FloatOmeter: User-Friendly Input of Floating-Point Numbers in Virtual Environments

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Goals

- Specifying floating-point numbers in immersive virtual environments.
- Supporting an unknown range of values.
- Making quick changes between numbers of different order of magnitude.
- Making small changes to previously entered numbers.

Other Methods

Sliders:

- Their main disadvantage is that they have lower and upper bounds.
- They are not useful when the range of the numbers to be entered is not previously known, or when parts of the range need much finer control than others.

Light-Pen-Based Method [3]:

- Used to change numbers continuously (similar to the iPod's touch wheel).
- Gives additional control over the granularity of the changes.
- Range is larger then sliders', but is still limited.

Virtual Numeric Keyboard:

- Works better than a slider-based interface [2].
- Changing an existing number is cumbersome and requires placing a cursor next to the digit to be changed and typing in the new digit, or entering the entire number again.

Text Input:

- Using pen and tablet, pinch glove, chord keyboard or speech [1].
- None of these techniques work well when a previously entered number just needs a small change.

FloatOmeter

- The FloatOmeter is used as an extension of our virtual dial knobs, because many parameters can be set with dials alone and also because it takes up a relatively large screen area.
- A virtual laser pointer (a ray is cast from a hand-held six-degrees-of freedom input device) is used for the interaction.
- Our dials display a value that can be changed by intersecting the ray with the dial and holding the wand button while rotating the wrist.
- The FloatOmeter allows more control over the value and shows up when the laser pointer reaches the top sixth of the dial and the left button is pressed.
- Each digit of the floating-point number is displayed in a little widget box that highlights when the ray intersects it.
- The decimal point is directly above the dial, so that just by looking at the number of boxes on either side of the decimal point the user can estimate how big and precise the number is.
- The FloatOmeter is closed by clicking anywhere outside it.

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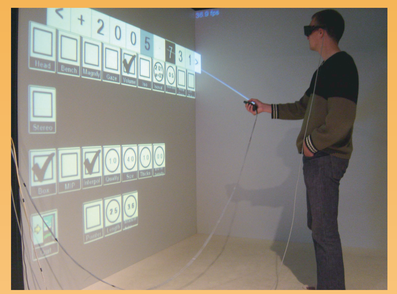
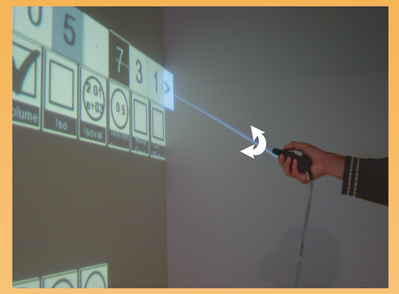


User sets a value in a virtual environment.



User rotates hand to change the value of a digit.

Example: Changing a Number

Goal: Change value from 30 to 540.05 and allow further changes with the dial in steps of 10. Unused widgets are grayed out.

Step #5: Click on ">" widget to add a digit after the decimal point.

Step #1: Click on iso-value dial and move wand pointer up with button pressed to display the FloatOmeter.

Step #6: Click on ">" widget again to add another digit after the decimal point.

Step #2: Click on "<" widget to add a new digit to the left end of the number.

Step #7: Turn the "hundredth-place" digit to 5.

Step #3: Turn "hundreds-place" digit to 5.

Step #8: Right-click on "tens-place" digit to mark it as the step size for the dial.

Step #4: Turn "ones-place" digit to 9 ...

Goal reached: Number is 540.05, and step size is set to 10.

... and further until it turns back to 0 and the "tens-place" digit turns to 4. Or the user could have pointed at the 3 and rotated it to a 4.

Subsequent changes of the iso-value dial change its value in steps of 10.
Here we clicked on the dial and rotated the wrist clockwise by 30 degrees, thus changing the dial value to 570.05.

Interaction

- A highlighted digit is changed by depressing the left button while rotating the wrist (just as changing the value of the dial).
- Rotations to the right increase the digit's value, rotations to the left decrease it.
- When the digit is zero and the user rotates to the left, it is set to nine and the next higher valued digit is decreased by one. When the digit is nine and the user increases the value, it is set to zero and the next higher valued digit is increased by one. These processes are recursive up to the highest valued digit.
- This method reminds us of mechanical odometers, hence the name "FloatOmeter" (floating-point odometer).
- Leading or trailing zeros are not displayed when editing is finished. The user can add digits with a default value of zero by clicking on the arrows to the left or right to the number.
- A digit is automatically added if the most significant digit is increased above nine.
- To avoid problems due to rounding errors in the storage of floating-point numbers, we store the number of displayed digits after the decimal point. The next time we display the number we round it off to that number of digits.
- A little box with a plus or minus sign between the left arrow and the most significant digit indicates the sign of the number. A click on it toggles the sign.
- A value set with the FloatOmeter can also be changed with the dial.
- The amount of change per ten-degree rotation is specified by clicking on a digit in the FloatOmeter with the right wand button to mark it as the step size, indicated by a gray background.

Future Work

- We plan to run a user study to compare the FloatOmeter to other methods of number input in virtual environments.

Acknowledgments

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References

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