The Wand , 21 June 1991

an early interface designed for free-space interfacing to computer applications in much the same way as the Nintendo's Wiimote does today, but using a cheap stick to do the same functionality

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A new user interface - The WAND

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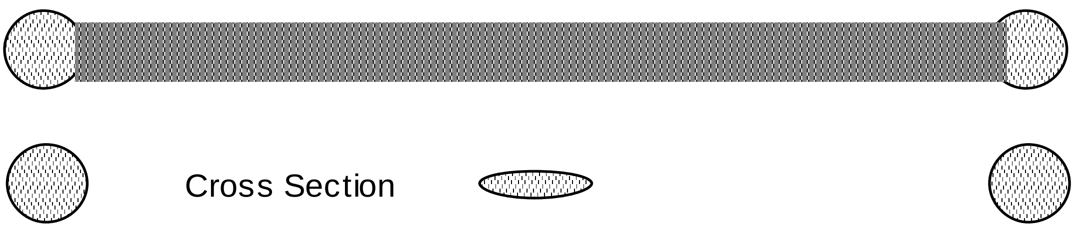
Introduction

There appears to be an interface bottleneck as far as drawing on the computer is concerned. Mice, light pens, graphics tablets and all other current interfaces (as far as I am aware) are two dimensional, whereas it would be nice to be able to draw in three dimensions. Solutions to this problem are thin on the ground, and even virtual reality interfaces such as data-gloves and spaceballs do not offer ideal solutions to drawing production.

This note describes a versatile new tool which allows the computer to receive spatial instructions in three dimensions. For lack of any other obvious name, I have called it a wand. I suppose 'stick' is an alternative.

Wand Description



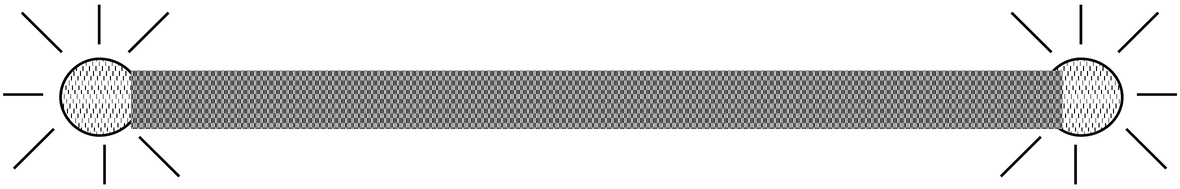


Fig 1 : Wand

The wand consists of a simple stick with a means of detecting the position of the ends. This can be done simply by having reflectors at both ends (the position of one end would suffice for many applications such as line drawing but two gives increased functionality such as the ability to draw planes and to shape three dimensional objects). There are no restrictions on the wand's size, shape or rigidity. It can be made stiff or flexible, out of plastic, wood, metal, stone or anything else.

Advantages

It offers the following advantages:

The wand conforms to the most standard of ergonomic designs. For a hundred thousand years, Man has been using poking devices such as sticks, drawing tools such as pencils and paint brushes, modelling tools such as chisels and knifes and even batons for conducting orchestras. The stick is thus a very natural form for a tool and one which people have become very skilled at using. Thus

- the interface is very 'natural'
- people already have a very high degree of skill in using it
- its simplicity gives it a universal appeal
- it could substantially speed up any form of graphical input compared to other devices

Software would determine the exact function of the wand in any situation. In a standard drawing package, it could be a pencil, paintbrush or general reseating tool. Obviously, the computer is capable of offering many 3d equivalents to simple ovals and rectangles, where a simple wand movement would be able to produce fairly complex objects. Because of its simplicity of use, it should appeal to a large proportion of the population. As a result, the numbers and sizes of drawing files will increase. It could also be used to good effect in moving graphics. People like to have something in their hand - even in virtual reality, a wand would be a useful interface, with software changing the wand's use. Thus:

- the wand will stimulate information production, ultimately increasing network traffic
- it lends itself well to software configuration to allow its use in many applications as a universal tool

The wand can be made out of any material, thus giving a wide range of designs and pricing options, from the cheap plastic version to the deluxe diamond studded gold version. People would use whichever one they find most comfortable. Many different shapes and sizes are possible. Although a user may use just one or two favourites, others such as artists may find a use for a whole set of different wands for different purposes, rather than relying on software configuration. Thus, whole ranges of wands can be produced, with shapes, materials and prices to suit everyone. A market similar to todays market for pens could arise. Thus:

- it offers significant new markets for manufacturers

Implementation

There are many implementations possibilities which would be interesting to study. The next few sections attempt to stimulate thought by asking a few questions and suggesting initial answers.

What are the major likely design variations

Just as we have optical mice, there will be wand variations too. Instead of reflectors, light emitting ends could be used (figure 2). Wands with an ability to convey rotation about the long axis are also possible (see later).

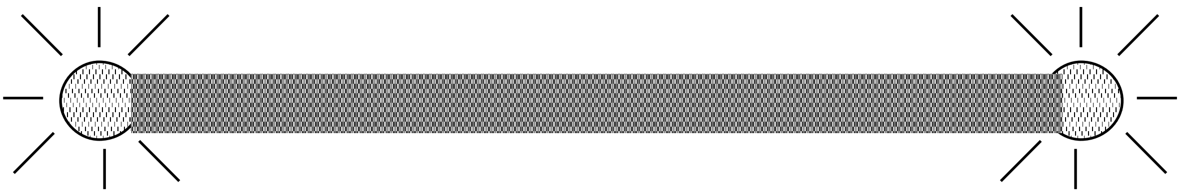


Figure 2 - Light Emitting Wand

What about two wands used together?

Many times we use two hands at the same time. In drawing, we may want to change or distort a shape in some way. Having a wand in each hand offers many options that a single wand does not: e.g. being able to hold opposite sides of a shape and stretching it; writing with one hand while moving the text in space with the other, describing different levels of detail with each hand, there are many others limited only by imagination.

what is the best way to detect the location of the wand ends?

Although LEDs in the wand could be implemented, the simple reflector is an aesthetically pleasing solution, allowing a passive wand which is totally portable. An LED or laser diode (which allows tracking or scanning) would provided a light source from the computer. Two receivers are then enough to pin-point the reflector in space (our eyes use this mechanism all the time). Receiver design needs consideration, but is certainly feasible at low cost with current technology.

An alternative is to create a field and to locate the disturbance in this field. The following are some simple options in this category:

A polarised light field, detecting alternate polarisations in the reflected light to indicate crossing lines in the field.

The same could be done with different colours of light.

The way headsets are located in current VR can also be used.

Some other methods are possible but more clumsy, such as fibre gyros in the wand itself with some sort of transmitter.

can theses methods and technologies be extended to other interfaces?

A 'hands in machine' interface is certainly possible using 'reflecting thimbles'. See Appendix.

what about 'active' wands, ie wands with intelligence?

such wands offer potential for allowing a range of tools to be used simultaneously, facilitating the ID and wand characteristics to be set. There must be other advantages too, but I prefer the simple version aesthetically.

how should the equivalent of a mouse click be implemented, if at all?

Again, many possibilities exist. My favourite is to use a reflector which can be switched off, making use of the ubiquitous LCD.

axis rotation information?

rotation of the simple design shown would not be picked up if the ends don't move. This may not be a problem and for some applications would be undesirable. However, with the light emitting wand, a grid can be drawn on the end to give a resolve mechanism (Figure 3). In fact this would work with reflectors too. The pattern of the grid can be designed in the same way as current resolvers if an absolute orientation is needed. Colours may also be used to differentiate directionality's. It is possible to make a wand which twists, so that twist information could be conveyed. All extra models in the range! Rotation about the other axes is picked up by the position of the ends. This includes bending.

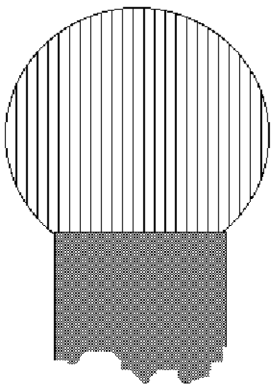


Figure 3 - Wand End

The potential of the wand depends on the software which is used. As mentioned above, Man has used tools which are basically customised sticks for thousands of years. The wand offers the potential to take this customising into software.

Appendix - Hands in Machine Interface

Although the wand is a versatile tool, there are times when the user wants to get his bare hands into the machine for some reason. VR has the concept of the data glove. The technology which allows implementation of the wand can allow development of 'thimbles' . Much less cumbersome than a data glove, some lightweight reflectors areas or LEDs on the finger tips are all that is required to locate the finger tips in space, thereby providing the required interface. While this would be insufficient for tactile applications, it still offers potential. The main problem to solve here is the obscuring of some of the fingertips some of the time. This may be solved by providing more emitters and detectors.

Mechanisms for Wand End-Point Location

Summary

This note describes two potential mechanisms for remote determination of the positions of points in space which reflect light. It is primarily concerned with the Wand interface, which uses reflectors as its end-points, but the mechanisms are generally applicable to location of one or more point sources

Introduction

[1] describes a new interface which uses a stick shaped 'wand' to represent points in three dimensions, thus facilitating 3d drawing and manipulation. Such a device is illustrated in figure 1. The initial note described the wand at a high level and suggested a few ways of detecting where the ends of the wand are in space. This note looks at some of these mechanisms in slightly more detail. In particular, it assumes a passive wand, ie one with simple reflecting ends rather than light emitters.

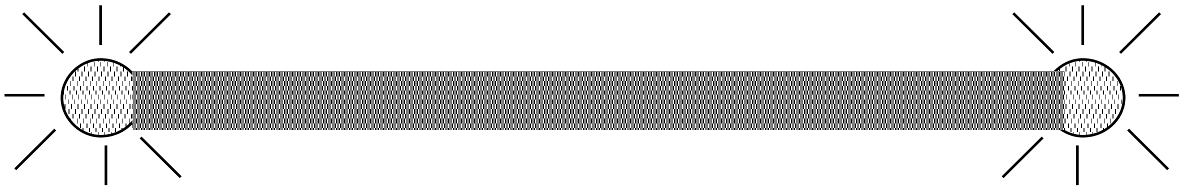


Figure 1

In order to detect the wand ends in three dimensions, two light sources or two detectors are needed (a single light source and distribution system such as a mirror would give two effective sources which is sufficient). The general principle of detection which is largely common to all the solutions is illustrated in figure 2. Light coming from the sources hits the wand end and is reflected to the detector. In practice, the sources and detectors would be situated close to each other to make for easy detection. The light detected by the detector would in some way indicate where in space it had been reflected from. Several methods will now be suggested for this.

Method 1 - Use of Colour

Using a filter or prism in front of a simple white light source can produce a pattern of colours in space. If the colour of the reflected light is found, it is possible to determine the position of the wand end in the colour pattern. This can be done for both sources, using different colour patterns from each source. The combination of colours in the reflected beam will then indicate the location in both patterns, after which a simple geometrical calculation will reveal the reflector's location in space. Obviously, if the wand has two ends, then these will both reflect and the beam will contain four colours.

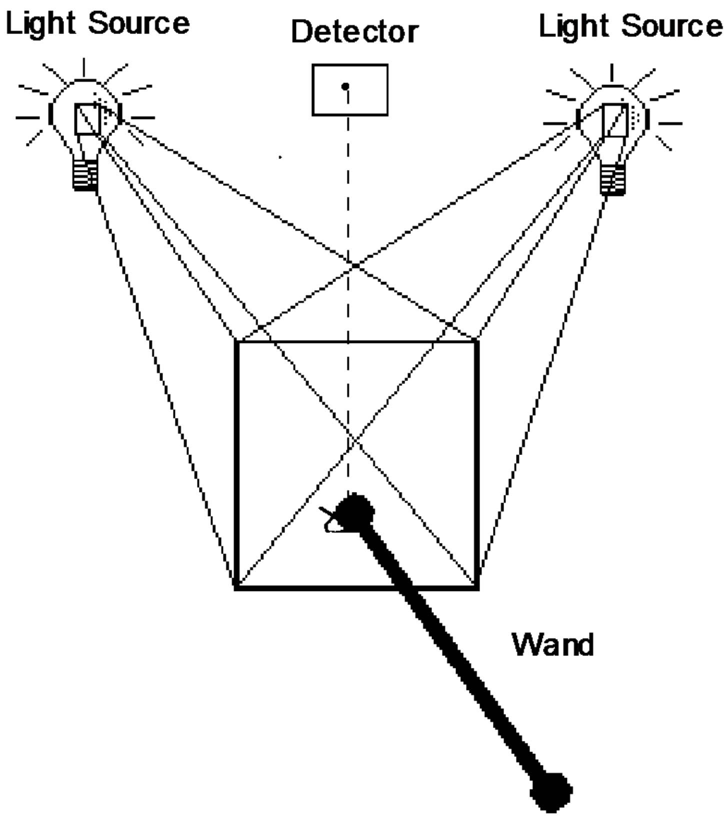


Figure 2

Method 2 - Use of Coding

If the light source is a laser, it is possible to scan out a grid in space, so that the light at any point is modulated with a code indicating the grid location. Decoding the reflected beam will reveal where the light was reflected from. Since the beam is scanned, it is simple to arrange for only a single reflection at a time. This is because each end will reflect at different times anyway, and the grids can be space shifted so that its position in the two grids will be highlighted at different times too.

Obviously, this method is even simpler if two sources are used. If not, a shutter can be used to alternate between the two sources to avoid collision. Even if these methods are not practical, a sensible design of coding could ensure unambiguous decoding of location even if two reflections are simultaneously received.