Project VISION

-Team Sahaay

Centre For Innovation

SAHAAY
Social Innovation Club

So Who are We ?

WE ARE ONE OF YOU !!
With just a different VISION and roll numbers...

1. Harshit Raj - ME19B110
2. Vinayak Nishant - EE19B129
3. Yogesh Agarwala - EE19B130

THEIR PROBLEM is OUR MOTIVATION

Walking on street for visually impaired/BLIND individual without any assistance is extremely difficult.

Sadly even with cutting edge technology, we don't have any solution to this issue.

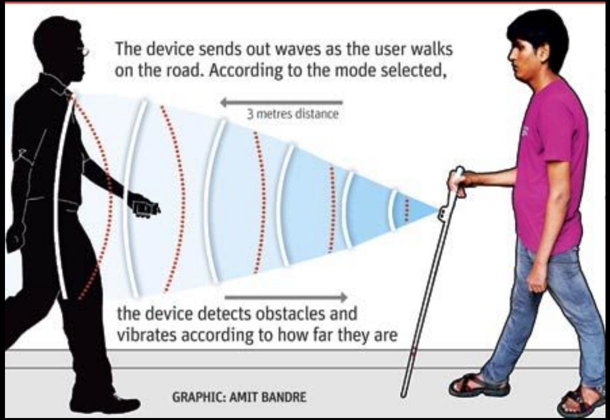
Our aim is to redefine mobility for visually impaired and make them self dependent and their lives easier with the help of engineered eyes.

Centre For Innovation

SAHAAY Social Innovation Club

INITIAL DESIGNS

1.



3.

2.

THE Final DESIGN

Centre For Innovation

The idea is to develop a Smart Belt that the user can wear and a specialized gripper, for output, attached to his usual walking stick.

The Belt will have :

- Two cameras at a separation capturing images and an ultrasonic sensor-aka EYES
- A Jetson nano microprocessor for ------------------------------------ aka BRAIN
  1. Object detection using deep learning algorithm
  2. Distance calculation for every object using triangulation algorithm (much like parallax you read in school)
  3. Sending the output signal to the gripper using bluetooth

SAHAAY
Social Innovation Club

THE DESIGN continue..

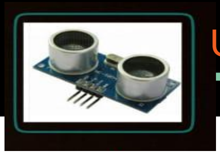
- Gripper -- aka LIMB

Attached on the walking stick it will create a 3D map using the hand as 2D plane and add the depth dimension using specialised cam - follower assisted pins protruding from the gripper.

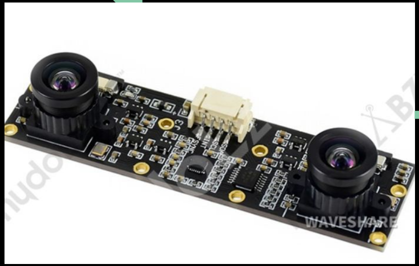
Centre For Innovation

SAHAAY
Social Innovation Club

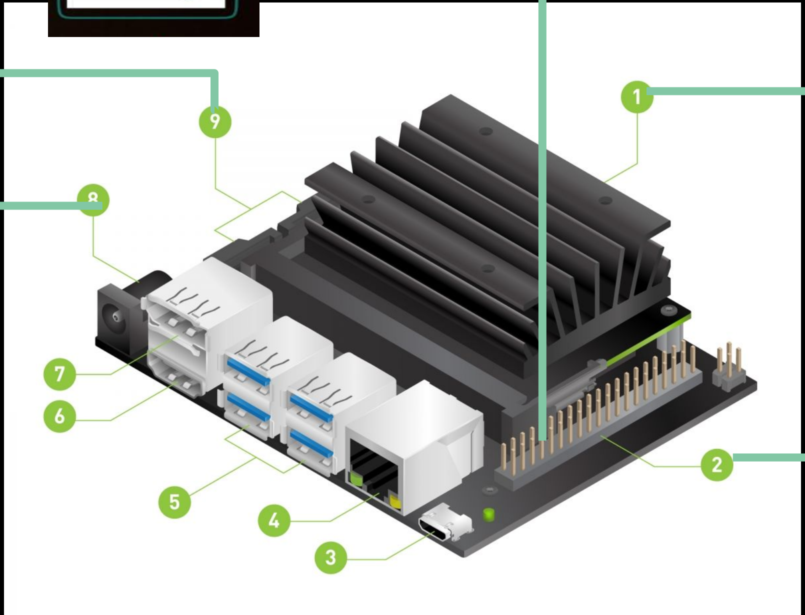
Circuit designing



Ultrasonic sensor

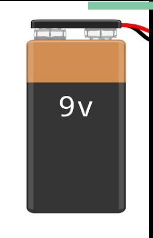


Camera module is connected to MIPI CSI Camera connector.

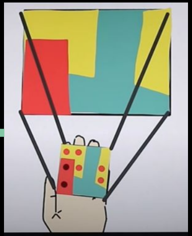


Jetson nano

The Algorithm goes in an sd card which will go inside the microSD card slot.



Power Source

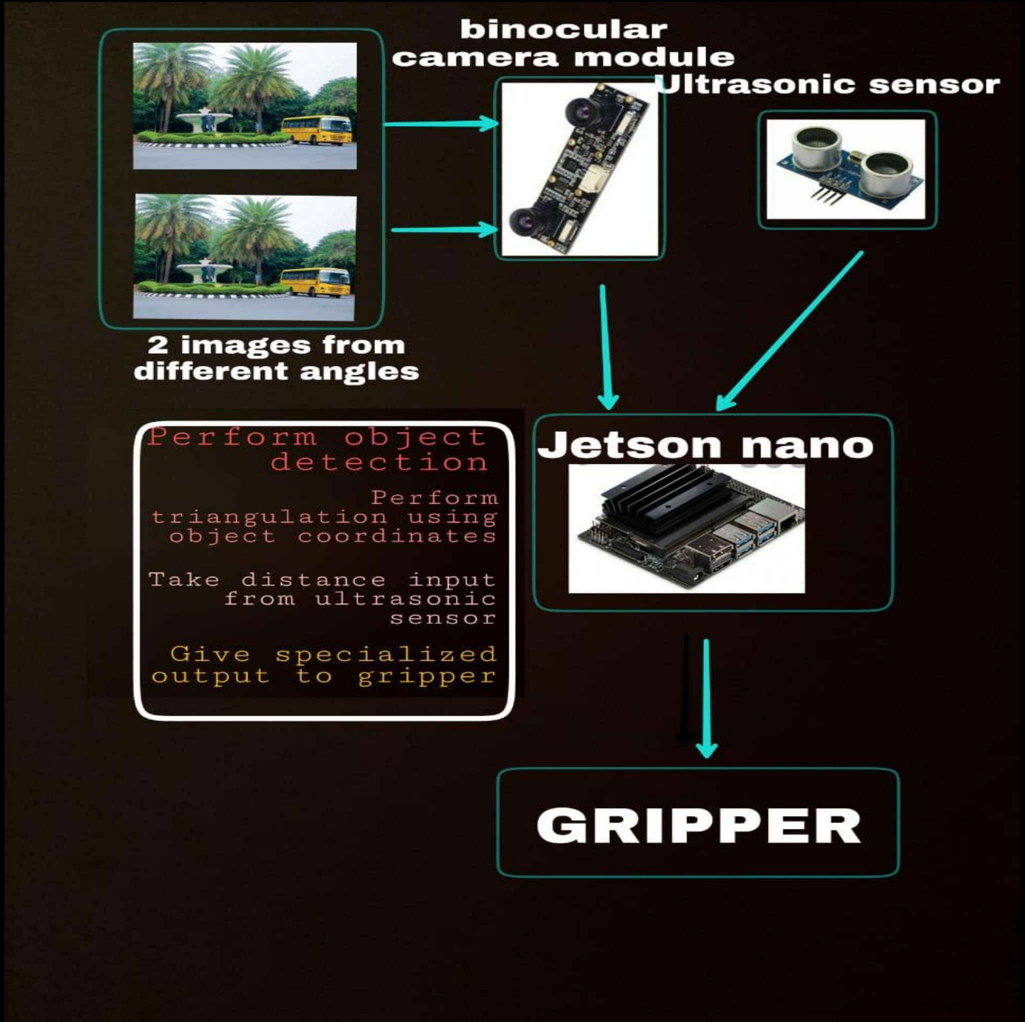


Output through cam-follower

Centre For Innovation

SAHAAY
Social Innovation Club

PROJECT DESIGN



Centre For Innovation

SAHAAY Social Innovation Club

Hardware used

1. Jetson nano

   Specifications:

   GPU: 128-core NVIDIA Maxwell
   CPU: Quad-core ARM A57 @ 1.43 GHz
   MEMORY: 2 GB 64-bit LPDDR4 25.6 GB/s
   STORAGE: micro SD card
   USB: 1x USB 3.0 Type A, 2x USB 2.0 Type A, 1x USB 2.0 Micro-B

2. Ultrasonic Sensor

   The module sends eight 40Khz square wave pulses and automatically detects whether it receives the returning signal. If there is a signal returning, a high level pulse is sent on the echo pin. The length of this pulse is the time it took the signal from first triggering to the return echo.

   Specifications:

   Voltage: 5VDC
   Detection distance: 2cm - 400cm
   Static current: < 2mA
   Level output: high-5V

Hardware used continue..

Centre For Innovation

Hardware used:

3. Binocular Camera Module :
IMX219-83 Stereo Camera, 8MP Binocular Camera Modul

Specifications:
8 Megapixel

Resolution: 3280 × 2464 (per camera)

Operating Current: 90uA

The module supports NVIDIA Jetson Nano Developer Kit B01 version

SAHAAY
Social Innovation Club

IMAGE RECOGNITION PROGRESS

Centre For Innovation

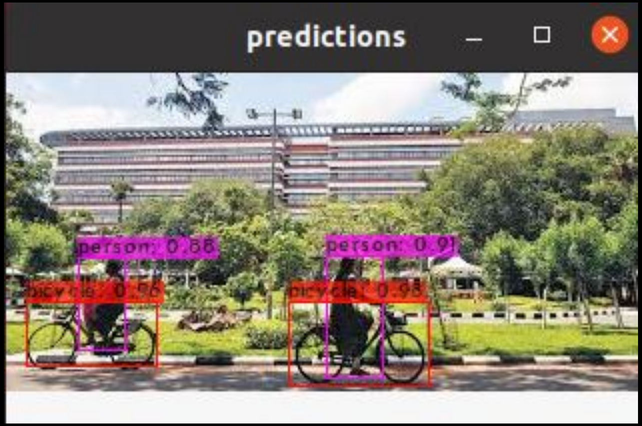
Image Recognition model is applied using YOLO algorithm utilizing deep learning.

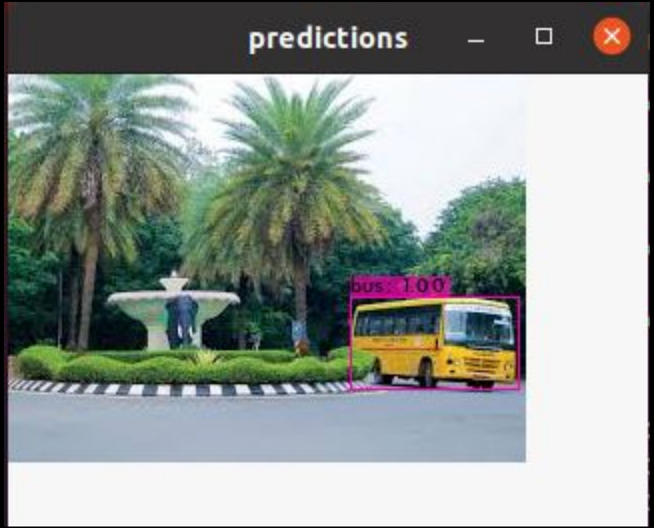
Since it is a computationally expensive algorithm therefore tiny yolo, a modification of yolo algorithm with lesser accuracy than parent version, is chosen for the project.

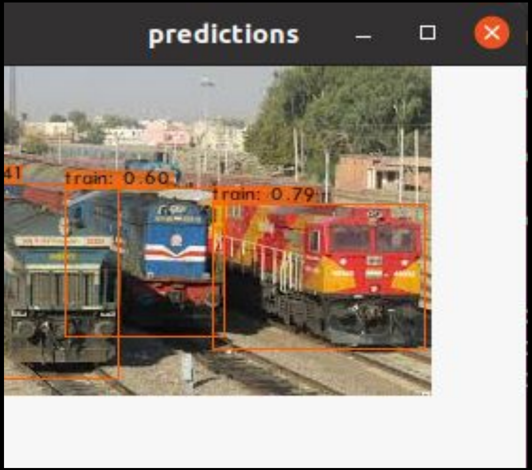
Next few slides contains sample images used to test the algorithm.

SAHAAY

Social Innovation Club







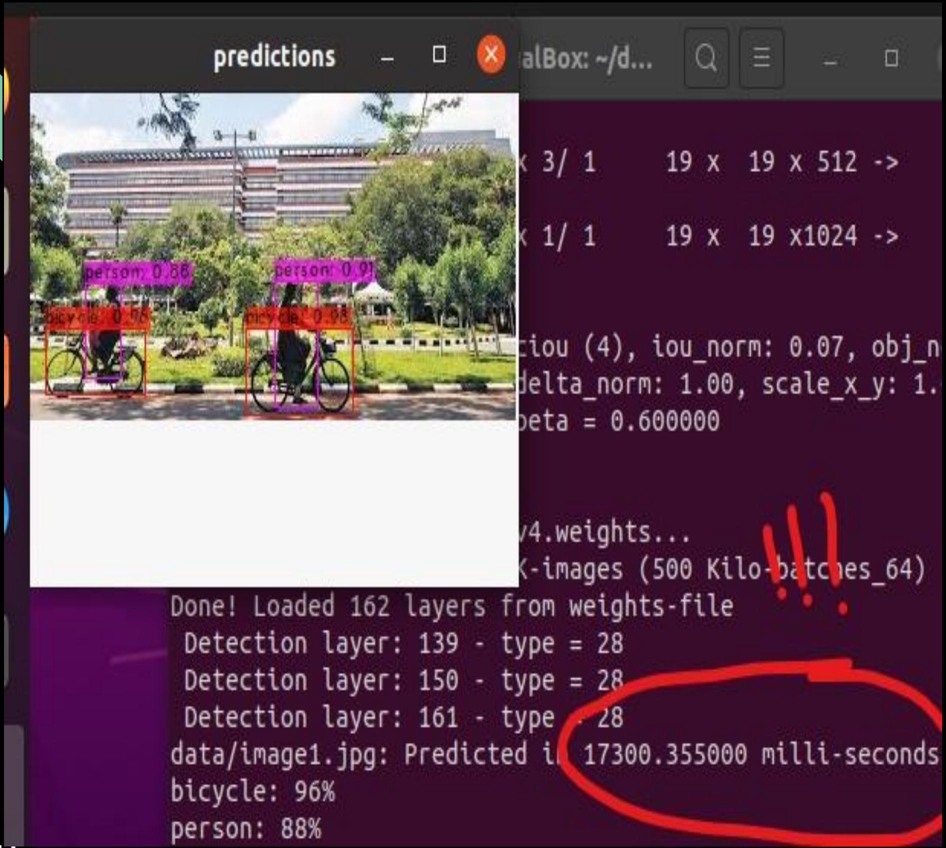
The yolo algorithm shows output with decent accuracy.

however there is the issue with FPS...

Centre For Innovation

SAHAAY
Social Innovation Club

Centre For Innovation

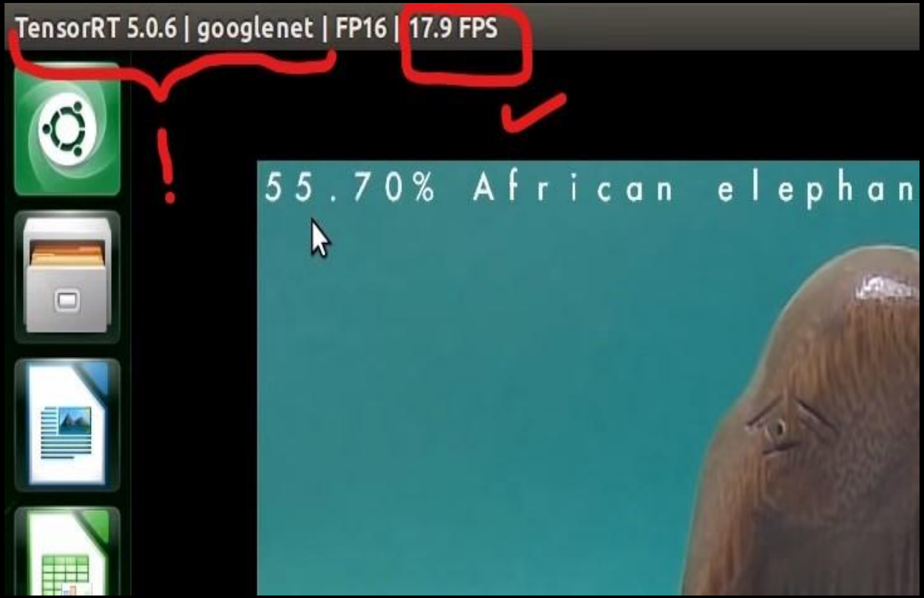


Since I have tested this on a virtual machine with low specs and only CPU therefore the time for detection is ~17 seconds.

However this issue can be solved using JETSON NANO processor as it utilizes GPU for processing images and hence will be faster

SAHAAY
Social Innovation Club

More on issue with fps...



Jeton Nano running image recognition using TensorRT SDK gives good enough fps (~18fps).

However YOLO is based on darknet, still we expect it to deliver similar performance.

Even if it doesn't, we have backup solutions which are a little bit complex and non traditional yet promising.

THE TRIANGULATION METHOD

Centre For Innovation

The Concept is just like our eyes !!

The two slightly different images are used to find the depth of the image ie, the distance of the object from the camera.

We use trignometry to achieve this !!

Let us look in through each step.

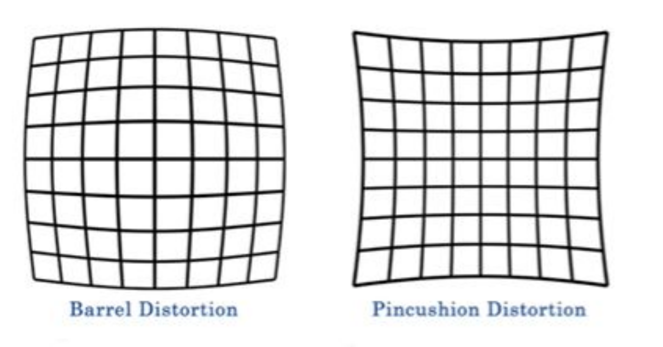
SAHAAY
Social Innovation Club

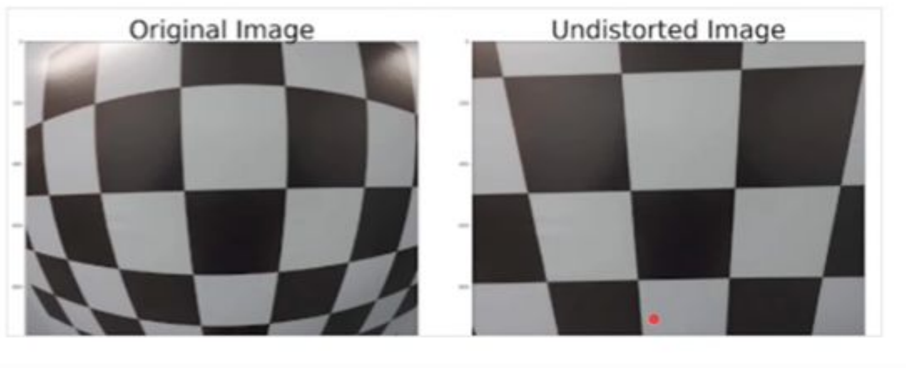
THE PROCEDURE

1. Calibrating the two cameras and removing the distortions
   - Remove Distortion
   - Compute Extrinsic and Intrinsic parameters for camera
2. Estimate the Disparity map of image using Trignometry and Epipolar geometry.
3. Using the Disparity calculate the Depth Map having the depth of each pixel in the image.

CAMERA CALIBRATION

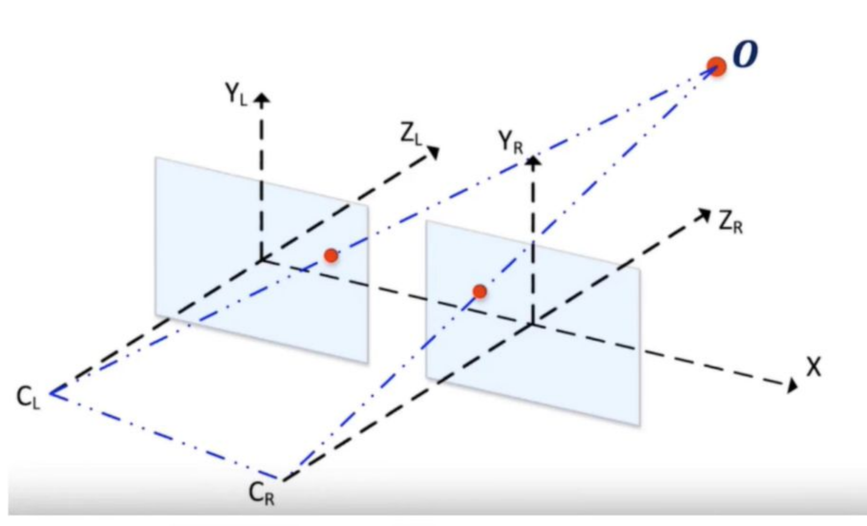
- Finding the Distortion matrix using various known readily available techniques
- Computing various camera parameters like the Focal length, Optical Centre etc.





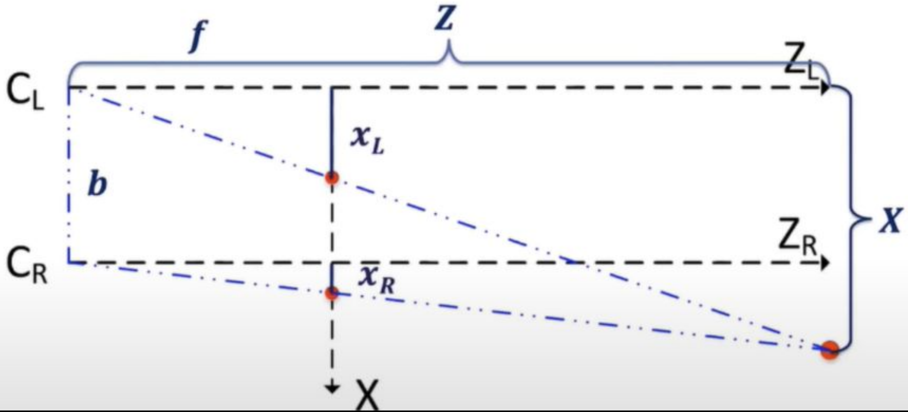
Finding the Disparity Map

- From the two images from the cameras, we use trignometry to find the disparity of pixels in each image
- Disparity is the difference in the location of the same 3d image from 2 different camera angles



Both cameras have the parallel X and Y axis

Top View



$$\frac{Z}{f} = \frac{X}{x_L} \qquad \frac{Z}{f} = \frac{X-b}{x_R}$$

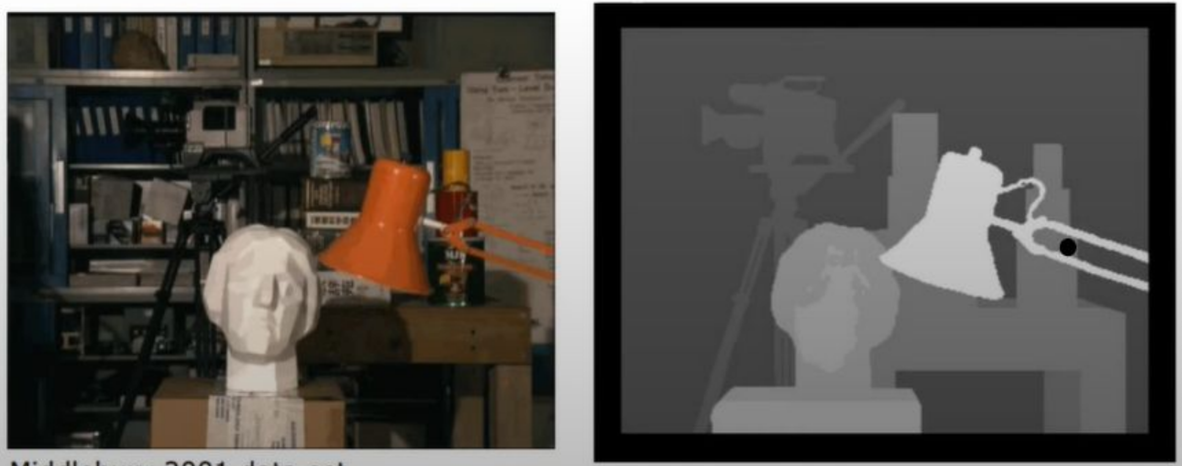
$$x_L = \frac{X}{Z} \cdot f \qquad x_R = \frac{X-b}{Z} \cdot f$$

$$Disparity = x_L - x_R$$

f = Focal Length, b = Distance between the cameras, Cr and Cl = Optical Centres

Finding the Disparity and Depth Map

- From the disparity values, We now find the depth(Z) parameter of each pixel using the formulas.
- Using the X,Y and Z coordinates of each pixel, we can create the intensity depth map.
- Finally, locate the coordinates of the detected object and find the depth...   Eureka !

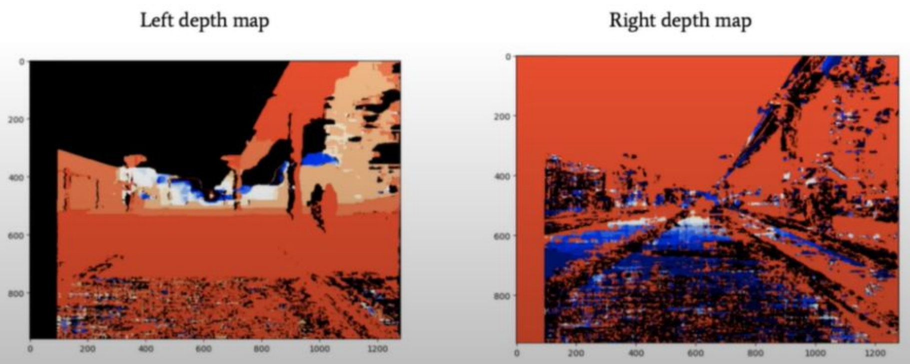


Middlebury 2001 data set.

$$Z = \frac{fb}{d}$$

$$X = \frac{Zx_L}{f}$$

$$Y = \frac{Zy_L}{f}$$



$$Z = \frac{fb}{d}$$

$$X = \frac{Zx_L}{f}$$

$$Y = \frac{Zy_L}{f}$$

The Triangulation Method - PROGRESS

The Intensity map code is ready to go. To test it, we need to have the Camera parameters and distortion matrix.

And hence the Camera !!! We are waiting for the Stereo camera to be delivered, Once we have it, The remaining parts of the code will be done in a thanos' snap

Example Intensity map Code Snippet:

```
import numpy as np
import cv2 as cv
from matplotlib import pyplot as plt

imgL = cv.imread('tsukuba_l.png',0)
imgR = cv.imread('tsukuba_r.png',0)

stereo = cv.StereoBM_create(numDisparities=16, blockSize=15)
disparity = stereo.compute(imgL,imgR)
plt.imshow(disparity,'gray')
plt.show()
```

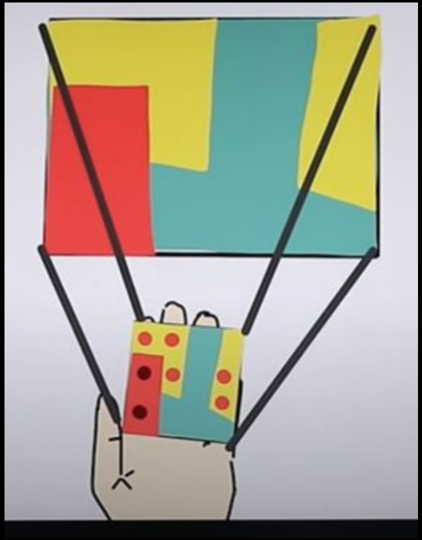
THE GRIPPER CONCEPT

The gripper is our way of displaying the output to the blind person.

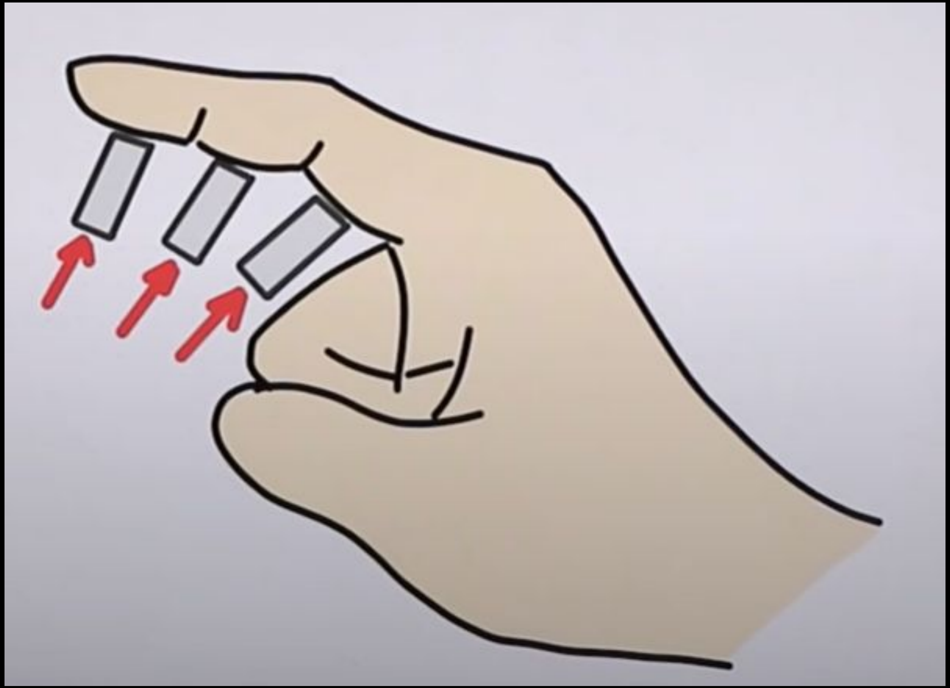
We map the whole intensity-depth map detected by the Camera into his hand !!!!

How we do it ??

Using tiny haptic sensors/linear actuators,
We push the parts of his fingers with more pressure on more nearer object and there by Conveying him the information about the obstacles



THE GRIPPER CONCEPT



Our Journey and The ENDGAME

Centre For Innovation

The Pandemic hasn't stopped us from designing and learning but we are yet to assemble the hardware for a demonstrable prototype. However we do expect to soon have one.

Once we have our working model, we plan to improve accuracy and add features like navigation, smartphone compatibility and our very own Google voice Assistant etc.

and maybe someday see the invention bringing smile in other lives.

SAHAAY
Social Innovation Club

Thank You

- Team Vision

Centre For Innovation

SAHAAY
Social Innovation Club