Inventions on Three Dimensional GUI- A TRIZ based analysis

Umakant Mishra
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Umakant Mishra, Bangalore, India
http://umakantm.blogspot.in

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1. Introduction

The graphical user interface has become popular because of its simplicity and user friendliness. The user can do very complex operations through GUI by simple pointer movements. One of its major drawbacks is that it consumes active display area. Every icon, every window and every other GUI element occupies some amount of screen space. It is desirable to display more GUI features within the limited amount of display screen.
1.1 Basics of three-dimensional display

⇒ The most fundamental characteristic of a 3D display is its perspective view. That means the images, which are relatively farther, will look proportionately smaller.

⇒ A Z value is calculated for each object using perspective algorithm. Thus every point of every object has 3 coordinates (x, y and z).

⇒ The solid bocks of windows can have a thickness property. For example, the mouse may move slower through a window block when the thickness of the window is higher.

⇒ The windows in a 3D environment should appear actually in front or behind one another, instead of simply overlapping as in 2D systems.

⇒ While moving or rotating 3d objects, the sides which are closer to the user will move faster than the objects which are farther to the user.

⇒ While objects in 2D interface can be dragged to any side, the objects in 3D environment can be rotated too.

⇒ When the user moves his head (which changes the eye-monitor angle) the perspective view of the display should change correspondingly.

1.2 Benefits of a three-dimensional GUI

⇒ A three-dimensional GUI can look better than a two-dimensional GUI.

⇒ A three-dimensional GUI can utilize the screen space better by displaying more icons and other graphical elements within the available space.

⇒ Ease of locating objects by exploiting spatial memory of the user

⇒ A 3D GUI is more suitable in circumstances where the user deals with 3D objects, such as, graphic designing and gaming applications.

1.3 Ideal features of a three-dimensional GUI

⇒ The 3D GUI should be aesthetically great and should give a vivid impression to the user.

⇒ The three-dimensional GUI should be able to display a large number of graphical elements simultaneously at any given point of time.
The user interface should exploit spatial memory to the fullest extent.

The user interface should also be intuitive to minimize the time needed for a user to become familiar with it.

The icons on the interface should be easily recognizable.

The user interface should provide intelligent help to the user.

The 3D GUI should work with the existing display devices (without demanding new hardware).

2. Inventions on 3D Graphical User Interfaces

2.1 Four dimensional Graphical User Interface (US Patent 5678015)

Background problem
In a typical graphical user interface, various types of icons are used to represent various functions or applications. When the user adds more and more icons to the desktop (or other interfaces) there is a shortage of space on the available screen. A three-dimensional presentation is one of the solutions to present more icons on the limited screen space.

The previous methods of three-dimensional presentation of icons display only a portion of the total set of icons at any given point of time. There is a need to display a large number of icons simultaneously.

Solution provided by the invention
Eng Lim Goh invented a four dimensional interface (Patent 5678015, assigned by Silicon Graphics Inc, Oct 97) which solves the above problem. According to the invention the interface is displayed like a rotating cube, which can display upto six workspaces simultaneously. The workspaces are translucent so that all six workspaces are visible to the user simultaneously. It is a combination of a three dimensional figure with a real-time rotation features that leads to the name “Four-Dimensional Graphical User Interface”.
The advantage of the present invention is that it permits a user to view a larger effective workspace than the conventional two-dimensional windows.

**TRIZ based analysis**

The graphical user interface should accommodate and display a large number of icons as required *(Ideal Final Result)*.

**Solution-1:** In some cases the scrollbars are used to give larger workspace than the window *(Principle-15: Dynamize)*. The disadvantage here is that only a portion of the workspace is available at any given time.

**Solution-2:** Another strategy is to provide multiple windows *(Principle-1: Segmentation)* each containing a portion of the total set of icons. But because the windows must overlap, the user can see only a portion of the total set of icons at any given time.

**Solution-3:** Display the icons in a three/ four dimensional Graphic User Interface *(Principle-17: Another Dimension)*. But even in a three-dimensional cube, the icons on the rear panel are not visible.

According to this invention, the interface is translucent so that the icons on the rear side are also visible *(Principle-32: Color Change)*.

The cube is capable of rotating that makes any icon easily accessible by the user *(Principle-15: Dynamize)*.
2.2 Generating 3 Dimensional effects in 2 Dimensional Graphical User Interface (US Patent 5864343)

Background problem
In 3D graphics computer systems, realistic 3D effects are achieved by rendering objects on the 2D raster display using perspective algorithm. In 2D graphics computer systems, the 3D effects are not realistically achieved. How to render 3D display in a 2D raster display?

Solution provided by the invention
Naughton et al. invented a method (Patent 5864343, assigned by Sun Microsystems, Jan 99) to achieve 3D effects in 2D graphics computer systems. Normally the 2D graphics have two coordinates (x and y values). The 3D effect can be achieved by the graphics application of a 2D graphics computer system provided each object to be rendered with a relative depth (z value).

According to the invention, when the user moves the objects, the graphic toolkit routine recomputed the x, y and z coordinate values and display objects to give a 3D movement. For example, the objects that are farther from the user will move slower than the objects that are closer to the user. The invention also discloses which generates stereophonic sound to enhance the 3D appearance of the objects displayed.

TRIZ based analysis
The invention adds a depth value (z) to the two dimensional display (x, y) of the objects which can produce 3D effect (Principle-17: Another dimension).

The method includes a pair of stereo speakers to play predetermined stereophonic sounds to enhance the 3D simulation (Principle-38: Enrich).
2.3 Background image with a continuously rotating and functional 3D icon (US Patent 6043818)

Background problem
The icons in a GUI are generally presented on a window with simple plane background. Although a flat background helps user to easily recognize the presence of icons, they have limited aesthetic value. Such a monotone color window lacks variety and therefore fails to give a vivid impression to the user.

Solution provided by the invention
Patent 6043818 (invented by Nakano et al., assignee Sony Corporation, issued Mar 2000) discloses a new type of three-dimensional graphical user interface which enables the user to quickly and intuitively recognize menus arranged in a three dimensional space.

According to the invention the GUI displays a background image and the three-dimensional icons are superimposed on the background image. The icons are displayed as if rotating and having shadows thereunder. The icons are displayed at fixed positions on the display such that they don’t overlap on the sidewalls regardless of the mode selected by the user.

TRIZ based analysis
The invention uses three-dimensional symbols as icons (Principle-17: Another dimension).

It is desirable to show a pictorial background to give a vivid impression to the user. But pictorial buttons are difficult to be identified on a pictorial background. The user can easily confuse the pictorial buttons to be parts of the background image. It is desirable to put a pictorial background but without causing problems to identify the buttons (Contradiction).
According to the invention, the icons are rotated so that they are differentiated from the background image and the user can certainly recognize them as icons and not a part of the background image (Principle-15: Dynamize).

The icons are displayed with their shadows in the background to show more realistically that they are three-dimensional images (Principle-35: Parameter change). The size of the shadows changes as the icons rotate (Principle-15: Dynamize).

2.4 Three-dimensional GUI windows with variable-speed perspective movement (US Patent 6344863)

Background problem
With the improvement of graphic processing systems, the 3 dimensional pictures are becoming more commonplace. This makes the GUI interfaces to move from 2D to 3D perspective. The windows in a 3D environment are to be placed in front or behind one another instead of simply overlapping as in conventional 2D systems. Further the 3D desktop can be “rotated in space” on the computer display. The icons in 3D desktop are no longer 2D pictures, but 3D objects.

Solution provided by the invention
Patent 6344863 (invented by Capelli et al., assigned by IBM, issued in Feb 2002) discloses a 3D graphical user interface wherein the windows have a “thickness” property.

The user can interact with the 3D interface either using a three-axis mouse or a conventional mouse with supplemental keyboard controls. The movement and speed of the mouse is controlled in a way to give 3D feeling to window-blocks.

TRIZ based analysis
The invention adds a “thickness” property to the windows. Each window will have a Z plane position (z) and a Z plane thickness (cz) as well as the traditional x, cx, y and cy (Principle-17: Another dimension).
The user can change the perspective of the windows by moving the mouse along any axis (*Principle-15: Dynamize*).

When the pointer is moved through a window-block the mouse mikey ratio (i.e., the amount the on-screen cursor or perspective moves relative to the distance the mouse or other pointing device has been moved) can change according to the specific attribute of the window, thus giving the illusion of traversing through water or a thick substance (*Principle-35: Parameter change*).

2.5 Three-dimensional graphical user interface for managing screen objects (US Patent 6404443)

**Background problem**
A graphical user interface contains various screen objects such as icons and windows. But the space available on the screen is limited to view only a limited number of screen objects. It is necessary to increase the size of the screen.

The concept of “virtual workspace” has tried to solve this problem by providing an infinite surface dimension that can handle a very large number of screen objects. Although it solves the problem of insufficient screen, the user often loses track of the location of his information and spends a lot of time on searching on the large view space.

**Solution provided by the invention**
Patent 6404443 (invented by Westerman, assigned by Sharp Laboratories of America, issued in Jun 2002) provides a method of displaying a large number of screen objects on a tabbed sheet. According to the invention new planes can be created and old planes can be deleted. The sequence of the planes can be changed and the objects can be moved from one plane to another.
According to the invention the objects of the selected tab are displayed prominently whereas the objects of next plane are displayed less prominently. The objects of other screens cannot be worked upon. The user moves from screen to screen by choosing tabs. This adds a dimension of depth and increases the screen space without requiring virtual windows to extend outside the viewport.

**TRIZ based analysis**

The invention adds another dimension to the display by using tabbed planes (*Principle-17: Another dimension*).

The objects of the next page are displayed less prominently to inform the user about their presence (*Principle-32: Color change*).

The mechanism allows adding, removing and changing sequence of the pages and also allows moving objects from one page to another (*Principle-15: Dynamize*).

**2.6 Function presentation and selection using a rotatable function menu (US Patent 6411337)**

**Background problem**

The conventional flat display of menu items does not give required aesthetic value to high quality multimedia systems or Television interfaces. There is a need to improve the aesthetics by giving a depth to the presentation.

**Solution provided by the Invention:**

US Patent 6411337 (Invented by cove et al., Assigned by Matsushita Electric Corporation of America, Jun 02) discloses a rotatable function menu. The function menu in the invention includes a three dimensional graphic object that rotates in virtual space. The menu is normally ring or wheel shaped. This invention organizes the functions in a novel way with 3D effect.
TRIZ based analysis:

The menu should look beautiful and contain high aesthetic value without compromising other features and benefits (Ideal Final Result).

The invention gives a 3D effect by adding a depth value to the menu objects (Principle-17: Another Dimension). The menus are built in the form of a ring or wheel shaped graphics (Principle-7: Curve). The menus are virtually rotatable in three-dimensional space (Principle-15: Dynamize).

2.7 Methods, apparatus and data structures for providing a user interface, which exploits spatial memory in three-dimensions, to objects and which visually groups proximally located objects (US Patent 6414677)

Background problem

One of the main purposes of using a computer is to access information. A computer can store large amount of data and documents. Besides it can access lot more information from the network and Internet. But the size of the display screen provides very limited space to display the information. A three dimensional presentation of documents and visual objects is one of the solutions to use the display screen more effectively and efficiently.

Solution provided by the invention

US Patent 6414677 (invented by Robertson et al., assignee Microsoft Corporation, issued July 2002) disclosed a three-dimensional graphical user interface which allows more information to be rendered on a given screen.

The invention presents thumbnails or image objects in a perspective view such that the farther images look proportionately smaller. The user can add, move or delete the thumbnails from the simulated three-dimensional environment. The simulation may be reinforced by partial image occlusion, shadows and spatialized audio etc. Arranging objects in such a three-dimensional environment exploits users' spatial memory.
TRIZ based analysis
The invention introduces three-dimensional user interface (Principle-17: Another dimension).

The invention uses perspective views (perceived image scaling with distance), partial image occlusion, shadows and spatialized audio etc. to reinforce the simulated three-dimensional landscape (Principle-38: Enrich).

In some situations the user may move his head in order to “look around” the objects on the screen. To reinforce the simulated three-dimensional environment in such cases, the invention proposes to simulate head motion parallax, by detecting the position of a user’s head through a camera (Principle-23: Feedback, Principle-15: Dynamize).

3. Other inventions on three-dimensional interface

⇛ Patent 5295243, “Display of hierarchical three-dimensional structures with rotating substructures”, by Robertson, et. al., assigned to Xerox Corporation, issued March 1994. The invention proposes hierarchical structures with conical substructures having vertical and horizontal axes. The cones can be rotated in steps to view its nodes.

⇛ Patent 5880733, “Display system and method for displaying windows of an operating system to provide a three-dimensional workspace for a computer system”, by Horvitz, et al., assignee Microsoft Corporation, issued March 1999. The invention provides a three-dimensional virtual workspace for a window based display system. The user may activate a control button to transform a typical two-dimensional window to a three dimensional perspective.

⇛ Patent 6054989, “Methods, apparatus and data structures for providing a user interface, which exploits spatial memory in three-dimensions, to objects and which provides spatialized audio”, invented by Robertson et al., assignee Microsoft Corporation, issued April 2000.


⇛ Patent 6157383, “Control polyhedra for a three-dimensional (3D) user interface”, invented by Loop, assigned by Microsoft Corporation, issued Dec 2000. The invention provides an intuitive capability to two-dimensional pointing devices to control movement of three-dimensional objects within a three dimensional user interface.
Patent 6166738, “Methods, apparatus and data structures for providing a user interface, which exploits spatial memory in three-dimensions, to objects”, invented by Robertson et al., assignee Microsoft Corporation, issued Dec 2000.

Patent 6243093, “Methods, apparatus and data structures for providing a user interface, which exploits spatial memory in three-dimensions, to objects and which visually groups matching objects”, invented by Czerwinski et al., assignee Microsoft Corporation, issued June 2001. The invention renders thumbnails on a simulated three-dimensional surface, which (i) exploits spatial memory and (ii) allows more objects to be rendered on a given screen.

4. Summary

Adding another dimension to a graphical user interface can yield tremendous benefits such as improving aesthetics, data presentation, screen space utilization and user friendliness. The user can easily locate the objects in a three-dimensional environment by using his spatial memory. Many people think that a three-dimensional GUI is the future of the current trend in the evolution of graphical user interface.

Reference to patents:


2. US Patent 5864343, “Method and apparatus for generating three dimensional effects in a two dimensional graphical user interface”, invented by Naughton et al., assigned by Sun Microsystems, Jan 99


7. US Patent 6414677, “Methods, apparatus and data structures for providing a user interface, which exploits spatial memory in three-dimensions, to objects and which visually groups proximally located objects”, invented by Robertson et al., assignee Microsoft Corporation, issued July 2002.

Inventions on three dimensional GUI, by Umakant Mishra
Other references:


