UNIVERSITY OF ILORIN

FACULTY OF COMMUNICATION AND INFORMATION SCIENCES

DEPARTMENT OF COMPUTER SCIENCE

PROGRAMME: B. Sc. COMPUTER SCIENCE

Course

Course code: CSC 446; Course title: Computer Graphics I.
Credit unit: 2; Course status: Compulsory

Course Content

Computer Graphics application area. Hardware support: input storage and output devices (include graphic plotter, light pen etc.), Geometry generation: line, conics, polygon and character generation etc., Transformation and magnification: scaling, translation, rotation. Viewing: projections and their types. Windowing and clipping.
15h(T); 45(P); C.

Lecturer's Data

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Consultation Hours: Tuesday 10am – 2pm.

HARDWARE SUPPORT: INPUT STORAGE AND OUTPUT DEVICES

1.0 Introduction

Interactive computer graphics opens up a myriad of applications, ranging from interactive design of buildings, to control of large systems through graphical interfaces, to virtual-reality systems, to computer games. One of the most important advances in computer technology was enabling users to interact with computer displays. The user sees an image on the display. She reacts with this image by means of an interactive device.

The interactive devices are the devices which give input to the graphics system and provide necessary feedback to the user about the accepted inputs. Various interactive devices are keyboard, mouse, trackball, joysticks, data glove, touch panels and light pen

2.0 Objectives

At the end of this lecture students should be able to:

i. differentiate between (i) the physical input devices and (ii) logical input devices;

ii. List and discuss at least five (5) physical input devices;

iii. Explain the various categories of the logical input devices

3.0 Main Content

The interactive devices can be viewed from two different perspectives: (i) the way that the physical devices can be described by their real-world properties (Physical devices); and (ii) the ways that these devices appear to the application program (Logical devices).

3.1 Interactive Computer Graphics

3.1.1 Logical Input Devices

i. Categorized based on functional characteristics.
ii. Each device transmits a particular kind of data.
iii. The different types of data are called ***input primitives***.

1. Locator Devices

i. Input Primitive: Coordinate position (x,y)
ii. Examples: Mouse, Keyboard (Cursor-Position Keys), Tablet(Digitizer), Trackballs, Lightpens.
iii. Applications: Interactive drawing and editing, Graph digitizing.

2. String Devices

i. Input Primitive: A string of characters
ii. Example: Keyboard
iii. Applications: Text input

3. Valuator

i. Input primitive: Scalar values (typically between 0 and 1).
ii. Examples: Control Dials, Sensing devices, Joysticks
iii. Applications: Input of graphics parameters, Graphics representation of analog values, Process simulation, Games.

4. Choice

i. Input primitive: A selection from a list of options.
ii. Examples: Mouse, Keyboard (Function Keys), Touch Panel etc
iii. Applications: Interactive menu selection, Program control.

5. Pick

i. Input primitive: Selection of a part of the screen.
ii. Examples: Mouse, Cursor Keys, Tablet.
iii. Applications: Interactive editing and positioning.

3.1.2 Physical Input Devices

From the physical perspective, each device has properties that make it more suitable for certain tasks than for others. We take the view used in most of the workstation literature that there are two primary types of physical devices: pointing devices and keyboard devices. The **pointing device** allows the user to indicate a position on the screen, and almost always incorporates one or more buttons to allow the user to send signals or interrupts to the computer. The **keyboard device** is almost always a physical keyboard, but can be generalized to include any device that returns character codes to a program. The mouse (Figure 1) and trackball (Figure 2) are similar in use and, often, in construction.

Figure 1 The mouse

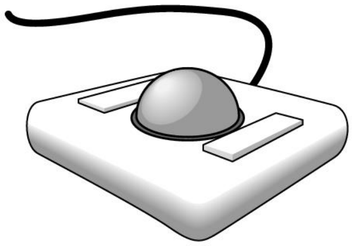

Figure 2 The trackball

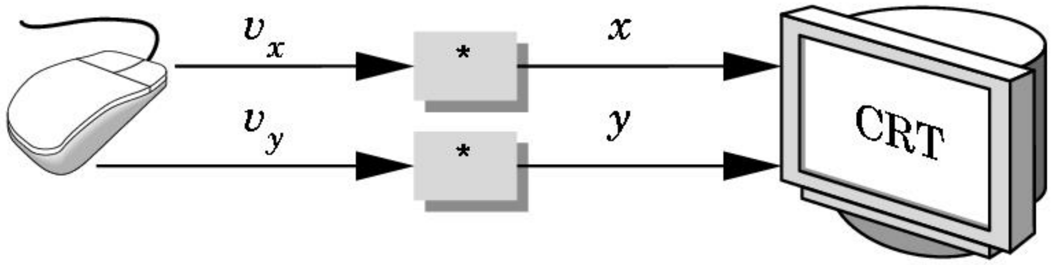

Figure 3 Cursor positioning

A typical mechanical mouse when turned over looks like a trackball. In both devices, the motion of the 1```ball is converted to signals sent back to the computer by pairs of encoders inside the device that are turned by the motion of the ball. The encoders measure motion in two orthogonal directions. There are many variants of these devices. Some use optical detectors, rather than mechanical detectors, to measure motion. Optical mice measure distance travelled by counting lines on a special pad. Small trackballs are popular with portable computers because they can be incorporated directly into the keyboard. There are also various pressure-sensitive devices used in keyboards that perform similar functions to the mouse and trackball, but that do not move; their encoders measure the pressure exerted on a small knob that often is located between two keys in the middle of the keyboard. We can view the output of the mouse or trackball as two independent values provided by the device.

These values can be considered as positions and converted—either within the graphics system or by the user program—to a two dimensional location in either screen or world coordinates. If it is configured in this manner, we can use the device to position a marker (cursor) automatically on the display; however, we rarely use these devices in this direct manner. It is not necessary that the output of the mouse or trackball encoders be interpreted as a position. Instead, either the device driver or a user program can interpret the information from the encoder as two independent velocities. The computer can then integrate these values to obtain a two dimensional position. Thus, as a mouse moves across a surface, the integrals of the velocities yield x, y values that can be converted to indicate the position for a cursor on the screen, as shown in Figure 3. By integrating the distance travelled by the ball as a velocity, we can use the device as a variable-sensitivity input device. Small deviations from rest cause slow or small changes; large deviations cause rapid large changes. With either device, if the ball does not rotate, then there is no change in the integrals, and a cursor tracking the position of the mouse will not move. In this mode, these devices are **relative-positioning** devices, because changes in the position of the ball yield a position in the user program; the absolute location of the ball (or of the mouse) is not used by the application program. Relative positioning, as provided by a mouse or trackball, is not always desirable. In particular, these devices are not suitable for an operation such as tracing a diagram. If, while the user is attempting to follow a curve on the screen with a mouse, she lifts and moves the mouse, the absolute position on the curve being traced is lost.

Data tablets provide absolute positioning. A typical data tablet (Figure 4) has rows and columns of wires embedded under its surface. The position of the stylus is determined through electromagnetic interactions between signals traveling through the wires and sensors in the stylus. Touch sensitive transparent screens that can be placed over the face of a CRT have many of the same properties as the data tablet. Small, rectangular pressure-sensitive touchpads are embedded in the keyboards of many portable computers. These touchpads can be configured as either relative- or absolute-positioning devices.

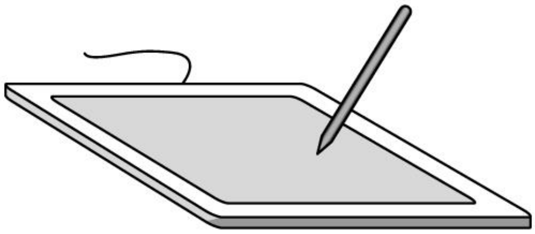

Figure 4 Data Tablet

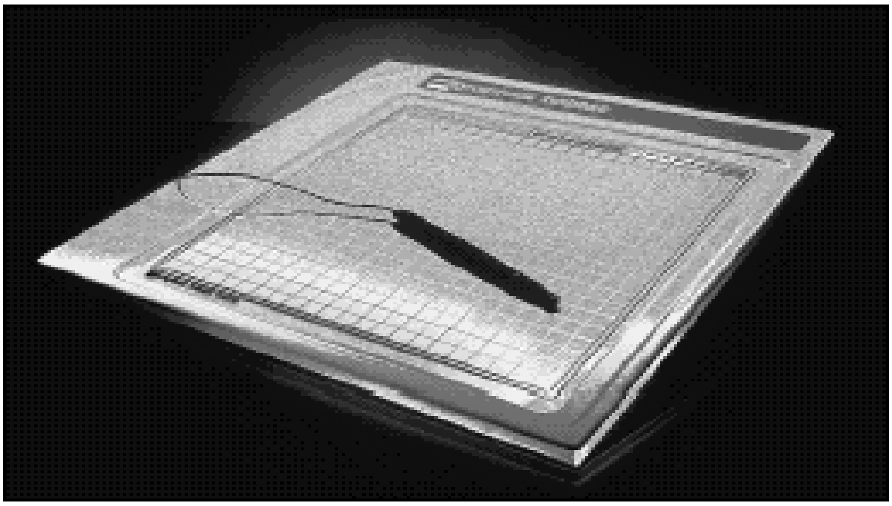

FIGURE 1.45 A graphics tablet.

The **lightpen** has a long history in computer graphics. It was the device used in Sutherland's original Sketchpad. The lightpen contains a light-sensing device, such as a photocell (Figure 5). If the lightpen is positioned on the face of the CRT at a location opposite where the electron beam strikes the phosphor, the light emitted exceeds a threshold in the photodetector, and a signal is sent to the computer. Because each redisplay of the frame buffer starts at a precise time, we can use the time at which this signal occurs to determine a position on the CRT screen. Hence, we have a direct-positioning device.

The lightpen is not as popular as the mouse, data tablet, and trackball. One of its major deficiencies is that it has difficulty obtaining a position that corresponds to a dark area of the screen.

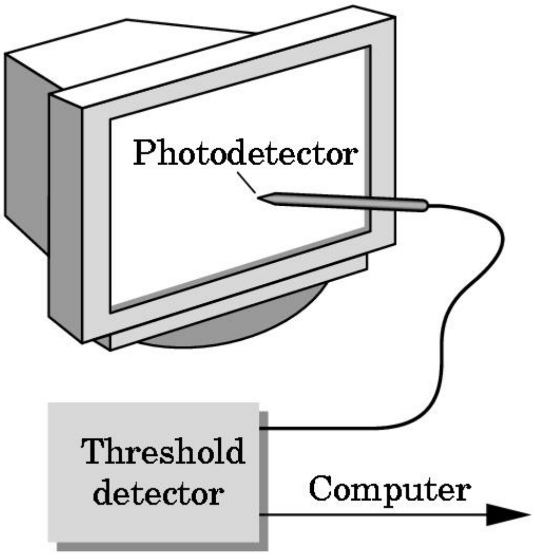

Figure 5 Lightpen

One other device, the **joystick** (Figure 6), is worthy of mention. The motion of the stick in two orthogonal directions is encoded, interpreted as two velocities, and integrated to identify a screen location. The integration implies that, if the stick is left in its resting position, there is no change in the cursor position, and the farther the stick is moved from its resting position, the faster the screen location changes. Thus, the joystick is a variable-sensitivity device. The other advantage of the joystick is that the device can be constructed with mechanical elements, such as springs and dampers, that give resistance to a user who is pushing the stick. Such mechanical feel, which is not possible with the other devices, makes the joystick well suited for applications such as flight simulators and games. For three-dimensional graphics, we might prefer to use three-dimensional input devices. Although various such devices are available, none have yet won the widespread acceptance of the popular two-dimensional input devices.

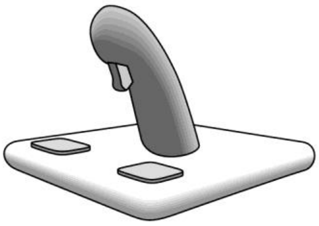

Figure 6 Joystic

A **spaceball** looks like a joystick with a ball on the end of the stick (Figure 7); however, the stick does not move. Rather, pressure sensors in the ball measure the forces applied by the user. The spaceball can measure not only the three direct forces (up–down, front–back, left–right), but also three independent twists. Thus, the device measures six independent values and has six **degrees of freedom**. Such an input device could be used, for example, both to position and to orient a camera.

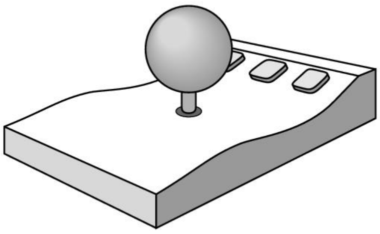

Figure 7 Spaceball

Other three-dimensional devices, such as laser-based structured-lighting systems and laser-ranging systems, measure three-dimensional positions. Numerous tracking systems used in virtual-reality applications sense the position of the user.

Virtual-reality and robotics applications often need more degrees of freedom than the two to six provided by the devices that we have described. Devices such as data gloves can sense motion of various parts of the human body, thus providing many additional input signals. We shall not use three-dimensional input in our code, although there is nothing in the API that restricts the input to two dimensions

3.2 3D Interaction Devices (Recent additions)

These devices are used in advanced rendering methods and virtual reality systems for providing information about three dimensional positions and motion.
Few examples are:

1. Data Gloves
2 Space Balls

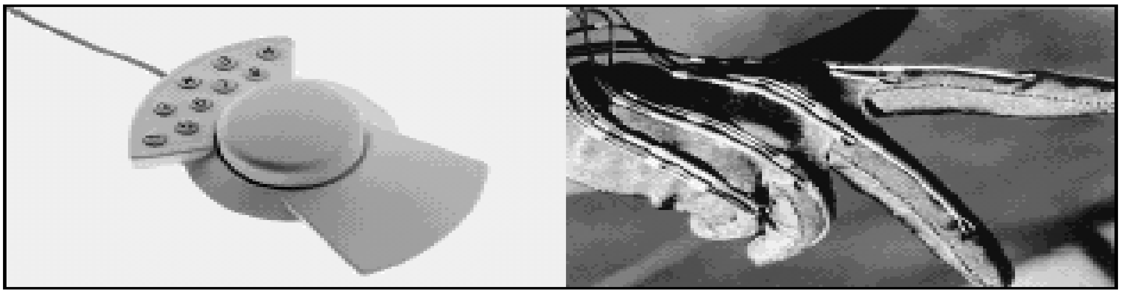

FIGURE 1.48 The space ball (Courtesy of Logicad 3D, a Logitech Company) and data glove (Courtesy of NASA Headquarters).

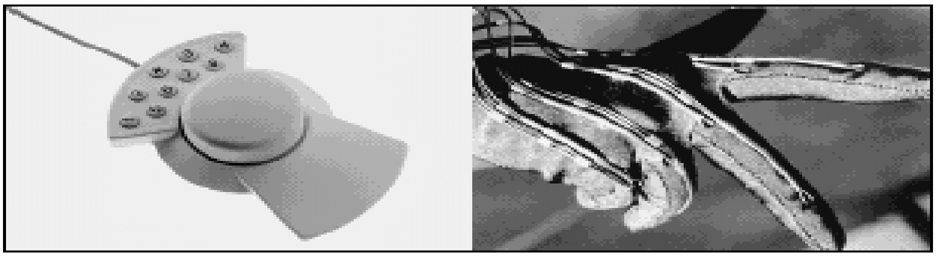

FIGURE 1.48 The space ball (Courtesy of Logicad 3D, a Logitech Company) and data glove (Courtesy of NASA Headquarters).

Figure 8 : DATA GLOVES/SPACE BALLS

4.0 Summary

Interactive devices are the devices which give input to the graphics system and provide necessary feedback to the user about the accepted input. Various interactive devices are keyboard, mouse, trackball, joysticks, data glove, touch panels and light pen.

A plotter is a device that draws pictures on paper based on command from a computer. A computer printer produces a hard copy of documents stored in electronic from, usually on physical print media such as paper.

5.0 Self-Assessment

6.0 Tutor Marked Assignment

1. Write a short note on:
   a. Keyboard b. Traceball
   c. Joystic d. Lightpen

e. Digitize

2. (a) Briefly explain the interactive Computer Graphics.

   b. Outline and explain at least 3 interactive devices that you know.
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7.0 References/Further Reading.