A Seamless Navigation Device for Visually Challenged People

1 Project Report

1.1 Problem statement

The WHO reported that Globally, it is estimated that at least 2.2 billion people have a vision impairment or blindness, of whom at least 1 billion have a vision impairment that could have been prevented or has yet to be addressed [1].

1.2 Problem description

There are several AI systems designed to support visually impaired people and to improve the quality of their lives. Unfortunately, most of these systems are costly or limited in their capabilities and does not support a robust depth-sensing mechanism.

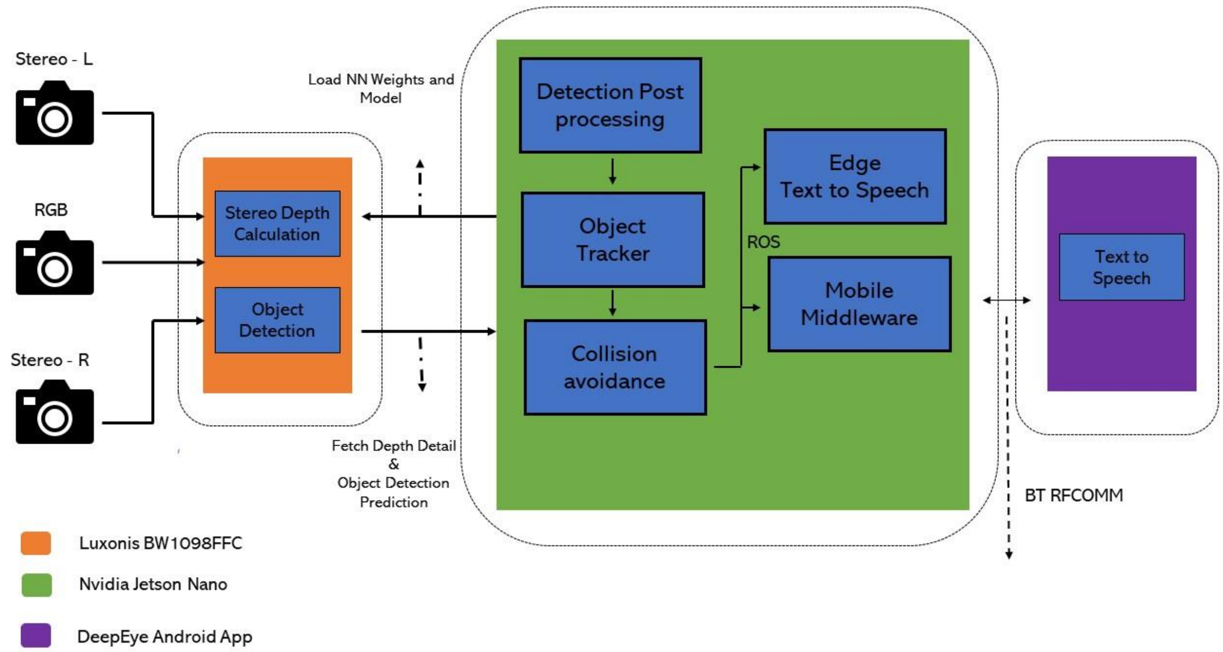
There are powerful devices that can help legally blind live independently, for example, IrisVision, MyEye2, Jordy, eSight but the cost of those products between 3000 USD to 6000 USD. [2].

An opensource project like blind device [3], Blind Reader [4] out there but those are limited in their capabilities. We don't find any major work on this issue from the open-source community on a product level.

1.3 Implemented solutions

The first sub-task is a perception or perceiving the environment in which our end users would be walking. It includes tracking an object motion and identifying the various elements in the world around us, like the people, road surface, road signs, vehicles, pedestrians and so on. We also need to track all moving objects and predict their future motions.

This information gained using the device can be first converted to text using OCR and then into speech or even tactile force so that our end users can be alerted.



DepthAI hardware design and computational capability can help us to get the depth calculation (to get X, Y, Z for every pixel) and we used **SSD-MobileNet V2 model** can detect 20 classes. Then the detected output fetch from OKD kit to Jetson Nano for post-processing.

We create a JSON dump for all the detected objects and used for object tracking [5] and collision avoidance [5].

The calculation process of the collision avoidance takes the depth information provided by the OAK-D camera. The calculations are being made in 2D, taking only x (horizontal) and z (depth) into account,

The collision may occur when:

1. Object trajectory is pointing towards the camera
2. Object speed, and therefore time to impact, is below a threshold

The reference implementation taken from depthai-experiments work [5]. The collision message publishes to ROS master node. We have two Text to speech implementation.

If the device connected to the mobile device, we will send a text to android device using RFCOMM TTY serial. Then we have on-device text to speech conversion as well as.

Then android device automatically enables BT and connect with deepEye edge device.

And, we have retrained an SSD MobileNet SSD-V2 with Open Image dataset. We picked up and trained all the object classes that help visually impaired people to navigate when they go to outdoor environments.

1.4 Limitations

1. We are having too many false positive collision avoidances and we need to improve.
2. The collision avoidance algorithm not a robust.
3. The SSD mAP for small and medium objects are poor.

1.5 Future work

1. Custom model with **32 object classes** that help visually impaired people to navigate when they go to outdoor environments.
2. OCR Second stage implementation.
3. Path planning based on User designation selection.

1.6 References

[1] World Health Organization Visual Impairment and Blindness. [(accessed on 24 January 2016)]
[2] Devices-that-can-help-legally-blind-live-independently
[3] GitHub project – Blind device
[4] GitHub project – Blind Reader
[5] GitHub Project - Luxonis Holding Corporation

2 Code and Demo Video

https://github.com/nullbyte91/deepEye