because if the pointing is success, the users can notice whether the target is selected or not and if pointing is success, then the user choose next the target. This provides feedback and will have a notable influence on 3D point selection performance. Overall, accumulated data from the testing will be analyzed using Fitts' law and the results indicate that which device is outperform.