Smart Cap for Visually Impaired in Disaster Situations

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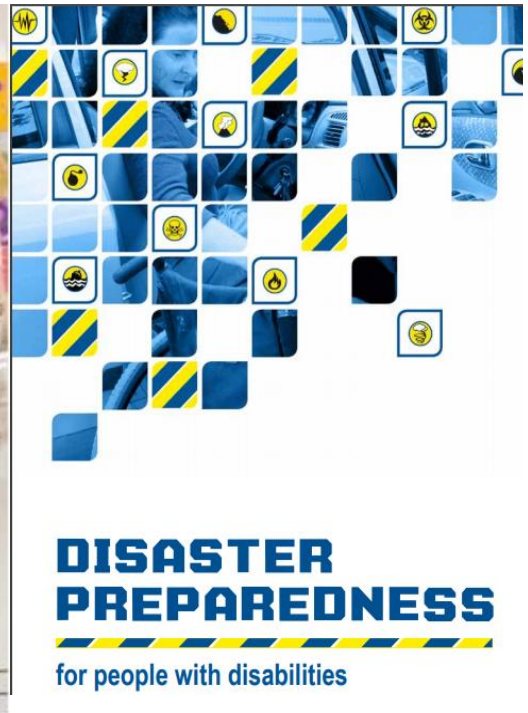
Agenda

- Research Motivation
- Current Challenges in Disaster Management Plan
- Visually-Impaired and Disasters
- Available Technologies and Services
- Smart Cap Solution

Research Motivation



When it comes to disaster preparedness for people with disabilities, can we do better?

Emily Spink · 19:00, Jan 20 2017

DAVID WALKER/FAIRFAX NZ

Current Challenges

- Have the current disaster management plans considered all people?

- Physically challenged people and their requirements are often excluded/neglected in disaster emergency plans

- Different disaster management plans have been put forward addressing groups with special requirements [1, 2, 3].

BUT

- WHO in 2017 announced that compared to the diversity of the problems and their population, this is still minimal [4]

Visual Impairment

- WHO reports states that there are 285 million people worldwide with visual impairment.
  - Blind
  - Partially Blind

- A fundamental challenge faced by this group of people is the inability to navigate between locations effectively

- Today, many physically challenged individuals depend on assistive technologies to undertake their day-to-day activities.

Visually Impaired and Disasters

- People with impaired vision during and after disasters
  - have greater needs for assistance
  - require additional support
- According to the American Foundation for the Blind, they are a vulnerable group that could highly be impacted by the influence of disasters [5]
- New Zealand's Christchurch 2011 earthquake and Japan's Honshu Island earthquake 2016 affected people with visual impairment

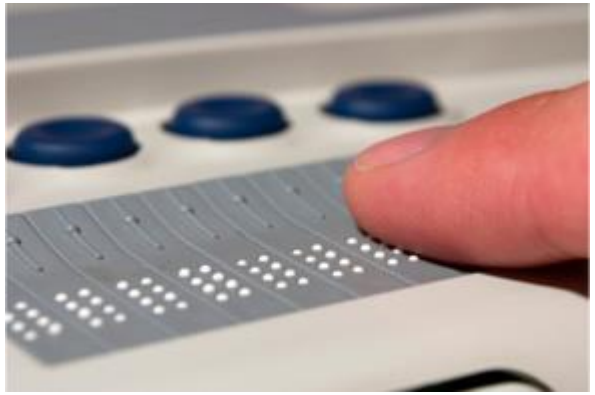
Before and After Disasters

- These people may be excluded from disaster plans while their communication, support, mobility, safety, and access to evacuation centres are common concerns [6].

- Roadways and footpaths become blocked and inaccessible [7].
- It is particularly traumatic for people with visual impairment

Assistive Technological Aids and Supporting Services

- Almost all people with impaired vision use some sort of systems, services, devices, or equipment to help them make their activities easier and provide them safe mobility [1].



GUIDE DOGS

Assistive Technologies for Visual Impairment

Technology	Description	Functionalities
BrainPort V100 [8]	This device provides mild electrical stimulation patterns over a person's tongue based on the information translation of the wearable video camera.	❑ An electro-tactile stimulation to assist the blind for mobility and object recognition
Eye cane [9]	Augments or translates point-distance information (5 meters) into auditory and tactile cues for people with impaired vision.	❑ Enhanced navigational abilities ❑ Covers greater distances (5 meters) and more angles compared to traditional White-Cane ❑ Allows visually impaired person to have better distance estimation ❑ Helps navigate from obstacles
Vision smart glasses [10]	A navigational pair of glasses, which helps the visually impaired to navigate paths and avoid obstacles.	❑ Enhanced awareness of surroundings through spatial awareness ❑ Helps navigate past obstacles ❑ Enhances people's social interaction
Smart braille watches [12]	A smart watch for the blind, fitted with sensors to help with time notification and alerts	❑ Displays time using up to four braille characters at a time ❑ Vibration and touch sensor for tactile recognition of time notification and alerts

Available Technologies and Their Challenges

- Most of these aid devices and services are designed for normal situations

Technology	Limitations
BrainPort V100	▪ Not useful for text and sign recognition ▪ Mostly suitable for totally blind individuals ▪ Users need to learn how to interpret the signals on their tongue
Eye cane	▪ Not useful for text and signs ▪ Limited to obstacles identification
Vision smart glasses	▪ Limited to only people with partial blindness and not suitable for the totally blind
Screen readers	▪ Use is limited to the computer or other portable electronic devices ▪ learning to listen to speech output is challenging and takes time for users to use to it
Screen magnifiers	▪ Not suitable for blind or near blind people ▪ Limited to computer devices and not for the environmental signs in disaster.
Smart braille watches	▪ Usage is limited to alerts and notifications. Other functionalities become unusable to the blind

Proposed Supporting Services During Disasters

- The Blind Foundation of New Zealand (2018) has outlined specific needs for this category of people during a disaster [13], including:
  - the availability of support persons that could lead them to safety,
  - use of a guide dog (harnessed) that could lead them to safety while taking along a home emergency survival kit
  - white cane for safe navigation to safety.

Aid Type	Limitations of Aid Type
Support person	Support person may be unavailable, trapped or scampering for safety too.
Guide dog (harness)	Could be trapped, killed or even traumatized due to disaster.
White cane	Ineffective as it cannot be used to map a pathway to safety during disaster.

Smart Cap Idea

- people with disabilities need to be prepared to do as much as possible for themselves during crises [14].
- A simple, portable and multi-faceted system would be invaluable.

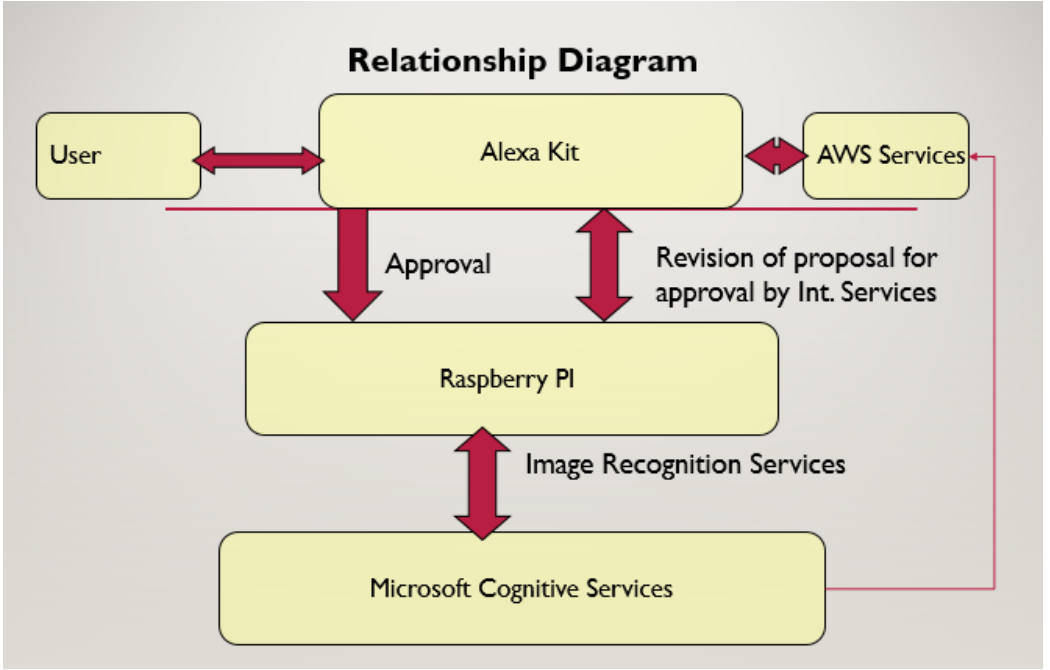
- The Smart Cap aims to provide support for visually impaired persons in a way that a user can interact with their environment via a device that provides navigational narratives of direction and objects surrounding the user.
- The narrative is generated by converting the scenes in front of the person to text, which describes important objects captured by the Smart Cap

Hardware and software requirements

No.	Device	Description
1	P-Cap	Used by the user and hosts the camera.
2	Camera	This is fitted to the P-Cap. The Creative live HD webcam was used.
3	Raspberry Pi B+ model	The Raspbian framework was installed and used.
4	Microsoft Cognitive Services	Deployed for image recognition.
5	Amazon Alexa	Deployed in order to use the AWS services

Smart Cap Data and Process Relationship Diagram

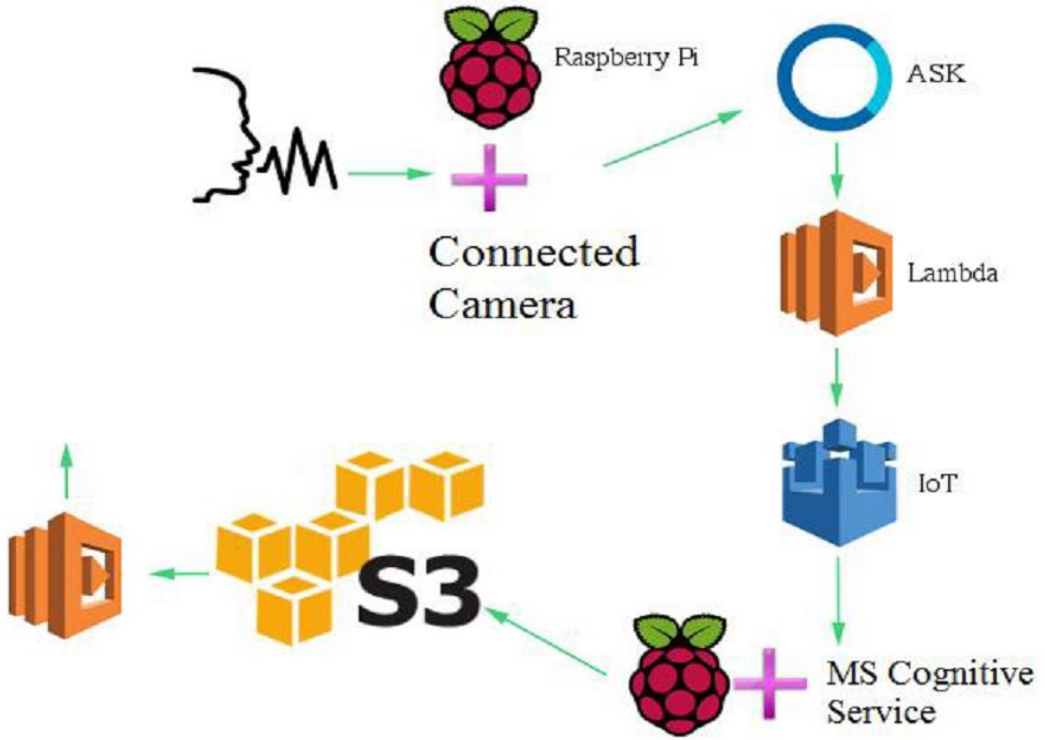
- **Microsoft Cognitive Services** interacts with:
  - a fitted visual camera to a P-Cap
  - via a Raspberry Pi
- for interpretation of objects captured by the camera.



Data and Process Relationship Diagram

Smart Cap System Design

- **Amazon Web Services (AWS):** This platform is used as a device gateway, rule engine, things registry, security services and thing shadow
- **AWS Software Development Kit (SDK):** AWS SDK helps clients associate the equipment with the IoT gadget.
- **Microsoft Cognitive Services:** Used for tasks and objects identification.
- **Raspberry Pi:** The Raspberry Pi publishes the message to AWS-IoT Shadow.

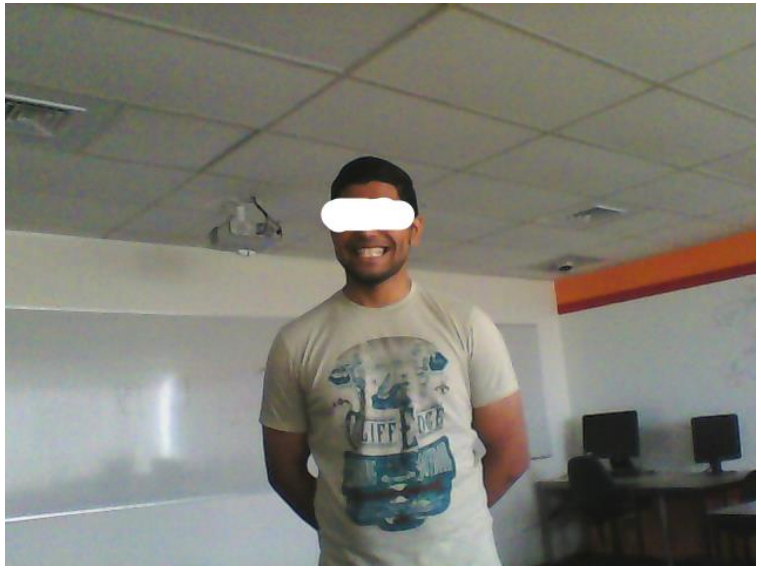


System Design of Smart Cap

Smart Cap Vs Visually Impaired Special Requirements

Special needs of the visually impaired	Unique qualities of Smart Cap for disaster/emergency situations
▪ Need or expect special rescue efforts	▪ used independently to navigate a damaged path
▪ Desire confirmation of blurry images	▪ ideally suited to those with severe impairment in a disaster situation
▪ Need a confirming ‘calm voice’ in a disaster/emergency situation	▪ excellent for those living alone (often overlooked in emergencies)
▪ Extra support in unfamiliar circumstances or environments	▪ can be used immediately in disasters if relief efforts are stretched
▪ Disabled need to do things for themselves	▪ confirms and relays information clearly (when normal communication channels are disrupted)
▪ Need familiar, unchanging environments	▪ connected to the Cloud thus, navigates if terrain is changed during disaster

Testing and Evaluation



Captured Image Source by the Smart Cap Camera

Sample Output of an Image Recognition

Image Source	Image metadata	Keywords	Description	Request Id
Smartcap1	Height:480 Width:640	Person, indoor, man, standing, front, posing, black, holding, shirt, camera, room, wearing, large, table, woman, young, white, blue, kitchen	A man standing in a room.	4fe73a03-6197-4daa-8ad9-fb6e9bb468a4

Future Work

- To reduce dependency of Smart Cap to the network connectivity and the Internet

- Hybrid Services
  - Online
  - Offline

Thank you

Q&A

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