Inclusivity/Urban City

The Outliers

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Content Outline

Significance of problem

Many countries are trying to achieve social equity in all areas by removing barriers and providing access for disabled people as accessibility is increasingly recognized as a key element of a high quality, efficient and sustainable transport system. However, there are several important factors that need to be considered for a better understanding and experience of the whole journey of accessibility for disabled. Figure 1 below shows the journey cycle standard for disabled people. Research by Seyed Hassan, Mashita, Awang and Rostam (2011) supports that most of the commuter feels unsafe with current infrastructure, specifically on the journey to and from the terminal, boarding and alight from the chosen public transport.

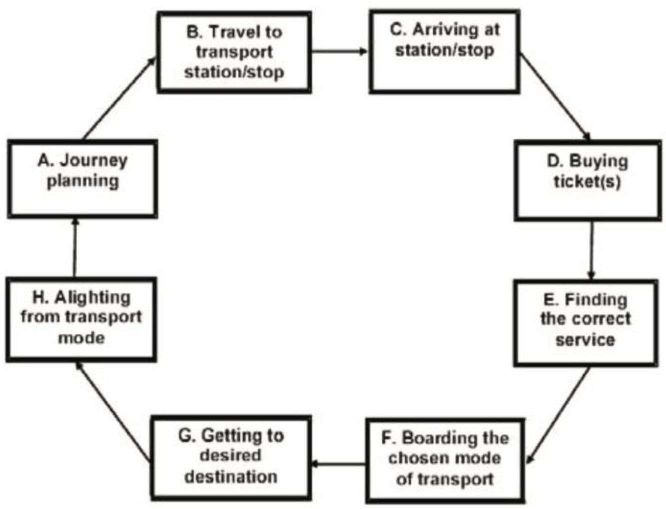
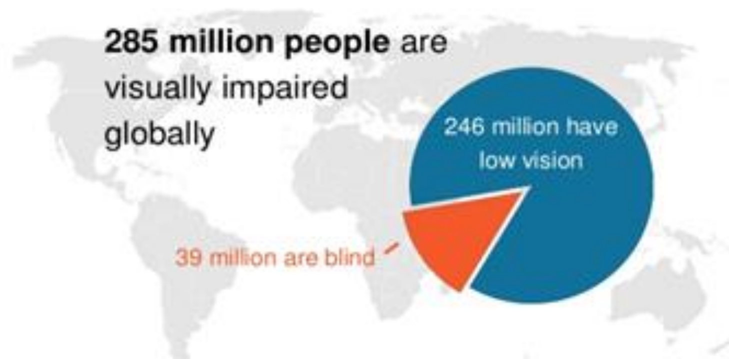


Fig. 1: The Journey Cycle. (Source: Assessment of Accessibility Standards for Disabled People in Land Based Public Transport Vehicles, Lafratta, 2008).

According to American Foundation for the Blind (AFB) (2013), locating bus stops is a significant access barrier for the visually impaired riders often due to information lack of details, bus stops are not clearly marked with non-visual indicators or are placed inconsistently off roadways. The challenge of locating a bus stop is exacerbated when traveling to an unfamiliar location where both bus stop placement and the position and type of surrounding landmarks are not known to the traveler a priori. As public transport systems reduce or stop service due to Covid-19, persons with disabilities who rely on these methods for accessible transport may not be able to travel, even for basic necessities or critical medical appointments. With statistics provided by WHO has shown that 295 million people are visually impaired worldwide and 39 million of them are blind, it is important to note how these people are uniquely impacted by the Covid-19 that continues to have wide-reaching impacts across the globe.

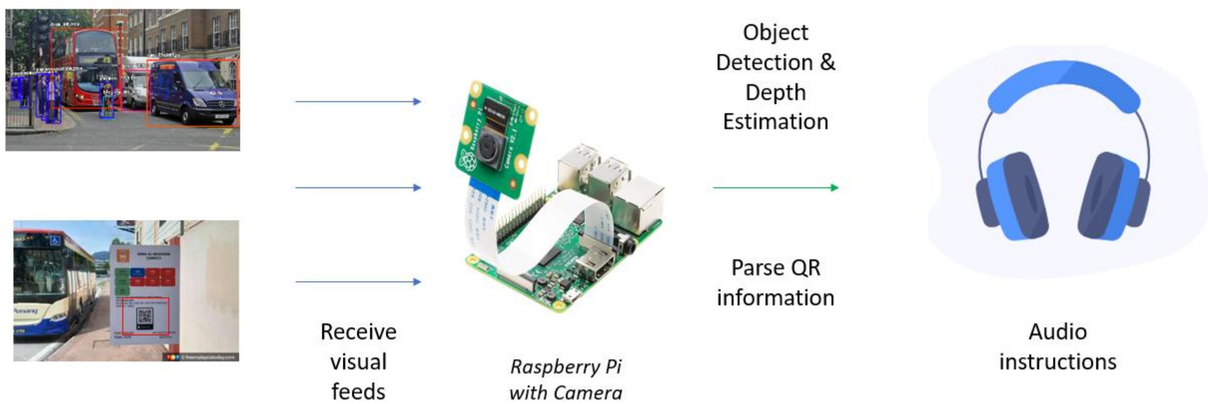


References:

Seyed Hassan Khalifeh Soltania, Mashita Shamb, Mohamad Awangb & Rostam Yamanb (2011). *Accessibility for Disabled in Public Transportation Terminal*.

American Foundation for the Blind (2013). Retrieved from: https://www.afb.org/

Solutions Introduction



A navigation device is proposed to assist a disabled person (visually impaired) to navigate around cities. This device consists of multiple features. The features of this navigation device are as follows:

1) A visual reception waist band equipped with four cameras, worn by the disabled person to capture visual feeds of the surroundings.

2) A computer vision software to process the visual feeds to identify obstacles and its closeness to the disabled person.

3) Generation of audio instructions based on the processed information. This will assist the disabled person to navigate an area based on the instructions.

To assist a disabled person to navigate and reach a specific landmark point, a navigation scanner system is proposed. This system consists of customized pictorial code and scanner software to translate the code into information. The features of this navigation scanner are as follows:

1) The customized pictorial code (such as QR code) can be placed along the landmark points. These codes can encode information such as surface type, elevation etc. These codes can be placed along

important landmark points such as the entrance to the exit of a building that are designed for disabled people to traverse.

2) The scanner software will be embedded in the device. The scanner software will use computer vision to scan for codes in the surrounding and process the embedded information.

3) Generation of audio instructions based on the processed information. This will assist the disabled person to navigate an area based on the instructions.

Impact of Solution

Government is putting efforts to ensure all segments of society benefit from the development of the country. Government has come out with the National Transport Policy (NTP 2019-2030) to include the interests of disabled community.

After the announcement of NTP 2019-2030, Damai Disabled Person Association Malaysia president V. Murugeswaran said that "Public transport is a key factor for disabled people to go out and live independently. Accessibility should be available everywhere for disabled community." (NST, 2019) Hence there is a desperate need to enhance the accessibility of the public transport system for the benefits of the disabled community.

We came up with a solution to compliment the limitations of the traditional approach on public transport accessibilities. This solution is to ensure that visual impaired community too can enjoy equal opportunities to use public transport with ease.

Traditional approach vs Our solution

Attributes	Traditional Approach	Our Solution
Feature	Tactile Ground Surface Indicators and audio guides at selected platforms.	Navigation IoT device with real time audio guides.
Safety	Medium, unable to detect the real time changes of the surroundings.	High, able to detect the real time changes of surroundings.
Flexibility	Low, people affected by visual impairment tend to memorize the layout of the area. Therefore, not encouraged to change the layout of the area frequently.	High, the device is able to detect the real time surrounding changes and feedback to the user. Hence, no need to redesign the layout of the area on a large scale.

Implementation Time	Low, training centers are readily available.	Medium, needs time to educate and train the user to familiarize with the device.
Coverage	Major cities.	Nationwide.
Data Capture	No.	Yes, the captured data can be used to further enhance the accessibility of the public transport.
Cost	High, have to redesign the current infrastructure to cater the needs of users with visual impairment.	Medium, need to invest in IoT technology and some minor changes on current infrastructure.

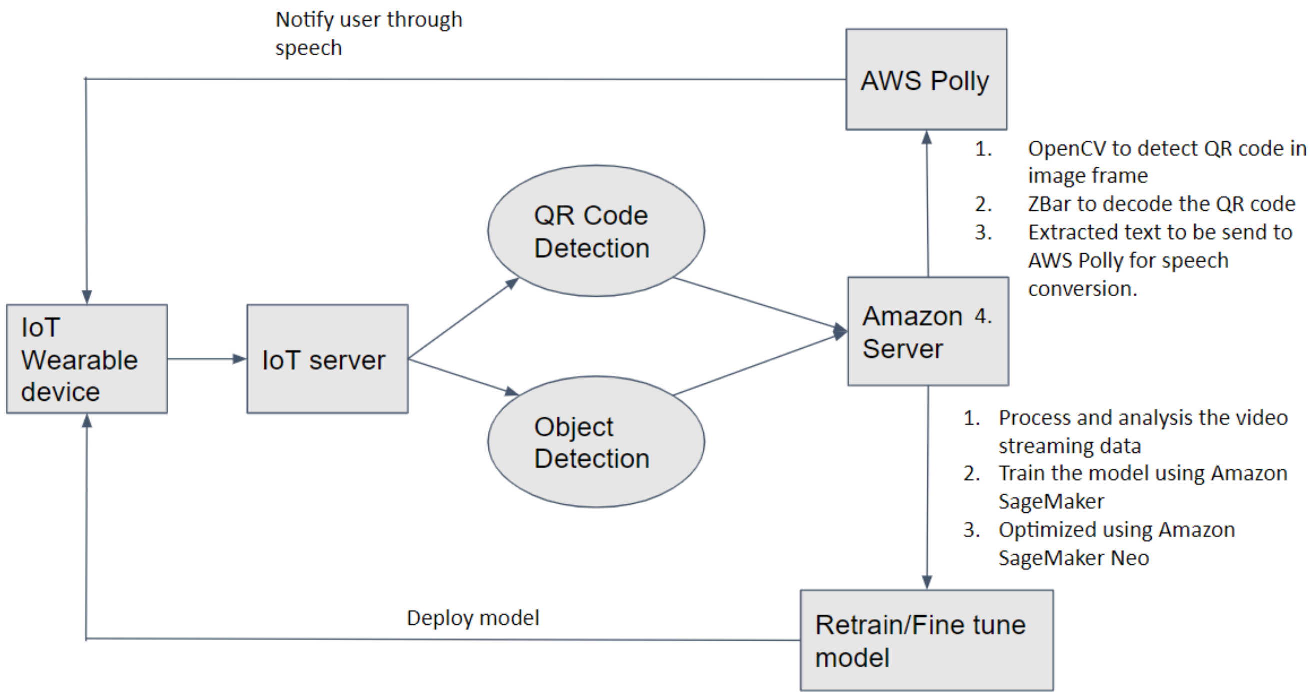
Impact Summary of our solution:

Improve quality of life of visual impairment community.

Improve safety when using public transport system.

Cost saving, instead of redesign the infrastructure, we design a solution to fit into current situation.

Deep Dive into Solution



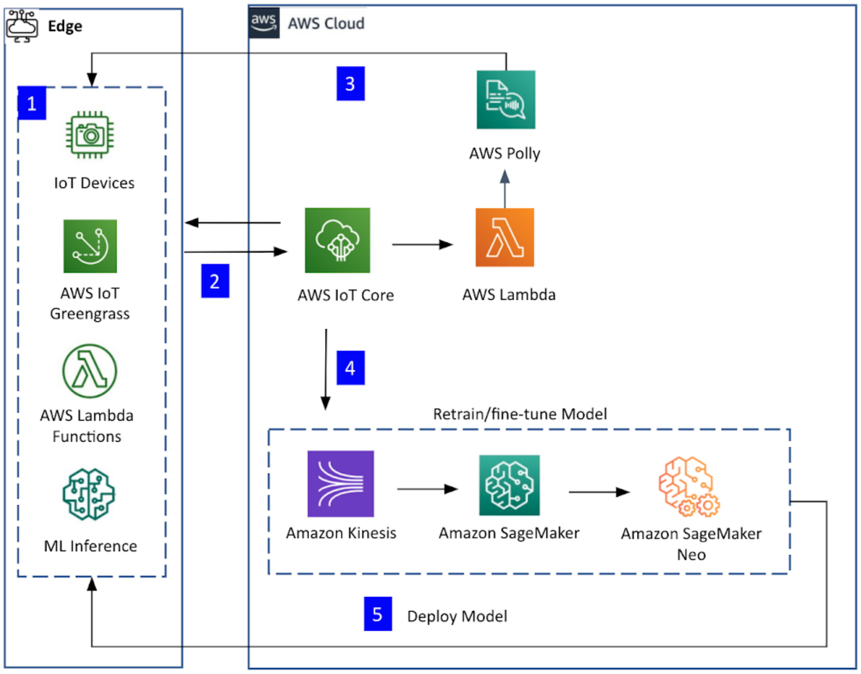
Through this solution, the visually impaired will be wearing IoT wearable devices (e.g. Raspberry Pi) that are installed with Amazon FreeRTOS or AWS IoT Devices SDK. The devices are equipped with cameras. The cameras will capture the video frames and pass to AWS IoT Greengrass. The service allows the edge devices to function using local data without reducing the ability to connect to the cloud for management, analytics and also durable storage. Even if the user's wearable is not connected to the internet, the service allows the device to operate in offline mode which is an advantage to the user as not all areas in Malaysia are fully covered with strong telecommunication signals. With AWS lambda functionality, the ML interface/model is able to run in the edge device that helps the visually impaired in traveling.

The data will pass the telemetry data from edge devices to AWS IoT core through MQTT, a lightweight communication protocol that is able to tolerate intermittent connections. Due to the ability of AWS IoT to support billions of devices and trillions of messages, it is extremely helpful in the solution due to the number of wearable devices worn by the visually impaired and possibility of extension to other groups of disability.

AWS IoT Core sends the telemetry data to two routes. One route is sending data to AWS Lambda to call a python script that uses OpenCV to detect the QR code in image. Then, a python library, ZBar will be used to decode the QR and the text will be extracted from the decoding process. AWS Polly is then utilized to convert the text to speech audio in PCM output format and send it to edge devices to help users navigate in their journey.

The other route is AWS IoT Core sends the telemetry data to the model re-training module in order to re-train the model with the latest data. Amazon Kinesis is built into the application in order to process and analyze the streaming data. Next, the analyzed streaming data is used to build and train the machine learning model using Amazon SageMaker. After the model is trained, it will be optimized using Amazon SageMaker Neo. This is crucial for edge devices where memory and computing power tend to be highly constrained. In addition, this enables fast and low-latency predictions in real-time. Once optimized, the model will be deployed back into edge devices to ensure that the user can always get up-to-date information.

Architecture of Solution



1. **IoT wearable devices** are installed with **Amazon FreeRTOS** or **AWS IoT Devices SDK**. These devices use sensors (i.e. camera) to capture video frames and **ML Inference** - an optimized ML model running at the edge, to detect objects. **AWS Lambda Functions** detects QR code.
2. **AWS Lambda Functions** sends telemetry data to **AWS IoT Core**.
3. **Amazon Polly** receives text and convert to speech audio in PCM output format.
4. Create, train and optimize ML models with **Amazon SageMaker** and use **Amazon SageMaker Neo** to optimize models to smaller memory footprint for resource-constrained edge devices.
5. Deploy optimized model to **IoT wearable devices.**

Going further

There are many ways to enhance the solution to benefit a larger group of disabled. One of the top priorities will be on the implementation of haptic feedback to cater for the hearing impairment community by using devices such as belts to create an experience of touch by applying forces, vibrations or motions to the user. Multi languages audio feedback can be considered as an option to cater for nationwide users too. Additionally, 360° cameras can be used instead to improve the detection of surroundings changes and raise alert to the moving closer objects from blind spots.

Moreover, the solution can be refined with adding more features such as GPS/GSM tracker as position locator to provide a more accurate location to the user. Emergency features can be applied to the IoT device by linking the video to the police, hospital, and fire station when accidents such as fire, fall down, theft or robbery are detected. With these features incorporated, disabled persons facing critical accidents can be noticed immediately.