Guardian Eyes
Final Presentation

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Conclusion

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Recap & Changes

Part.1

Recap

Motivation

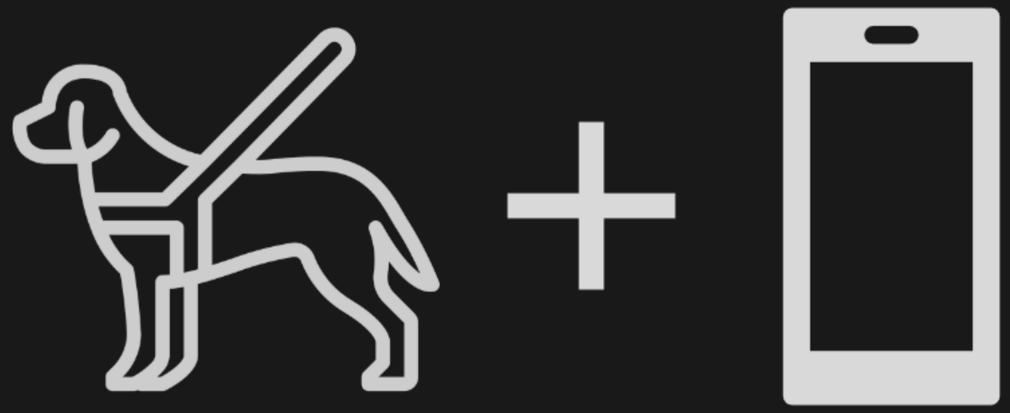
: 모바일 환경을 이용한 시각장애인들을 위한 안내 도우미

Proposed Idea

: Tensorflow + ARcore + Sound feedback

Novelty

: Vision-based approach



Rescope from midterm

Before midterm

계단 등 바닥 장애물들을 custom deeplearning model을 통해 감지

After midterm

Custom deeplearning model을 개발하지 않고, Google AR Core의 기능을 이용해 지면 감지를 구현

Demo

Part.2

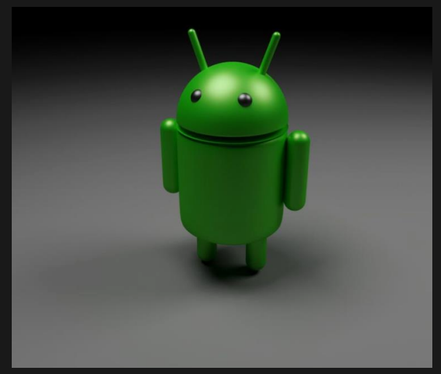
Demo

Technical details

Part.3

Technical details

DEVELOPMENT ENVIRONMENT



ARCore

OpenCV

OpenGL

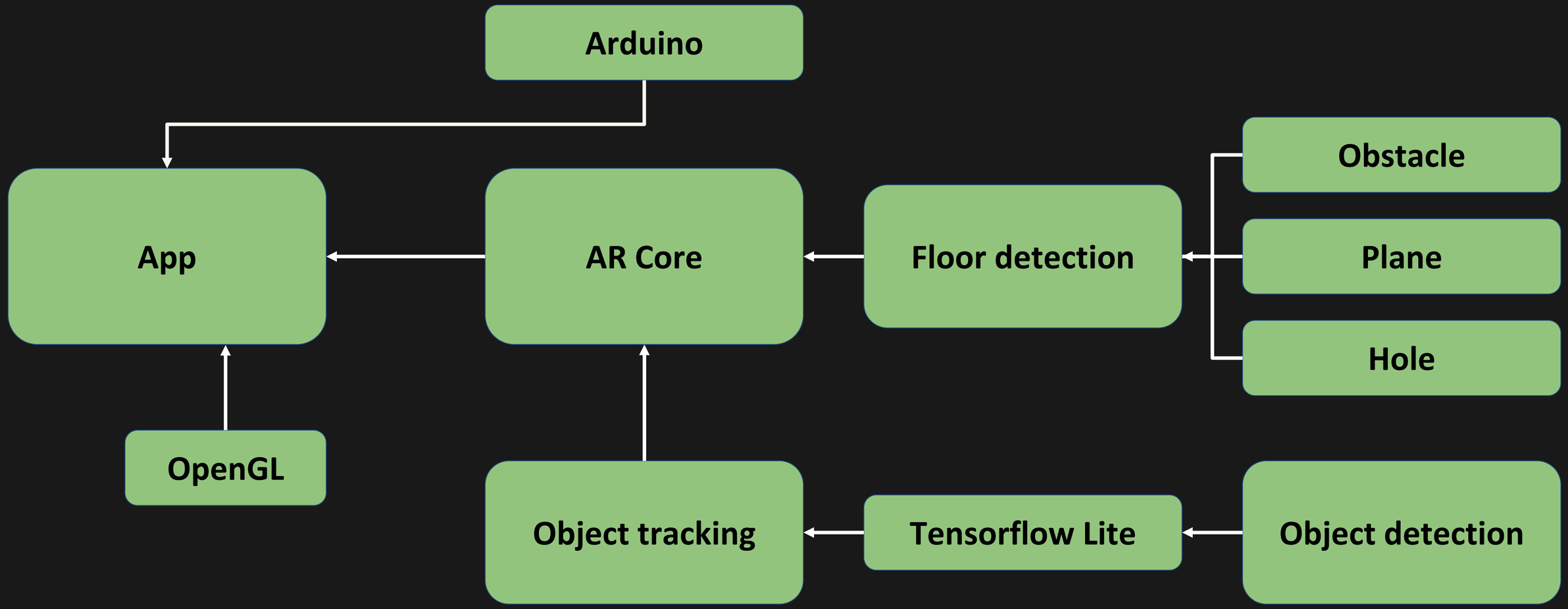
GitHub

TensorFlow Lite

ARDUINO

Technical details

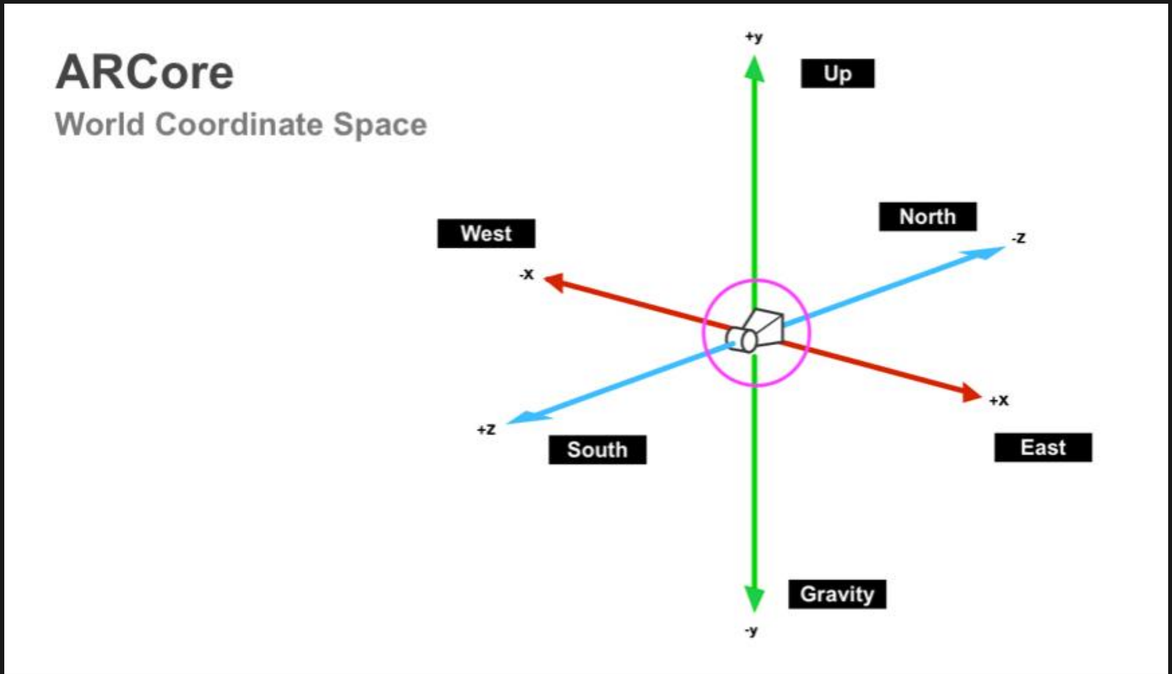
SYSTEM ARCHITECTURE



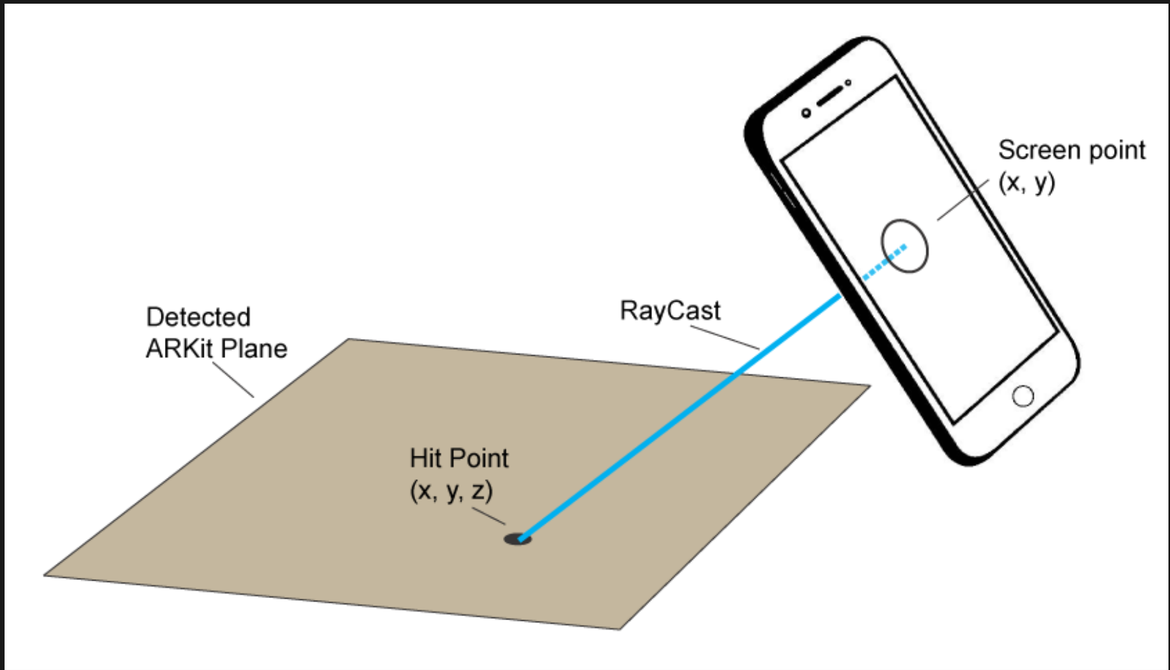
Technical details

(1) AR CORE : Floor detection

Approach



Real-world 3d coordinate system



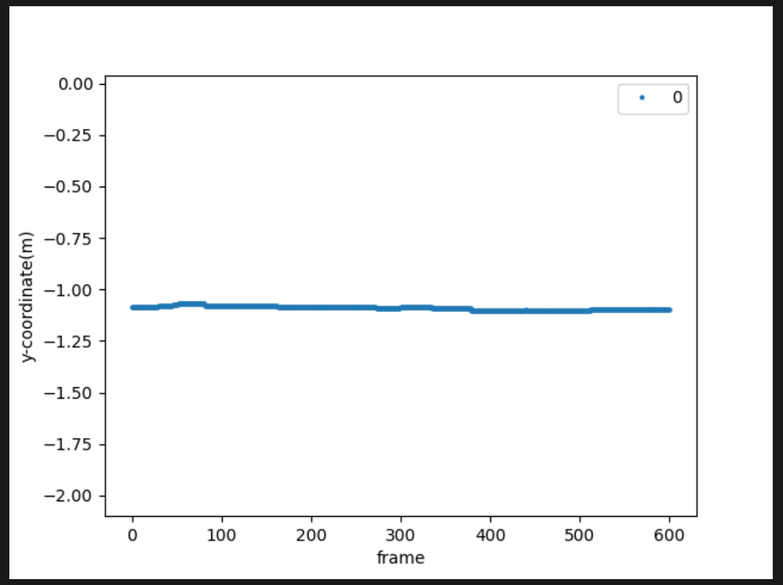
Get location of plane

Technical details

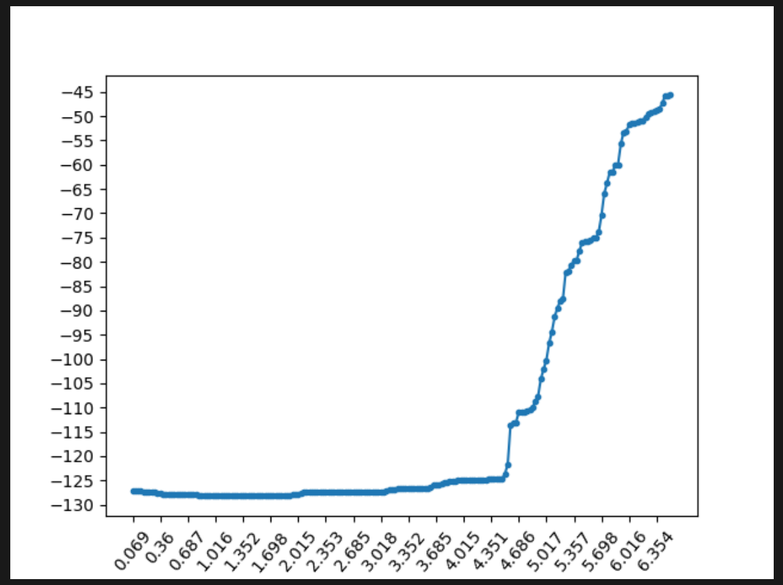
(1) AR CORE : Floor detection

Data

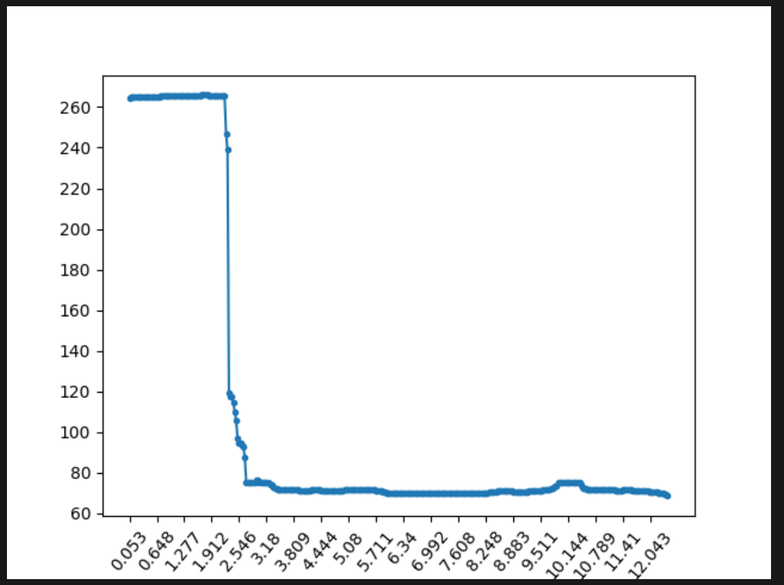
Plane



Obstacle



Hole



Technical details

(1) AR CORE : Floor detection

Implementation

Slope Threshold

```
If (data.slope > threshold1)
        state = ‘Obstacle’
else if (data[start] - data[end] > threshold2)
        state = ‘Hole’
else
        state = ‘Plane’
```

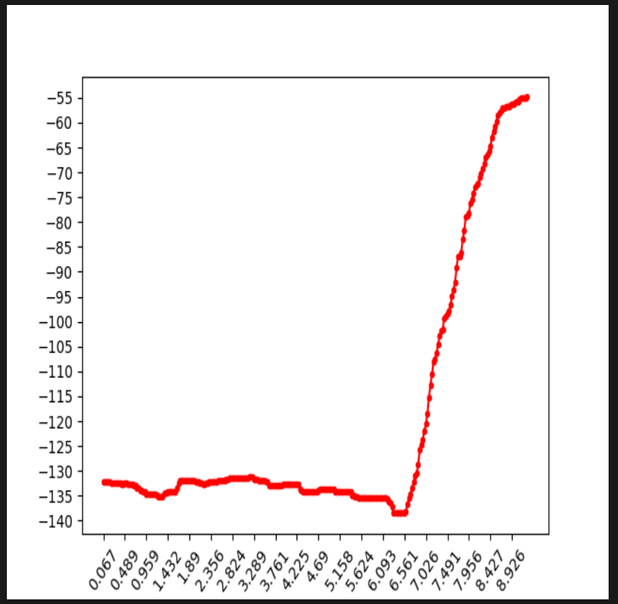
Height difference

Technical details

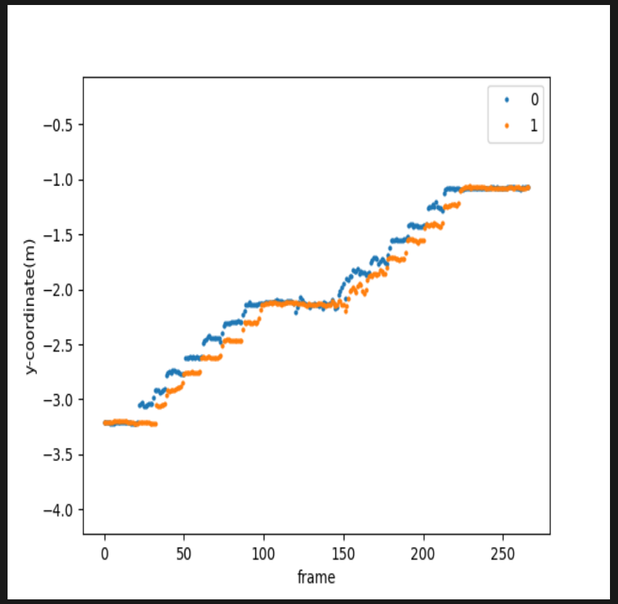
(1) AR CORE : Floor detection

Furthermore

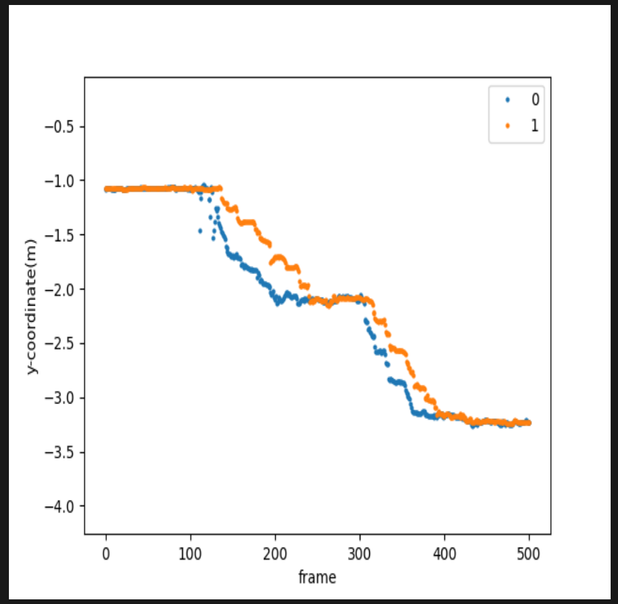
Wall



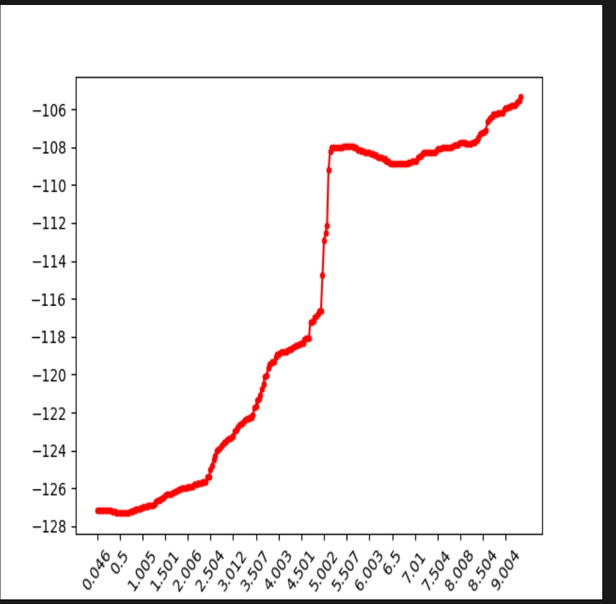
Upstair



Downstair



Raised spot

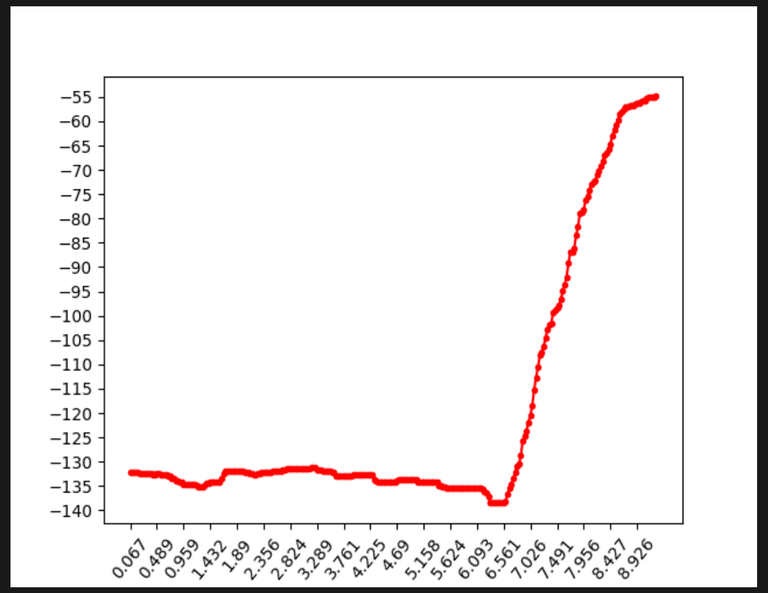


Technical details

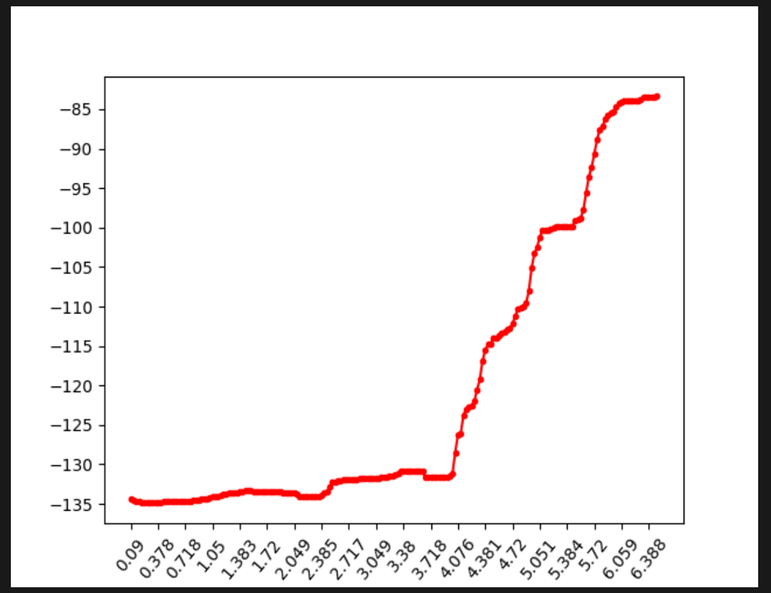
(1) AR CORE : Floor detection

Challenges 1.

Wall



Upstair

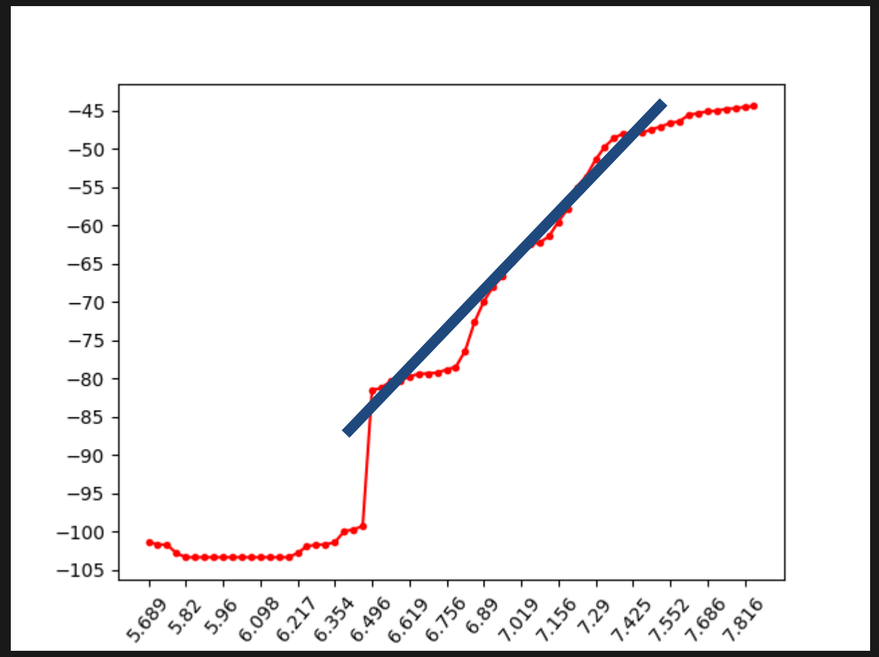


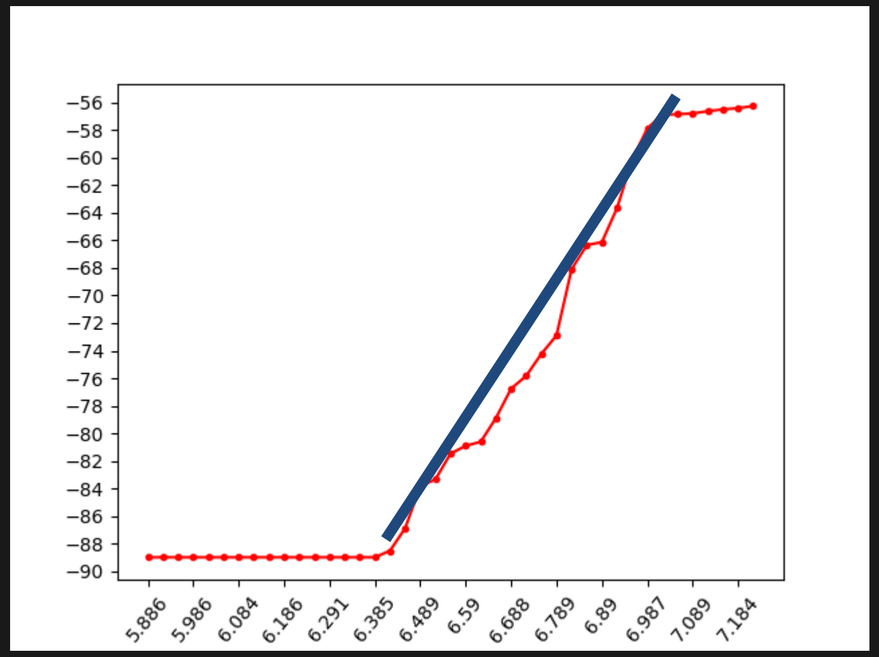
→ **There's not much difference in a short term.**

Technical details

(1) AR CORE : Floor detection

Challenges 2.



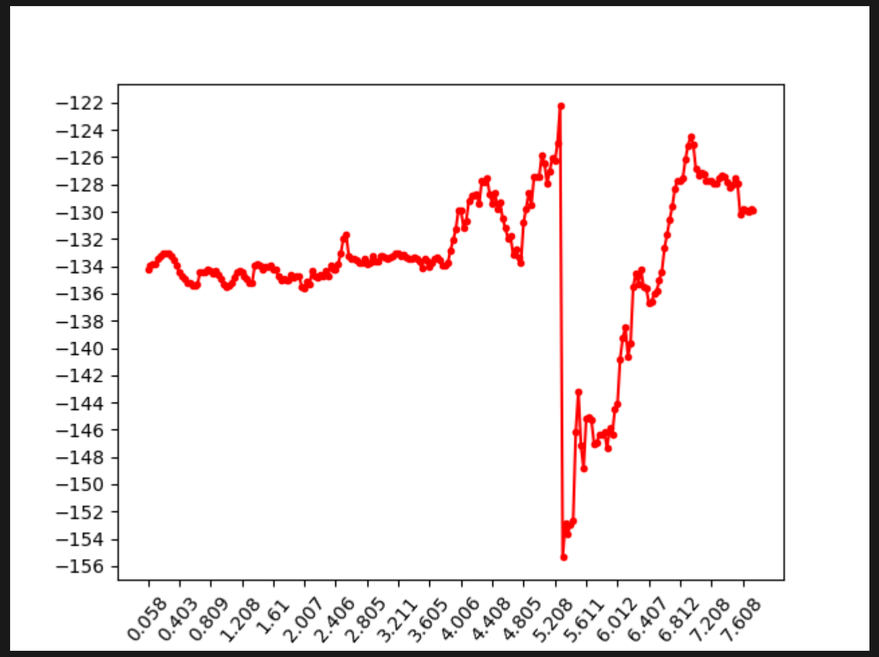


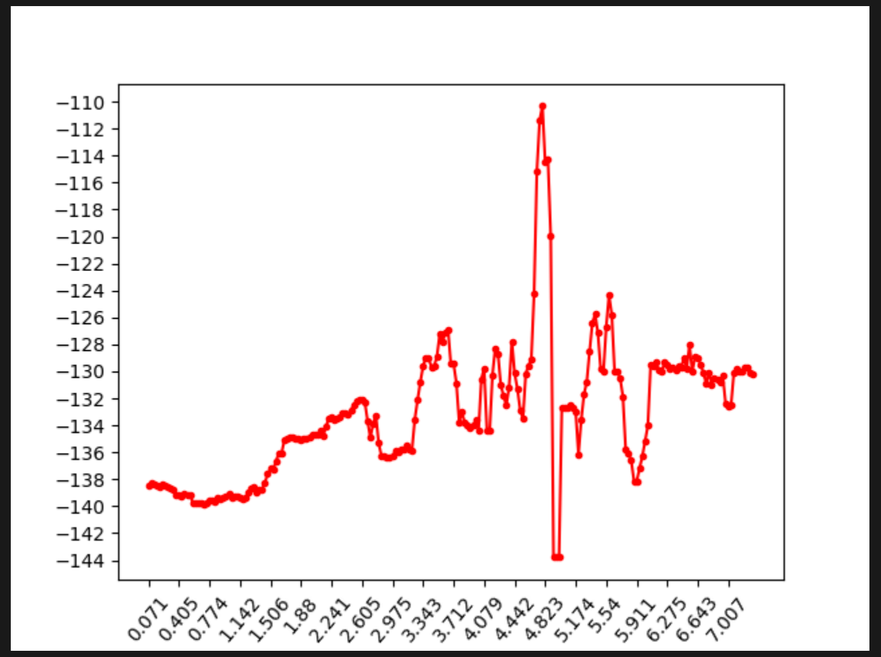
→ **Difference in data according to the walking speed.**

Technical details

(1) AR CORE : Floor detection

Challenges 3.



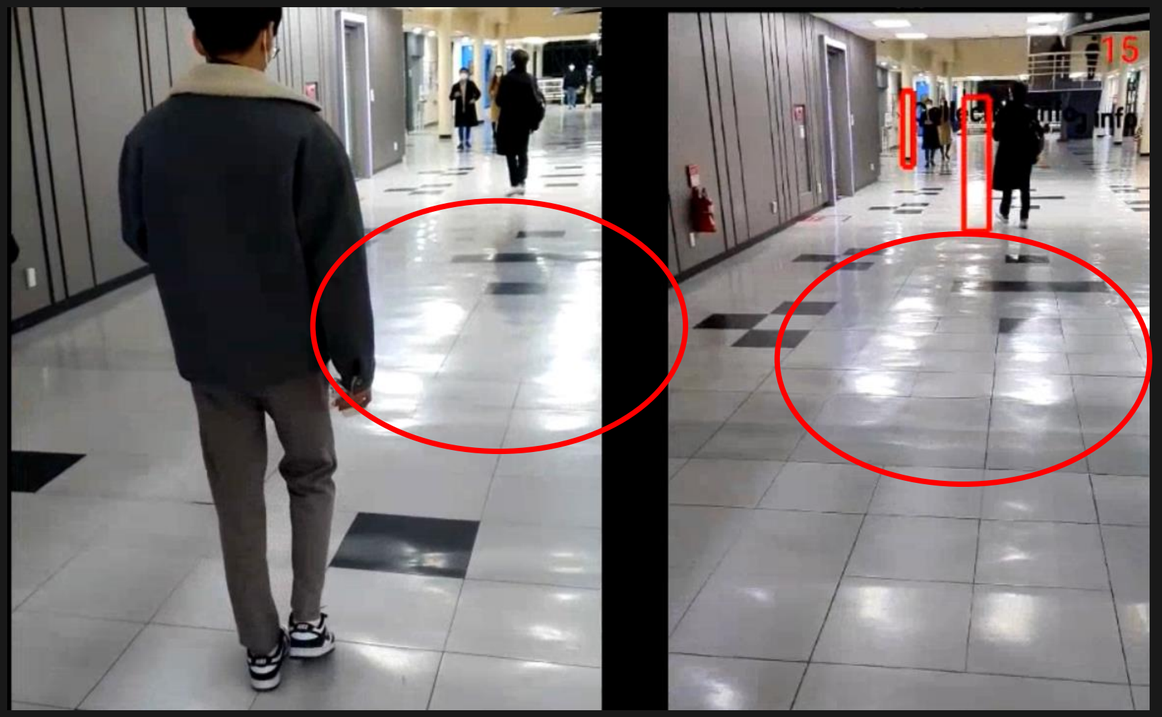


→ **Too much noise in data**

Technical details

(1) AR CORE : Floor detection

Challenges 4.



→ **Error occured by illuminance of surfaces**

Technical details

(1) AR CORE : Floor detection

Possible Solution

- Use a good noise cancellation algorithm
- State classification with deep learning
- Improve performance of AR Core

Technical details

(2) OBJECT TRACKING : object detection

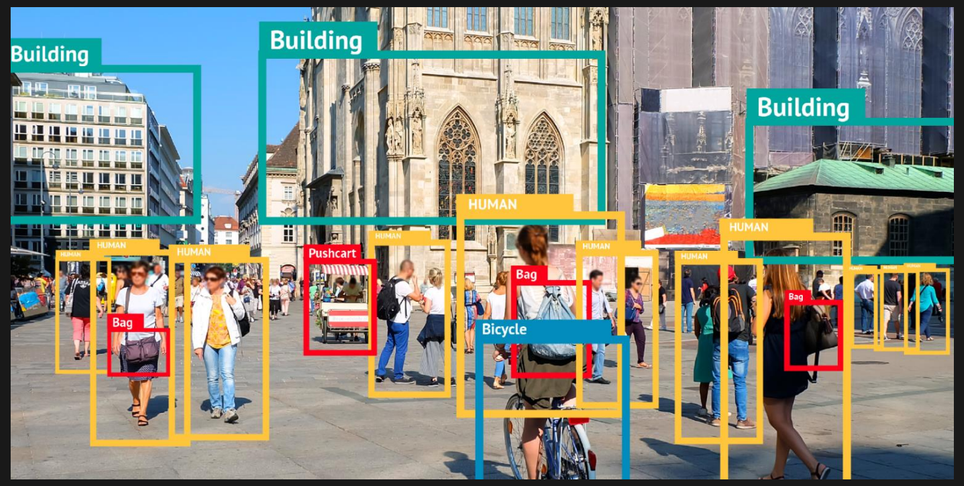
Approach

→ **Warning in advance**
if there’s an object at risk of hitting

Technical details

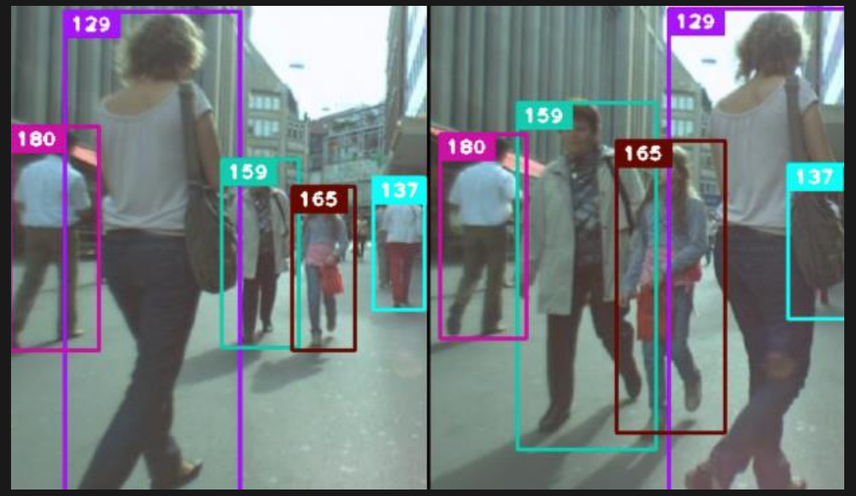
(2) OBJECT TRACKING : object detection

Structure



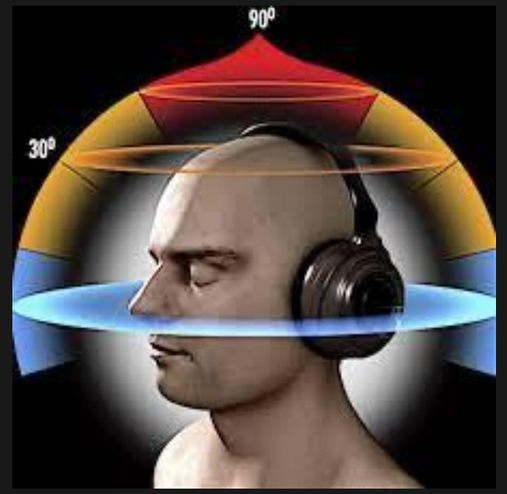
Object detection

+



Object tracking with SORT Algorithm

+

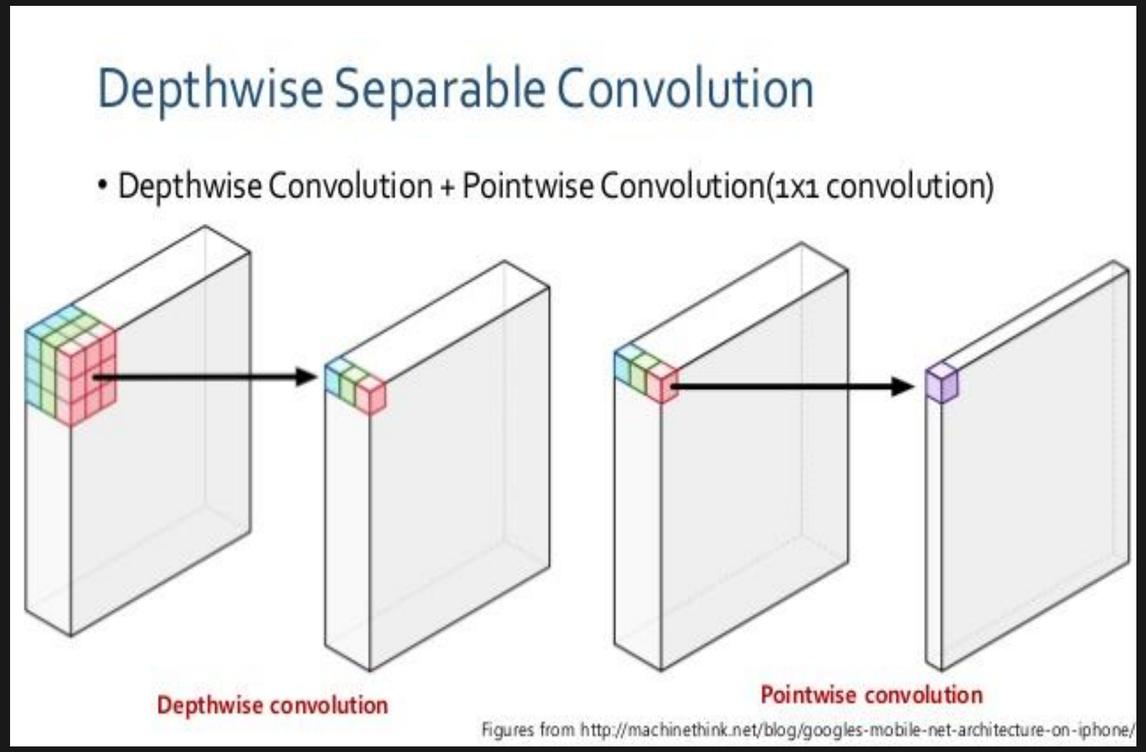


3D sound feedback

Technical details

(2) OBJECT TRACKING : object detection

Object detection



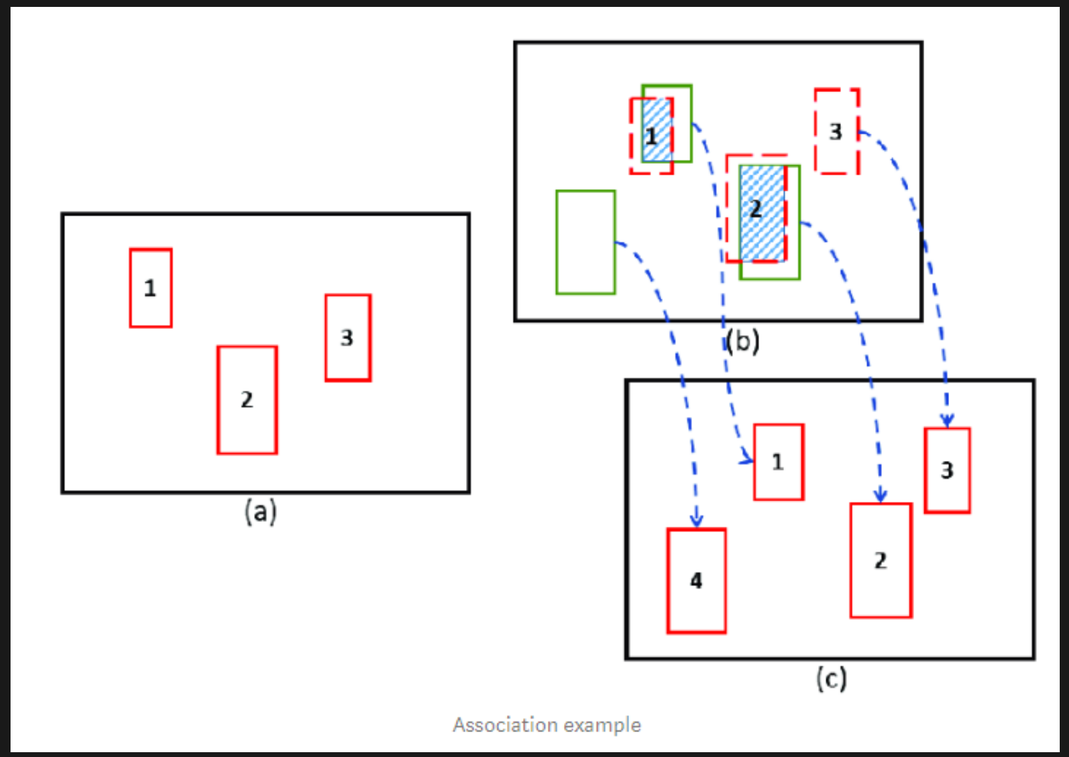
Mobilenet v1

Coco dataset

Technical details

(2) OBJECT TRACKING : object detection

Object tracking : SORT(Simple Online Real-time Tracking)



Kalman Filter

+

Hungarian Algorithm

Technical details

(2) OBJECT TRACKING : object detection

3D sound feedback

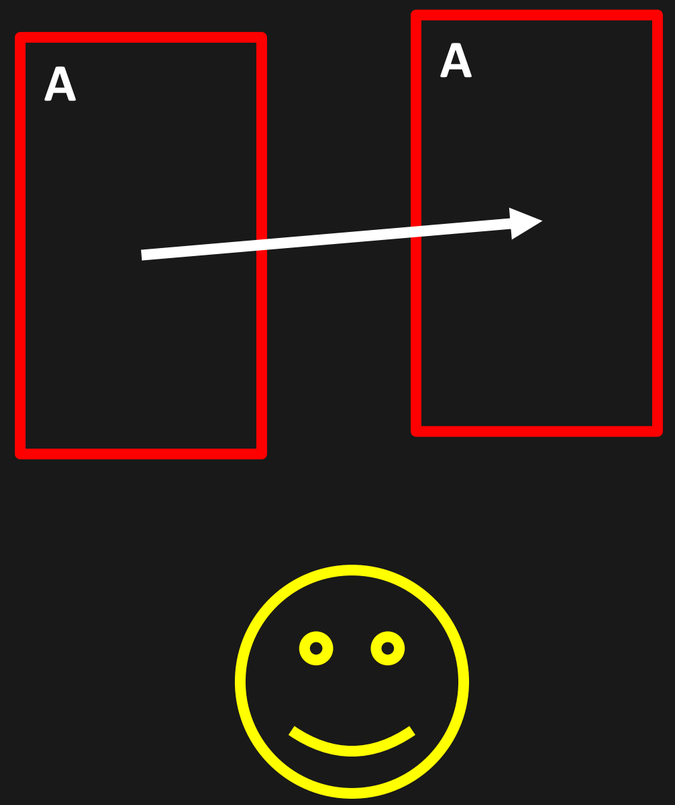
Google VR

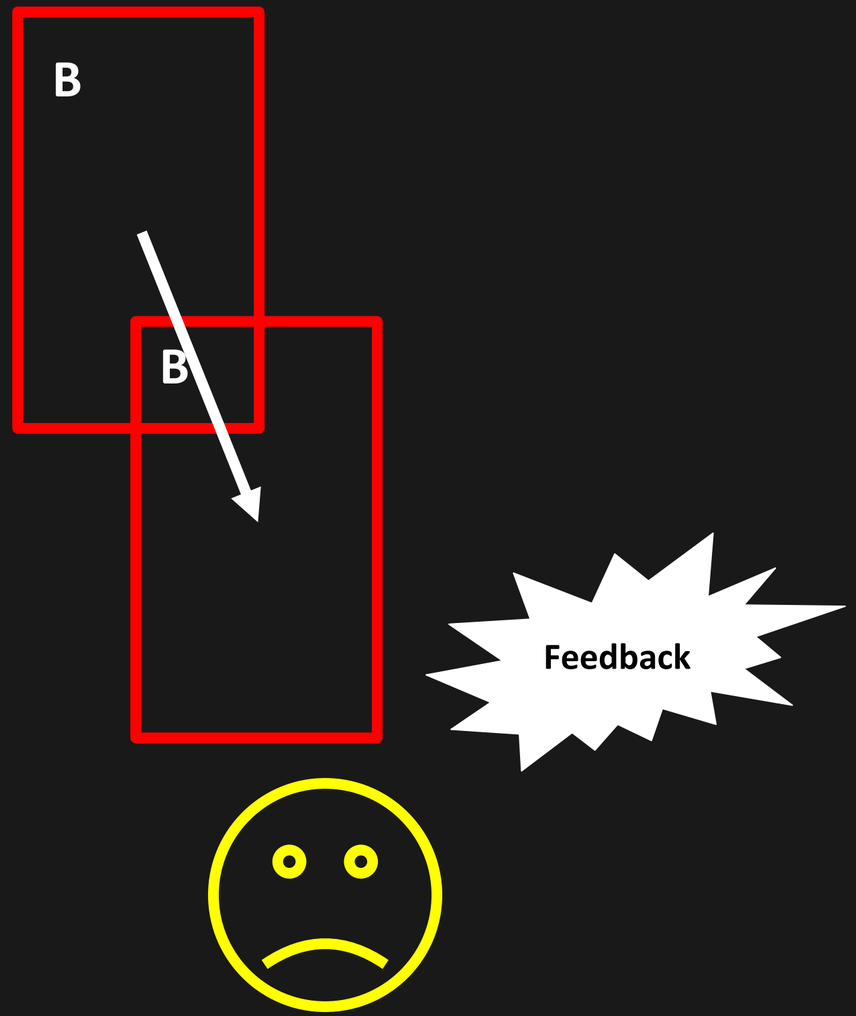
GVR Audio Engine

Technical details

(2) OBJECT TRACKING : object detection

Detailed Implementation





Technical details

(2) OBJECT TRACKING : object detection

Limitation

Too much noise in data → Velocity vector is not accurate

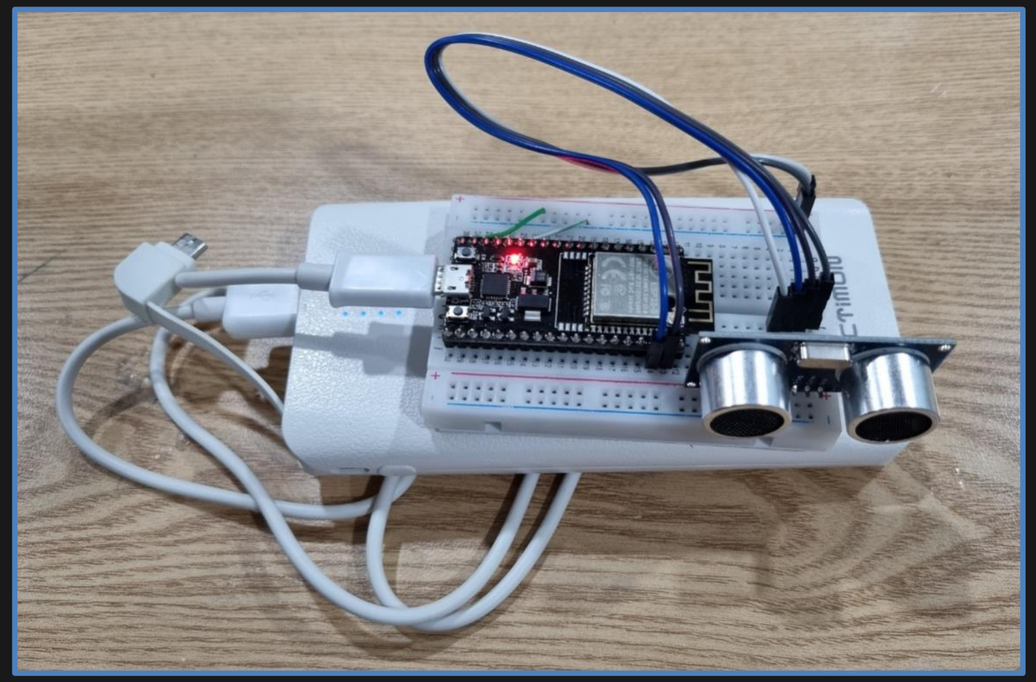
Solution

Take a long frame to calculate the velocity vector

Use a function in GVR audio engine

Technical details

(3) ARDUINO : 그 외 위험요소 감지



Arduino gives vibrate feedback
when object approaches from blind spot!

Technical details

Evaluation and Success Criteria

사용 기기별 FPS

측정 기기	갤럭시 S21+	갤럭시 S20	갤럭시 노트10	갤럭시 S10	갤럭시 S9
FPS	28	25	20	17	5

Technical details

Evaluation and Success Criteria

Accuracy = (TP+TN) / (TP+TN+FP+FN)
Precision = TP / (TP+FP)
Recall (검출률) = TP / (TP+FN)

# of FN = 0, 위험이 있는데 감지하지 못하는 상황은 없었다!

Recall = 100%
Accuracy = Precision

Technical details

올라가는 계단

평가항목	감지 성공	위험이 없는데 감지	Accuracy(%)
Stationary object	-	4	0
Moving object	1	0	100
Obstacle	2	0	100
Hole	-	0	-
총계	3	4	43

Technical details

내려가는 계단

평가항목	감지 성공	위험이 없는데 감지	Accuracy(%)
Stationary object	-	4	0
Moving object	5	0	100
Obstacle	-	2	0
Hole	2	0	100
총계	7	6	54

Technical details

강의실

평가항목	감지 성공	위험이 없는데 감지	Accuracy(%)
Stationary object	3	0	100
Moving object	-	0	0
Obstacle	-	0	0
Hole	-	0	0
총계	3	0	100

Technical details

301동 1층, 실제 상황

평가항목	감지 성공	위험이 없는데 감지	Accuracy(%)
Stationary object	3	3	50
Moving object	5	0	100
Obstacle	1	4	20
Hole	-	2	0
총계	9	9	50

Conclusion

1. 어려운 주제였음에도 적절한 scope 조절과 많은 heuristic을 통해 모든 위험을 감지하는데 성공했다.

2. 정확도는 50%를 달성하였다.

3. 하드웨어의 한계 내에서 가능한 최선의 성능을 끌어내는데 성공하였다.

Project management

Part.4

Project management

(1) TIMELINE

IDEA THINKING

주제설정

1주차

2주차

GUARDIAN EYES PROJECT 시작

model training
data collection
ARCORE 조사

MOBILE APP 시스템구축

UI 개발

3주차

4-5주차

MODEL TEST

COMBINE custom ML model with ARCORE

MIDTERM PRESENTATION

REPLACE floor detecting model with ARCORE

6-7주차

8-9주차

FLOOR DETECTION HEURISTICS STUDY

FIND proper threshold

OBJECT TRACKING

COMBINE object tracking with ARCORE

10주차

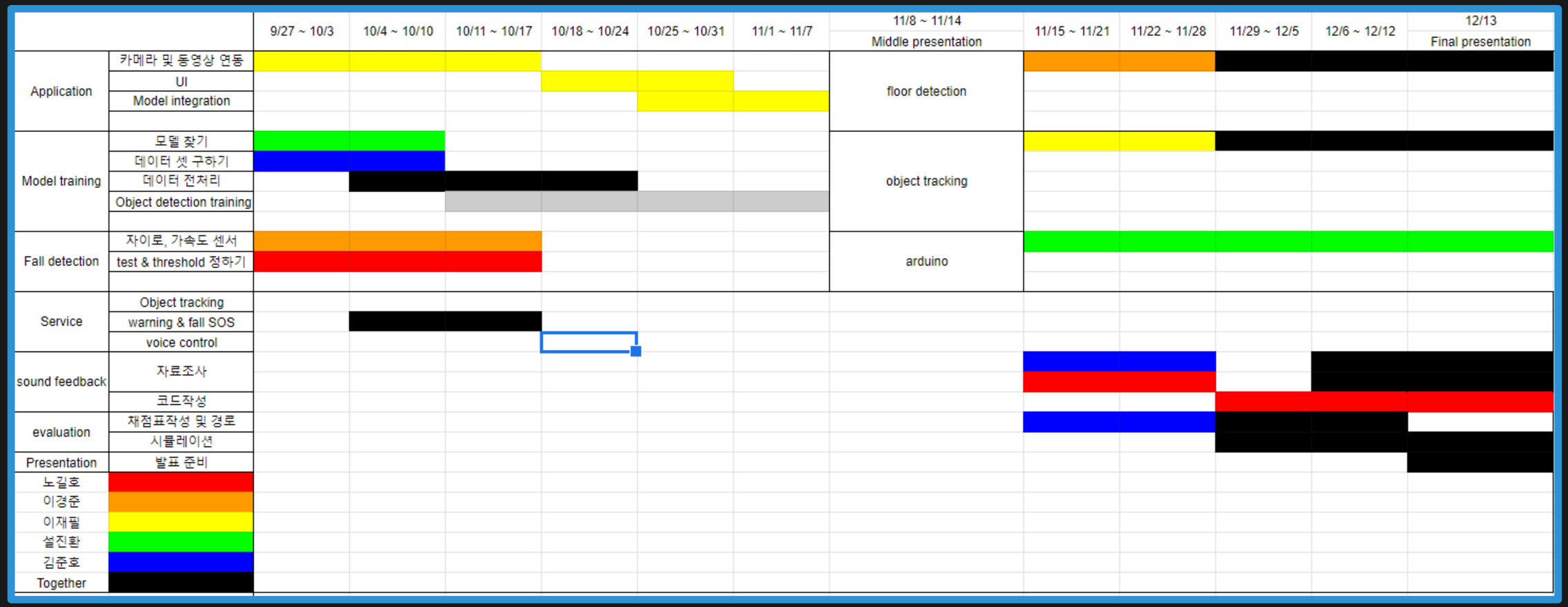
Today

Final PRESENTATION

Make guardian eyes successful

Project management

(2) ROLES AND CONTRIBUTIONS



Lesson learnt

LIMITATION IN MOBILE APP

THE IMPORTANCE OF DEEP LEARNING TO OBJECT DETECTION & CLASSIFICATION

VARIOUS RESEARCH TOPICS REMAIN IN MOBILE RESEARCH

Thank you for listening