An Introduction to Typing with Bimanual Gestures

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Typing involves the use of both hands in a coordinated pattern of staccato clicks. Writing with a pen involves a continuous looping flow while advancing across a page. This text entry system and corresponding research focuses on a method of text input that combines these two forms.

Simply Put

This method of text input makes use of two pointer-based devices. These devices can be two mice; two touch pads, a multi touch housing or smart phone. The user performs a gesture with the two pointers to create a character. If text is to be entered into a computer via two mice, position the mice comfortably. This is the home position, similar to the "home row" when touch-typing. To create a character, move the two mice in any of the eight compass directions and then return to the home position. This combination of the eight directions on one hand and eight directions on the other hand allows users to make 64 gestures by leaving and returning in straight lines.

A gesture like this  is a K.

A gesture like this  is an L.

This is sufficient for a Latin alphabet with some special characters but would need to be expanded for larger character set languages such as Japanese and to include additional functions that some keyboards allow. Since most computer keyboards have more than 100 keys, additional gestures are needed. To enable this, the return path can be curved. Rather than returning in a straight path back to the neutral home position, curve the return path either clockwise or counter clockwise.

A gesture like this  is a W.

A gesture like this  is a Q.

Combining the eight ways of leaving the home position and three ways of returning to the home position, results in a huge set of available gestures. Some of the gesture combinations are difficult but with the number available, these difficult gestures can remain unused.

The same gesture pattern of eight ways of leaving and three ways of returning can be used for one-handed gestures. This is useful for keys such as shift or some of the common characters such as period or space.

The left hand gesture  is the shift key.

The right hand gesture  is a question mark.

Picking the easiest gestures to match the most common characters and tasks still leaves plenty of gestures for commands and shorthand phrases.

A gesture like this  is "Copy".

A gesture like this  is "Paste".

A gesture like this is "the".

A gesture like this  is "therefore".

This system of bimanual gesture text input has many benefits. In particular, the 8-3 pattern, eight ways of leaving and three ways of returning, has several benefits based on some of the fundamental principles of text input.

The gesture is round trip in that the user needs to return to the "home position" to complete the gesture. This ensures the user always starts from the same position for each character. It also ensures that the user does not have to lift their thumbs from the device or pause between characters.

The system removes problems with targeting, homing and impact-based typing by replacing the key with a two-handed round-trip gesture. Targeting is reduced to motions that only need to be accurate to within a 45-degree range and, because the gestures are round trip, there is no physical impact involved.

Home Position

An analysis of the workflow suggests that one of the major components of text entry is the "home" position. With soft keyboards, this has been eliminated since there is no home position that the user can feel. The users are forced to hover above a graphical representation of a keyboard and visually target the keys thereby increasing the distance to a key and the time of a keystroke. In the terminology of traditional typing "homing" is the return of the hands to a neutral position on the home row with the index fingers on the f and j keys. A bimanual gesture based text entry method simplifies the homing task by integrating a detection of the neutral position into the gesture recognition. The home position can be adjusted automatically as the user gestures. Bimanual gesture based text input is ideally suited to reduce this distance, create automatic homing and eliminate the need for visual targeting.

Round Trip Gestures

A typist predominantly uses a round trip keystroke by extending to the target and returning to the home position.

Edgewrite and Graffiti are two stylus based text entry methods that are both single point inputs. One of the drawbacks of these two input methods are the pauses caused by the between character homing. The stylus is lifted between characters thereby creating a home position for the stylus that is hovering above the input surface. Other text input methods such as Quikwrite use a continuous gesture without pauses. The maximum theoretical typing speed of any text input system must account for the between gesture pauses and the return to a resting position [21]. The limitations of Edgewrite and Graffiti are that they are incomplete without a return to the home position.

The 8-3 pattern of bimanual gesture based text input is designed to be round trip so that the characters can be entered in a continuous stream of gestures without pauses. The form of the gesture as a departure and a return ensures that the user ends up back at the neutral home position ready to begin a new gesture and enter another character.

Text input speed benefit are apparent in systems which have the smallest transitions between individual characters. [8] This is the reasoning behind the design of the 8-3 gestures. It is completed when the home position is returned to so that neither a dwell time nor a stylus up is needed to confirm that a gesture is complete.

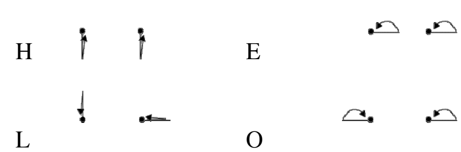
Follow along scenario

If you would like to try a follow along find a couple of spare mice not attached to a computer or even some paperweights. Lets start with inputting "hello". It can be described or illustrated. Depending on your learning style one may be better suited than the other but, more importantly, the description will help visually impaired users.

Described

Holding the two mice in a neutral position move both south or towards you then back to the home position, this generates an "h". Now move both to the right but instead of returning directly to the home position return to the home position by curving both in a counter clockwise direction, this generates an "e". Now move the left mouse north or away from you while moving the right mouse to the right and then return straight back to the home position, this generates an "l". Repeat this gesture again and then move both mice away from each other, the left mouse to the left and the right mouse to the right. Now instead of returning directly to the home position return to the home position by curving both towards the north as you return to the neutral position. This means that the left mouse curves in a clockwise direction while the right mouse curves in a counter clockwise direction, this generates an "o".

Visually



Transference

Now pick up an object that is smart phone sized and, without going back to the text above, try to remember the gestures for "hello" but use your thumbs to perform the gestures. Note how the gestures are easily transferred from one muscle group to another.

After performing this basic text, try transferring the gesture knowledge to different configurations. You have been using two mice and then your thumbs to do the above gestures, try it with a "track pad" by using your index fingers on a table surface to perform the same gestures. This ability to transfer knowledge from one environment to another can allow a user to enter text on one device and easily transfer that knowledge to other devices and configurations. This transference is a focus of ongoing research.

Eyes free

Try the gestures in those three configurations with your eyes closed or while looking away from the surface on which the gestures are being made.

The difficulties that disabled users have with visually dependent soft-keyboards [24] highlights the visual attention that is needed to maintain typing speeds on smart phones.

Peoples ability to target the eight directions while leaving the home position and still return to an approximate home position, even with the eyes closed, emphasizes how the home position is a key aspect of the design of this system. The nature of the gestures ensures that the home position is an easy to achieve aspect of entering text with this 8-3 pattern. Gradual migration, variations in the size of the home position and other calibration issues are accommodated for by the software.

The kinesthetic sense that accompanies two-handed movements has been shown to be useful even when visual cues are removed. [2] In essence, people still know where their hands are even if they cannot see them or cursor representations of them. Two-handed input has been studied with several different interaction techniques showing benefits for certain types of tasks. [19]

Visual Help

This system encourages "touch typing" by reducing the visual dependence of targeting but it still allows for visual targeting with use of a help system. An additional benefit of the 8-3 pattern is that it is divided into two parts, the departure and the return. Help can be then be triggered by initiating the first part of the gesture. By moving the pointers out from the central home position and not returning, the help display appears. The user can then browse a visual display of the gestures by rotating the pointers around the home positions.

Key Mapping

The gestures and letters described in the "hello" follow along exercise are associated using the form and shape characteristics of the letters as a mnemonic. The gesture for the "l" looks like a large "L" with the vertical component created by the left hand and the base by the right hand while the gesture for the "e" looks like the top section of the "e" by the nature of the curve created by both hands. This mapping is only one of many that are possible.

A mapping of gesture to letter can match the quickest gestures with the most common letters. Some forms of mapping can optimize to be more easily learned while others can optimize for speed and efficiency.

The assignment of a gesture to a particular letter, word, action or symbol can be optimized on a per language and situation basis. On a traditional typewriter, the QWERTY keyboard layout is changed to the AZERTY layout for the French language based on letter prevalence in the language. The same principle applies to swapping letters to optimize the gesture speed in an 8-3 pattern. Swapping is easy from a software perspective but will require further study to determine the appropriate optimizations.

Sociability and Notation

One of the benefits of this system is that it is easy to explain. For the system to be accepted and adopted by a group the typical person should be able to explain it to another person. The benefits of this gesture combination are that the gestures are simple and can be easily explained as "8 ways of leaving and 3 ways of returning". The gestures are easily drawn and so can be noted and illustrated with ease.

The ability for the gestures to be easily noted is another benefit. There are only three primary shapes needed to draw the basic motions.

These three forms illustrate the departure and the three ways of returning to the neutral home position. Illustrating a gesture involves drawing a pair of these forms in the appropriate angles. This is shown in documentation form such as the examples given.

This gesture is an "&".

More importantly, these can be easily drawn on note pads. The simplicity of these notations allows a user to easily draw them. This is related to the sociability of the system. It can be easily explained but just as importantly it can be easily drawn.

Visually impaired users can use the notation forms of the compass directions; N, S, E, W, NW, NE, SW, SE, and the short forms of; CC, CW and SB, to indicate clockwise, counter clockwise and straight back. An ampersand would be noted in abbreviated form as: & (E, CW: S, CC).

Game Learning

A simple game can be used to learn the gesture system. Two “arenas” are presented to the user with eight targets around the edges and a plain steel marble in the center of each. When the targets highlight, the player moves both pointing devices at the same time to hit the targets. Once the targets are hit, a barrier rises up and prevents the user from taking two of the three paths to return to the center of the ring. When the center is returned to, the barrier falls and the next set of targets light up.

As the user advances through levels of the game, the marble would improve by turning to different elements and becoming polished. Between the arenas, the points a player has gained for speed are shown. As well, the gesture needed to complete the challenge is shown and the corresponding character. As the user advances through the levels, a stack is shown so that the user knows which gestures and characters are coming next. At very advanced levels, the gesture notations are shrunk smaller and smaller until only the stack of characters remains so that the user must match the character to the corresponding gesture.

Although a simplistic game, the ease with which a target-based action game can be used to facilitate gesture learning will help in reducing the learning curve even more.

Set Up

For this brief description, a traditional computer will be used as an example. Two mice are attached and, in a preferences dialog, assigned to a position of either left or right. The user holds the mice in any position they feel is comfortable. This is called the “home position”. The system asks the user to calibrate by moving the pointers in a specific set of patterns until the system recognizes the scale of the user’s movements.

Gesture permutations

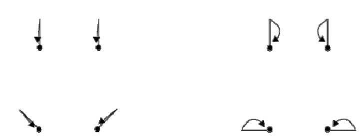
Combining the eight directions of the departing component of the gesture and the three curvature aspects of the returning gesture result in 24 primary gestures. Using one-handed gestures with either hand allows for 48 gestures. If the two hands are used simultaneously to perform combinations of the 24 primary gestures, 576 two-handed gesture combinations are added to the 48 basic single-handed gestures bringing the total to 624 gestures.

These include gestures where one hand is returning in a straight path while the other is returning in a curved path. These gestures are reminiscent of the childhood playground challenge of rubbing your belly and patting your head. When only identical return path gestures are paired then the combinations are reduced to 192 but some gestures that combine a counter clockwise movement on one hand with a clockwise movement on the other hand are intuitively easy and so an additional 128 are plausible. This allows for 368 plausible one and two-handed gestures of which the simplest to perform can be assigned to the most common actions, characters, symbols or words. Even this trimmed inventory of gestures can be selectively reduced to include the most easily produced gestures.

The combinations and patterns possible with a large set of gestures can accommodate character set languages such as Japanese and Chinese.

Gesture Dexterity

There are 624 gestures in the 8-3 pattern, of which several hundred are difficult, asymmetric and meaningless to the everyday world. This is in contrast to the pairs below and so many more like them that are symmetrical in nature, cooperative, kinesthetically pleasing and associated to natural actions in our everyday environment.



These bimanual motions are the type that Leganchuk et al noted were part of our everyday environment and so fit better when chunking them into cognitive subtasks. [15]

Stylus Dexterity

Stylus based gestures such as Graffiti were designed for input systems where a user is holding the device in one hand and interacting with the interface via a stylus or finger tip. The Qwerty keyboard phones and other smart phones with Qwerty based soft keyboards elicit a cradling interaction where both hands are used to hold the device leaving the thumbs free to interact with text entry. Even though this type of interaction is more constrained for movement, [24] there is a benefit to using both thumbs to enter text.

The concept of simplifying the gestures to very short round trip gestures works well with cradling the device. The gestures designed for stylus input such as Graffiti are too complex for thumb-based input where gesture dexterity is limited. As well, the large gestures required by such input techniques as Shark [14] would be difficult with a cradled interaction. A large device, such as a tablet or pad, where the user may be holding the device with two hands limits the movement of the thumbs. For these situations, the simplified thumb input of the 8-3 pattern works well.

Although Yatani and Truong examined a bimanual method of input focused on adding the left thumb as an input, the system still integrated a stylus. [26] The thumb of the left hand added some components of the gesture input and aided in cradling the device while the right entered the majority of the combinatorial input but was not helping in cradling the device.

Switching the interaction techniques from stylus to touch as with the newer smart phones, the users cradle the device with both hands. This reduces the dexterity of the input of the dominant hand from the full sweeping gestures available using a stylus input to the more constrained thumb based input. This transition also increases the dexterity of the non-dominate thumb because it is no longer performing the full duty of cradling the device as it is now only taking half the load being shared between the two hands.

Single Desktop Input

When entering text, time efficiencies can be found in examining the home position and reducing the time and distance to it. When entering text in a continuous stream the hands are kept on the keyboard but when editing or interacting with other command tools there is a time delay between moving the hands from the keyboard to the mouse. The ability to enter text and initiate hot keys or modifier keys without transferring the hands to another device would eliminate this transition time.

Pointing

When using a computer the user will want to return the right mouse to a pointing mode or, as the case may be, the left mouse. A reserved gesture, currently moving the mice towards each other, triggers a mode change. This separates the usage of the pointers on a computer into the two modes of pointing and texting. When the mode is “pointing” the right mouse can then be used as usual to point and click while the left mouse can be used to enter commands and activate other modifier keys using one-handed gestures. When in “pointing” mode, another reserved gesture, moving the left mouse towards the right mouse, would return both mice to a text entry mode.

When in “pointing” mode, users with carpal tunnel or mobility impairments can even use the left mouse to indicate clicks, right clicks and double clicks with simple gestures.

On a smart phone, these modes would not exist since the usage pattern is for a soft keyboard to appear when text is to be entered. A dedicated region would be used to detect the gestured text entry, as would a similar interface on a shared interactive table.

Adding two mice for text entry would bring down the barrier for other forms of two-handed interaction. The texting mode uses both mice to interpret gestures and the cursor remains inactive. The pointing mode uses the dominant mouse to point with the cursor and the non-dominant mouse is used to enter modifier keys. Other modes can be added to facilitate the use of two cursors for object manipulations. Many of the forms of two-handed interaction studied by Buxton et al. [19] such as marking menus, stretchable shapes. Adding two mice to a computer to enter text will bring to a wider audience all of the benefits noted in two handed interaction techniques. Reducing the workload on the dominant hand and increasing parallelism in tasks will all be easier to integrate into a system.

Calibration

A key feature of this system is that it can be customized to accommodate different ranges of motion by calibrating it to recognize large or small gestures. This allows a person to use their wrist and finger flexion to move the mouse in small gestures while other people would use their upper and lower arm for larger motions. This will depend on the user and their needs or preferences and is also associated to different levels of disability.

For example, differences are noted in gestures made by people with hand damage or amputations. A person with no hands will use large muscle groups such as the upper arms to make large sweeping gestures. Another user may make only slight movements by using only the finger.

The system can be calibrated to detect millimeter-sized gestures from the fingertips on a pair of touch pads attached to a computer. This calibration is useful for mobility impairments that leave only slight muscle activity in the fingertips due to neural damage.

The same calibration is suited to the dexterity that is available in the thumbs when interacting with a smart phone, slate or other e-book like device.

Amputations and rheumatoid arthritis tend to limit the text input speed of some users. This system can assist people with limited ranges of motion due to partial paralysis and can assist with amputees who are missing fingers or even entire limbs. Specific situations will require modifications of off-the-shelf components for extreme cases but typical forms of carpal tunnel or amputation could be addressed with standard components available today.

Device Compatibility

This product does not depend on any new advanced physical technology. At a rudimentary level, it reconfigures existing technology, and uses a method of input that is software driven. This method of text entry can be adapted to many devices. Existing computers with specialized drivers and the appropriate software can operate with two mice plugged in. The existing base of installed computers could be retrofit to use this method of text input mitigating any large hardware costs to disabled users.

Repetitive Strain Injury

For users that have difficulty with impact based typing this system may be an alternative. This product can assist carpel tunnel sufferers by eliminating the need for impact based character input.

Further research into extended use and the physiological differences in gesture input would need to be studied to determine if RSI would be avoided or merely relocated.

Corpus Collosum

Users with damage to the Corpus Collosum may not benefit from this system of text entry. [22, 16, 5] People with difficulties performing bimanual tasks such as people with Multiple Sclerosis may have difficulty timing the actions of both hands concurrently. Usage of the system described will depend on the extent of damage to the Corpus Collosum. If these timing issues are within detectable patterns, software may be able to detect, accommodate and correct for these variations. Further research would need to be done to confirm if this is feasible.

Fitts Law

The automated homing and scaling of the gestures to the user range of motion creates a Fitts' Law benefit. The change in direction between the departing and returning motions becomes the target. This is similar to the same benefits that are apparent in the Edgewrite text entry system and the Macintosh top-of-window menu system where "target over shoot" no longer effects accuracy. The exemplary paper by Jacob and Brad [24] and the analysis of diagonal crossing [1, 2] are very applicable as a method of analysis for the 8-3 pattern of gesture based text entry.

Kinematic Chain Theory

From Guiards characterizations of interaction and the Kinematic Chain theory, bimanual techniques fall into two classes [9, 7] symmetric and asymmetric. While performing asymmetric tasks, such as archery, guitar, drawing and writing, the non-dominant hand aids in the context of the task by helping with aim, chording or maintaining the angle the page. While performing symmetric tasks, such as piano, flute, skipping rope, folding linens and typing, the non-dominant hand participates equally in the task. [18, 19] It is assumed that the 8-3 pattern of gesture based text entry resides in the symmetric bimanual class of techniques.

The division of labour between the hands that Leganchuk et al studied looked at the nature of some bimanual tasks. [15] Some tasks fit into easy categories between asymmetric and symmetric but other tasks should be looked at in terms that are more granular. Some tasks can be described as symmetrical when both hands are doing the same thing but a timing action may be complicating the analysis. Traditional typing is a serial assembly task where the hands must cooperatively take turns assembling a word, letter by letter. The key in timing is to not press two keys at the same time. When using a stenotype or other chorded keyboard the opposite is true and the typist needs to press two keys at the same time. Bimanual gesture text input is a cooperative symmetrical task more akin to tying a knot. Both hands are acting in unison, timing movements together in a similar manner so that actions are coordinated in time and space.

Further Research

A fully refined proof of concept is being pushed forward as funds allow and further research is being planned into specific areas.

Market Opportunity

Several segmented markets exist for this product: medical, translation, industrial and mobile.

The medical market is targeted with this product as an assistive device for specific disabilities.

The translation market is targeted by the ability of the product to switch languages through software without incurring additional manufacturing costs. This text entry method enables manufactures to sell the same laptop in India, China, Japan and Europe without constraining it with any physical keyboard. This can also be a specialized niche product for rare indigenous languages where a mass manufactured keyboard is prohibitively expensive. This capacity allows for single physical device manufacture for a global market with no reconfiguration of hardware for language specific regions.

The industrial market is also a potential niche since a person in a HAZMAT, space or hard shell scuba suit will have constrained ranges of motion with difficulty targeting, gripping and clicking. Although these environments will require modifications to off-the-shelf components to account for moisture, pressure, resilience and chemical variations in the environment the same underlying technology can be utilized to allow for text entry in these environments.

The mobile market is targeted both for speed of text entry but also for the same reasoning as the translation market and the ease with which to change the character set.

This system is targeted at institutions that deal with multiculturalism and the disabled. Institutions tasked with the need for multiple translation steps between languages as well as institutions that support people with disabilities.

Market Segmentation

The segmentation of the market depends on the text entry speed achieved with the product. If the product is a success and the text entry speeds in a large public test population are an improvement over the Blackberry or iPhone then the target will be smart phones, internationalized laptops and other handheld devices. If text entry speeds end up being lower then the target will be people with minor dexterity restrictions such as carpal tunnel syndrome. The fundamental premise of the product will allow text entry with even slight movement; therefore, key target regardless of text entry speeds will be specific physical disabilities such as m or limb amputation.

Switching Costs

This new text entry method works on any platform with common off the shelf components. Mice, track balls or touch pads. The cost for a license to install the gesture recognition software and purchase a second mouse could easily be in the range of an off the shelf keyboard. This would still be much less than a specialized ergonomic keyboard.

Speed

The importance of the speed of text input may not be the driving factor in most systems [8]. Chorded keyboards, the Dvorak layout and other methods for increasing text entry speed have not been successful in replacing the traditional keyboard. These physical hardware changes have found niche uses in certain markets. Speed may be important but flexibility in usage patterns has prevalence. Soft keyboards can accommodate single-handed input, which is also the case on traditional keyboards. The apparentness of a visual layout and the click-it-to-get-it immediacy of hard and soft keyboards is a hard convenience factor to overcome. In these cases, the emphasis should be that touch-typing is learned skill and people invest time so that they become more proficient with a payoff reward of in the future. Bimanual text input with an 8-3 pattern is the same type of investment with future payoff. Increased text input speed in small devices and other touch input devices is the motivating factor to switch.

Competition

Specialized RSI keyboards are $500 - $1000 per unit retail and chorded keyboards such as the Datahand start at $500. The Orbi-Touch starts at $399 and is hardware specific and there are one handed chorded keyboards that are $150. Systems that accept text based on stylus such as ShapeWriter or Graffiti tend to be device and language specific. Other strategies such as Speech to Text are not private. There are extremely expensive solutions such as the Sign Language Glove and NASA’s sweatband muscle movement sensing keyboard. All of these solutions require device specific solutions which this text entry system overcomes by being device agnostic.

Market Potential

The niche markets of RSI sufferers are estimated to be 2 million nationally and nearly 200 million worldwide while the specialized market of indigenous languages is currently untapped. In addition, the general translation market and industrial environments would add to this. In Canada alone, there are 200,000 with an indigenous language as their mother tongue. A penetration into mobile or desktop markets would result in a much larger market potential.

Intellectual Property

An initial Canadian patent application was filed September12th, 2008 at the Canadian Intellectual Property Office, Application Number: 2,639,611 and a Patent Cooperation Treaty application was submitted on September 11th, 2009 this has been published according to the treaty on or around March 12th, 2010. No competing patents of note have been laid open that resemble the current text entry system.

Background

When typing, a user must maintain either of two modes; one based on visual feedback the other on tactile feedback. The visual mode is used by typists who depend on being able to see the keys to target them. The tactile mode depends on touch and the typist makes use of a "home position" which is often indicated by small bumps on the f and j keys. Of the methods of entering text, touch-typing is the most dominate. With the expanding use of touch screen smart phones, on screen soft keyboards have increased in prevalence. This changes the mode that people use when typing for the past 100 years. Small physical keyboards for telephones are a small incremental change that has a large effect on typing speed. The use of thumb only typing is only slightly different from the hunt and peck index finger typists. Small physical keyboards changed the appendage used to enter text but still allow for the detection of errors and corresponding corrections that the sensitive ends of the fingers can feel.

Soft keyboards are motivated by a reduction of hardware costs, the flexibility of the language character set and an increase in screen size for non text-entry tasks. The elimination of tactile feedback of the key shapes eliminated the typist's ability to feel the targets.

Malik and Laszlo pointed out how, when a user can no longer feel the keys on a soft keyboard, the absence of the feeling of the edge of the keys interferes with the ability to target them. [17]

Replacements such as a full screen key-down sensation available on some devices only add to the input and feedback of key completion but not the sensation of a target. The sense of the shape of the keys that allows the typist to know if they are between keys or on a key has been lost. This lack of feedback emphasizes and exaggerates the compensation that begins with hunt and peck typists on full sized keyboards. The typist looks at the keyboard and uses sight to target the keys.

Touch typists or thumb typists that use tactile feedback position their fingers as close to the keyboard as possible. This last strategy reduces the distance to target and correspondingly increases typing speed based on the formula by Fitts. A touch typist uses memory and a positional reference frame to eliminate the need to visually target keys. When miniature keyboards were added to a cell phones touch typists changed to accommodate the new configuration of thumbs and tiny keys. Some hover above the keyboard and like the rapid hunt and peck typist they can use the memory of key positions. Some typists will move rapidly across the surface of the keys using tactile feedback to reinforce positional information and help in targeting but when a soft keyboard replaces the small physical keyboard, this last tactile targeting assistance is lost. The mobile soft keyboard typist must emphasize visual targeting to confirm that they are moving towards the correct key and to look at the result to confirm that they had hit the key they were targeting. A home row can still be hypothesized as the position hovering above the soft keyboard but the same home row position of the thumbs on the tactile raised surface of a mobile miniature QWERTY keyboards is lost. This has slowed the speed of text entry and has resulted in a growth of tricks and auto completion that attempts to giveback to users the speed has been lost.

Comparison of Relevant Technologies

There are several text entry techniques available that are summarized here and the benefits and shortcomings of each are examined. They roughly group into bimanual systems that use positional combinations and single input stylus systems. Single point stylus input systems use more complicated gestures to create the required breadth of gestures to encompass a text entry system. The combinatorial systems tend to be limited to positional systems that do not make use of gestures since most of them originate with joysticks and the gaming industry.

Graffiti

Graffiti is a stylus-based text entry system developed for the Palm OS. This system is the most commercially successful of the stylus based text input methods. The Graffiti system was designed reduce the complexity of printed characters to speed the recognition of text input.

Unistroke

Unistroke is a stylus-based input that uses a single stroke for each letter. By eliminating the stylus lift within a character, it is theoretically faster to enter text than Graffiti, although it still requires a pen up and pen down between letters. Litigation occurred between Xerox and Palm regarding patent conflicts between Graffiti and Unistroke.

Edgewrite

Edgewrite adds a corner emphasis to Unistroke making it easier for disabled users. The targeted user group was the disabled to facilitate text input to a Palm Pilot. A physical square punch-out was placed over the text area to limit the overshoot of the users.

Quikwrite

Quikwriting [20] uses a 9-quadrant grid with the distinction of transiting the grid squares to increase the number of characters available. The Quikwrite method has the benefit of a continuous gesture with a home position but the gestures are single point of input and so limited to the 32 base character limit forcing the use of modes to generate less common characters.

OrbiTouch

OrbiTouch is a physical combinatorial keyboard that uses the eight cardinal directions to enter text into a computer. The two large physical joysticks and constrained movement allows for use by people with limited motor control as it eliminates over-shoot issues.

TwoStick and ItoNe

Both TwoStick [13] and ItoNe [12] are soft combinatorial keyboards using joysticks. ItoNe uses a layout maximized for Japanese character input.

UniGest

UniGest is a gesture text input for positional devices centered on the Wii.

Dasher

Uses a predictive text method where the letters and then words appear as options that a user can navigate towards with a cursor or other pointing device. The user points at different options that appear in a zooming interface.

Shapewriter

Shapewriter or SHARK is a technique where a soft keyboard is displayed and used in the traditional manner of taping the keys to type. [14, 27] The benefit of Shark is based on shorthand notation for common words. A common word such as "the" can be gestured by placing the finger down on the keyboard and "connecting the dots" through each of the letters of the word. The keyboard can be laid out in either the traditional Qwerty layout or a Shark optimized layout.

Marking Menus

Marking menus are the idea of radial cascading menus. These menus can be visually opened or the gesture of the selection made without visually displaying the menu. A pen up occurs between gesture commands.

Octopocus

Octopocus [4] is a help system triggered by the component of the stroke and the options available. This help system can accelerate learning of some types of gesture systems.

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