EYERING: THE MOTIVATION FOR VISUALLY IMPAIRED PEOPLE

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Abstract— Visually impaired people typically resort to audio feedback to access information on electronic devices like smartphones running on Android OS. However, this modality is not always an appropriate form of output. Novel approaches that allow for private and obscure interaction are hegemonic. In this paper we introduce Eyering technology which is the finger-worn device that allows using a pointing gesture. It opens up a world of possibilities for solving day-to-day problems for the visually impaired and the sighted alike. According to the World Health Organization (WHO), in 2011, there were about 60 million visually impaired people living in USA and Europe.

'EyeRing' technology is invented by Roy Shilkrot (PhD student) and another person Suranga Nanayakkara (Alumnus) who received his PhD in 2010 and BEng in 2005 from National University of Singapore (NUS).The EyeRing concept mainly based on the Pointing Gesture, Computer Vision and Text to Speech Synthesis technologies and consists Hardware (Microcontroller, Image Acquisition Module, Wireless Module) with Software (Computer vision software).A visually impaired user worn this device on index finger. A user single click the pushbutton switch on the side of EyeRing with his thumb. Instantly, snapshot of an image is taken and transferred via Bluetooth to the smartphone. The smartphone Analyze an image. After analyzing the image data, smartphone based on Android OS uses a Text-to-Speech module to read the information using Headset. Also we can give verbal command by double-clicking the pushbutton.

We conclude that EyeRing technology Motivates visually impaired people and also reduces effort and disruption to a sighted user.

Index Terms -
(Introduction,Components,Working, Applications,Future Enhancement)

I. INTRODUCTION

EyeRing is the finger-worn device that allows using a pointing gesture or touching to access digital information about objects and the world which is autonomous, wireless, and includes a single button to initiate the interaction[1,13].It opens up a world of possibilities for solving day-to-day problems for the visually impaired and the sighted alike[3]. EyeRing applications are indeed intuitive and seamless. Our first target audience would be visually impaired people (mainly in developed countries) who are keen to explore new types of Assistive devices. It addresses fundamental challenges faced by visually impaired people and helps them to fulfill their basic safety and protection needs while improving their self-esteem and self-actualization. EyeRing brings about a breakthrough in assistive technology devices for the visually impaired by using widely available technology in a much more compact, convenient form.

The EyeRing a finger -worn device consist of JPEG Camera, AVR processor, Bluetooth module, Polymer Lithium-ion battery, and push button switch. 'These components are attaches onto ring-shaped Plastic piece [1] as shown in(figure 1)[16].

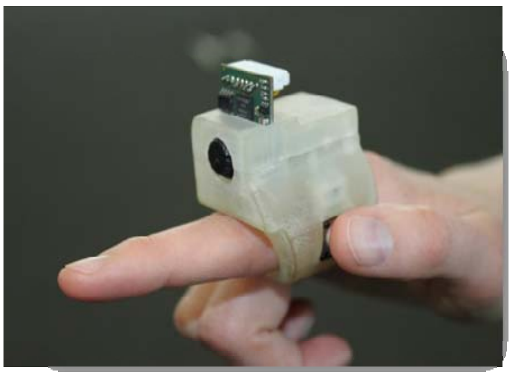

Figure 1: EyeRing- A finger-worn device[16]

The EyeRing concept mainly based on the Pointing Gesture, Computer Vision and Text to Speech Synthesis technologies. The Pointing gesture is fundamental to human behaviour. In Pointing gesture technology there are two types of gesture: Free-air Pointing (FP), and Touch Pointing (TP). TP gestures utilize the natural touch sense, however the action trigger is not based on touch sensitivity of the surface. FP gestures are used for showing a place or a thing in space-a passive action. However augmenting FP for information retrieval is an interesting extension. This system is based on both pointing gestures[4]. The computer vision technology is based on extraction of information from images or videos. This field includes methods for acquiring, processing, analysing, and understanding images and, in general, high-dimensional data from the real world in order to produce numerical or symbolic information[5]. In EyeRing technology first we capture an image then computer vision method extract the information from that image. The text-to-speech synthesizer is used to provide audio feedback and is also a less disruptive interaction for sighted and visually impaired people alike. When used for the first time, EyeRing must be paired with the smartphone or PC application; however, this is done only once and henceforth a Bluetooth connection will be automatically established. Bearing in mind that the device should support both sighted and visually impaired users, we completely rely on non-visual interaction for all usage of the system. A typical interaction starts when the user performs a single click on the push button switch located on the side of the ring using his or her thumb. The type of analysis and corresponding response that follows depend on the selected application (currency, tag, insert, etc.)The user may change to a different application by double clicking the push button and giving the system a brief verbal command that names the application, for example ‘insert’ (to insert some pictures previously taken into some online document),‘currency’(to recognize the value of a dollar bill), ‘tag’ (to recognize a price tag), and so on[1].

II. Components

A. Hardware design

The devices which are used in EyeRing technology are:

- Microcontroller
- Image acquisition module
- Wireless module

1. Microcontroller: Atmel 8-bit AVR (ATmega32U)

EyeRing only requires basic peripherals-

i. Digital i/o - this pin is configured as an i/p and connected to a push button for user interaction.

ii. Two UART communication(universal asynchronous receiver/transmitter).

a) image acquisition module

b) setting up Bluetooth communication channel

UART is type of embedded interface. A UART is usually an individual (or part of an) integrated circuit used for serial communications over a computer or peripheral device serial port. UARTs are now commonly included in microcontrollers that translates data between parallel and serial forms [6].

2. Image acquisition module

Figure 2: Image acquisition module[7]

The EyeRing design is based on the Image acquisition model in which they use the C329 UART JPEG compression module (Lossy compression) acts as a video camera as shown in (figure 2).
User can give the snapshot command to capture full image with the help of OV7725 VGA CMOS sensor and the OV529 JPEG engine. This module has a power saving mode characterized adjustable Resolution[7].

3. Wireless module

Figure 3: RN-42 Bluetooth module[10]

In this design consideration they use wireless (unguided) communication protocol. Bluetooth is wireless technology standardized as IEEE 802.15.1 which is used for exchanging data over very short distance having frequency spectrum of 2.4GHZ to 2.485GHZ. so, the wireless communication between EyeRing and mobile device is done through a Roving Networks RN-42 Bluetooth module is low power, high performance with shorter length and delivers up to a 3 Mbps data rate for distances up to 20 meters as shown in (figure 3)[8,9].

B. Software Design
EyeRing technology consists a Bluetooth communication model connected with mobile device (smartphone running Android V2.2)or notebook computer with operating system Windows 7.Also they are using a computer vision technology which is a discipline that studies how to reconstruct, interpret and understand a 3D scene from its 2D images in terms of the properties of the structures present in the scene. Computer vision software runs on the smartphone, while other applications run on the PC depending on the task at hand. Software design provides ease for development of different applications[12].

III. WORKING

A user needs to pair the finger-worn device with the mobile phone application only once and henceforth a Bluetooth connection will be automatically established when both are running. A visually impaired user indicated this as an essential feature. Typically, a user would single click the pushbutton switch on the side of the ring using his thumb. At that moment, a snapshot is taken from the camera and the image is transferred via Bluetooth to the mobile phone. An Android application on the mobile phone then analyzes the image using our computer vision engine.

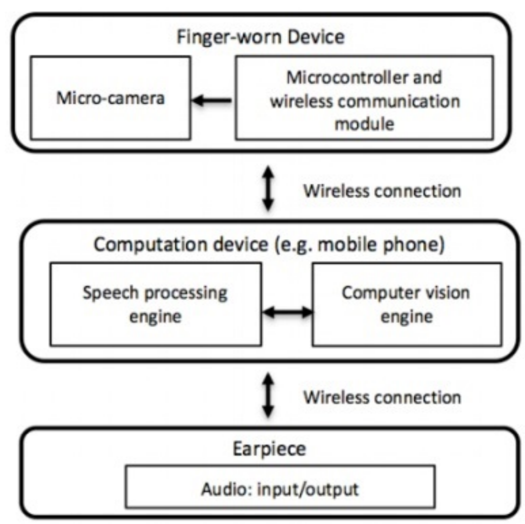

Figure 4: Block Diagram of EyeRing System[2]

Type of analysis and response depends on the preset mode (colour, distance, currency, etc.). Upon analysing the image data, the Android application uses a Text-to- Speech module to read out the information though a headset. Users may change the preset mode by double-clicking the pushbutton and giving the system brief verbal commands such as “distance”, “colour”, “currency”, etc., which are subsequently recognized. Overview of the EyeRing system is shown in (figure 4)[2].

IV. APPLICATIONS

Assistive applications for the visually impaired:

- Shopping assistant (e.g. price tag recognition, currency recognition)
- Indoor navigation
- Reading non- braille text
- Augmented and Mixed Reality applications for the sighted:
- Smart assistant (copy-paste from a book to a computer; get personalized information by pointing at objects)
- A tool to empower children in pre-reading stage (read text on their own)
- 'Paint brush' to capture a colour/texture from a real object (for brush stroke) and draw or paint on a screen or projected canvas .Many of these types of applications may exist for iPads, iPhones or similar devices.
- Remote troubleshooting (get remote assistance by pointing at different parts of a complex system) [14].

Visual Impaired users:

Our first target audience would be visually impaired people (mainly in developed countries) who are keen to explore new types of assistive devices. According to the World Health Organization (WHO), in 2011, there were about 60 million visually impaired people living in USA and Europe.

This technology is available in a much more compact, convenient form. It assists the visual impaired peoples to fulfil their basic necessities, safety while improving their self-esteem and self-actualization [2].

1. Currency Detector:-

Figure 5: Identifying Currency [2]

This application assists the user to identify the currency. In this user simply points an index finger to currency note and click the button with the help of thumb as shown in (figure 5). The system will voice out what the note is.

A detection algorithm based on a Bag of Visual Words (BoVW) approach scans the image and makes a decision on the type of note it sees [13]. We use Opponent Space SURF features to retain colour information, for notes detection. Our vocabulary was trained to be of 1000 features long, and we use a 1-vs.-all SVM approach for classifying the types of notes. For training we used a dataset of 800 images using k-fold cross- validation, and 100 images withheld for testing. As of writing these lines the overall recognition rate is over 80% with a 0.775 kappa statistic. Our vocabulary was trained to be of 1000 features long, and we use a 1-vs.-all SVM approach for classifying the types of notes.

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2. Tag Detector

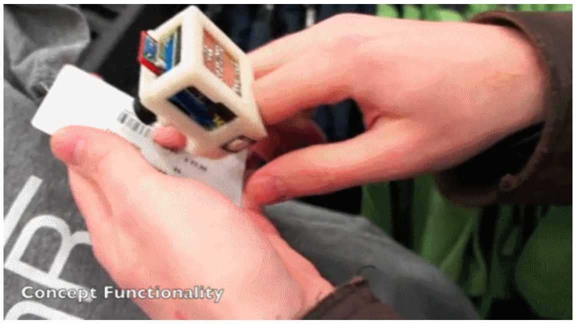

Figure 6: Tag Detector Application [1]

This application helps visual impaired users in reading price tags on store products. It is based on searching the input image for cues of tag existence, and then extracting textual features or barcodes that allow for retrieving the price. EyeRing provides more natural way of aiming the camera at the price tag and getting the result with a single-click operation as we can see in (figure 6). Most product price tags include a UPC-type barcode, as it is a worldwide standard, and the price is usually indicated in a parallel or orthogonal alignment in relation to it. They developed an automatic method to detect the orientation of the barcode in the image to extract the indicated price [1].

V. FUTURE ENHANCEMENT

Future version of EyeRing is in progress which may include application using EyeRing rely on more advanced capabilities of the device, such as sensors like gyroscopes and microphone, real-time video feed from the camera, higher computational power etc. These capabilities are currently in development for the next prototype of EyeRing.

Reading Non-Braille: Braille is a series of raised dots that can be read with the fingers by people who are blind or whose eyesight is not sufficient for reading printed material. Teachers, parents, and others who are not visually impaired ordinarily read Braille with their eyes. Braille is not a language. Rather, it is a code by which languages such as English or Spanish may be written and read with the aid of Braille Ring as shown in (figure 7) .But there are some limitations over the Braille. The fact remains that natural interaction in our world requires decent visual abilities for reading.

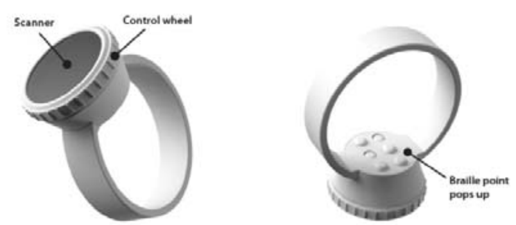

Figure 7: Braille Ring [15]

This application will allow the visually impaired to read regular printed material using EyeRing. The user simply touches the printed surface with the tip of the finger (TP gesture) and moves along the lines. Naturally, a blind person cannot see the direction of the written lines. For that reason they plan to implement an algorithm to detect the misalignment between the movement of the finger and the direction of the text, correcting the user's movement using the audio feedback.

VI. CONCLUSION

They have proposed an always available and intuitive system, which allows users to interact with the physical and digital worlds seamlessly. It creates a metaphorical digital information 'channel' for exchanging data between digital devices and excerpting visual information from the physical world into digital domain.

They are in the process of conducing a more formal and rigorous study to validate this. One of the biggest challenges is creating the supporting software that works in unison with this unique design. However, we believe that adding more hardware such as a microphone, an infrared light source or a laser module, a second camera, a depth sensor or inertial sensors, will open up a multitude of new uses for this specific wearable design.

We discussed the limitation of the system and future enhancements. Despite some limitations of the current implementation, we believe EyeRing is a step towards creating an always available seamless 'finger-worn device' between digital and physical worlds.

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