ABSTRACT

Computing is now not limited to desktops and laptops, it has found its way into mobile devices like palm tops and even cell phones. But what has not changed for the last 50 or so odd years is the input device, the good old QWERTY keyboard. Virtual Keyboard uses sensor technology and artificial intelligence to let users work on any surface as if it were a keyboard. Virtual Devices have developed a flashlight-size gadget that projects an image of a keyboard on any surface and let's people input data by typing on the image. The Virtual Keyboard uses light to project a full-sized computer keyboard onto almost any surface, and disappears when not in use. Used with Smart Phones and PDAs, the VKEY provides a practical way to do email, word processing and spreadsheet tasks, allowing the user to leave the laptop computer at home.

INTRODUCTION

Virtual Keyboard is just another example of today's computer trend of 'smaller and faster'. Computing is now not limited to desktops and laptops, it has found its way into mobile devices like palm tops and even cell phones. But what has not changed for the last 50 or so odd years is the input device, the good old QWERTY keyboard and the virtual keyboard technology is latest development.

The new virtual keyboard technology uses sensor technology and artificial intelligence to let users work on any surface as if it were a keyboard. Virtual Keyboards lets you easily create multilingual text content on almost any existing platform and output it directly to PDAs or even web pages. Virtual Keyboard, being a small, handy, well-designed and easy to use application, turns into a perfect solution for cross platform multilingual text input.

The main features are: platform-independent multilingual support for keyboard text input, built-in language layouts and settings, copy/paste etc. operations support just as in a regular text editor, already existing system language settings remain intact, easy and user-friendly interface and design, and small file size.

QWERTY KEYBOARDS

Inside the keyboard

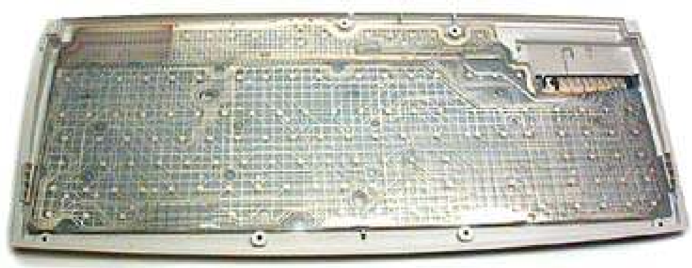
The processor in a keyboard has to understand several things that are important to the utility of the keyboard, such as:

- Position of the key in the **key matrix**.
- The amount of **bounce** and how to filter it.
- The speed at which to transmit the **typematics**.

The microprocessor and controller circuitry of a keyboard.

The key matrix is the grid of circuits underneath the keys. In all keyboards except for capacitive ones, each circuit is broken at the point below a specific key. Pressing the key, bridges the gap in the circuit, allowing a tiny amount of current to flow through. The processor monitors the key matrix for signs of continuity at any point on the grid. When it finds a circuit that is closed, it compares the location of that circuit on the key matrix to the character map in its ROM. The character map is basically a comparison chart for the processor that tells it what the key at x,y coordinates in the key matrix represents. If more than one key is pressed at the same time, the processor checks to see if that combination of keys has a designation in the character map. For example, pressing the **'a'** key by itself would result in a small letter "a" being sent to the computer. If you press and hold down the Shift key while pressing the **'a'** key, the processor compares that combination with the character map and produces a capital letter "A."

A different character map provided by the computer can supersede the character map in the keyboard. This is done quite often in languages whose characters do not have English equivalents. Also, there are utilities for changing the character map from the traditional QWERTY to DVORAK or another custom version.



A look at the key matrix.

Keyboards rely on switches that cause a change in the current flowing through the circuits in the keyboard. When the key presses the keyswitch against the circuit, there is usually a small amount of vibration between the surfaces, known as **bounce**. The processor in a keyboard recognizes that you pressing the key repeatedly do not cause this very rapid switching on and off. Therefore, it filters all of the tiny fluctuations out of the signal and treats it as a single keypress.

If you continue to hold down a key, the processor determines that you wish to send that character repeatedly to the computer. This is known as **typematics**. In this process, the delay between each instance of a character can normally be set in software, typically ranging from 30 characters per second (cps) to as few as two cps.

DIFFERENT TYPES

Keyboards have changed very little in layout since their introduction. In fact, the most common change has simply been the natural evolution of adding more keys that provide additional functionality.

The most common keyboards are:

- 101-key Enhanced keyboard
- 104-key Windows keyboard
- 82-key Apple standard keyboard
- 108-key Apple Extended keyboard

Portable computers such as laptops quite often have custom keyboards that have slightly different key arrangements than a standard keyboard. Also, many system manufacturers add specialty buttons to the standard layout. A typical keyboard has four basic types of keys:

- Typing keys
- Numeric keypad
- Function keys
- Control keys

The typing keys are the section of the keyboard that contains the letter keys, generally laid out in the same style that was common for typewriters. The numeric keypad is a part of the natural evolution mentioned previously. Since a large part of the data was numbers, a set of 17 keys was added to the keyboard. These keys are laid out in the same configuration used by most adding machines and calculators, to facilitate the transition to computer for clerks accustomed to these other machines. In 1986, IBM extended the basic keyboard with the addition of function and control keys. The function keys, arranged in a line across the top of the keyboard, could be assigned specific commands by the current application or the operating system. Control keys provided cursor and screen control. Four keys arranged in an inverted *T* formation between the typing keys and numeric keypad allows the user to move the cursor on the display in small increments.

Keyboard Technologies

Keyboards use a variety of switch technologies. It is interesting to note that we generally like to have some audible and **tactile** response to our typing on a keyboard. We want to hear the keys "click" as we type, and we want the keys to feel firm and spring back quickly as we press them. Let's take a look at these different technologies:

- Rubber dome mechanical
- Capacitive non-mechanical
- Metal contact mechanical
- Membrane mechanical
- Foam element mechanical

From the Keyboard to the Computer

As you type, the processor in the keyboard is analyzing the key matrix and determining what characters to send to the computer. It maintains these characters in a buffer of memory that is usually about 16 bytes large. It then sends the data in a stream to the computer via some type of connection.

The most common keyboard connectors are:

- 5-pin DIN (Dutch Industries Norm) connector
- 6-pin IBM PS/2 mini-DIN connector
- 4-pin USB (Universal Serial Bus) connector
- Internal connector (for laptops)

Normal DIN connectors are rarely used anymore. Most computers use the mini-DIN PS/2 connector; but an increasing number of new systems are dropping the PS/2 connectors in favor of USB. No matter which type of connector is used, two principal elements are sent through the connecting cable. The first is power for the keyboard. Keyboards require a small amount of power, typically about 5 volts, in order to function. The cable also carries the data from the keyboard to the computer. The other end of the cable connects to a port that is monitored by the computer's **keyboard controller**.

This is an integrated circuit (IC) whose job is to process all of the data that comes from the keyboard and forward it to the operating system.

Difficulties and alternatives

It is now recognized that it is important to be correctly seated while using a computer. A comfortable working position will help with concentration, quality of work, and reduce the risk of long-term problems. This is important for all who use computers, and especially so for those with disabilities.

The increased repetitive motions and awkward postures attributed to the use of computer keyboards have resulted in a rise in cumulative trauma disorders (CTDs) that are generally considered to be the most costly and severe disorders occurring in the office. Lawsuits for arm, wrist, and hand injuries have been filed against keyboard manufacturers allege that keyboarding equipment is defectively designed and manufacturers fail to provide adequate warnings about proper use to avoid injury.

As early as1926, Klockenberg described how the keyboard layout required the typist to assume body postures that were unnatural, uncomfortable and fatiguing. For example, standard keyboard design forces operators to place their hands in a flat, palm down position called forearm pronation. The compact, linear key arrangement also causes some typists to place their wrist in a position that is skewed towards the little fingers, called ulnar deviation. These awkward postures result in static muscle loading, increased muscular energy expenditure, reduced muscular waste removal, and eventual discomfort or injury. Researchers also noted that typing on the QWERTY keyboard is poorly distributed between the hands and fingers, causing the weaker ring and little fingers to be overworked.

Alternatives

When a standard keyboard does not meet the needs of the user, several alternatives can be found. Keyboards come in a variety of sizes with different layouts. The four alternatives described below are considered "plug and play" keyboards, as they require no special interface. Just plug them into the existing keyboard port and use them.

Ergonomic Keyboards:

These keyboards are designed to ensure safe and comfortable computer use by providing additional supports to prevent repetitive muscular injuries. Many offer flexible positioning options (Comfort Keyboard), while others use "wells" for support (ergonomic), or chords instead of keys (BAT Keyboard), or require minimal finger/hand movements (Data Hand).

Compact or Reduced Keyboards:

These keyboards are designed with keys in closely arranged order. These compact or reduced keyboards offer options for students with a limited range of motion in their hands or arms and can be accessed with head or mouth pointers. Examples of these are TASH mini keyboards (WinMini, MacMini), or the Magic Wand Keyboard; both provide for keyboard and mouse control.

Enlarged Keyboards:

These keyboards are a larger version of the standard keyboard, in whole or in part. Larger keys may provide an easier target, as fewer key choices with clear key labels can provide a successful input method for many. The IntelliKeys keyboard is one example; it comes with 6 keyboard overlays and varying key layout designs and can be further customized with the use of Overlay Maker software.

Portable Keyboards :

The last type of keyboard is one which addresses the portability needs of individuals with disabilities. A portable keyboard is one which can be used as a not-taker when battery-powered and then connected to a computer to download the information. The AlphaSmarta is an example of a portable keyboard. It connects to the Apple, Mac, and IBM computers and can be used as the computer keyboard when it is connected to the computer.

VIRTUAL KEYBOARD TECHNOLOGY

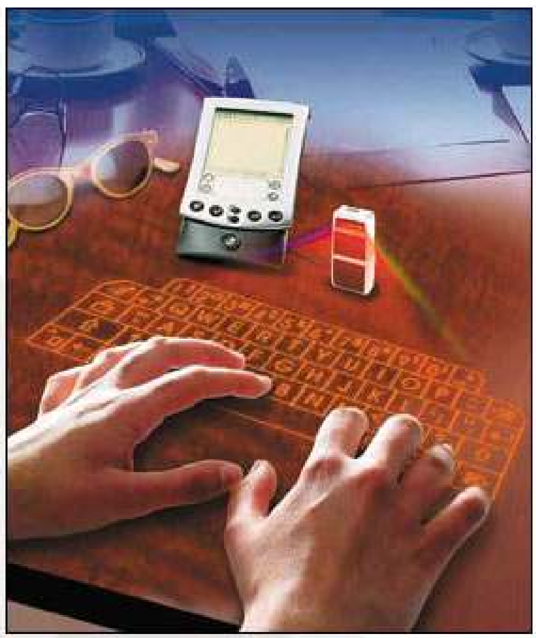
Virtual Keyboard is just another example of today's computer trend of "smaller and faster". Computing is now not limited to desktops and laptops, it has found its way into mobile devices like palm tops and even cell phones. But what has not changed for the last 50 or so odd years is the input device, the good old QWERTY keyboard. Alternatives came in the form of handwriting recognition, speech recognition, abcd input (for SMS in cell phones) etc. But they all lack the accuracy and convenience of a full-blown keyboard. Speech input has an added issue of privacy. Even folded keyboards for PDAs are yet to catch on. Thus a new generation of virtual input devices is now being paraded, which could drastically change the way we type.

Virtual Keyboard uses sensor technology and artificial intelligence to let users work on any surface as if it were a keyboard. Virtual Devices have developed a flashlight-size gadget that projects an image of a keyboard on any surface and let's people input data by typing on the image.

This system comprises of three modules,

1. The sensor module,
2. IR-light source and
3. The pattern projector.

The device detects movement when fingers are pressed down. Those movements are measured and the device accurately determines the intended keystrokes and translates them into text. There is a set of clips that fit into your hand and try to sense the motion of the fingers and the hands (wrist) and translate them into keystrokes. The translation process also uses artificial intelligence. Once the keystroke has been decoded, it is sent to the portable device either by cable or via wireless.



The Virtual Keyboard uses light to project a full-sized computer keyboard onto almost any surface, and disappears when not in use. Used with Smart Phones and PDAs, the Vkey™ provides a practical way to do email, word processing and spreadsheet tasks, allowing the user to leave the laptop computer at home. VKey™ technology has many applications in various high-tech and industrial Sectors. These include data entry and control panel applications in hazardous and harsh environments and medical markets.

Projection key boards or virtual key boards claim to provide the convenience of compactness with the advantages of a full-blown QWERTY keyboard. An interesting use of such keyboards would be in sterile environments where silence or low noise is essential like operation theaters. The advantage of such a system is that you do not need a surface for typing, you can even type in plain air. The company's Virtual Keyboard is designed for anyone who's become frustrated with trying to put information into a handheld but doesn't want to carry a notebook computer around. There is also the provision for a pause function to avoid translating extraneous hand movements function, so that users can stop to eat, drink etc …

It is also a superior desktop computer keyboard featuring dramatically easier to learn touch-typing and leaving one hand free for mouse or phone. Combination key presses ("chords") of five main and two extra control keys allow users to type at 25-60 words per minute, with possibly greater speeds achieved through the use of abbreviation expansion software. Most users, however, will find memorizing the chords easy and fun, with the included typing tutorial. The scanner can keep up with the fastest typist, scanning the projected area over 50 times a second. The keyboard doesn't demand a lot of force, easing strain on wrists and digits. virtual keyboards solve the problem of sore thumbs that can be caused by typing on the tiny keyboards of various gadgets like PDAs and cell phones. They are meant to meet the needs of mobile computer users struggling with cumbersome, tiny, or nonexistent keyboards. It might help to prevent RSI injuries.

An infrared adapter allows PC usage without any driver software being necessary. The standard coin-sized lithium battery lasts about eight months before needing to be replaced.

The Virtual Keyboard uses an extremely durable material which is extremely easy to clean. The Virtual Keyboard is not restricted to the QWERTY touch-typing paradigm , adjustments can be done to the software to fit other touch-typing paradigms as well, such as the DVORAK keyboard. It will work with all types of Bluetooth enabled devices such as PDAs and smart phones, as well as wearable computers. Applications include computer/PDA input, gaming control, TV remote control, and musical applications.Thus virtual keyboards will make typing easier, faster, and almost a pleasure.

VIRTUAL DEVICES

Just like every conventional loudspeaker can also be used as a microphone, for some input devices there is a complimentary form where they can also be displays. However, just as few loudspeakers are used as microphones (so few, in fact, that most people forget - if they even knew - that this was possible), very few input devices incorporate this duality into their design. Force feedback devices are one exception. With them, the "display" is felt rather than seen. Touch screens and other direct input devices appear to have this property, but in fact, this is appearance only, since their input/output duality is accomplished by designing two separate technologies into one integrated package. The acoustic analogy would be integrating a microphone and speaker into one package, a bit like a telephone handset, rather than using the same transducer for both the microphone and speaker functions. It is interesting to note that this is not the case with force feedback devices since with them, the same motors that generate the force output also serve as the encoders that capture the actions of the user.

Recently a new class of device has started to emerge which is conceptually rooted in exploiting this input/output duality. They can be called Projection/Vision systems, and/or Projection/Scanning or Projection/Camera technologies. In the "pure" case, these are devices that use a laser, for example, to project an image of the input controller - such as a slider or keypad - onto a surface. In doing so, they are performing a function analogous to an LCD displaying the image of a virtual device under a touch screen. However, in this case, the laser is also used to scan the same surface that it projecting onto, thereby enabling the device to "see" how your fingers, for example, are interacting with the projected virtual device.

In a slightly less pure "hybrid" form, the projection and scanning functions can be performed by two separate, but integrated technologies. For example, instead of a laser projector, a conventional video or data projector could be used, and an integrated video camera (supported by vision software) used for input.

Both the "pure" and "hybrid" classes of device have been used and have strengths and weaknesses. Since laser projection is far less advanced than conventional data projection, the hybrid solution sometimes has advantages on the display side. However, 2D and 3D scanning using lasers is far more developed than 2D and 3D vision using video based vision techniques. This is partially due to the degree to which the laser technology can extract 3D information. Going forward, one can expect laser projection technology to advance extremely quickly, especially in its ability to deliver extremely small, low power, bright, relatively high resolution projection capability. This will likely have a strong impact on how we interact with small portable devices, such as PDAs, mobile phones and even wristwatches. Not only does this technology provide a means to couple large (virtual) I/O transducers with small devices, it provides the potential for sharing and interacting with others, despite using devices as small as a wrist watch.

On the other hand, these technologies have strong potential on the other side of the scale, in large-scale interaction, where what is scanned are bodies in a room, rather than fingers on a surface, and the projection surface may be the floor or ceiling of a room, rather than a desktop.

Besides the obvious, there are a couple of interesting challenges with this type of system. First, it is generally not sufficient to simply know where the fingers are over the display. One has to be able to distinguish the difference between pointing or hovering, versus activating. This must be reliable, and responsive. The system and the user must agree as to if and when activation takes place. Also, since the device is virtual, a means (acoustic of visual) is likely needed to provide some form of feedback at the device level. Since, especially in the mobile case, the projection surface, and hence the input control surface, is arbitrary, so there would be no opportunity for any tactile feedback, vertical or lateral. Of course, if the projector was fixed, then there are a range of techniques that could be used to provide tactile feedback.

Electronic whiteboards that use projection technologies coupled with touch screens, such as those available from Smart Technologies, and 3Com, for example, are related to this class of device. However, they differ in that the input transducer is integrated with the projection surface, rather than with the projector. This is a significant technological difference (but one which may be transparent to a user). The same could be said of touch screens; especially in the future as touch screens become thinner and more inobtrusive, such as if/when they are made with OLEDs, for example. That is, they could appear the same to the user as "pure" projection vision systems. However, I treat touch screens and this latter class of projection boards separately.

What is unique, distinct, or new, from the usage/user perspective of the type of projection/vision systems that I highlight in this section is that they are not fixed in position. The same unit may project/sense in different locations, on different surfaces, and in many cases be mobile. That is, there is no specific surface, other than the (perhaps) arbitrary surface on which one is projecting, on which the system operates. This is especially true of the miniature laser projector/scanner systems. But it is even true of installed systems, such as the IBM steerable projection/vision system. In this later case, while the projector and vision systems are fixed in architural space, they can be directed to work on different surfaces/areas in the room.

Projection/Vision systems constitute an area where products are beginning to emerge. Below is a listing of some of the companies who are playing in this field. As well, there is a body of work emerging from the research community around this type of interaction.

DIFFERENT VIRTUAL KEYBOARDS

Developer VKB™

Its full-size keyboard also can be projected onto any surface and uses laser technology to translate finger movements into letters. Working with Siemens Procurement Logistics Services Rechargeable batteries similar to those in cell phones power the compact unit .The keyboard is full size and the letters are in a standard format. As a Class 1 laser, the output power is below the level at which eye injury can occur.

Canesta™

The Canesta Keyboard, which is a laser projected keyboard with which the same laser is also used to scan the projection field and extract 3D data. Hence, the user sees the projected keyboard, and the device "sees" the position of the fingers over the projected keys. They also have a chip set, *Electronic Perception Technology,* which they supply for 3rd parties to develop products using the projection/scanning technology. Canesta appears to be the most advanced in this class of technology and the only one who is shipping product. They have a number of patents pending on their technology.

Sense board Technologies

The Senseboard SB 04 technology is an extreme case of a hybrid approach. The sensing transducer is neither a laser scanner nor a camera. Rather, it is a bracelet-like transducer that is worn on the hands which captures hand and finger motion. In fact, as demonstrated, the technology does not incorporate a projection component at all; rather, it relies on the user's ability to touch type, and then infers the virtual row and key being typed by sensing relative hand and finger movement. The system obviously could be augmented to aid non-touch typists, for example, by the inclusion of a graphic representation of the virtual keyboard under the hands/fingers. In this case, the keyboard graphically represented would not be restricted to a conventional QWERTY keyboard, and the graphical representation could be projected or even on a piece of paper. I include it here, as it is a relevant related input transducer that could be used with a projection system. The technology has patents pending, and is currently in preproduction proof of Concept form.

Sensors made of a combination of rubber and plastic are attached to the user's palms in such a way that they do not interfere with finger motions. Through the use of Bluetooth technology, the "typed" information is transferred wirelessly to the computer, where a word processing program analyzes and interprets the signals into readable text. The device is currently usable via existing ports on personal digital assistants (PDAs) from Palm and other manufacturers. Senseboard officials say it eventually will be compatible with most brands of pocket PCs, mobile phones and laptop computers.

KITTY™

KITTY, a finger-mounted keyboard for data entry into PDA's, Pocket PC's and Wearable Computers which has been developed here at the University of California in Irvine.

KITTY, an acronym for Keyboard-Independent Touch-Typing, is a Finger mounted keyboard that uses touch typing as a method of data entry. The device targets the portable computing market and in particular its wearable computing systems which are in need of a silent invisible data entry system based on touch typing .the new device combines the idea of a finger mounted coding device with the advantages of a system that uses touch typing.

InFocus™

InFocus is one of the leading companies in providing video and data projectors. Their projectors are conventional, in that they do not use laser technology. This has that advantage of delivering high quality colour images with a mature technology. However, it has the disadvantage of larger size, lower contrast, and higher power requirements, compared to laser projection systems. In 2000, InFocus merged with Proxima, which had been one of its competitors. I include InFocus/Proxima in this survey not only because they make projectors. In their early days, Proxima developed one of the first commercially available projection/vision systems. It was called Cyclops, and they still hold a patent on the technology. Cyclops augmented the projector by adding a video camera that was registered to view the projection area. The video camera had a band pass filter over the lens, which passed only the wavelength of a laser pointer. The system, therefore, enabled the user to interact with the projected image, using a provided laser pointer as the input device. The camera detected the presence of the laser pointer on the surface, and calculated its coordinates relative to the currently projected image. Furthermore, the laser pointer had two intensity levels which enabled the user to not only point, but to have the equivalent of a mouse button, by the vision system interpreting the two levels as distinguishing button up and down events.

ADVANTAGES

1. It can be projected on any surface or you can type in the plain air.
2. It can be usefull in places like operation theaters where low noise is essential.
3. The typing does not require a lot of force. So easing the strain on wrists and digits.
4. The Virtual Keyboard is not restricted to the QWERTY touch-typing paradigm, adjustments can be done to the software to fit other touch-typing paradigms as well.
5. No driver software necessary, It can be used as a plug and play device.
6. High battery life.

DRAWBACKS

- Virtual keyboard is hard to get used to. Since it involves typing in thin air, it requires a little practice. Only people who are good at typing can use a virtual keyboard efficiently.
- It is very costly ranging from 150 to 200 dollars.
- The room in which the projected keyboard is used should not be very bright so that the keyboard is properly visible.

APPLICATIONS

- High-tech and industrial Sectors
- Used with Smart phones, PDAs, email, word processing and spreadsheet tasks.
- As computer/PDA input.
- Gaming control.
- TV remote control.

CONCLUSION

Virtual Keyboard uses sensor technology and artificial intelligence to let users work on any surface as if it were a keyboard. Projection key boards or virtual key boards claim to provide the convenience of compactness with the advantages of a full-blown QWERTY keyboard. The company's Virtual Keyboard is designed for anyone who's become frustrated with trying to put information into a handheld but doesn't want to carry a notebook computer around.

Canesta appears to be the most advanced in this class of technology and the only one who is shipping product. Other products are KITTY, a finger-mounted keyboard for data entry into PDA's, Pocket PC's and Wearable Computers and KITTY, a finger-mounted keyboard for data entry into PDA's, Pocket PC's and Wearable Computers.

Thus virtual keyboards will make typing easier, faster, and almost a pleasure.

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