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CORRECTED PUBLICATION

(54) **TACTILE AND VISUAL DISPLAY WITH PAIRED AND ACTIVE STYLUS WITH MEANS AND METHODS**

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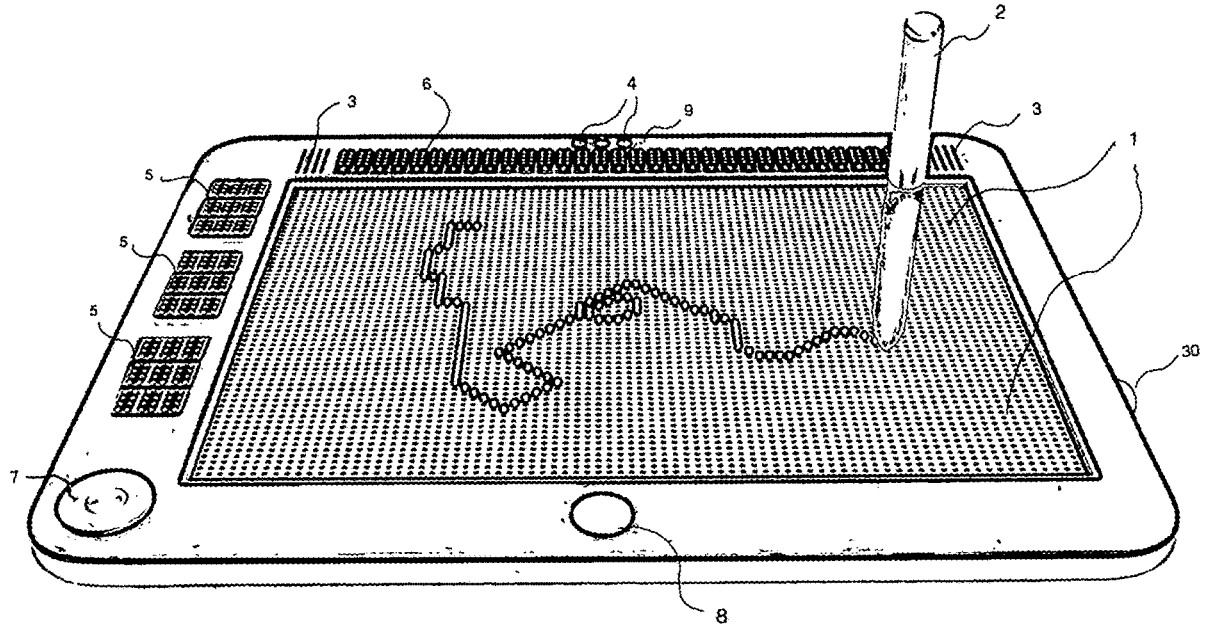
CPC ***G09B 21/004*** (2013.01); ***G09F 9/305*** (2013.01); ***G09F 9/372*** (2013.01); ***G09B 21/002*** (2013.01)

(57) **ABSTRACT**

An active, specialized stylus and sharp color graphics may be combined with a tactile display in order to increase accessibility to the blind and visually impaired. A tactile display may consist of an array of pins that may be raised to varying heights to represent contours and outlines of images that are recognizable when touched. A specialized stylus may allow the user to instantly create, touch and save tactile drawings or alter with multi-sensory feedback.

A tactile and visual display may consist of an array of pins, with circular or squared-off tops. Physical attributes may be given to individual pins, the screen itself (LED), or a LCD WXGA or other type of projector may be incorporated so that enhanced visual imaging is combined with tactile graphics to give those with different levels of visual impairment a multisensory feedback when experiencing images or drawings. Also this technology may be used with autistic students and those with learning disabilities, as well as serve as a means of entertainment.



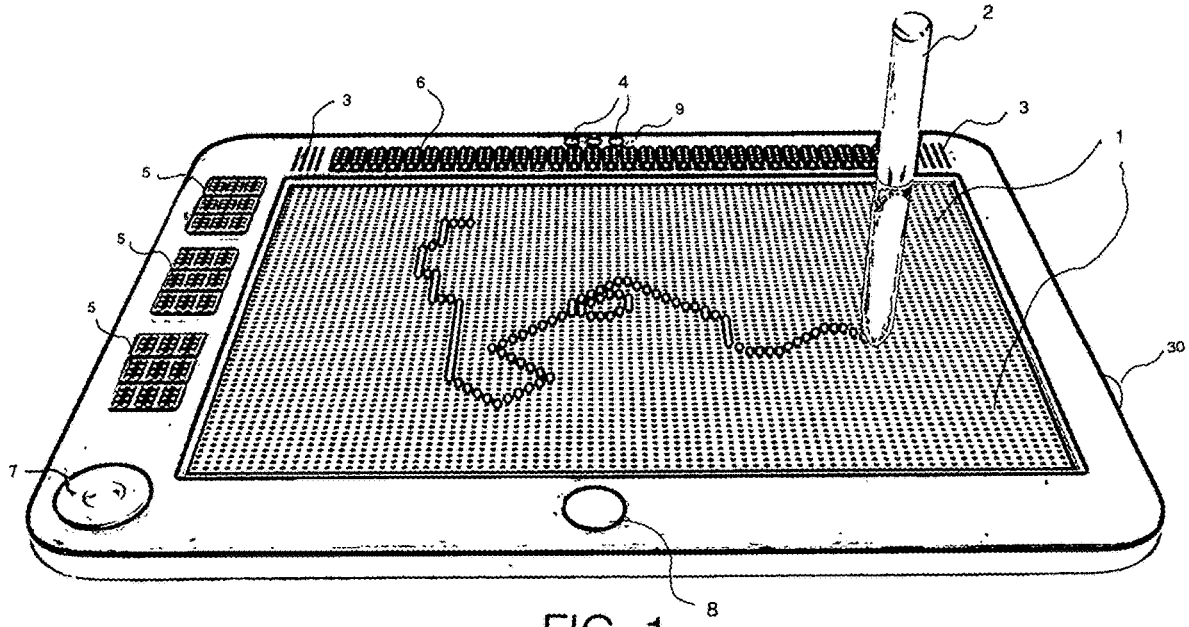


FIG. 1

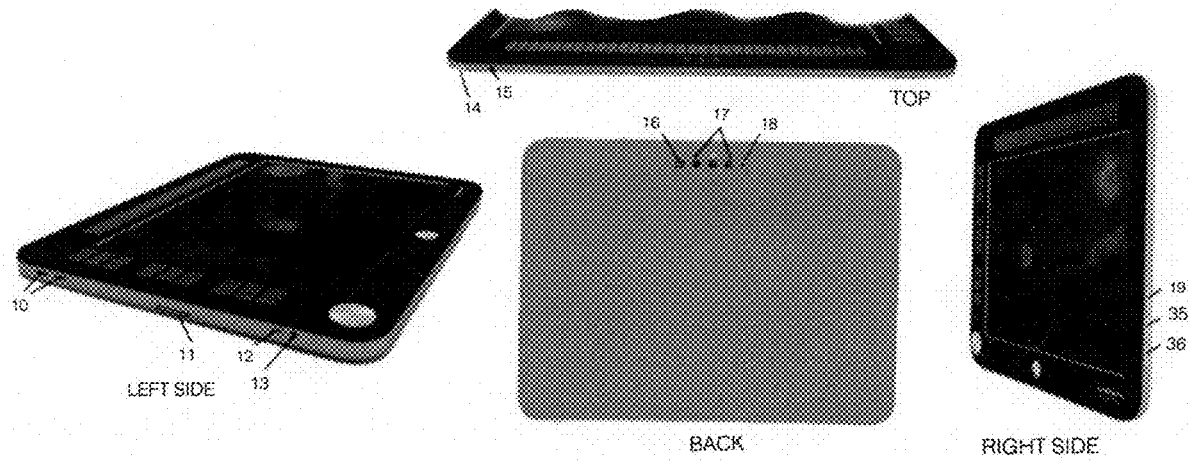


FIG. 2

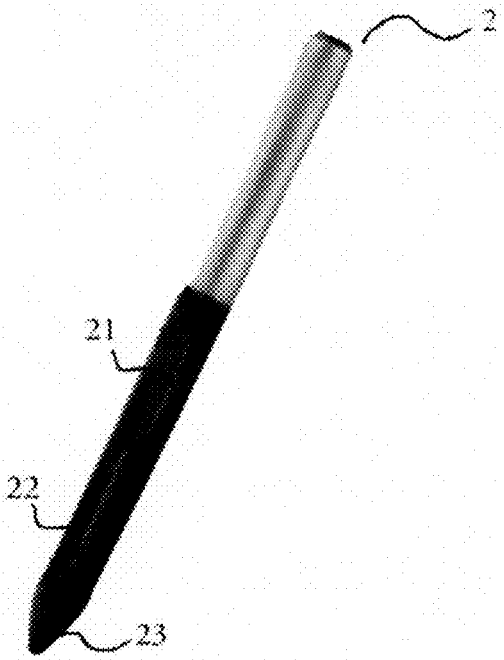


FIG. 3

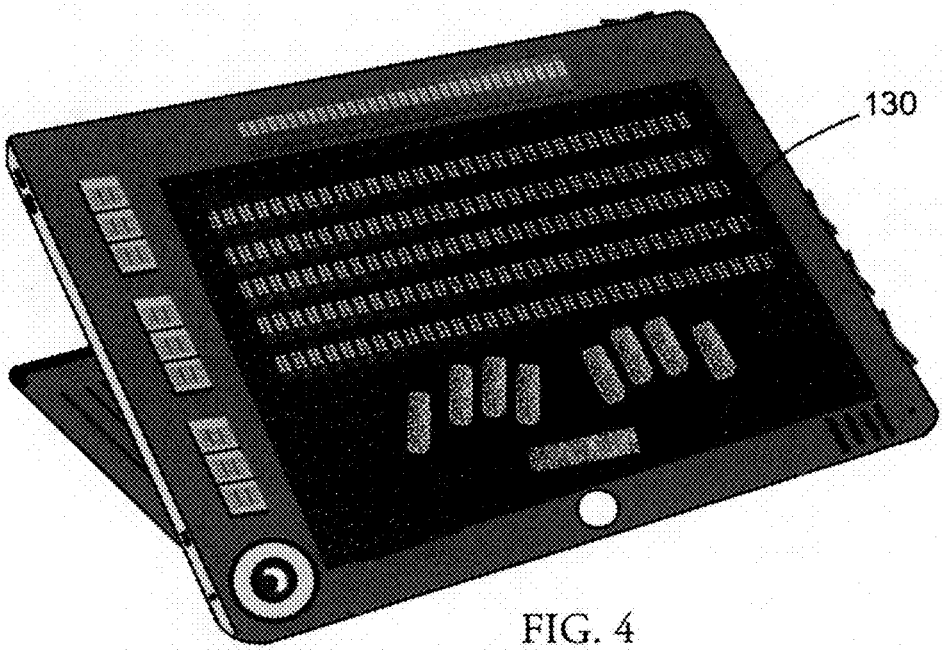


FIG. 4

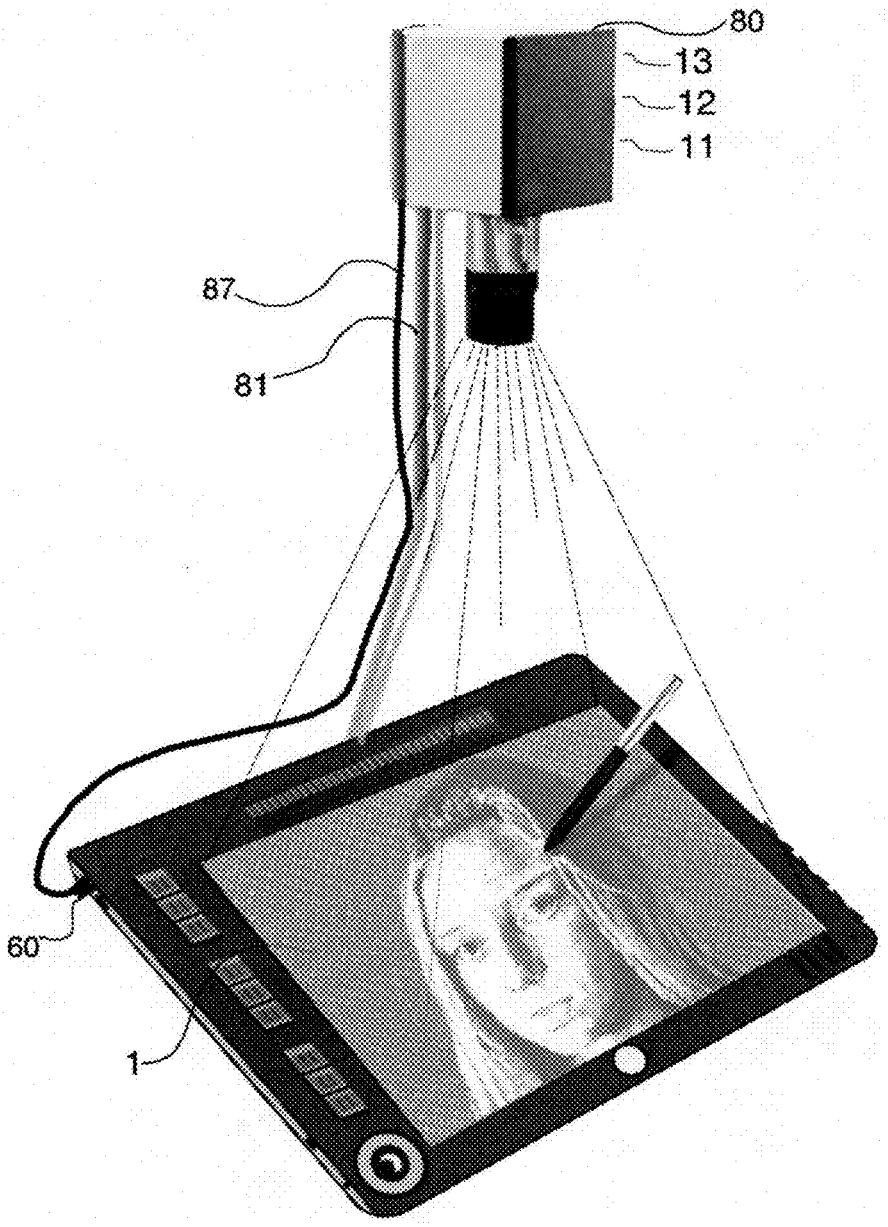


FIG. 5

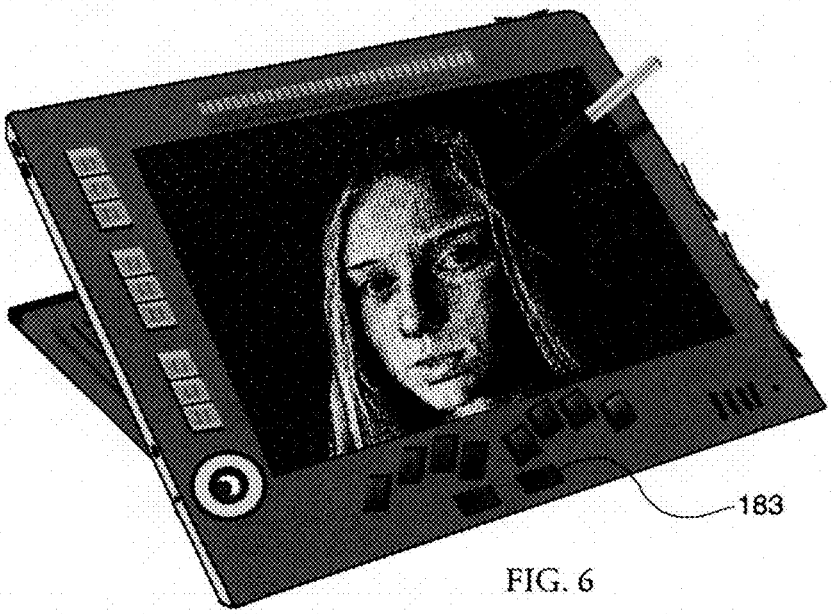


FIG. 6

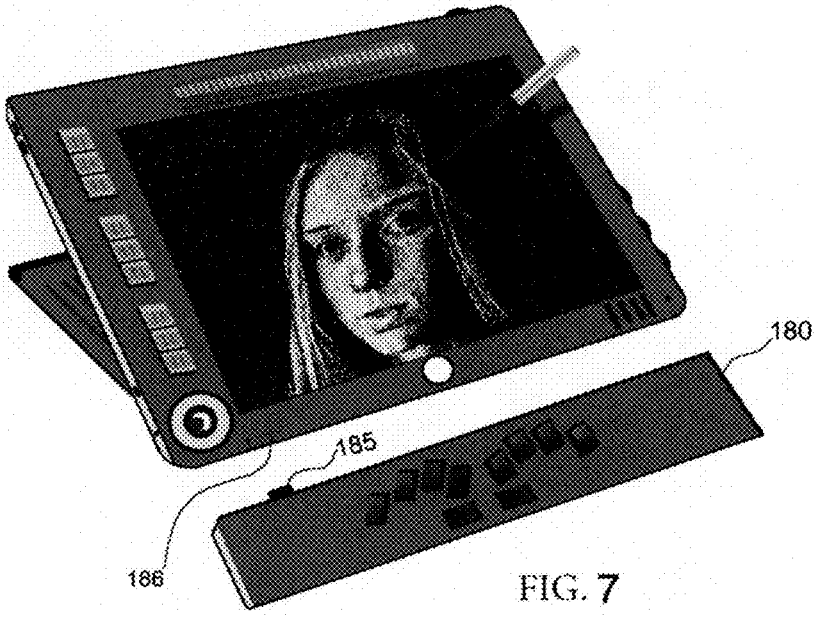


FIG. 7

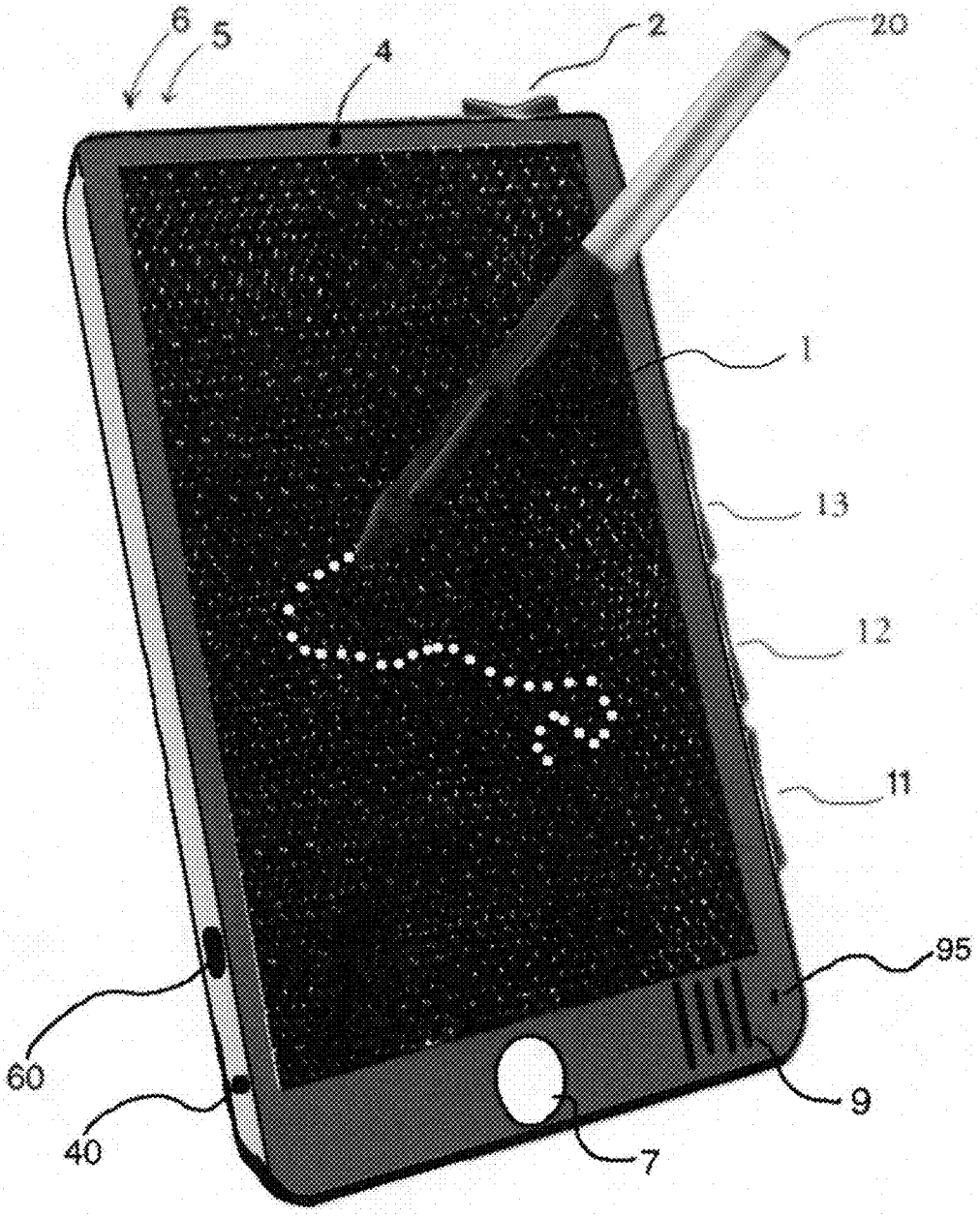


FIG. 8

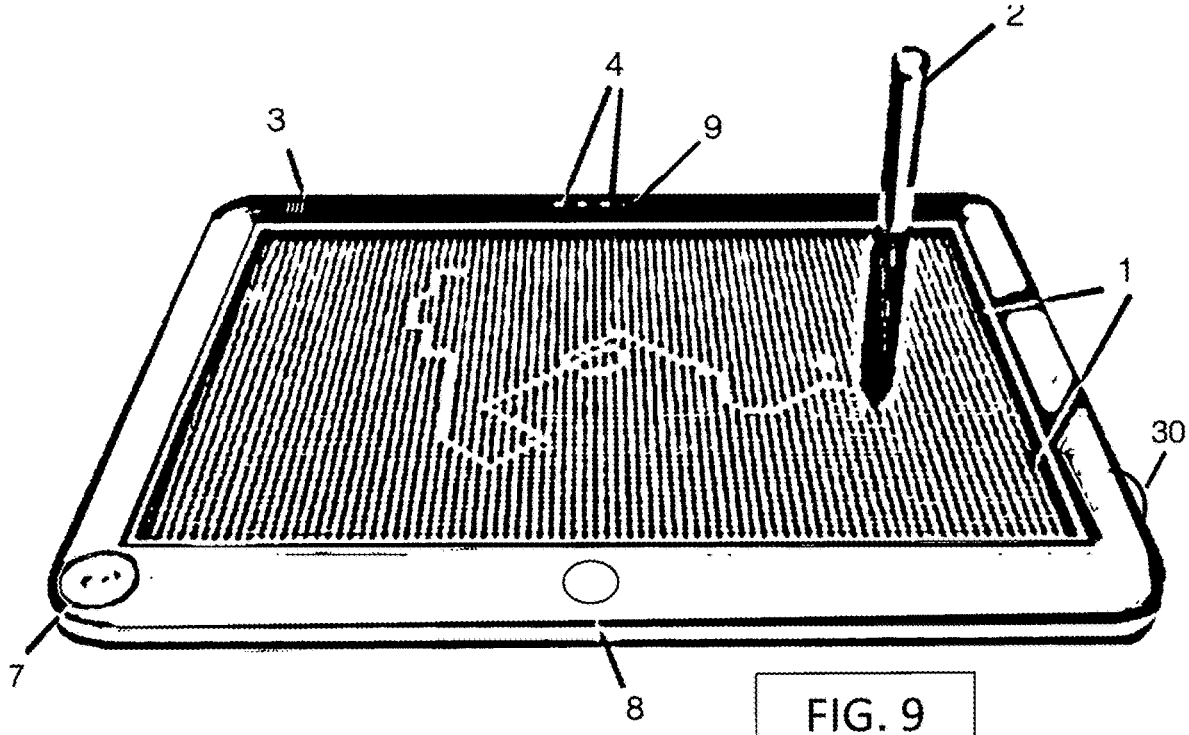


FIG. 9

FIG. 11

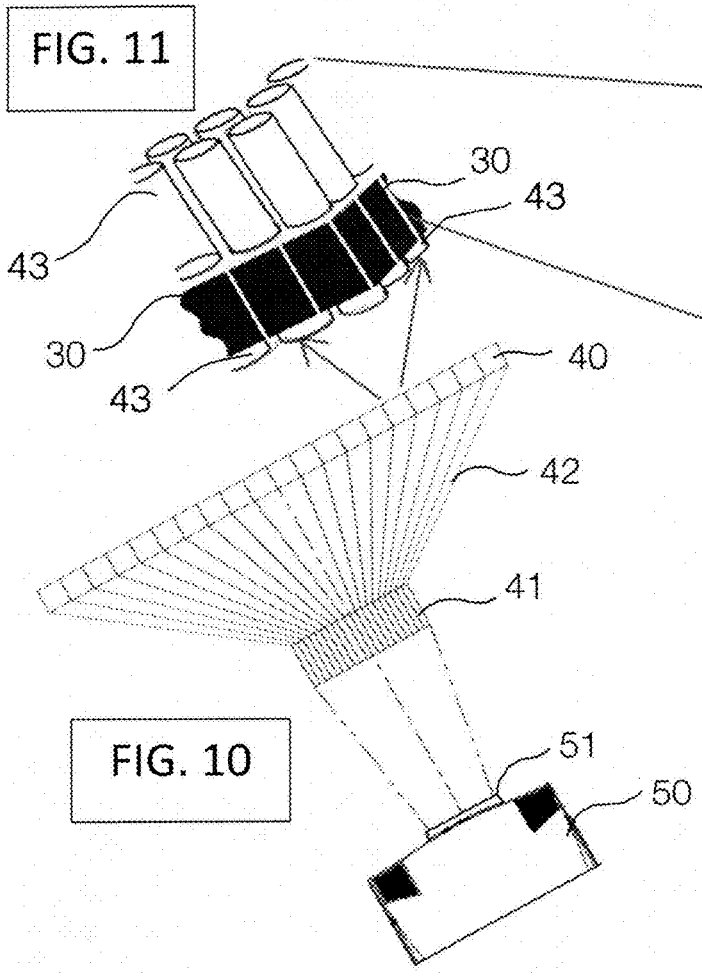


FIG. 10

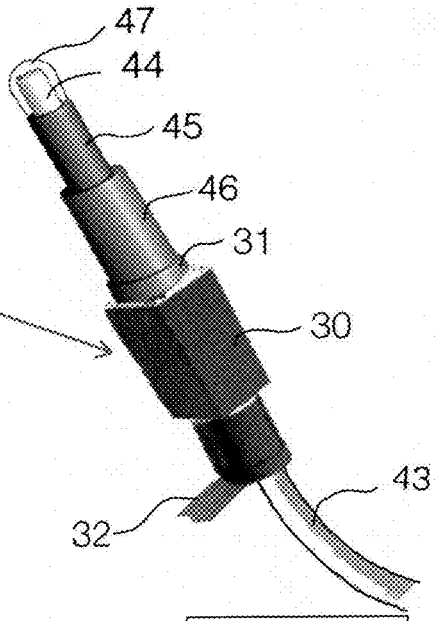


FIG. 12

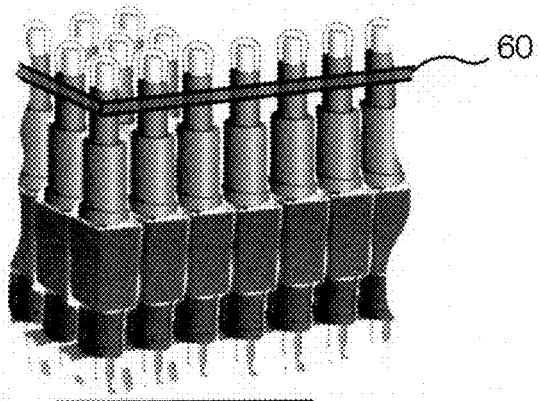


FIG. 13

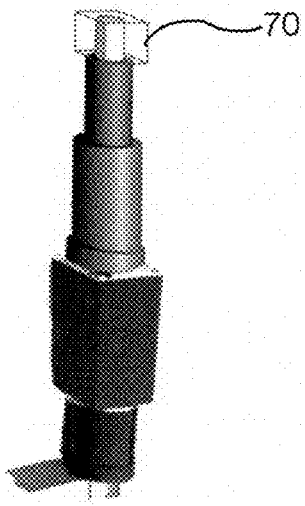


FIG. 14

TACTILE AND VISUAL DISPLAY WITH PAIRED AND ACTIVE STYLUS WITH MEANS AND METHODS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority from provisional Application 62/622,947 filed Jan. 28, 2018, entitled Fiber optic tactile display.

FIELD OF THE INVENTION

[0002] Embodiments of this invention relate to devices with tactile displays. More particularly, these displays are both tactile and visual and be manipulated by an active stylus and the methods and means to accomplish these ends.

BACKGROUND INFORMATION

[0003] Tactile displays are evolving presently that extend many possibilities for use for the blind and visually impaired. For example, patents now exist that describe a tactile display device comprised of a two-dimensional array of variable height pixels or pins, wherein the height of each pixel in the tactile display is converted from incident light using proportions to the gray scale intensity of an image. Some of these are in the testing phase. Patents US20090130639 A1, U.S. Pat. No. 9,105,198 B2, and U.S. Pat. No. 7,352,356B2 are some of the prior art that are the basis of this invention.

[0004] Also, the technology of the active stylus that transmits data to an electronic device has evolved considerably, and the variety is extensive. However, an electronic stylus that is made to be user friendly to a blind or visually impaired person does not exist. With a device like this, a stylus would need to be designed to the task of raising and lowering the pins and changing the colors of said pins. Lastly, there are many features on existing tablet computers that are inaccessible to blind and visually-impaired people.

[0005] To another end, the toy Lite Brite gained its popularity by creating a unique way for children to do art that is both tactile and visual. Also, a current trend among millions of artists is Pixel Art. Pixel artists create drawings either 2 dimensionally or 3 dimensionally (on computer) by combining numerous squares or cubes in various colors. This invention may also create a unique tool for artists, young and old.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] The foregoing and a better understanding of the present invention may become apparent from the following detailed description of arrangements and example embodiments and the claims when read in connection with the accompanying drawings, all forming a part of the disclosure of this invention. While the foregoing and following written and illustrated disclosure focuses on disclosing arrangements and example embodiments of the invention, it should be clearly understood that the same is by way of illustration and example only and the invention is not limited thereto.

[0007] FIG. **1** is a front view of this invention with the active stylus

[0008] FIG. **2** is a view of the left side, the right side, the back, and the top of the invention

[0009] FIG. **3** is view of the active stylus

[0010] FIG. **4** is a view of this invention serving as a small braille Keyboard with multiple-lines of braille.

[0011] FIG. **5** is a view of this invention on a dock with an LCD WXGA Projector on a stand.

[0012] FIG. **6** is a view of this invention with an integrated braille keyboard.

[0013] FIG. **7** is a view of this invention with a detachable braille keyboard.

[0014] FIG. **8** is a view of this invention as a smaller, more portable version of the device.

[0015] FIG. **9** is a view of the device as an educational tool and a toy

[0016] FIG. **10** is a view of a projector transmitting visual images to expanding optical fiber

[0017] FIG. **11** is a close-up view of the display

[0018] FIG. **12** is a view of the cable structure of a single optical cable with display tip and a device (motor) for causing linear movement.

[0019] FIG. **13** is a view of the actuators (motors) and pins and how they may form an array.

[0020] FIG. **14** is a view of the cable structure of a single optical cable with square/cube display tip.

DETAILED DESCRIPTION

[0021] In the following detailed description, well-known methods, procedures, components, and circuits have not been described in detail as not to unnecessarily obscure aspects of the invention. It should be apparent to one skilled in the art that the invention can be practiced without these specific details.

[0022] FIG. **1** shows an example of a construction of a hardware system; a generic computer system, which can be used with a tactile and visual display according to the present invention. The blind and visually impaired are limited in the way they can utilize the current and ever-improving touch-screen devices. Advances have been made in the area of tactile displays, comprised of an array of pins that may be raised in height relative to one another to represent contours and outlines of images and objects when touched. Also, there is the increasing usefulness of haptics technology. However, the technology is in its infancy. There is also a relative dearth of technology attending to the needs of the majority of visually-impaired people who are not completely blind. A refreshing, interactive (multi-touch) tactile display created with hundreds of self-adjusting pins encompassing. Enhanced visual imaging combined with a tactual display **1** offers a rich set of possibilities. In addition to a tactile experience, an apparatus that utilizes clear pins, or uses fiber optics, or LED technology. This would allow the user with limited vision to see their drawings come to life in bright, colorful illuminated illustrations that they can experience in a multi-sensory way.

[0023] An active stylus **2** is paired with this invention in the action of drawing (raising pins). Lacking in current thinking is the fact that the blind, whether reading or drawing, use two hands—one to draw and one to feel as they draw. This makes drawing with one finger impossible.

[0024] The device may also include the many of the aspects of a tablet or portable computer. With USB, Wi-Fi, wireless network (with SIM card) and Bluetooth connectivity, information and graphics can be 'viewed', saved, shared and sent over the Internet or to another device like a printer.

[0025] Incorporating voice-recognition and AI software, like that of 'Siri' in the device will also increase the

accessibility of this invention. The user can speak into the microphone, **9** and get feedback through the speaker **3** or through the headphone jack **13** (see FIG. **2**) with a means to control volume **30**. Pictured also is a "mouse" wheel or "joystick" with push button to scroll and select that may include haptics feedback **7**.

[0026] The technology included in this invention may also be utilized to become the most user-friendly way for the blind and visually impaired to use the internet.

[0027] Multi-lens 3D cameras at the front **4** and the rear **17** (see FIG. **2**) and a flashlight **16** (See FIG. **2**) of this invention take and create line pictures for the users to "see" what the camera sees. It might also be possible for a user to create a tactile "selfie" with the front-facing camera or send such an image to a different device also opening the door to a tactile 'video chat'. Thirty-two braille display cells with cursor-routing buttons **6** built into the top of the current invention add considerably to its usefulness. Visually-impaired people will be able to read or write captions, commentary, or other verbiage that corresponds to the drawings or images.

[0028] The user may use a "mouse" wheel or "joystick" with push select button **7** to scroll, navigate and select items displayed on **1** and it may include haptics feedback. Programmable buttons with refreshable braille cells **5** indicate functions. The functions of the buttons can include, clearing screen, saving, bookmarks, switching programs, 'undo' and more. Buttons with refreshable braille cells **5** to indicate functions have never been utilized before. Above the display is a line of refreshing braille cells **6** for basic reading, writing and for captions (as seen in currently available refreshable braille devices).

[0029] FIG. **2** is a view of the left side, the right side, the back, and the top of the present invention. The rear-facing 3D camera **17** with a LED flash and light **16** and a microphone **18** can take photographs or video of objects in front of the apparatus. Technology is already being developed to incorporate the image of a camera to create a tactile likeness of the landscape in front of a user. It is exciting to think of the impact this technology could have on mobility instruction and navigation for visually impaired and blind people.

[0030] A brightness control switch **19** can, like on a cell-phone, increase or decrease the brightness on the visual display. However on this device, the brightness of the display could increase significantly, like twice or three times that of a cell phone display. Some visually impaired people are able the see things better when displays are brightly lit. A brightness switch may allow users to adjust the brightness to a level that works best for them in a simple way. Like the brightness, a contrast control switch **35** and a color saturation control switch **36** could allow users to further customize the visual image to best suit their needs. This feature would also help those with varying degrees of color blindness.

[0031] A stylus storage and charging port **14** is a useful addition to this device. The blind and visually impaired could easily store and retrieve the electronically-connected stylus. Also, it will not require a separate action (e.g. plugging it in) to charge it.

[0032] The SIM card and memory-card tray **11** may allow the user to expand the memory and allow it to connect, with a SIM card wirelessly to a network for portable internet and phone capabilities. Also pictured are features of the apparatus including a charging/fire-wire port **12**, a Headphone jack **13**, USB ports **10**, and a charging port **15**.

[0033] FIG. **3** shows a representative view of the active and paired stylus **2**. The stylus would have means to communicate exact location on the tactile display and other information to the invention. It may also include a means of creating haptic feedback to the user. Lacking in the current field of the invention is an active, electronic stylus made specifically to interface with the interactive tactile/visual display. A stylus **20** programmed and adjustable to raise and lower pins on a tactile display **1** may allow a user to simultaneously 'draw' and feel what is being drawn. The present invention could be useful to an artist with visual disabilities. For example, an artist may press programmable buttons **21** and **22**, that have raised indicator bumps, on the stylus to switch from creating curved lines to straight lines, and from rectangles to circles. A button **22** on the stylus may change the input to "eraser mode" to eliminate parts of the drawing. Drawing can then be saved and shared in their digital form allow those with all vision types to view it. A pressure sensitive tip **23** that change the height of the pins in response to the amount of pressure the user places on the stylus.

[0034] FIG. **4** shows a representative view of this invention with a braille keyboard with multiple lines of braille **130** on a tactile display **1** that allows the user more flexibility and usefulness when reading and writing.

[0035] FIG. **5** shows a representative view of this invention on a dock with a LCD WXGA or other type of Projector (with assumed power source) **80** on a stand, **81**. The tactile display, **1**, is enhanced by a full color representation of the same image that being conveyed by the relative heights of the array of pins. The image is projected on the display by an LCD WXGA Projector, **80**, positioned above this invention. If the image is changed or manipulated by the user, both the tactile display and the overhead projector will be synced to display the changes in real time. Like the Switches pictured in FIG. **1**, a brightness control switch **11**, a contrast control switch **12** and a color saturation control switch **13** would in this case be incorporated into the projector as pictured. **87** indicates a cord to allow for communication between the projector **80** and the device via a USB port **60**.

[0036] FIG. **6** is a view of this invention with an integrated braille keyboard **188**. Braille keyboards are integrated into most current electronic devices for the blind and visually impaired. This may increase the usefulness of the invention for use as a writing tablet and for use on the Internet.

[0037] FIG. **7** is a view of this invention with a detachable braille keyboard **180**. **185** is the USB connection to the device in port **186** or another means of connecting this invention to the keyboard **180** such as Bluetooth. As mentioned above this may increase the usefulness of the invention for use as a writing tablet and for use on the Internet. However, a detachable keyboard **180** may add to portability and versatility of the device.

[0038] FIG. **8** is a representation of the device as a smaller, more portable version. This invention may be made into a variety of different sizes to suit different needs. In this version, the device may be small enough to hold in one hand. Encompassing many of the features of explained in FIG. **1** including: **1** a refreshing, interactive (multi-touch) tactile display created with hundreds of self-adjusting pins encompassing features to use also as an enhanced visual color display. **20** is an illustration of an active stylus that is paired with this invention, **2** switches to control volume of speaker **9**, **11** switches or controller for brightness, **12** switches or

controller for contrast, **13** switches or controller for color saturation, **4** a front facing camera and **5** indicating a place for a rear facing camera and **6** an LED flash and light not pictured, **40** a Headphone jack, **60** indicates a charging/fire wire port, **95** indicates a Microphone, and **7** a power and home button.

[0039] FIG. **9** is the apparatus without braille and the utilization of the same technology in a device illustrated in FIG. **1** and FIG. **2** to be used by a sighted person, comparable to an electronic 'Lite Brite' or a multi-sensory teaching tool. Pictured above is an illustration of an apparatus with a tactile and visual display **1**, an active stylus that is paired with this invention **2** , a controller and selecting device **7**, a means to control volume **30** of speakers **3**, a Microphone **9**, a power and home button **8** and a multi-lens 3D camera **4**.

[0040] Not pictured, like illustrated FIG. **2**, is a controller for brightness **19**, a controller for contrast **20**, and a controller for color saturation, a rear-facing camera **17**, LED flash and light **16** , a Headphone jack **13**, a charging/fire wire port **12**, a SIM and memory card tray **11**, USB ports **10**, a stylus storage and charging port **14** are features that may be included in the apparatus.

[0041] As a toy for all ages, the apparatus would be similar to the extremely popular toy "Lite Brite" but a much more complex and with electronic capabilities. The smaller pins and the stylus **2** would allow the user to draw more detailed drawing. The operating system of the portable computer would be similar to that of a common computer Tablet. Learning-disabled students learn to read and write best with multi-sensory feedback. People with autism or other disabilities may also find the device motivational and helpful. A multi-sensory experience is a preferred intervention method. Thus, the tactile and color visual display **1**, along with auditory feedback provided by either the speaker **3** or through the headphone jack **40**. Students could write with the stylus **2** and feel and hear the letter or word they are writing. Students could also experience reading of letters or words or stories in a multisensory way.

[0042] FIG. **10** shows an example of a construction of a hardware system; a generic projector **50**, optical receiver and optical fiber bundles that create a display screen **40** This may be used to construct a tactile display according to the present invention.

[0043] The genetic projector **50** transmits light, pictures and images through the projector lens **51**. The projector **50** may take advantage of advances in the area of high-definition projectors that are increasing in quality and decreasing in size for more compact and portable use.

[0044] The image is projected onto aperture optical receiver **41** carried and expanded by optical fiber "bundles" or "cables" (below to be referred to as cable) **42** to a display **40**. Display **40** may be pressure sensitive to receive inputs from the user.

[0045] FIG. **11** is close-up view of the display and how an array optical fibers **43** may be combined with an array linear motors **30**. The array of columns (Pins) **43** represent a simplified view of a pixel-like display constructed of optical fiber "bundles" or "cables" **43** either with cores of glass or plastic. The preference being for optical fibers would be OPF (optical plastic fiber) for its characteristics of being more durable, flexible and inexpensive.

[0046] FIG. **12** is a view of the cable structure of a single optical cable with display tip and the rectangular prism **30** representing a device for causing linear movement. This small device is that of a linear actuator or other such motor that causes linear movement like a cam and gear assembly, rack and pinion system, or a screwing motion. Any such means of causing linear motion could be enhanced with the addition of the fiber optics at its core. The moving part **31** of the motor/actuator **30** is attached to the fiber optic cable **43** to cause it to move up and down in a vertical fashion. The bundle of wires **32** is representative of how the motor will communicate with a computer and receive its power to operate.

[0047] The optical fiber cable **43** shown being attached to the motor/actuator **30** and broken down to its parts; the outer jacket **46**, the inner jacket and cladding **45** and the optical fiber itself **44**.

[0048] A transparent or translucent plastic cover **47** surrounds the optic fiber. Ideally, this plastic cap will enhance the light from the optic fiber and, together with hundreds of others, form a bright, colorful, touchable image. Covers **47** may also be constructed with fiber optics to enhance or aim the light in a particular direction.

[0049] Pins may also be pressure sensitive as to receive inputs from the user.

[0050] FIG. **13** is a view of the actuators and pins and how they may form an array. They may be raised and lowered through a display surface **60** at varying heights.

[0051] FIG. **14** is a view of an individual pin with a square/cubed plastic cover **70** to form square pixels in an array. This feature may allow the user to make "Pixel Art" on a tactile display.

1. A device with a tactile display, comprising:
an array of pins;
an actuator to move each pin to a height relative to other pins in the array, wherein the relative heights so the surface conveys a graphic image when touched; and a paired, active, stylus to manipulate pins; powered by an energy source (not shown).

2. The device with a tactile display as recited in claim **1**, wherein the means for conveying electrical signals from the stylus to the display via Bluetooth or similar technology.

3. The device with a tactile display as recited in claim **1**, wherein the means for conveying electrical signals from the stylus to the display is variable: i.e., pins raise and lower in response to the way the user is pressing buttons on the stylus.

4. The device with a tactile display as recited in claim **1**, wherein the means for conveying electrical signals from the stylus to the display is variable: i.e., raise and lower pins in response to the way the user is holding the stylus.

5. The device with a tactile display as recited in claim **1**, wherein the means for conveying feedback to the user includes haptics.

6. The device with a tactile display as recited in claim **1**, wherein there is a means for saving images, eg hard disk or flash memory device.

7. The device with a tactile display as recited in claim **1**, wherein there is incorporated Wi-Fi technology.

8. The device with a tactile display as recited in claim **1**, wherein there is incorporated Bluetooth Technology.

9. The device as recited in claim **1**, wherein a sim card or other means is used to connect the device to a wireless network.

10. The device as recited in claim **1**, wherein piezoelectric actuators are used to move each pin in a linear way.

11. The device as recited in claim **1**, wherein the pins may move to a variety of heights.

12. The device as recited in claim **1**, wherein a portable computer operating system is incorporated. Eg. 'IOS' or 'Android'.

13. The device as recited in claim **1**, wherein a linear actuator or other such motor that causes linear movement like a cam and gear assembly, rack and pinion system, or a screwing motion.

14. The device as recited in claim **1**, wherein there is incorporated piezoelectric ceramic actuators.

15. A device for displaying an image on a tactile display, comprising: raising individual pins in an array of pins wherein the relative heights convey a graphic image when touched; and

an illuminated visual image.

16. The device as recited in claim **15**, wherein the device may be used with or without the paired stylus of claim **1**.

17. The device as recited in claim **15**, wherein an operating system is incorporated. Eg. 'IOS' or 'Android'.

18. The device as recited in claim **15**, wherein each pin has a physical attribute comprised of materials that transmit light. e.g., Fiber optics, LED

19. The device as recited in claim **15**, wherein a Projector linked to the device creating an image that overlays the array of pins.

20. The device as recited in claim **15**, wherein the means for conveying a visual display is with an optical fiber system.

21. The device as recited in claim **15**, wherein the means for conveying a visual display utilizes an aperture optical receiver.

22. The device recited in claim **15**, wherein there is incorporated piezoelectric ceramic actuators.

23. The device as recited in claim **15**, wherein there are illuminated pins that could either appear round or square (for a pixel appearance).

24. The device as recited in claim **15**, wherein there are wheels/switches/dials that allow the user to easily adjust brightness, color and contrast.

25. The device as recited in claim **15**, wherein a sim card or other means is used to connect the device to a wireless network.

26. The device as recited in claim **15**, wherein a braille keyboard incorporated into the device.

27. The device with a tactile display as recited in claim **15**, wherein there is incorporated Wi-Fi technology.

28. The device with a tactile display as recited in claim **15**, wherein there is incorporated Bluetooth Technology.

29. The device as recited in claim **15**, wherein a detachable braille keyboard is able to link with the device through a means including USB and Bluetooth.

30. The device as recited in claim **15**, wherein a front-facing multi-lens 3D camera.

31. The device as recited in claim **15**, wherein a rear-facing camera is incorporated.

32. The device as recited in claim **15**, wherein a rear-facing camera is incorporated, a multi-lens 3D camera.

33. The device as recited in claim **15**, wherein a sensor for auto focus and/or distance measurement sensor is incorporated.

34. The device as recited in claim **15**, wherein images captured by camera(s) are digitized and create a corresponding tactile image.

35. The device as recited in claim **15**, wherein images captured by cameras using an edge-detecting filter to detect contours of objects to simplify and display a tactile image.

36. The device as recited in claim **15**, wherein there exist an ability to display multiple lines of braille.

37. The device with a tactile display as recited in claim **15**, wherein the means for the array of pins to form a touch sensitive braille keyboard.

38. The device as recited in claim **15**, wherein GPS technology is included.

39. The device as recited in claim **15**, wherein there is an embedded line of refreshing braille cells.

40. The device as recited in claim **15**, wherein piezoelectric actuators are used to move each pin in a linear way.

41. The device as recited in claim **15**, wherein a portable computer operating system is incorporated. Eg. 'IOS' or 'Android'.

42. The device as recited in claim **15**, wherein a linear actuator or another such motor that causes linear movement like a cam and gear assembly, rack and pinion system, or a screwing motion

43. The device as recited in claim **15**, wherein OPF (optical plastic fiber) is used to transfer light.

44. The device as recited in claim **15**, wherein there is incorporated a microphone and speakers.

45. The device as recited in claim **15**; wherein voice-recognition software is incorporated to enable voice controls and voice to text/braille abilities.

46. The device as recited in claim **15**, wherein voice-recognition and AI software, like that of 'Siri' or "Alexa" is incorporated in the device.

47. An electronic apparatus that has buttons comprising of refreshing, braille cells to indicate different functions.

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