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Augmented Reality Virtual Keyboard Including Text to Speech Conversion

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ABSTRACT

Enhancing the virtual keyboard to make the differently abled people to communicate with others. This paper deals with enhancement of human interaction with the digital world and also evaluates the performance changes that occurs with different modalities. The virtual keyboard is based on menu selection with seven commands that allows to type 30 different characters and allows us to correct the errors using clear button. The performance of the proposed system was evaluated by information transfer rate (ITR) (1) at both command and application levels. The performance rate also depends on the user's experience. The Limit switch is used to allow low pulse to the circuit. The accelerometer placed in the head acts as a cursor and feeds the head movement into ATmega328 and IR eye blink sensor which is fitted to a glass and worn by a differently abled people is used to select the particular command by blinking the eye continuously for two seconds and the letter is displayed in the monitor. Templates are also included here. Visual Studio is used for displaying the output. C# is used for interfacing pc with ATmega328. The Database is managed in pc to display the performance (ITR) of the proposed system.

Keywords: Head movement, Eye blink, Graphical user interface (GUI) design, Human–computer interaction and Performance evaluation.

1. INTRODUCTION

It is possible to propose new adaptive solutions that can improve the independence of people with disabilities. Assistive technology allows differently abled people to perform essential daily tasks, which are necessary, to live, work, and communicate with family members and friends. A large number of disabilities such as patients with neuro-locomotor disabilities [8] or amyotrophic lateral sclerosis are real challenges for caregivers and assistive technology. Patients with severe speech and motor impairment, who are not able to speak nor use sign language, require specific human–computer interfaces to communicate with the world. Depending upon the type of disability, communication devices have to be customized in relation to the constraints imposed by the user, from the adaptation of existing devices (e.g. Keyboard, joystick),to the creation of advanced technologies (e.g., brain–machine interfaces in the case of locked-in patients). Disabled people using head movement and eye blink as a means for communication (e.g., for controlling a wheelchair).

This paper deals with enhancement of human interaction with the digital world and also evaluates the performance changes that occurs with different modalities. The virtual keyboard is based on menu selection with seven commands that allow us to type 30 different characters and allows us to correct the errors using clear button. An accelerometer is a device to track the position of head (left, right, up, down) and enables the person to position the pointer on a particular command. An IR Eye blink sensor is used to select the particular command by continuously closing the eye for two seconds [6]. The output of the accelerometer is fed into the Arduino MPU6050, which is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. LCD (Liquid Crystal Display) which displays the moving position of the accelerometer and its axis. C# is used to interface the Arduino board with the Visual Studio.

Microsoft Visual studio is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web apps, web services and mobile apps. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation and Windows Store. It can produce both native code and managed code.

Visual Studio includes a code editor supporting IntelliSense (the code completion component) as well as code refactoring the integrated debugger works both as a source-level debugger and a machine-level debugger. Other built-in tools include a code profiler forms a designer, and database schema designer. It accepts plug-ins that enhance the functionality at almost every level-including adding support for source control systems and adding new toolsets like editors and visual designers for domain-specific languages or toolsets for other aspects of the software development lifecycle.

C# is a modern, general-purpose, object-oriented programming language developed by Microsoft and approved by European Computer Manufacturers Association (ECMA) and International Standards Organization (ISO). C# is

designed for Common Language Infrastructure (CLI), which consists of the executable code and runtime environment that allows use of various high-level languages on different computer platforms and architectures.

The purpose of Limit switch is to enable the accelerometer to avoid unnecessary selection of commands which leads to mistyping of words. It also gives low pulse to the accelerometer.

The performance of the proposed system was evaluated by information transfer rate (ITR) at both command and application levels. The performance rate also depends on the user's experience. The performance rate is managed using a data base in PC which allows easy evaluation of the proposed system. The time taken for selecting each command is also noted.

2. BACKWARD APPROACH

A Virtual Keyboard is a software component that allows the user to enter characters. A virtual keyboard can usually be operated with multiple input devices, which may include a touch screen, an actual computer keyboard and a computer mouse.

On a desktop computer, a virtual keyboard might provide an alternative input mechanism for users with disabilities who cannot use a conventional keyboard, or for bi- or multi-lingual users who switch frequently between different character sets or alphabets, which may be confusing over time. Although hardware keyboards are available with dual keyboard layouts, the on screen keyboard provides a handy substitute while working at different stations or on laptops, which seldom come with dual layouts.

Virtual keyboards are commonly used as an on-screen input method in devices with on physical keyboard, where there is no room for one, such as a pocket computer, personal digital assistant (PDA), tablet computer or touch screen-equipped mobile phone. Text is commonly inputted either by tapping a virtual keyboard or finger-tracing. Virtual keyboards are also used as features of emulation software for systems that have a fewer buttons than a computer keyboard would have.

Virtual keyboards can be categorized by the following aspects Physical keyboards with distinct keys comprising electronically changeable displays integrated in the keypads. Virtual keyboards with touch screen keyboard layouts or sensing areas, optically projected keyboard layout or similar arrangements of "keys" or sensing areas, optically detected human hand and finger motions, Virtual keyboards to allow input from a variety of input devices, such as a computer mouse, switch or other assistive technology device. Online virtual keyboard for multiple languages that do not require OS settings change.

An optical virtual keyboard was invented and patented by IBM engineers in 2008. It optically detects and analyze human hand and finger motions and interprets them as operations on a physically non-existent input devices like a surface having painted keys. In that way it allows to emulate unlimited types of manually operated input devices such as a mouse or keyboard. All mechanical input units can be replaced by such virtual devices, optimized for a current application and for the user's physiology maintaining speed, simplicity and unambiguity of manual data input.

On the internet, various JavaScript virtual keyboards have been created, allowing users to type their own languages on foreign keyboards, particularly in internet cafes. Multi-touch screens allow the possibility to create virtual chorded keyboards for tablet computers, touchscreens, touchpads and wired gloves.

Virtual keyboards may be used in some cases to reduce the risk of keystroke logging .For example, Westpac's online banking services uses a virtual keyboard for the password entry as does Treasury Direct. It is more difficult for malware to monitor the display and mouse to obtain the data entered via the virtual keyboard, than it is to monitor real keystrokes. However it is possible, for example by recording screenshot at regular intervals or upon each mouse click. The use of an on-screen keyboard on which the user "types" with mouse clicks can increase the risk of password disclosure by shoulder surfing, because:

An observer can typically watch the screen more easily than the keyboard, and see which characters the mouse moves to. Some implementations of the on-screen keyboard may give visual feedback of the "key" clicked, e.g. by changing its colour briefly. This makes it much easier for an observer to read the data from the screen. In the worst case, the implementation may leave the focus on the most recently clicked "key" until the next virtual key is clicked, thus allowing the observer time to read each character even after the mouse starts moving to the next character .

A user may not be able to "point and click" as fast as they could type on a keyboard thus making it easier for the observer.

3. PROPOSED SYSTEM

In our system we enhance the virtual keyboard to allow differently abled people to interact with digital world. Here, we implemented the virtual keyboard using head movements and eye blink.

The present system aims at improving the communication means of disabled people further experiments will be required to evaluate the performance with patients who may benefit most from the proposed system.

It reduce the dependencies of hardware devices. It is also portable to be used at anywhere at any time. The virtual keyboard is displayed in the PC. Based on the movement of Head movements and eye blink [7] the typing of letter occurs. Special characters also included here. Templates are included and the typed or selected word is also converted into speech. Here, we also measure the performance of our system Information Transfer Rate (ITR) [1].

3.1. Block Diagram

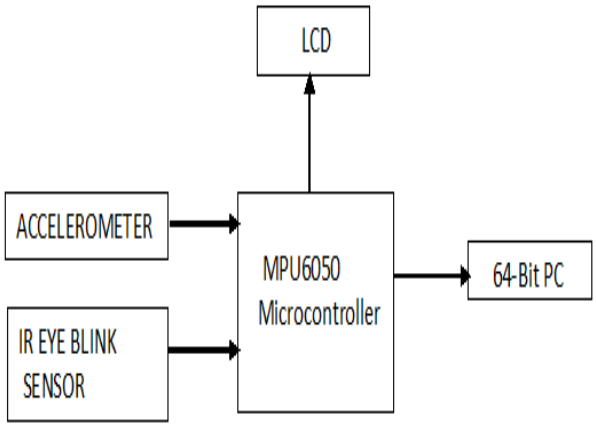

Fig 3.1 Block diagram of virtual keyboard

The IR eye blink sensor is used to monitor eye blink and accelerometer tracks the user's head movement. It sends the data to the ArduinoATmega328 which processes the data. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. It displays the accelerometer position reading.

The Code written in C# is used for interfacing Arduino ATmega328 with the PC .Based on the head movement and eye blink the result will be displayed in PC.

The accelerometer in the head is used as a pointer was continuously displayed on the screen to show the subject the current location of head. The IR eye blink sensor in the glass monitors the eye blinking if it continuously closed for 2 sec. Using the pointer particular command is selected by eye blinking. The time taken for selecting particular command is monitored for maintaining performance analysis.

Visual Studio is used as GUI (graphical user interface) [4] in PC so that the particular command is selected in the virtual keyboard in PC.

Database is managed in the PC to measure the Information transfer rate (ITR).Based on the Experience of the user the efficiency will increased.

4. SYSTEM DESIGN AND IMPLEMENTATION

The complete system can be considered as a package of comprising a limit switch, accelerometer ADXL 345, IR eye blink sensor using LM358, Arduino ATmega328, LCD display.

4.1. *Accelerometer*

The ADXL345 is a small, thin, low power, 3-axis accelerometer with high resolution (13-bit) measurement at up to=16 g. Digital output data is formatted as 16-bit twos complement and is accessible through either a SPI (3- or 4-wire) or I2C digital interface. The ADXL345 is well suited for mobile device applications. It measures the static acceleration of gravity in tilt –sensing applications, as well as dynamic acceleration resulting from motion or shock. Its high resolution (4mg/LSB) enables measurement of inclination changes less than 1.0'.Several special sensing functions are provided. Activity and inactivity sensing detect the presence or lack of motion and if the acceleration on any axis exceeds a user-set level. Tap sensing detects single and double taps.

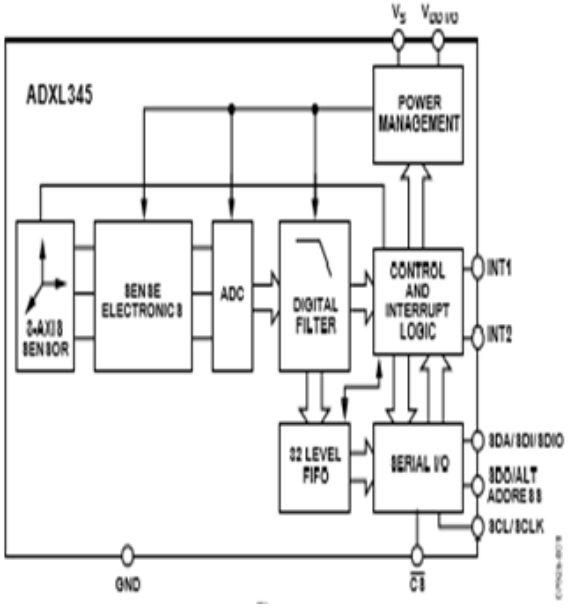

Fig4.1 Functional block diagram of Accelerometer

Free-fall sensing detects if the device is falling. These functions can be mapped to one of two interrupt output pins. An integrated, patent pending 32-level first in, first out (FIFO) buffer can be used to store data to minimize host processor intervention [3]. Low power modes enable intelligent motion-based power management with threshold sensing and active acceleration measurement at extremely low power dissipation. The ADXL345 is supplied in a small, thin, 3mm × 5mm × 1mm, 14-lead, plastic package.

4.2. IR Eye Blink Sensor

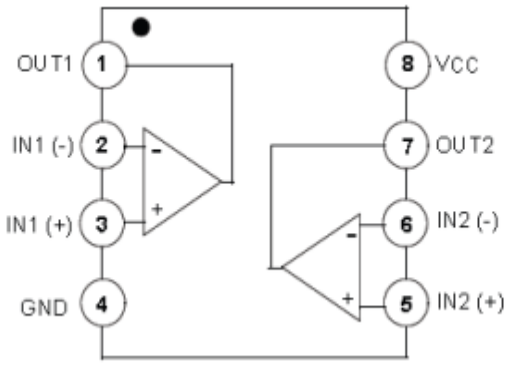

Fig 4.2 Block diagram of IR Eye blink sensor

LM358 consists of two independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltage operation from split power supply is also possible and the low power supply current drain is independent of magnitude of power supply voltage. Application area include transducer amplifier, DC gain block

and all the conventional op-amp circuits which now be easily implemented in single power supply systems.

4.3. ARDUINO

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller, simply connect it to computer with a USB scale or power it with an AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the ATmega8U2 programmed as a USB-to-serial converter.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.o will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions.

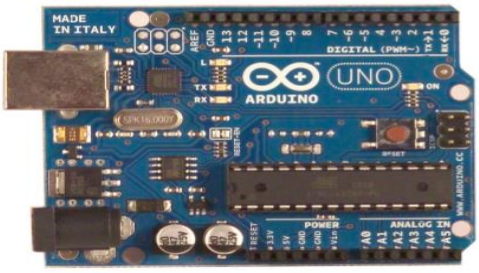

Fig 4.3 Arduino UNO board

4.4. LCD

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16×2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over segments and other multi segments LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

4.5. C#

C# is a modern, general-purpose, object-oriented programming language developed by Microsoft and approved by European Computer Manufacture Association (ECMA), International standard organization (ISO). C# is designed for Common Language Infrastructure (CLI), which consists of the executable code and runtime environment that allows use of various high-level languages on different computer platforms and architectures.

4.6. Visual Studio

Visual Studio does not support any programming languages, tool: instead, it allows the plugging of the functionality coded as a VSPackage. When installed, the functionality is available as a service. The IDE provides 3 services: SVsSolution, which provides the ability to enumerate projects and solutions; SVsUIShell, which provides windowing and UI functionality; and SVsShell, which deals with registration of VSPackages. Visual Studio uses COM to access the VSPackages. The Visual Studio SDK also includes the Managed Packaged Framework (MPF), which is a set of managed wrappers around the COM interfaces that allow the packages to be written in any CLI compliant language. The services can then be consumed for creation of other packages, which adds functionality to the Visual Studio IDE.

Like any other IDE, it includes a code editor that supports syntax highlighting and code completion using IntelliSense for variables, functions, methods, loops and LINQ queries. IntelliSense is supported for the included languages as well as for XML and for JavaScript when developing web applications. Auto complete suggestions appear in a modeless list box over the code editor window, in proximity of the editing cursor. In Visual Studio, it can be made temporarily semi-transparent to see the code obstructed by it. The code editor is used for all supported languages.

5. METHODOLOGY

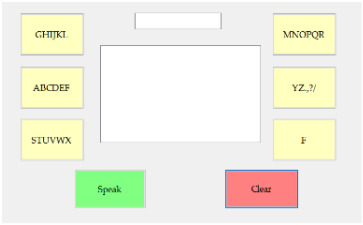

Fig 5.1 Representation of screenshot of the application with commands

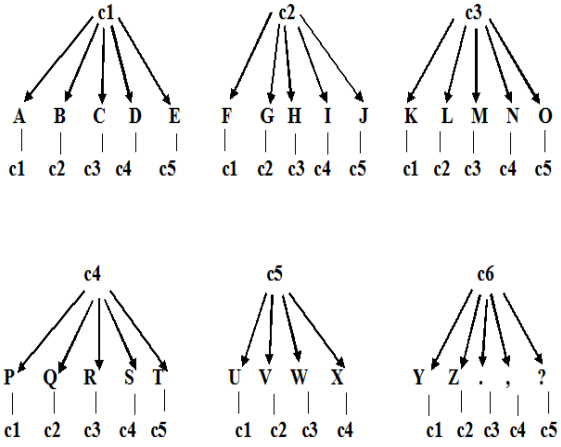

Fig 5.2 Tree structure depicting the command tags used for letter selection

The GUI of the virtual keyboard is composed of two main components: the centre of the screen where the text is displayed, and the edge of the screen where the possible commands are displayed. A screenshot of the system is depicted [1]. The virtual keyboard is based on a tree selection with eight commands (c1 to c8).

A similar principle was applied in a virtual keyboard using the detection of steady-state visual evoked potentials .The tree

has two levels. In the first level, five commands (c1 to c5) are dedicated to the selection of the letters: "ABCDE," "FGHIJ," "KLMNO," "PQRST," "UVWX", and "YZ .,?" Each of these items contains five characters.

The command c6 ("Undo") allows the user to cancel the previous action (e.g., a deleted character, a selected character). Thecommandc7 is used for word completion if the current word contains more than four characters; otherwise, the command does not produce an output. The command c8 is used to delete a character. By selecting one of the first five commands, the layout is changed: the commands c1, c2, c3, c4, and c5 contain the letters from the command in the upper level of the tree. For instance, if the user selects the first command "ABCDE," then the commands c1, c2, c3, c4, and c5, become "A," "B," "C," "D," and "E," respectively. As the user has to look at the items to select them, it may be possible to forget what is currently written in the message in the middle of the screen.

6. OUTPUT RESULT

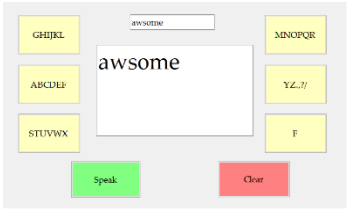

Fig 6.1 Representation of screenshot of the application with Output

6.1. Performance

FIRST BUTTON	SECOND BUTTON	TIME ELAPSED
BUTTON 1	BUTTON 5	43
BUTTON 1	BUTTON 2	18
BUTTON 1	BUTTON 1	15
BUTTON 1	BUTTON 4	28
BUTTON 3	BUTTON 1	16
BUTTON 3	BUTTON 5	22
BUTTON 4	BUTTON 3	20
BUTTON 6	BUTTON 3	30

Tab 6.1. Performance analysis table

7. CONCLUSION

The performance of the augmented reality virtual keyboard using head and eye movement has been presented. As the present system aims at improving the communication means of disabled people further experiments will be required to evaluate the performance with patients who may benefit most from the proposed system. The current application layout displays the letter from left to right, top to bottom, when a box of letters split into different boxes. Using embedded C, the project was developed.

7.1. FUTURE SCOPE

Further works will include an extended menu selection with digits to write numbers and additional items to increase the possibility of the system. Implementing 3-D keyboard using LASER Technology.

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