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A Novel On-Screen Keyboard for Hierarchical Navigation with Reduced Number of Key Strokes

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***Abstract*— This paper discusses about on-screen keyboard with hierarchical character or symbol organization which are operated by an accompanying remote control to allow navigation with reduced number of key strokes and enhanced user experience for using convergent services like internet browsing, short message service (SMS), Instant Messaging (IM) on devices like TV or Set Top Box obviating the need for separate physical keyboard.**

***Keywords*— User Interfaces, Keyboards, TV, Set Top Box**

I. INTRODUCTION

The world is witnessing phenomenal convergence in terms of content, access technology and access device. Several categories of contents like voice, data and multimedia content can be converged on and accessed on the same device. Content from multiple applications including voice call, video call, television program, Internet, video conference, short message service and instant message can be accessed using a single access device which can be desktop computer, laptop computer, mobile phone, PDA, Television, Set Top Box or any suitable device.

As Television is widely available in many homes, it is worthwhile to use it as the display device to bring this vast range of converged services and applications cost-effectively to vast population of humanity. It will be cost-effective because users do not have to buy another device for access. Television screens are usually bigger than some of the access device screens and this makes it ideally suitable for accessing large range of applications and content.

However it has been a challenge to provide cost-effective and easy-to-use keyboard for accessing services like Internet and short message services from Television. This arises mainly from the fact that TV viewing is normally done at distance. A full-fledged separate wireless keyboard adds up to the cost. A cheaper option is infra-red remotes with on-screen keyboard on TV screen. However the available on-screen keyboards require a large number of keystrokes to navigate which makes it cumbersome to use.

Thus to overcome this problem, the current paper elaborates a framework for an on-screen keyboard which allows user to navigate to and select characters with reduced number of key-strokes required for navigation.

II. NATURAL USER EXPERIENCE

The main purpose of this paper is to describe a mechanism to provide very good user experience at a very low cost while using the following services on TV using a Set Top Box or similar devices.

-- Browse information over the internet.

-- Collaborate/virtually connect over the IP network using IM or SMS

-- Communicating via email

The people who use the above mentioned services over the TV may not have previous exposure to computer and keyboard. So the interface or mechanism to use the services should not be complicated, daunting or intimidating. They should be presented with a familiar and encouraging interface to interact with the services on their TV. People use remote controls naturally when using their TV. So the ability to use the remote control to use a whole new lot of services keeps user in natural, familiar and comfortable frame while at the same time allows them to benefit and enjoy these new breed of convergent services.

Along with being natural and intuitive, the interaction mechanism should allow user to accomplish their desired task easily and quickly, rather than spending too much time dealing with the interface mechanism. To achieve this goal, the current authors propose a novel organization of characters and symbols for the on-screen keyboard based on mathematical foundation, which can be operated by a specially designed remote control to significantly reduce the number of key strokes while typing during use of the services. Thus it allows users to access and enjoy the services with less effort and in less time.

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III. System Overview

To achieve the stated goals, a system is proposed where an on-screen keyboard is displayed on the monitor of a Television, Computer or similar device and is operated by a remote control (Figure 2) which has among other things 9 keys for performing navigation and selection of character or symbols. The character set is organized in blocks with each block containing up to a maximum of 4 characters (Figure 1). Characters are organized into character-blocks according to a mathematical formulation. Hierarchical navigation and selection method is used across and within the specially organized character blocks in such a way as to reduce the number of key-strokes required for navigation and selection. Round robin navigation is used across each row and columns of the specially organized character-blocks to reduce the number of key-strokes further in some special cases. To reduce the typing effort even further, certain commonly used character sequence in a particular domain like "www." or ".com" is placed together in place of a single character, so that selecting the sequence will type the whole sequence.

The characters in the on-screen is organized into blocks of up to 4 characters or symbols, or character-sets in a block. However it is possible to have fewer than 4 characters, or symbols or character-sets in a key-block for providing greater prominence to some characters, or symbols or character-sets and thus better ease-of-use. The algorithm in Figure 5 describes a method for organizing a given number of characters, symbols or character-sets into an optimum number of key-blocks organized horizontally and vertically. The number of key-blocks in horizontal direction are called columns and number of key-blocks in the vertical direction is called rows.

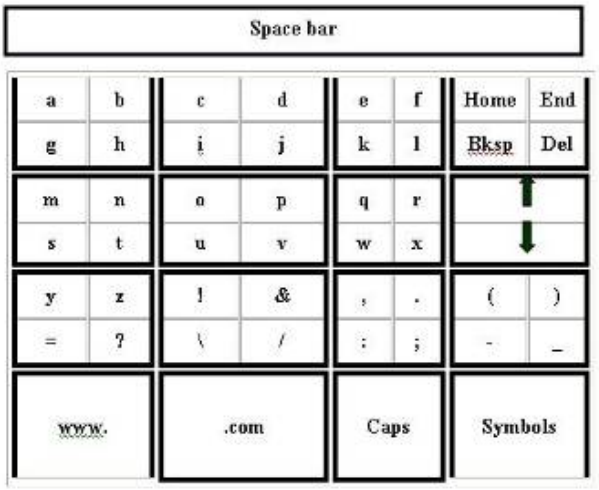


Figure 1. Lower case letters

In Figure 1, the top-left key-key block following the space bar key-block contains the characters a, b, g, h .

a	b
g	h

Each of the individual portions in a key-block is called cell. Thus the key-block above contain 4 cells and the cells contain a,b,g and h. A cell can contain a single character, a symbol or a set of characters. The character sets can be commonly used sequence in a given domain like "www" or ".com" in Internet. The advantage of this kind of character-sets is that the complete character-set can be typed with a single selection reducing the typing effort even further. Instead of typing ".com" separately using 4 characters, selecting the ".com" short-cut will achieve the same result with significantly reduced key strokes. In the above-mentioned key-block the letter a is in the up-left cell in top-left corner, the letter b is in the up-right cell in top-right corner , the letter g is in the down-left cell in bottom-left corner and the letter h is in the down-right cell in bottom-right corner.

IV. Accompanying Remote Control

The on-screen keyboard is operated by remote control and a typical representation of the keyboard is provided in Figure 2.

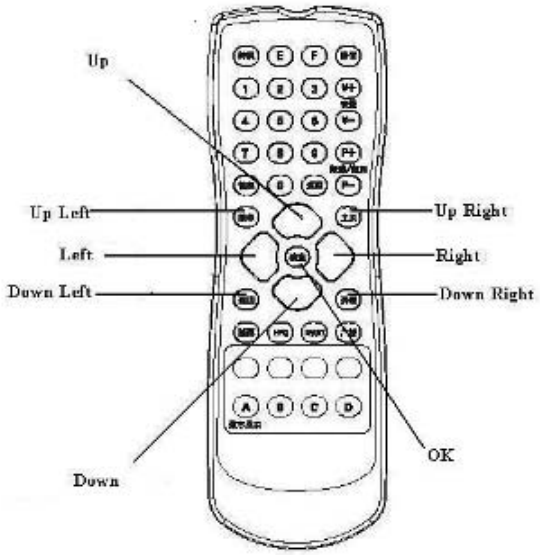


Figure 2. Accompanying Remote Control

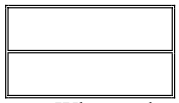
The Up, Down, Left and Right keys in the remote-control is used to move across the key-blocks in vertical and horizontal direction. As these 4 keys are used to navigate across key-blocks they are called Navigational keys.

The remote-control also has Up Left key, Up Right key, Down Left key, Down Right key and OK key. Up Left key, Up Right key, Down Left key, Down Right key are also called diagonal arrow keys. These 5 keys are used to select one of the available character, symbols or character-sets in a key-block and hence they are called selection keys.

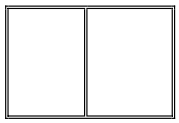
After navigating to a key-block, Up Left key can be used to select the character, symbol or character-set in the up-left cell, Up Right key can be used to select the character, symbol or character-set in the up-right cell, Down Left key can be used to select the character, symbol or character-set in the down-left cell, and Down Right key can be used to select the character, symbol or character-set in the down-right cell.

V. Value Addition to Basic Organization

A key block can have fewer than 4 cells to give prominence to and ensure greater visibility of some characters, symbols or character-sets. Some layouts of key-blocks are drawn bellow:



Where a key-blocks has only 2 cells organized vertically, either of Up Left and Up Right key can be used to select content in upper cell and either of Down Left and Down Right can be used to select content in lower cell.



Where a key-blocks has only 2 cells organized horizontally, either of Up Left and Down Left key can be used to select content in left cell and either of Up Right and Down Right can be used to select content in right cell.

When a key-block contains only one cell, any of the 5 navigational keys including OK key can be used to select its content.

A special meaning can be attached to a cell which, on selection will manifest some special behavior rather than typing the content on that cell. In representative Figure 1, the cell containing the sequence “Caps” has a special meaning in the sense that selecting it will bring forward the upper case version of the on-screen key-board with a typical representation given in Figure 3.

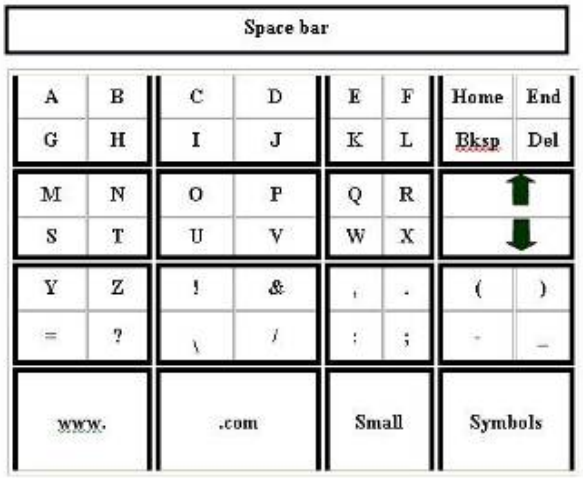


Figure 3. Upper case letters

The switching between Small letter screen, Capital letter screen, Symbol screen and any other types of screens can also be achieved through specially assigned hot keys in the remote control.

The navigation across the key-blocks is in Round Robin mode in both vertical and horizontal direction. In the vertical direction when the cursor is in the bottom-most key-block and if Down key is pressed then the cursor moves to the top-most key-block in that column. In similar manner Round Robin behavior can be observed in all direction.

A screen layout resembling the layout in Figure 1 can be used when mostly lower case English alphabets are required. In this case, when the cell containing “Caps” is selected, the keyboard containing the upper case letters appears and it allows typing in upper case. In this case, when the cell containing “Symbol” is selected, the keyboard containing some symbols appears and it allows typing symbols. A representation of screen-layout with the symbols is presented in Figure 4. Many smiley have been put as shortcuts along with normal keyboard symbols like ‘$’ and ‘#’. Thus the on-screen keyboard allows user to input both text and graphics in user-friendly way. It employs the same interface for inputting text and graphics enhancing its usability further.

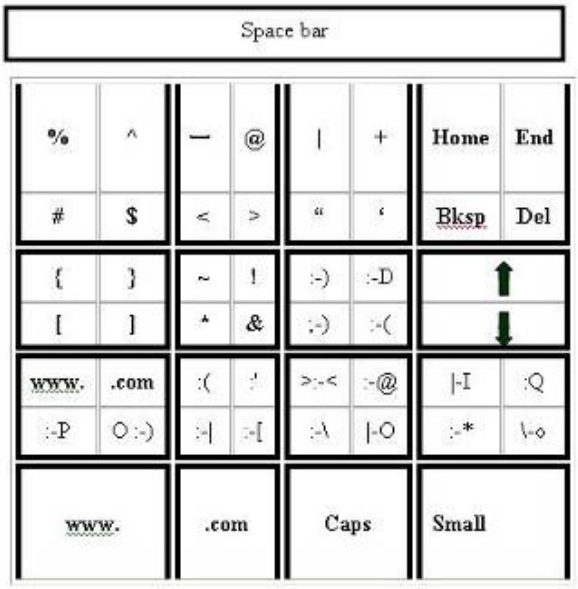


Figure 4. Symbols

Thus the on-screen keyboard framework invokes multiple screens, where each screen caters to a host of inputting options. Some keys have a constant function on each screen and some keys have variable functions on various screens. One screen showcases all the lower case alphabets and some punctuation marks. Another screen showcases upper case alphabets and the punctuation marks. Yet another screen showcases some special characters and graphic icon of popular smiley. The keys are thus encoded to produce multiple outputs.

VI. ALGORITHM

Figure 5 provides flow-chart for the algorithmic representation for organizing a given numbers of characters or symbols or character-sets optimally so that number of required keystrokes is reduced. Number of characters or symbols or character-sets or any combination of them is taken as an input for the algorithm and is represented by numChars variable in the flow chart.

This total set of numChars characters, symbols or character-set can be organized into blocks of C columns and R rows where each key-block have a maximum of 4 cells.

The algorithm determines the square number with even square root which is equal to numChars or the next square number after numChars. The reason for locating the square number with even number square root is that in each direction (vertical or horizontal) 2 cells can be placed in a key-block.

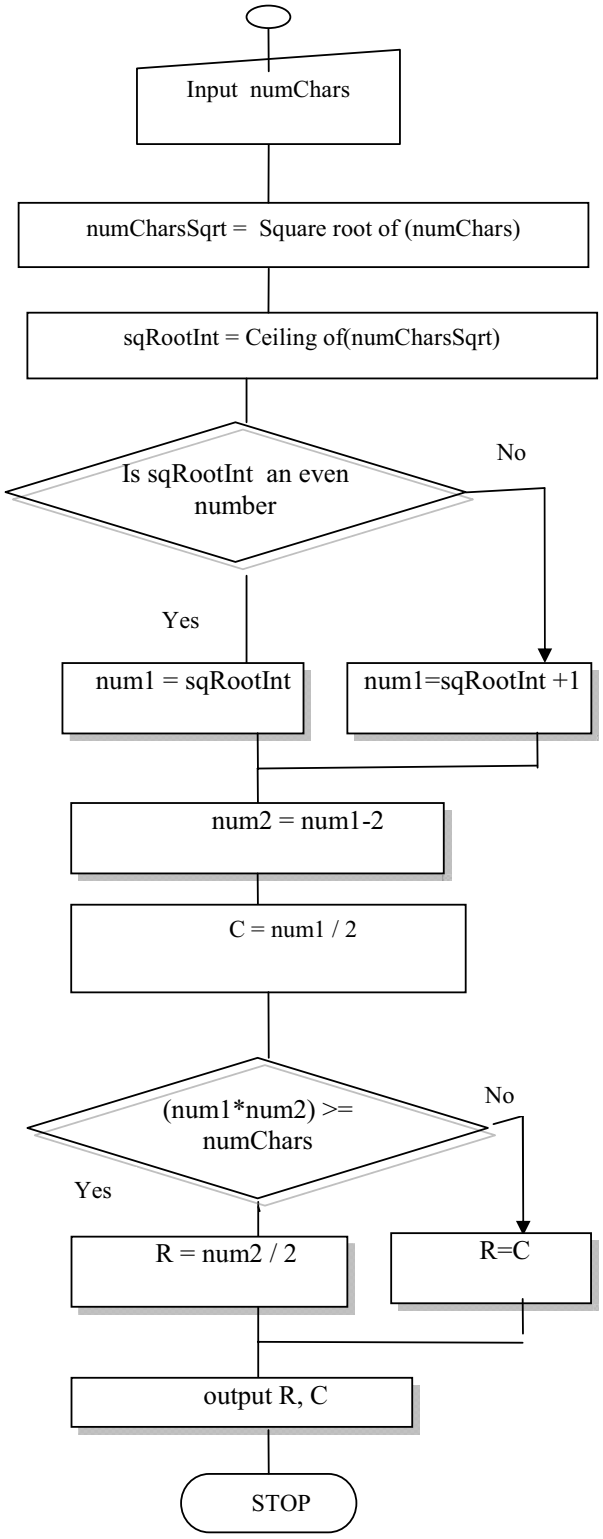


Figure 5. Algorithm Flowchart

In the flowchart in Figure 5, the variable named num1 contain the even square root number. Since square of num1 may be significantly more than numChars, there is a high probability that multiplication of num1 and its preceding even number can be more than or equal to numChars. It can be deduced from this algorithm that optimum number for columns and rows of key-block for optimal navigation can be either of (num1)/2 columns and (num1)/2 rows, or (num1)/2 columns and (num1 - 2)/2 rows or (num1 - 2)/2 columns and (num1)/2 rows.

A given number of numChars total characters can be optimally organized into R rows and C columns of key-blocks on the on-screen keyboard so that any character, symbol or character-set on the same screen will maximum be (R+C-1) keystrokes away. By making use of hot key, any character, symbol or character-set on a different screen will be maximum (R+C) key strokes way (assuming hot key press takes one key stroke). The alphabets are arranged from [a-z] in ascending order in each line for ease of search even by computer illiterate persons instead of the standard 'QWERTY' layout. Each block has 4 alphabets, and from block to block, you move using up, down, right and left arrow keys. Then using diagonal arrow keys, alphabet of interest is chosen. So for typing any alphabet, user does not have to use more than (R+C) keystrokes. This eliminates problem of traversing long distances while using QWERTY on-screen keyboard. It is trivial to prove (R+C) is minimum when the given algorithm is used to chose R and C.

Even with a non-optimal organization of columns and rows of key-blocks, quite significant amount of benefit of reduced keystrokes can be obtained in this hierarchical key organization.

VII. Smooth Integration with other Applications

In the arena of ubiquitous computing and converging service, as the seams between a display unit for use with a processing unit, a television, an internet access mechanism, an internet interaction mechanism all begin to vanish, integrated platforms are developed which cater to the multimodal functionalities of providing all services on a single platform, thus relegating the need for different input mechanisms for different applications. The current work of the on-screen keyboard is a perfect fit in this model. The on-screen keyboard framework is seamlessly integrated with rest of the applications, those it enables or co-exist with, both in appearance and interaction style such that its use feels a natural extension of over all user interface.

Thus the current work describes a single user interface to tie a variety of applications together. This way it enables seamless blending of the available broadcast TV content with information and media content available in local storage and internet for doing value added interactive applications on TV and various other media.

While platforms for achieving, transmitting, receiving, viewing such applications on a single platform are being developed, the on-screen keyboard along with its accompanying application interface provides a universal inputting mechanism which obviates the need to be adapted to the physical construction of the platform to which it is supposed to cater. The same mechanism can also be used for providing multilingual inputs through the proposed on-screen keyboard layout.

VIII. Conclusion

This paper elaborates the mechanism for hierarchical navigation and selection of characters and symbols on an on-screen keyboard which require reduced number of key strokes. This work brings values to systems which do not have wireless mouse implementation. Even with wireless mouse, positioning the cursor on an on-screen keyboard is troublesome for computer illiterate users.

This work makes accessing services likes Internet browsing, email, SMS, IM from TV easier, and require less effort from user, thereby enhancing the user experience. It allows the use of an Infra-red remote as the input device, which definitely helps in raising the comfort zone for a non-computer-savvy user (as would be the case for a mass-adopted internet TV device in developing countries).

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