Visual Access for Blind People

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Abstract

Visually impaired people are often severely disadvantaged in employment and education settings due to their inability to interpret non-verbal and pictorial information. This project proposal discusses the case for an electronic device that grants blind people access to everyday visual information, allowing them to independently interpret, learn and create graphics. The aim is to improve their education and employment prospects and access while enriching their daily lives.

I: Proposal

In this section, we will discuss the main obstacles the blind face in learning and employment and a proposal on this.

1.1 Problem Statement

Lack of access to visual based subjects (such as STEM & Economics), and occupations where graphs, schematics are widely used, along with basic needs like viewing stock charts, maps and statistics. As a result, they are generally unable to fulfil their true potential in society and often find it difficult to make a living, or even survive independently.

1.2 Business Case for a Solution

In the US, a study in 2009 stated 50% of blind people drop out after high school [1], overwhelmingly higher than the national average of 9.3% [2]. National graduation rate among the blind and visually impaired also hovers at around 30% [3], with many lacking the tools and support required to learn the content, (often containing visual information: e.g. plots, diagrams), as well as their peers.

There is also a severe shortage of qualified blind-support teachers. In 2003, 6700 of them were serving about 93600 students [4]. This in turns leads to unemployment and poverty, with an estimated 75% of blind people in the US being unemployed [3]. Similarly, in the UK, nationwide polls revealed that only 27% of visually impaired people of working age are in employment, with 39% expressing great difficulty in making ends meet [5].

Text to speech technology (alongside Braille) has made the interpretation of text much easier [6], but graphics and charts are still an issue. Some essential information is only conveniently expressed in 2D space through colours (e.g. pie charts) and intricate lines, something that is near impossible for blind person (that only experiences the world in 3D through touch) to interpret independently.

An electronic solution is therefore required to convert graphics into a form independently sensed and understood by the blind user.

On top of that, even in developed countries such as the US, nearly 90% of blind children are illiterate [4] because of limited access to Braille education. Since Braille is a pictorial, pattern language interpreted through touch, the same solution enabling the interpretation of graphics can also enable the blind to learn Braille independently anywhere at low cost when coupled with text to speech technology, massively boosting literacy rates as well.

1.3 Market & Competition Analysis

In 2010, the World Health Organization estimates that 285 million worldwide are visually impaired, with 39 million being blind [7], indicating significant market demand. 90% of them live in low-income countries [8] with little access to modern technology, signalling a dire need for low cost alternatives. The market is only set to grow larger in the future, with the number of people in the UK with sight loss set to increase to 2.7 million by 2030 and double to 4 million by 2050 [5] as the population further ages and eye health problems develop with age.

Current solutions involve converting graphics into audio information, through musical tones or very detailed description, but they are still relatively hard to interpret in a big picture.

Electronic solutions are also available: a haptic device using a pen-like stylus that simulates fingertip contact with virtual objects using vibrations is currently being experimented on for teaching blind students STEM [9]. However, not only is such technology incredibly expensive, making it inaccessible to most blind people living in poverty, it is also highly inflexible, with only a certain library of present, manually designed graphics being accessible.

Device	Price	Purpose
Refreshable Braille Display	GBP 2622.00 (RNIB Store) [10]	Digital text to Braille Display
Tiger Braille Embosser Printer	GBP 7194.00 (RNIB Store) [11]	Prints Braille embossed documents
Orcam MyEye 2.0 AI Glasses	GBP 4200.00 (RNIB Store) [12]	Reads out what the user is looking at
Braille Sense U2 Mini Notetaker	GBP 2874.00 (RNIB Store) [13]	User can input notes using Braille

II: Project Management

This section will discuss the initial project proposal and a potential solution that can be implemented in steps.

2.1 Objectives regarding Proposal

Our main objective is to develop a device that enables any 2D graphical object (such as graphs) to be easily sensed by the user, while allowing them to create and transmit 2D graphics of their own.

The development of a Visual Aid system will aim to:

- Enable the user to sense visual information using an interactive display.
- Be affordable than the current existing competition.
- Enable the user to easily input data via an onscreen sensor mechanism.
- Allow contour images to be uploaded onto the device and to represent graphs and curves.
- Be ergonomic, compact and easy to use.

2.2 Resources and Expertise

Developing a sophisticated visual aid system will require the help of both technical and societal organisations.

⇒ **Personal Robotics Lab, Imperial EEE** [14]: Insight into user haptics input and advice for making autonomous decision-making process.

⇒ **Imperial College Advanced Hackspace** [15]: This space will allow us to rapidly prototype our design during our development stage. This includes 3D printers and CNC cutters.

2.3 Technical Mapping to Modules

The development process will require technical skills from a broad range of modules we have covered so far.

⇒ **Fields and Devices**: Actuators and sensors may use motorised systems to cause movement.

⇒ **Analogue Electronics:** Circuitry needed to ensure each actuator is driven correctly via a digital signal.

⇒ **Signals & Systems:** An input from the user will be perceived as a signal and will need to be processed through basic signal processing before going to microcontroller.

⇒ **Digital Electronics:** Using digital means to perform complicated parallel logic from the visual data.

⇒ **Software Engineering:** An interface must be made to process inputs from user and generate content (such as graphs) on the device.

2.4 Project Planning & Management

The project is split into three main systems. These consist of the development of the external hardware, the on-board driver and signal processing boards and the front and back end software.

⇒ *Actuators and Sensor Method Production Group*
- Xia Chen Hao, Umut Ekinci, Pavan Gill

⇒ *Circuit Development Group*
- Issa Bqain, Alp Atakav, Omar Abdullah Inuwa

⇒ *Algorithms and Software*
- Arman Fidanoglu, Lukas Baliunas

Regular meetings will be held with most members of the meetings; scheduled every Friday from 10:00 to 11:30.

- Online 'Informal' Meetings will also be held on Google Hangouts
- Progress of each sub group and announcements made on Slack
- Informal Communications maintained via WhatsApp
- Formal Milestone communications made via Mailing list.

2.5 Timeline and Upcoming Tasks

A rough timeline of our expected progress throughout the coming months is detailed below.

Start	End	Task	Members
1/10/19	9/10/19	Group Formation	N/A
9/10/19	20/10/19	Work on the proposal of the three problems	Split into 3 teams. Everyone
20/10/19	31/10/19	Work on feasibility study	Everyone
31/10/19	7/11/19	Response to Feasibility study	Split into teams, Everyone
7/11/19	17/11/19	Work on Product Design Specification	Input from Everyone
17/11/19	2/12/19	Investigation on creating display	Umut, Xia, Pavan
		Investigation on control circuitry	Issa, Alp, Omar
2/12/19	2/12/19	Major Meeting with Team	Everyone
3/12/19	13/2/20	Testing: Display and Circuit Construction	Umut, Xia, Pavan, Issa, Alp
		Testing Software and Interface Development	Arman, Omar, Lukas
13/2/20	11/3/20	Prep for Poster presentation and Demo	Everyone
6/3/20	19/3/20	Work on Video and Final Report	Everyone

III: Referencing and Citations

This section includes the documentation referenced and cited in the above texts.

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IV: Editorial Note

Editor: **Issa John Bqain**