Hardware-software complex "Dashpoint" for learning and communication of deafblind people

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***Abstract*—This paper describes the project "Dashpoint". Dashpoint is a hardware and software system designed to make e-learning possible for the hearing and visually impaired. The system will also increase the communication capabilities for these specific types of disabled people.**

I. INTRODUCTION

E-learning is becoming more and more popular: a large number of e-learning management systems and e-learning courses have now been developed in various fields. Major vendors and universities are using e-learning within their curricula.

E-learning is widely used in many areas. However, there is a special category of people - disabled people - for whom e-learning is often the most appropriate option in many types of educational establishments and organizations. Among these people with disabilities are the visually impaired and this group occupies a special place. These people have particular learning difficulties and needs. There are many different methods used to convert training materials into an audio format. However, there is still a huge problem when attempting to train people with multiple disabilities such as deafness, especially when this is coupled with visual impairment. These people more than any others are cut off from the outside world. Normal communication is a difficulty they encounter on a daily basis and any form of training becomes a long and complicated process. Overcoming this handicap has been a major source of concern and has required a huge amount of research.

According to the British organization Sense [1] at the present time within the United Kingdom there are about 356,000 people who are both deaf and blind. According to the American Association of the Deaf-Blind [2] the number of such people in the USA is approximately 700,000. There are no such statistics available in many countries of the EU, because these countries do not consider deaf and blindness as an independent constraint. In Asian and African countries, statistics are not readily available. The statistics prove there are huge numbers of people afflicted in this way around the world. The massive problem of integrating these people into society is becoming very serious.

This project provides deaf and blind people with new opportunities. The ability to communicate with people who have similar disabilities: as well as, with people without physical limitations; whilst being allowed equal opportunities to learn. The project is based on communication and the perception and use of tactile sensations - vibration.

II. EXISTING SOLUTIONS

For teaching blind and deaf blind people there are various tools, both classical and modern. The classic tools include books in Braille and modern - Braille printers, Braille displays. However, these tools are not without their drawbacks. Braille books are expensive and typically do not contain more than 200 pages, besides the amount of information per page is much smaller than normal books. Therefore the Braille book contains relatively little information when compared to the same book written for the able bodied.

Braille printers are devices that connect to a PC. They can print Braille on plain paper. Such devices are manufactured by several companies and are quite expensive, the typical price of a Braille printer would be in the region of $ 6,000.

Also on the market are Braille displays. These are devices that use a special panel that simultaneously displays Braille characters 20-40 in one row, providing the user with limited vision and the possibility of a relatively comfortably to read text. However, such devices are very expensive; typical prices for the monitor are $ 2,000 per unit for a 20 display character and $ 5,000 per unit for a 40 display character.

The main restriction of the above devices is the expense of buying these devices, especially for the developing countries where people with visual impairment are not able to afford these devices for personal use. The high cost of Braille Monitors is largely due to the complexity of mechanical design, which includes a plurality of electric motors to the rods, forming a prominent point in the working field monitor.

The idea of using vibrations to transmit information to deaf and blind person in itself is not new, there are a few devices using vibrations. For example: application Nokia Braille Reader [3], by which the deaf and blind user can read a SMS on his Nokia mobile phone running Symbian. There is also the development by Indian engineers, as described in [4], which is a controller-glove worn on the hand. inside the controller a 'Vibro' is located on the tips of the user's fingers.

Using the 'Vibro' instead of advancing the rods to form Braille letters in the alphabet allows us to produce a much more compact and above all else, is a cheaper substitute for Braille display, which will be available to users with limited budgets.

We apply methods for transmission of information using vibration devices that are based on two types: regular joystick controller and our own controller Vibro6.

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III. METHOD FOR TRANSMISSION OF INFORMATION AND GENERAL CHARACTERISTICS OF SOLUTION

For the blind and the deaf people, the basic and most natural way to get information is to read using the Braille alphabet. Every character in this alphabet is a set of six dots arranged in 3 rows and 2 columns. Each point may or may not be convex, thus alternating convex and not convex point, enables us to encode information. Since the array of six binary symbols can take on only 64 variations, the encoding of some characters used by the control characters (similar to the escape sequences). The vast majority of blind and deaf blind people are familiar with the alphabet in Braille, so all the existing solutions for the information above is based on this alphabet. Transmission of information in our product is also based on the Braille alphabet, but Braille character encoding is not based on convex points, our alphabet is conveyed through the use of vibrations for Braille characters.

The simplest version of our proposed solution uses a common communication-feedback joystick equipped with a Vibro. This device has an output device, which uses the Braille alphabet and allows the user to input information by moving the joystick. As shown in Fig. 1, to transmit one symbol alphabet Braille using a standard joystick, six points of the symbol are transmitted simultaneously by vibration: a convex point is passed through a strong and continuous vibration. The non-convex point is passed through a weak and short vibration. The transfer is made sequentially from the top to the bottom of the first column, and then from the top to the bottom of the second column. After transmitting each symbol there will be transmitted inter-symbol pause.

The main advantage of this method of communication is its extremely low price, the cost of a controller starts from $10.

Obviously the main drawback of this approach is the low data rate making the transfer of information slower compared to a visually impaired person reading Braille. The visually impaired will take all the points of a character simultaneously and this was not possible with a controller.

To solve this problem, we've developed a special controller, which we call Vibro6, this is shown in Fig. 2 and Fig. 3. This device looks like an ordinary computer mouse, there are six vibro in three rows of two motors in series in the place where the palm of user is rests, ie, the location of the engine repeats the position of the points in the symbol alphabet Braille. Vibro is placed so that you can send Braille letters of the alphabet in parallel, which speeds up the process of transferring information from the PC to the user and allows you attain comparable data transfer speeds that provide Braille displays.

Figure 1. Serial Communications of Braille alphabet characters by using the joystick

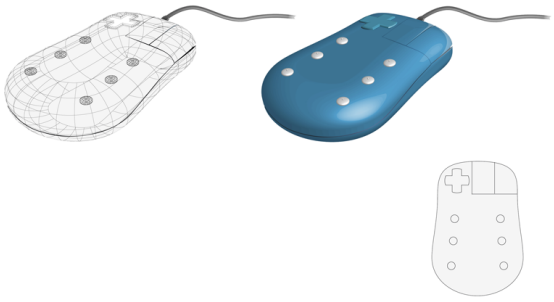

Figure 2. Project of device Vibro6

Figure 3. Vibro6 engineering sample

In addition to the output of information, Vibro6 can also be used by the user to input information. On the top of Vibro6 there is a cruciate four-way key for navigation and a button which is used for confirmation of the action. Also the controller is equipped with additional buttons (like many of today's mouse) to facilitate management of software product "Dashpoint".

Our solutions offers the following features:

-The possibility of being able to communicate with the user, using a normal joystick and a specially designed controller with a vibro attachment so that the Braille alphabet symbols are transmitted naturally and understandably

-possibility of using a mobile phone as a platform and to run the application and at the same time as a controller (currently only supported by Windows Phone 7)

-solution is an integrated environment in which for deaf/blind implemented opportunities related to training and opportunities and to communications.

IV. DASHPOINT SOFTWARE

The above-described controller Virbo6 is a support tool by which information is transmitted, the main core of "Dashpoint" is software that implements the education features, communication features and ability to expand the functionality.

Dashpoint consists of a core, which translates the symbols of the usual alphabet to the Braille alphabet and transfer of the symbols via vibrations applied to the controller. All other functions are implemented via a

separate module which we call gates. A description of the currently existing gates:

-Edu.gate implements the functionality associated with education. With this gate, deaf/blind can read literature and specially prepared training materials, and could also pass any test included in these special training materials.

-Communi.gate: allows the deaf and blind to communicate via MSN and Google Talk, enabling communication with other deaf/blind, and all other users.

-Social.gate: provides deaf/blind users with limited features while using today's popular social sites like Facebook and Twitter.

-Info.gate enables the user to receive information via popular stes like Wikipedia and RSS.

The kernel implements written by us Dashpoint API, through which the functionality of the project can be extended by third-party developers who can create new gates. However, even the existing gates at this time are enough to talk about accessibility for the deaf blind users who demand a tool for educational and communications.

Although the application is designed for use by people deprived of their sight and hearing the application has a GUI. The GUI is designed for people who can help deafblind users in the early stages of learning and how to use the application, how to pre-configure the application and monitor its correct operation in case of difficulty for the user. As with any new tool, it is inevitable to encounter problems in the early stages of use. In Fig. 4-6 shows screenshots of applications demonstrating the operation of some gates, application settings and the mobile version.

Ease of navigation depends upon the type of controller and there will be slight variations in use because of this. In the application using the Vibro6, hardware buttons are provided on the controller. Whilst still using the conventional joystick, navigation is achieved via the joystick movement and joystick buttons. Moreover, if the user's PC is equipped with touch screen or graphics tablet, the navigation is possible by means of touch on the screen/tablet. Navigation in the mobile version uses movement embedded in the Windows Phone 7 phone accelerometer and touch on the phone.

The application for the PC is written using Microsoft. NET Framework 4.0 in the language C#, GUI is implemented using WPF, xml is used to store data. The mobile application is written using Microsoft. NET Compact Framework, the application interface is implemented using Microsoft Silverlight, Microsoft SQL Server CE is used for storing data.

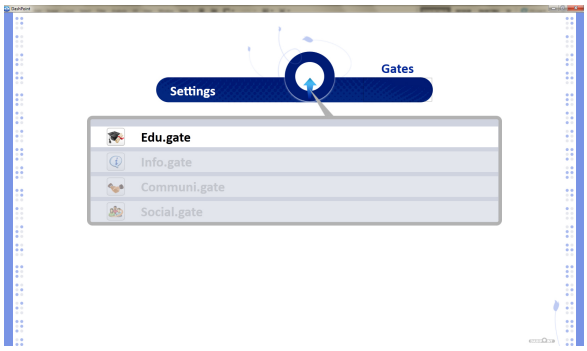

Figure 4. Dashpoint main menu screen

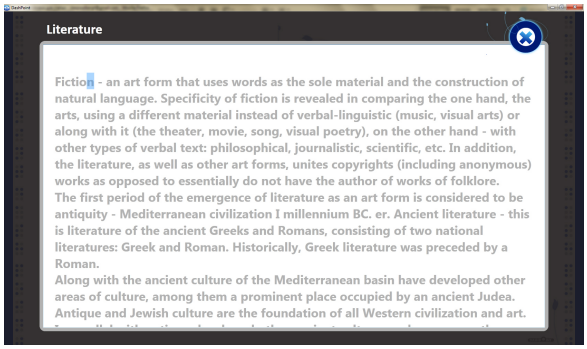

Figure 5. Reading process on PC

Figure 6. Mobile Dashpoin screenshots

Interaction with third-party developers in our project is realized on the basis of Managed Extensibility Framework. For potential developers we will provide an interface to input and output data to the device, the interface will be used to control the device and the interface will navigate within the developed module.

The interface for input and output has the following feature set: translation of a symbol to the Braille alphabet, translation of Braille symbol to vibration while receiving a user-entered character or gesture.

The interface used for controlling the device performs the following functions: a function that allows you to adjust the reading speed, a function that returns the current reading speed, a function for building a specific module setting in the program settings. Also each module has its own navigation system (menu, submenu), we provide a seamless integrated software project.

V. PLANS FOR FUTURE OF PROJECT

At the moment the project "Dashpoint" is a set of serviceable products, which includes software for the PC, software for Windows Phone 7 and controller Vibro6. We plan to continually develop the project. Over the next 6 months we plan to implement the following functions:

-support for web cameras for gesture recognition, and user input data

-server for synchronization. User is using the PC and Mobile versions they will be able to move seamlessly from one device to another while maintaining progress in learning, the history of communications in chat rooms, stories read RSS feeds, etc.

-development of game.gate, which will enable deaf blind play locally or over a network with others in chess, checkers and battleship.

-increased support of Facebook in social.gate

-expansion of the functions in social.gate and communi.gate in order to support other messaging systems and other social networks

-to develop mobile applications for other mobile platforms: Android and iPhone.

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