GOOD MORNING!
早上好!
안녕하세요!

DAY 2

NEW NOTION LINK

DAY 1 RECAP

2 PROJECTS

- Mini Project (Individual Team)
  - For learning techniques

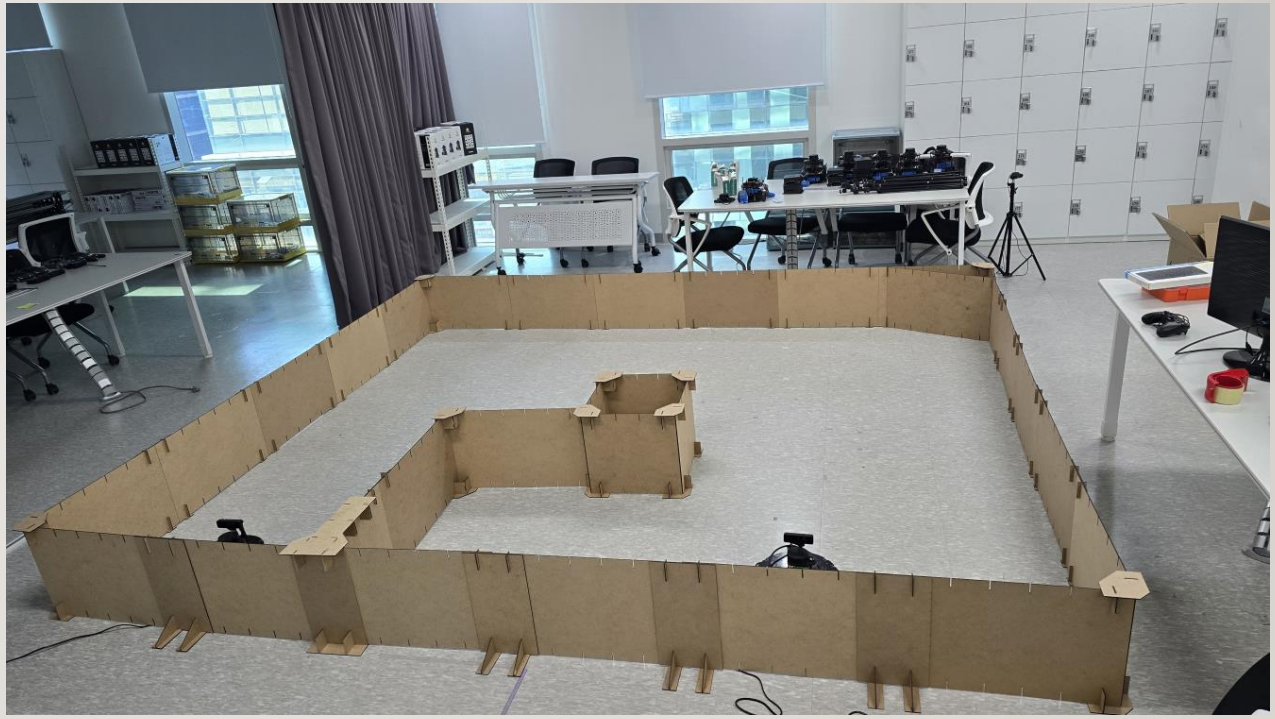
차시	구분	세부사항
1	프로젝트 계획 및 환경 구축	시스템 개발 프로세스의 이해, 개발 환경 구축
2	기술 탐색 및 검증	AI VISION 기술 탐색 및 검증
3	기술 탐색 및 검증	AMR 제어 기술 탐색 및 검증
4	기술 탐색 및 검증	Mini project 완성 및 발표

2 PROJECTS

- Final Project (2 Teams in One)

차시	구분	세부사항
5	프로젝트 설계	외부 시스템 모니터 기술 탐색 및 검증 파이널 프로젝트 시스템 요구사항 설계 및 프로세스 정립
6	개발	기능 구현 및 Unit Test
7	개발	기능 구현 및 Unit Test
8	개발	통합 시스템 구축 및 테스트
9	개발	통합 시스템 구축 및 테스트
10	최종 프레젠테이션 및 시연	프로젝트 발표 및 시연, 산출물 정리, 기술 컨퍼런스

MINI PROJECT DESCRIPTION

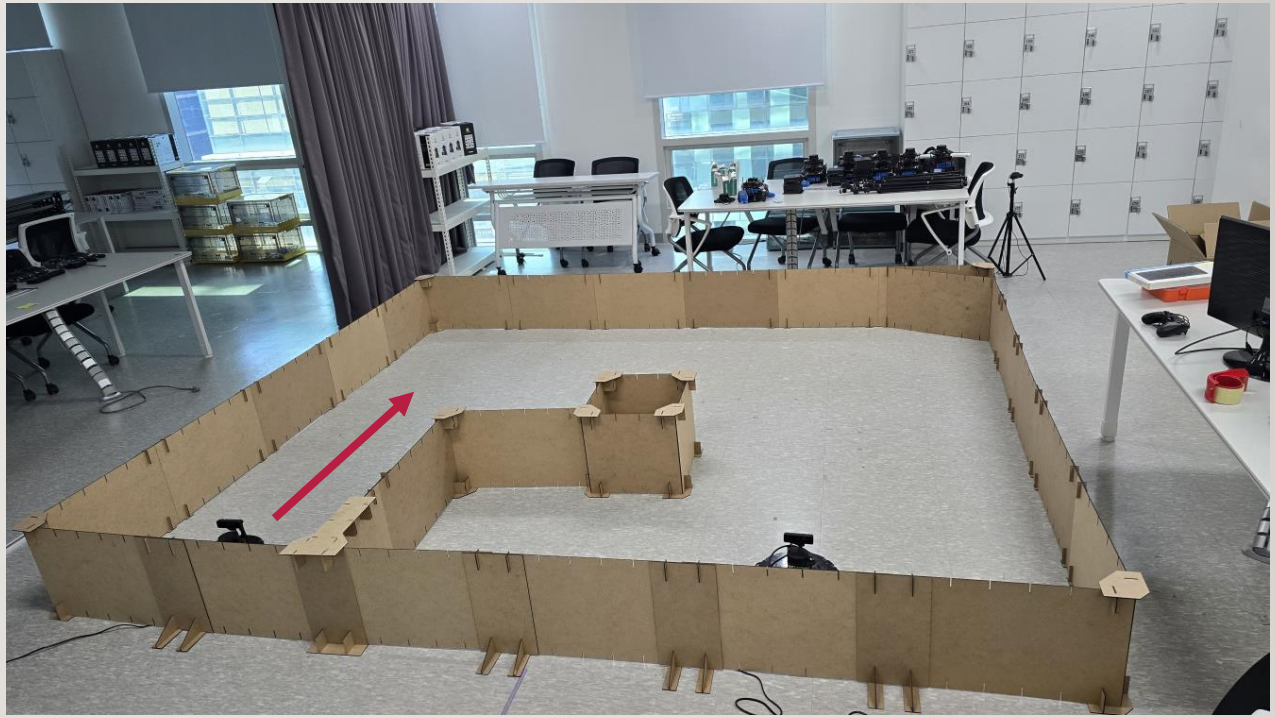


KEY SUBSYSTEM (MODULES) TO DEVELOP

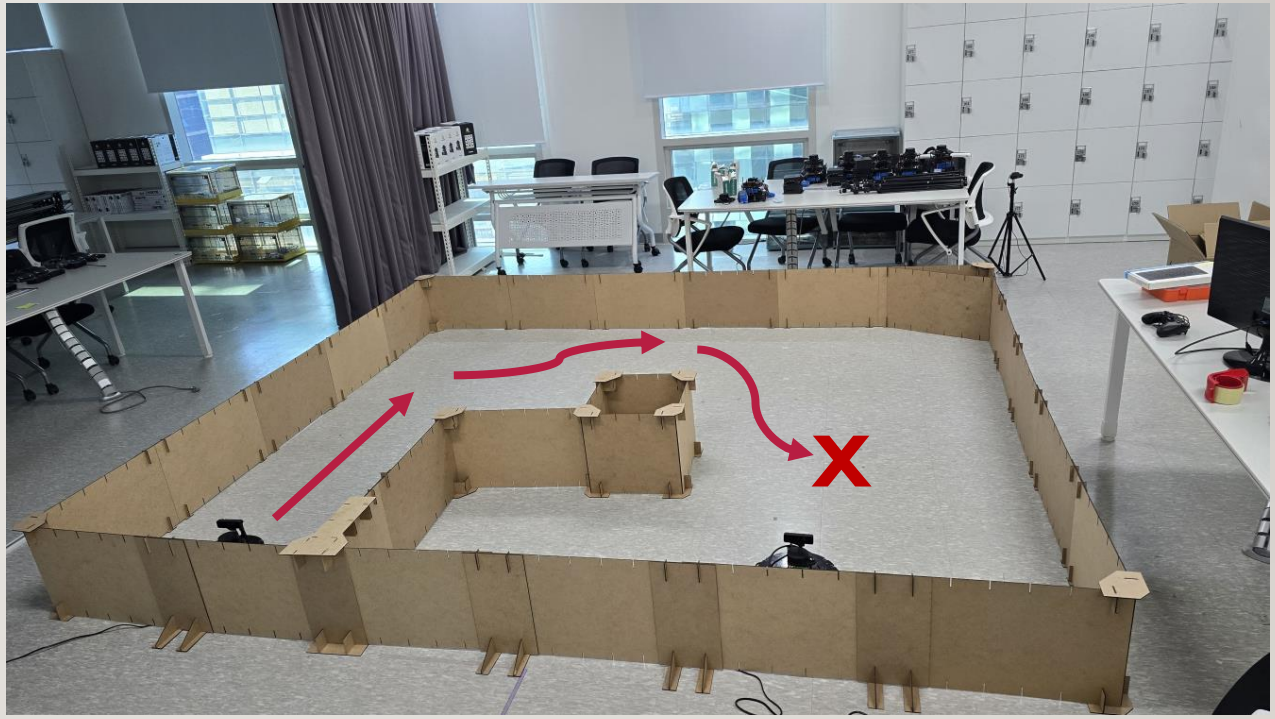
- Detection Alert
  - Camera Capture
  - Object Detection
  - Send messages to other subsystems
- AMR Controller
  - Receive messages and act accordingly
  - Move using (SLAM) with Obstruction avoidance
  - Target Acquisition (Obj. Det.) and Tracking
  - Follow target using camera and motor control

DETECTION ALERT

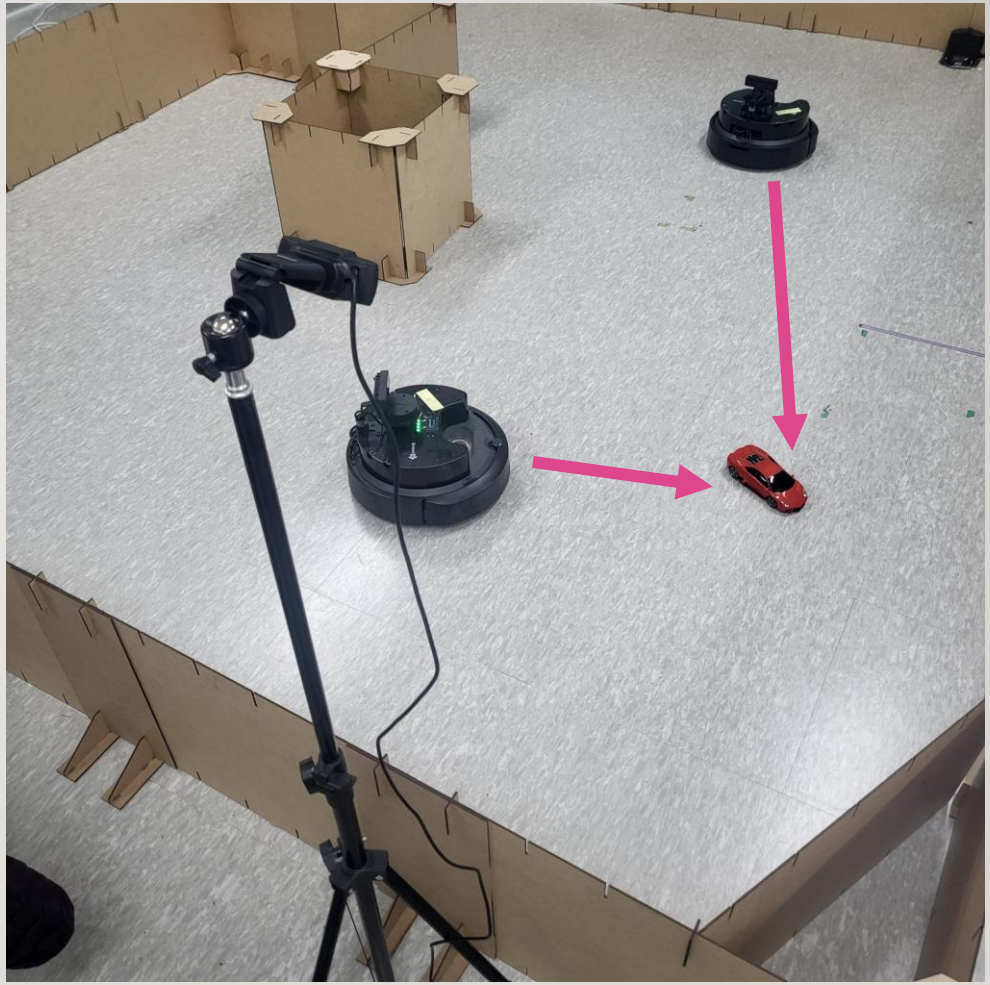
START



NAVIGATE TO A POSITION



TRACK & APPROACH



DAY 1

- Welcome
- Project Introduction
- Introduction to Project Development Process
- Business Requirement Development
- System Requirement Development
- System and Development environment Setup

DAY 2 (MINI PROJECT)

- Yolo객체 인식 모델 활용과 성능 평가 방법 이해
  - Custom Dataset과 Fine Tuning으로 자체 객체 인식 모델 구현 및 평가
  - (Optional)경량화 모델 등 개별 요구사항에 적합한 모델 탐색 및 성능 검증

DAY 2 (MINI PROJECT)

WEB-CAM 기반 객체 인식

- YOLOv8 기반 데이터 수집/학습/deploy (Detection Alert)
  - 감시용 데이터 수집(rc_car, dummy, 등)
  - 감시용 데이터 라벨링
  - YOLOv8 기반 학습
  - YOLOv8 Object Detection

AMR-CAM 기반 객체 인식

- AMR(Autonomous Mobile Robot) Turtlebot4 개발 환경 구축
- 로봇 개발 환경에 완성 모델 서빙 및 테스트 / 로봇 H/W, 제반 환경의 한계점 도출
  - Tracking 데이터 수집((rc_car, dummy, 등)
  - Tracking 데이터 라벨링
  - YOLOv8 기반 학습
  - YOLOv8 Object Tracking

DAY 3 (MINI PROJECT)

- Auto. Driving 시스템 학습
  - Digital Mapping of environment
  - Operate AMR (Sim. & Real)
  - Tutorial 실행
  - Detection, Depth and AMR 주행
  - 로봇 개발 환경에 적용 및 테스트 / 로봇 H/W, 제반 환경의 한계점 도출

TURTLEBOT4 시뮬레이션 DEMO

- SLAM과 AutoSLAM으로 맵 생성
- Sim. Tutorial 실행
- Detection, Depth and AMR 주행 example

DAY 3 (MINI PROJECT)

REAL ROBOT

- Manually operating the AMR (Teleops)
- autonomous driving 시스템 with obstacle avoidance
  - Digital Mapping of environment
  - Launching Localization, Nav2, and using Rviz to operate a robot
  - Goal Setting and Obstacle Avoidance using Navigation

TUTORIAL

- Turtlebot4 API를 활용한 Initial Pose Navigate_to Pose 구현
- Turtlebot4 API를 활용한 Navigate_Through_pose, Follow Waypoints 구현

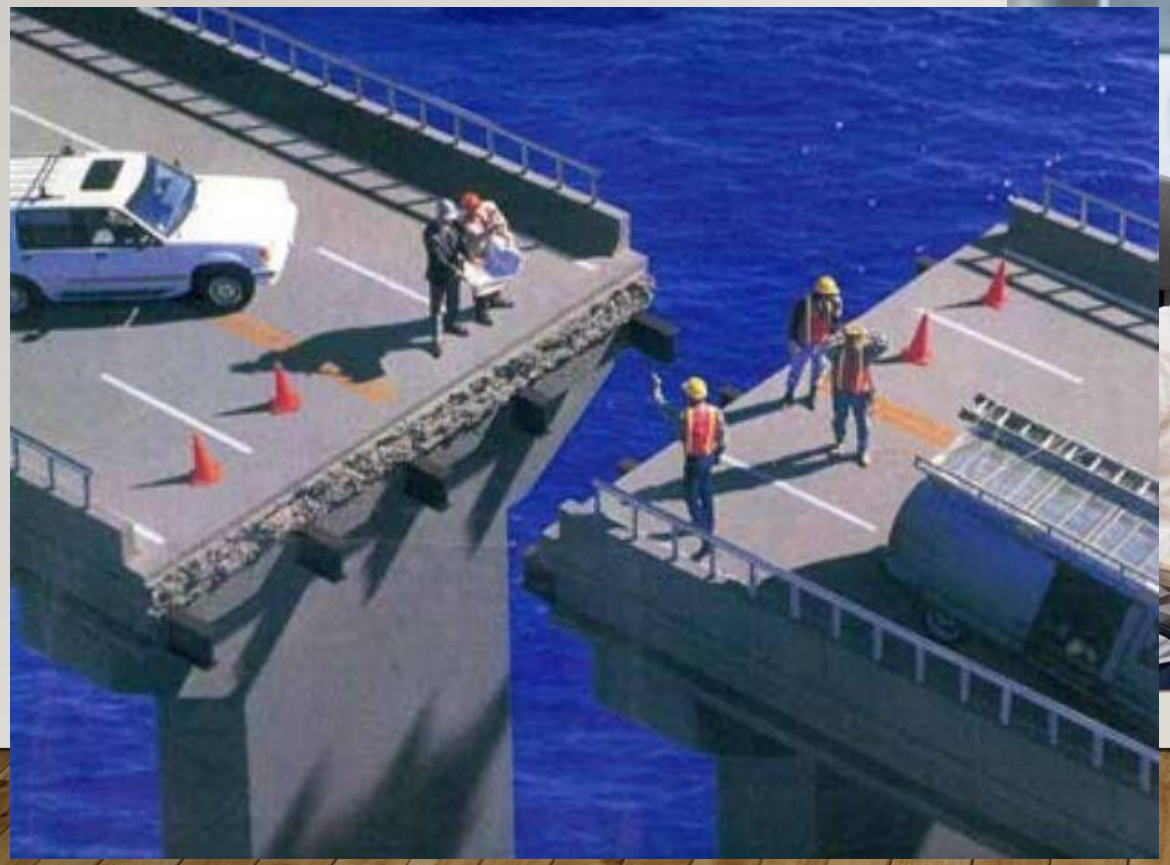
HOW TO WORK TOGETHER

- Participate, Participate, Participate!!!
- No long emails or Kakaotalk, prefer face to face
- Be open to suggestions and idea
- Be proactive (적극적), take initiative (주도적)
- HOW is as important as WHAT
- Ask the right questions? (to **YOU, team** and me)
- Investigate/Research/Analyze

프로젝트 RULE

80/20 → 20/80

TEAMWORK AND PROJECT MANAGEMENT



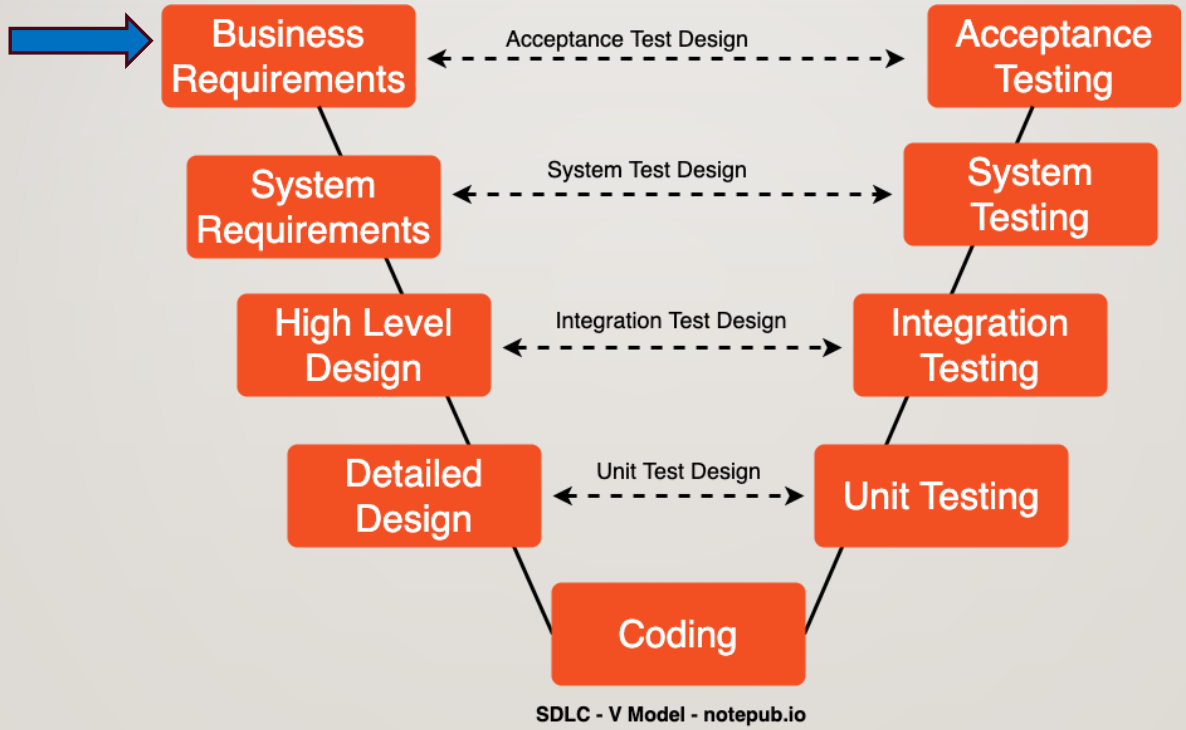
BRAINSTORMING RULES

- Every input is good input
- Do not critique inputs only seek to understand
- Organize inputs into logical groupings
- Sequence or show relationships as needed
- Use Posted Notes on Flip Chart

PROJECT DEVELOPMENT IS A PROCESS

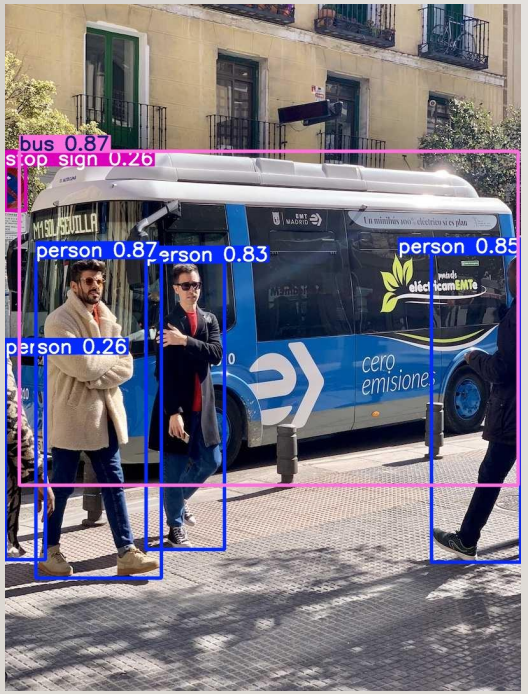
SW DEVELOPMENT PROCESS

Why and What



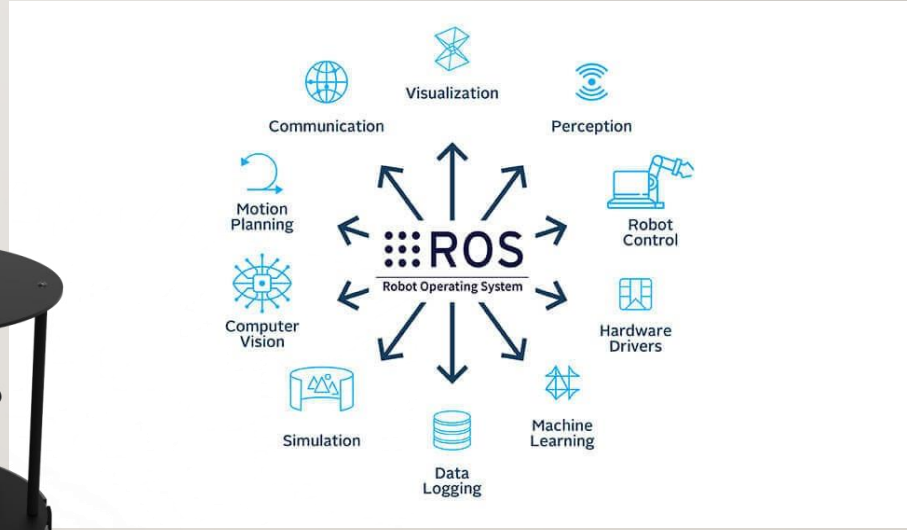
ADVANCED TECHNIQUES THAT WE HAVE

- AI Object Detection



- AMR
  - Navigation with obstruction avoidance
  - Sensors

- ROS2



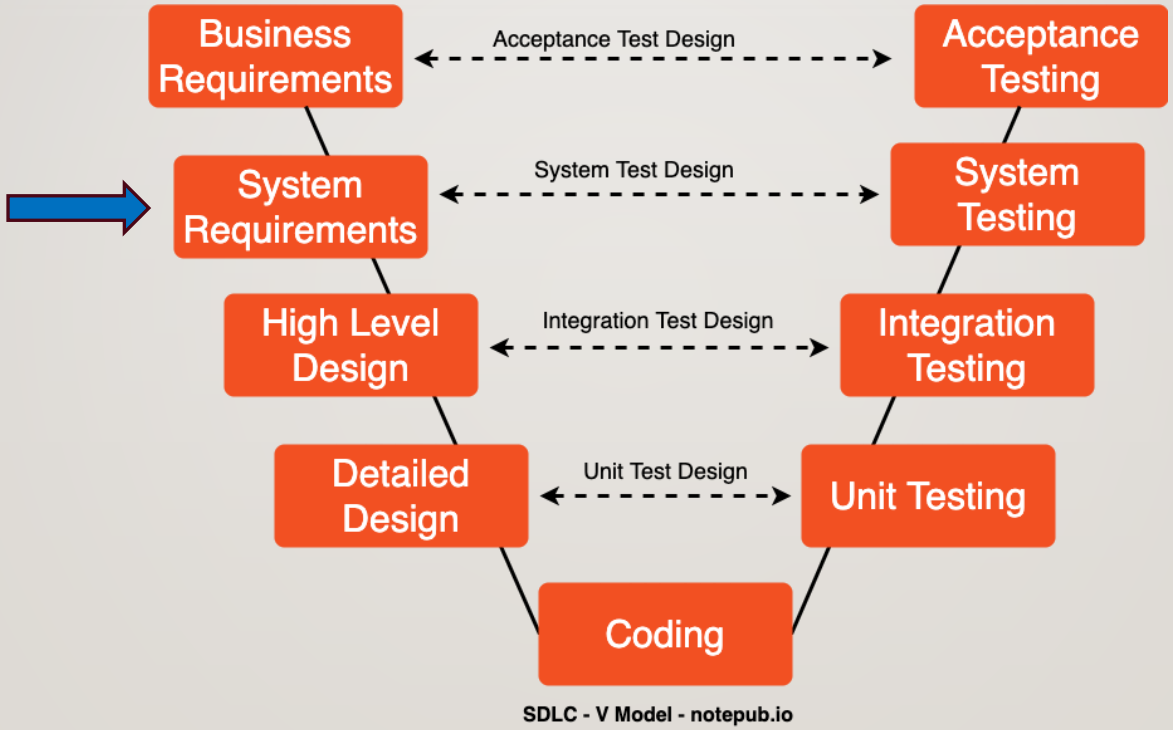
TEAM EXERCISE 1

Brainstorm Business/Solution Requirement for Your Solution and write business requirement statement

Using the posted notes and flipchart as needed

SW DEVELOPMENT PROCESS

With What
And
How Much

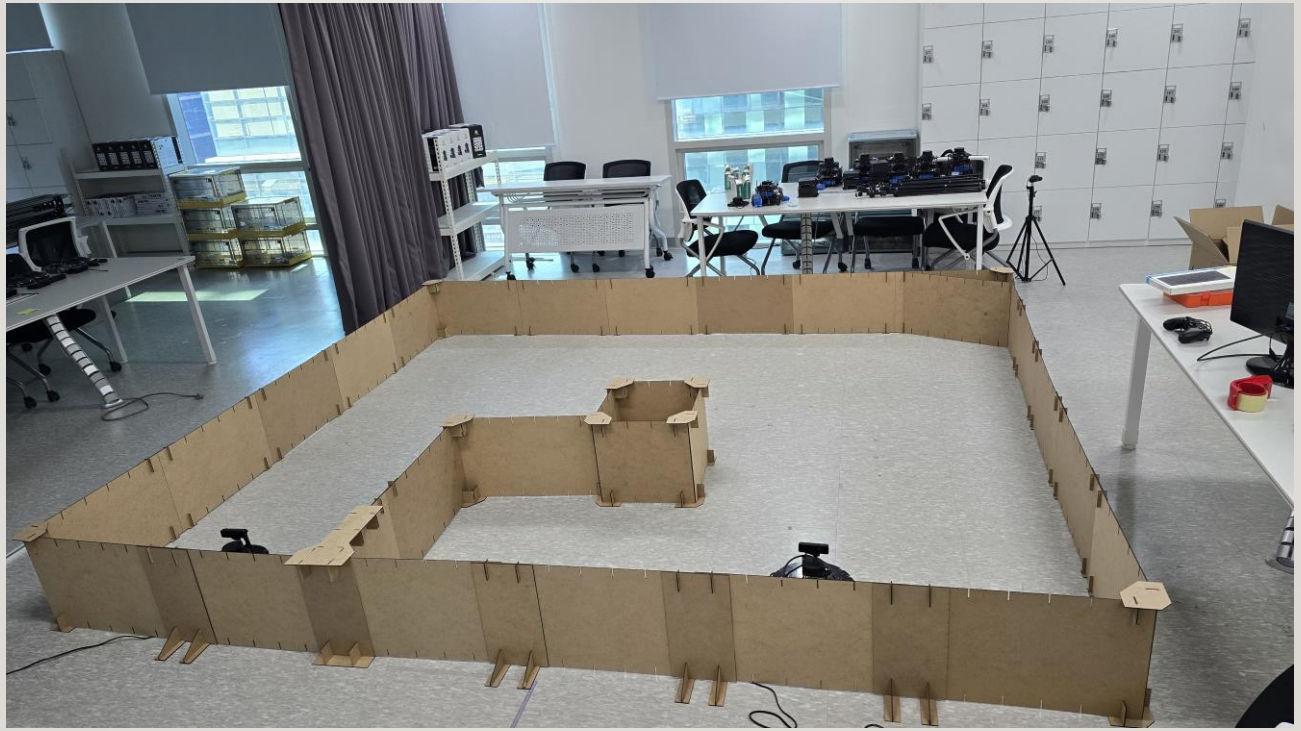


TEAM EXERCISE 2-1

Brainstorm System/Solution Requirement for Your solution and document

Using the posted notes and flipchart as needed

YOUR PROJECT ENVIRONMENT



BASE HW/OS

- PC
  - Ubuntu 22.04
  - USB Camera

- AMR
  - TurttleBot4
  - Ubuntu 22.04

- Network
  - Wifi

TEAM EXERCISE 2-2

Brainstorm mini-project System Requirement for the project and document

Using the posted notes and flipchart as needed

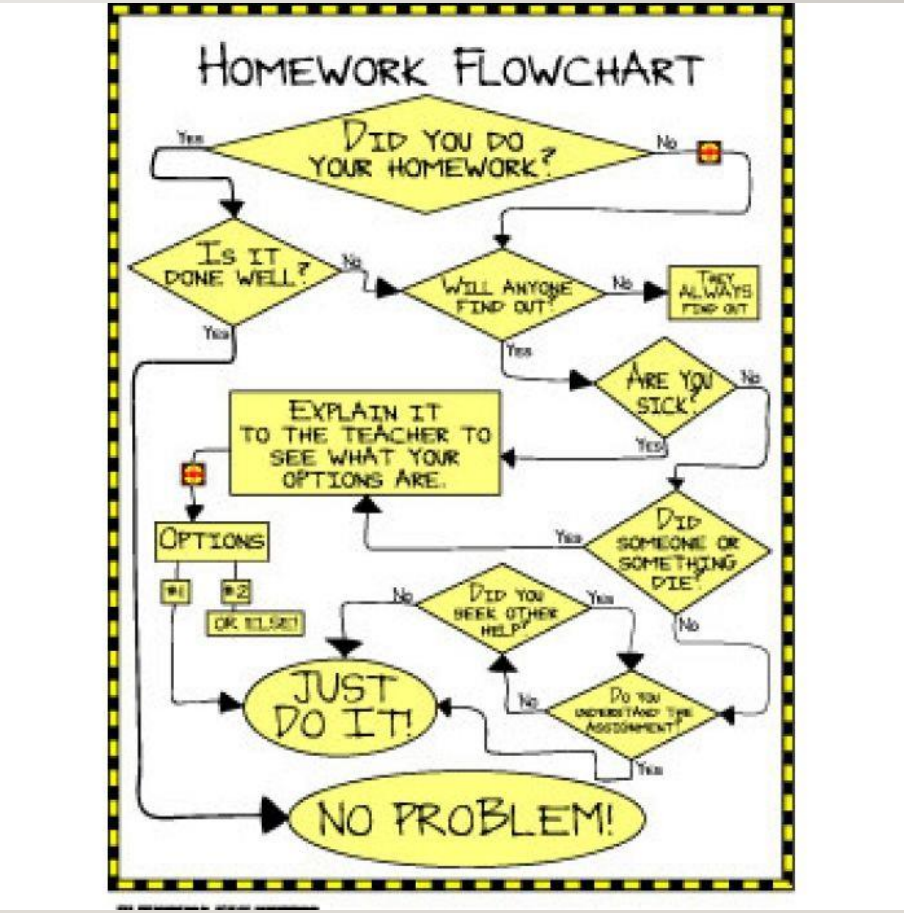
Include where, when, what will be used

DEVELOP YOUR BUSINESS SCENARIO (USE-CASE) PROCESS DIAGRAM

Using the posted notes and flipchart as needed

VISUALIZATION – SCENARIO PROCESS DIAGRAMS

- As-Is Functional Process Diagram
  - Current states
- To-Be Functional Process Diagram
  - Future states
- Untitled Diagram - draw.io
- https://app.diagrams.net/



SYSTEM AND DEVELOPMENT ENVIRONMENT SETUP

HOMEWORK CHECK

AMR (TURTLEBOT4)

- Features · User Manual
- https://turtlebot.github.io/turtlebot4-user-manual/overview/features.html

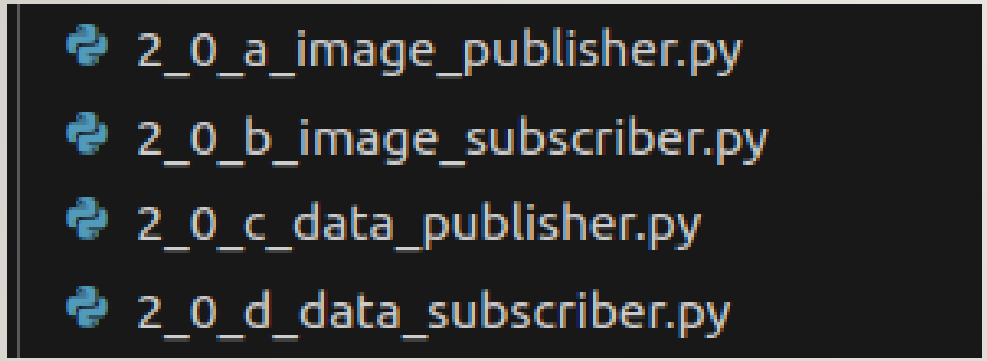
- Review the content

PLEASE REVIEW YOU WORK FROM EARLIER ONLINE CLASS

- Yolo obj. Det. Vs. Yolo Tracking
  - Object Detection - Ultralytics YOLO Docs
  - Track - Ultralytics YOLO Docs
  - Model Training with Ultralytics YOLO - Ultralytics YOLO Docs
- Yolo
  - Data Labelling (ex: LabelImg/roboflow)
  - Data pre-processing for YoloV8 Training
  - YoloV8 training to create .pt file
  - Using .pt file to predict/inference
- ROS
  - colcon build
  - Node, Topic, Service, Action, Interface, etc. coding

ROS EXERCISE 1

Create a ROS2 Package with these publisher and subscribers



- $ ros2 run rqt_graph rqt_graph
- $ ros2 node list
- $ ros2 node info <node_name>
- $ ros2 topic list
- $ ros2 topic info <topic_name>
- $ ros2 topic echo /chatter
- $ ros2 interface list
- $ ros2 interface show <package_name>/msg/<MessageName>

ROS EXERCISE 2

강의 보조 문서

DAY 1 - Setup/Development Process

New

Aa 이름	상태
평가 지표	시작 전
Turtlebot4 robot 만나기	시작 전
수업 환경 구성	시작 전
.bashrc 구성	시작 전
Turtlebot4 환경 구성_source	시작 전
Turtlebot4 Setup	시작 전
User PC Network Setup(Single Robot Setup)	시작 전
Move robot CLI	시작 전
ROS Workspace Example	시작 전
YOLO Setup	시작 전
Homework_삐뽀삐뽀 소리내기 노드 만들기	시작 전

New page

📝 미션 수행

CLI로 동작 확인

```
ros2 topic pub --once /robot<n>/cmd_audio irobot_creat
 {frequency: 880.0, max_runtime: {sec: 0, nanosec: 300
 {frequency: 440.0, max_runtime: {sec: 0, nanosec: 300
 {frequency: 880.0, max_runtime: {sec: 0, nanosec: 300
 {frequency: 440.0, max_runtime: {sec: 0, nanosec: 300
 ]}"
```

- 각 음이 **0.3초(300ms)** 재생됨
- `880Hz`와 `440Hz`를 번갈아 재생 → 경고음 같은 효과

▼ 삐뽀삐뽀 소리내기 노드 만들기

1. 코드 작성하기

```
#homework
```

2. setup.py 수정

프로젝트 RULE NUMBER ONE!!!

Are we having Fun???

DAY 2

KEY SUBSYSTEM (MODULES) TO DEVELOP

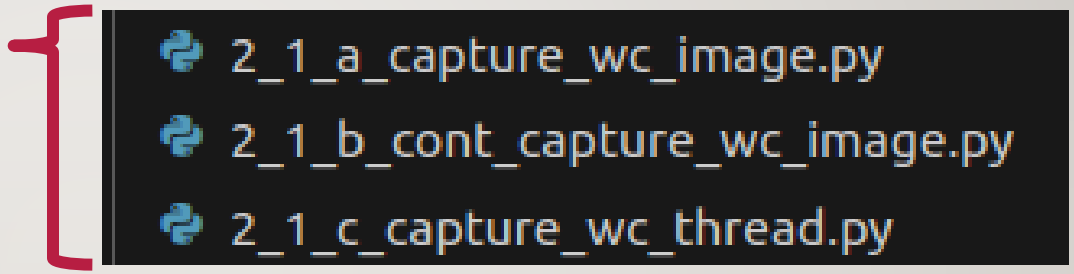
- Detection Alert
  - Camera Capture
  - Object Detection
  - Send messages to other subsystems

- AMR Controller
  - Receive messages and act accordingly
  - Move using (SLAM) with Obstruction avoidance
  - Target Acquisition (Obj. Det.) and Tracking
  - Approach target using camera and motor control

PERFORM DATA COLLECTION FOR DETECTION ALERT

COLLECTION IMAGES FROM WEBCAM

- Image Capture (WEBCAM)



COLLECTION IMAGES FROM AMR CAMERA

- Undock to see camera topics
- Are all camera topics available?
- Which image topic to use?
- Which dimensions and resolution?
- Are Depth and RGB pixel aligned?
- …

UNDOCK/DOCK AMR

UNDOCK

$ ros2 topic list

Check the list

$ ros2 action send_goal /robot<n>/undock irobot_create_msgs/action/Undock "{}"

$ ros2 topic list

Check the list and compare

DOCK

$ ros2 action send_goal /robot<n>/dock irobot_create_msgs/action/Dock "{}"

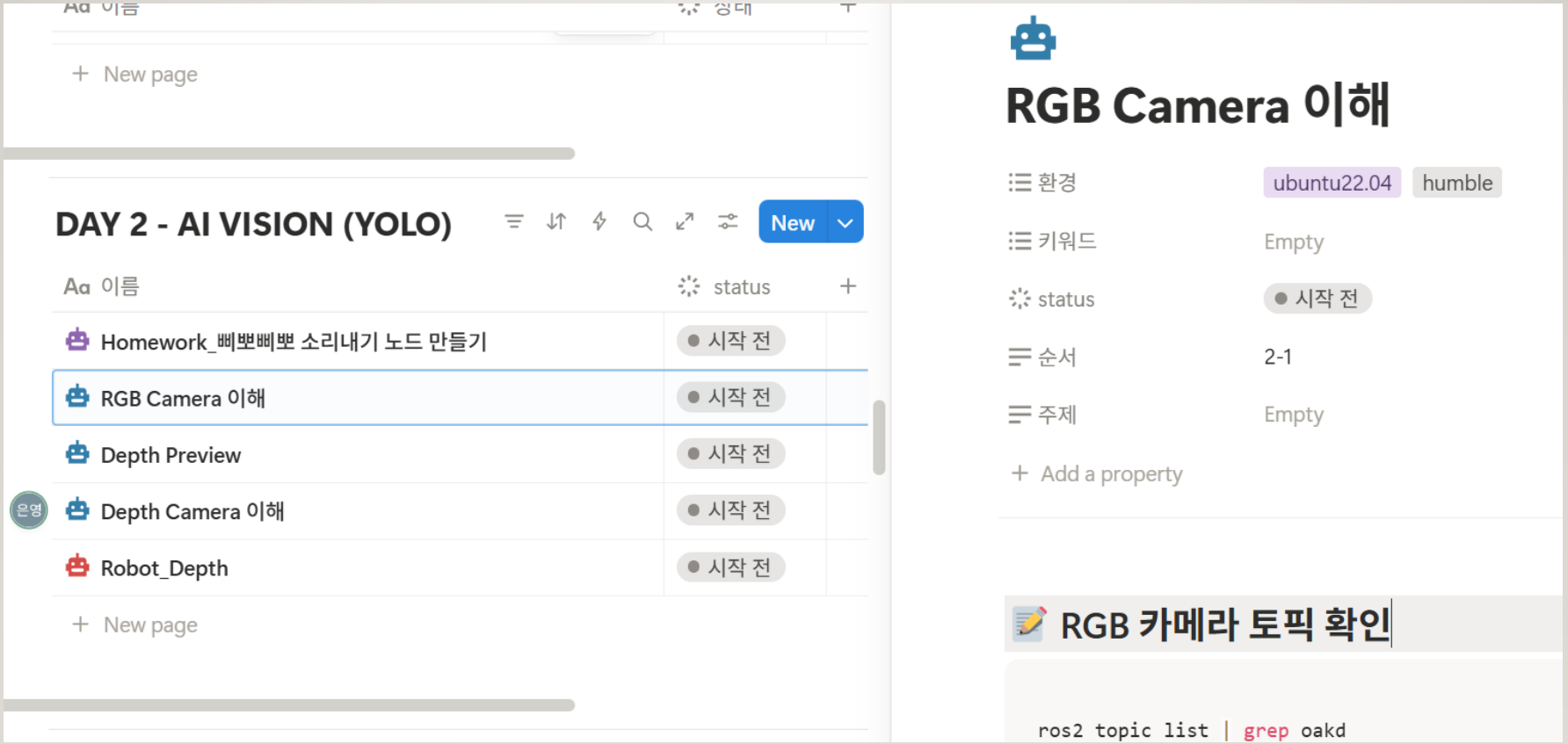
WHICH IMAGE TOPIC TO USE?

- /oakd/rgb/preview/image_raw
- /oakd/rgb/image_raw
- /oakd/rgb/image_raw/compressed
- /oakd/stereo/image_raw
- …

- ***** not all of the topics are visible, initially**

- EXERCISE
  - Create a script to display and compare

RGB CAMERA


New page
DAY 2 - AI VISION (YOLO)
New
Aa 이름
status
Homework_삐뽀삐뽀 소리내기 노드 만들기
시작 전
RGB Camera 이해
시작 전
Depth Preview
시작 전
Depth Camera 이해
시작 전
Robot_Depth
시작 전
New page
RGB Camera 이해
환경
ubuntu22.04
humble
키워드
Empty
status
시작 전
순서
2-1
주제
Empty
Add a property
RGB 카메라 토픽 확인
ros2 topic list | grep oakd

DIMENSIONS AND RESOLUTION

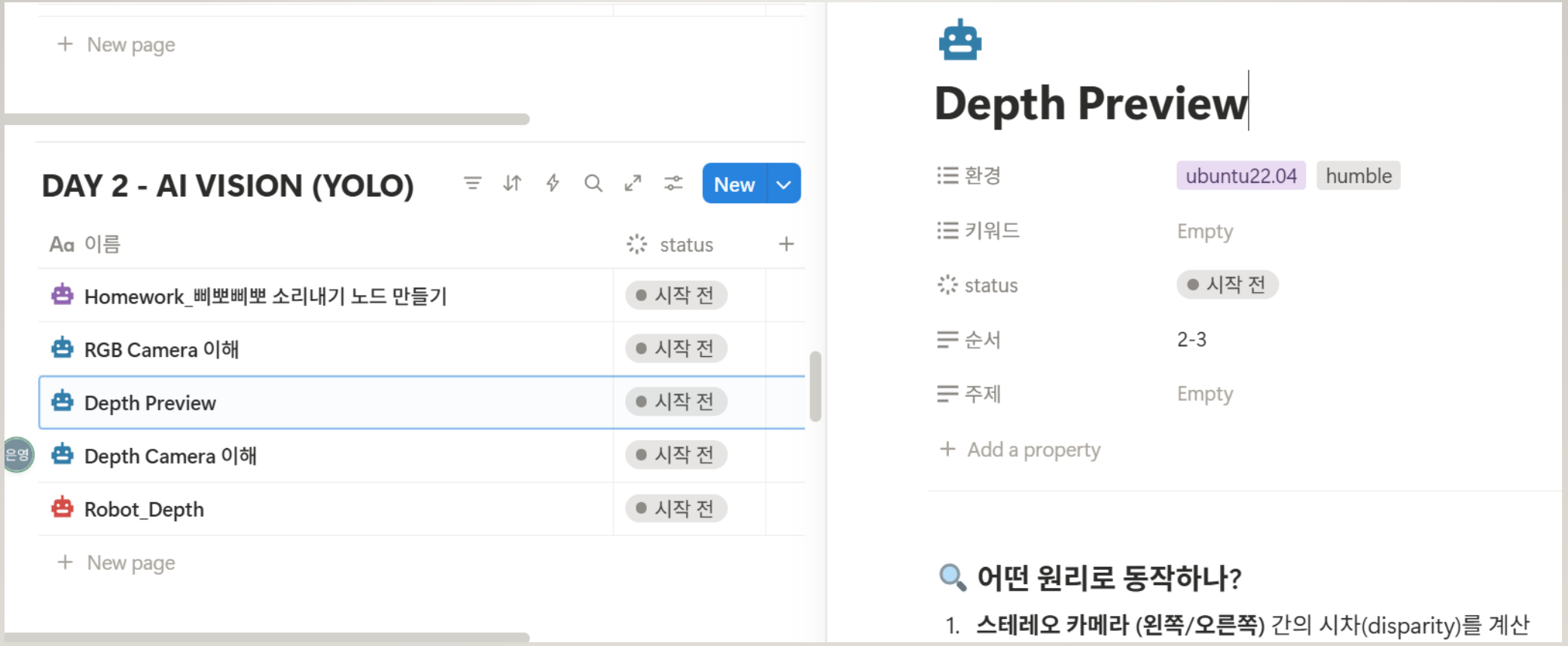
Supported `i_resolution` values (RGB):

Resolution Keyword	Width × Height	Notes
`1080P`	1920 × 1080	Default, high-res
`720P`	1280 × 720	Medium-res
`800P`	1280 × 800	Slightly taller
`480P`	640 × 480	✅ Ideal for alignment with stereo
`400P`	640 × 400	Wide, cropped top/bottom
`320P`	640 × 360	Lower-res
`240P`	320 × 240	Very low-res, fast

Use rqt to check and compare the different image topics

USING DEPTH

DEPTH INTRO


New page
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Homework_삐뽀삐뽀 소리내기 노드 만들기
시작 전
RGB Camera 이해
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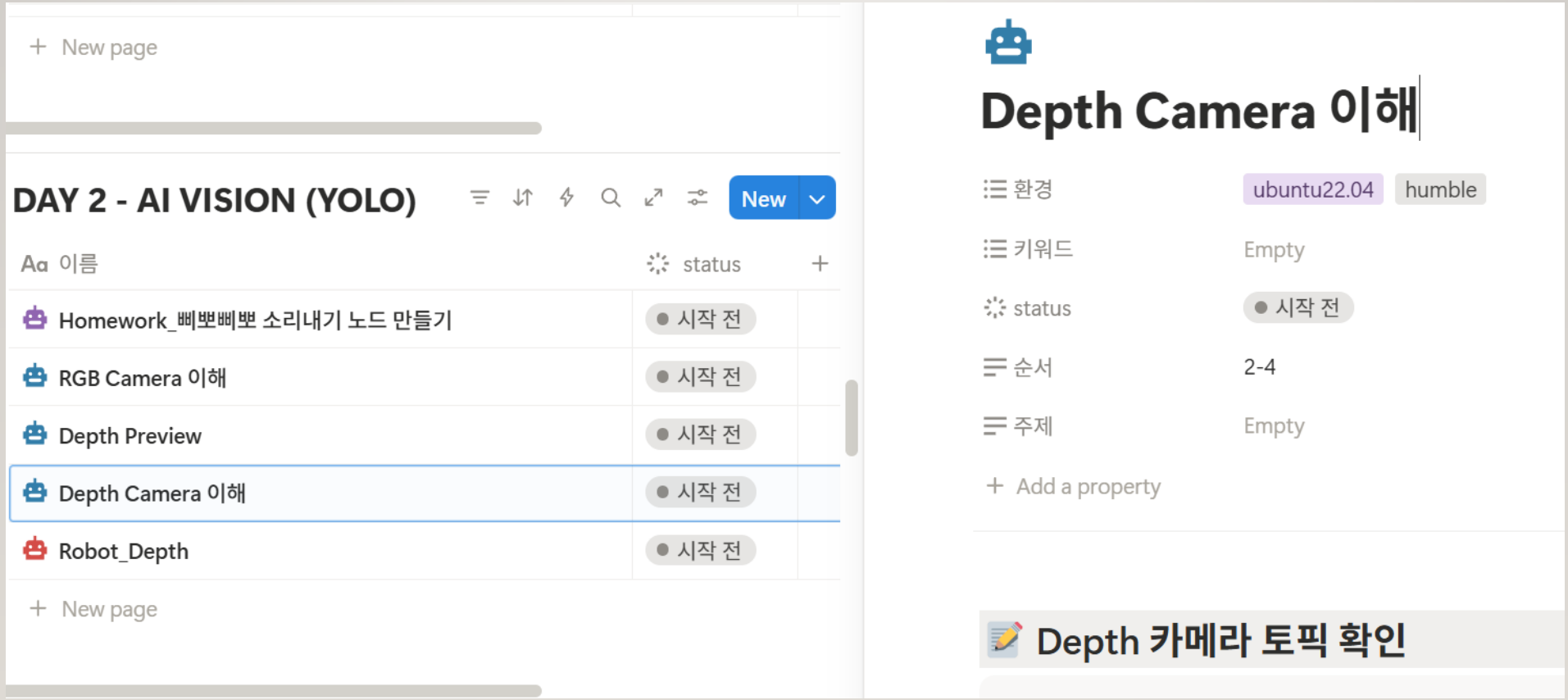
Depth Preview
시작 전
Depth Camera 이해
시작 전
Robot_Depth
시작 전
New page
Depth Preview
환경
ubuntu22.04
humble
키워드
Empty
status
시작 전
순서
2-3
주제
Empty
Add a property
어떤 원리로 동작하나?
1. 스테레오 카메라 (왼쪽/오른쪽) 간의 시차(disparity)를 계산

RGB AND DEPTH ALIGNMENT



UPDATING THE OAKD CONFIG (ROBOT)

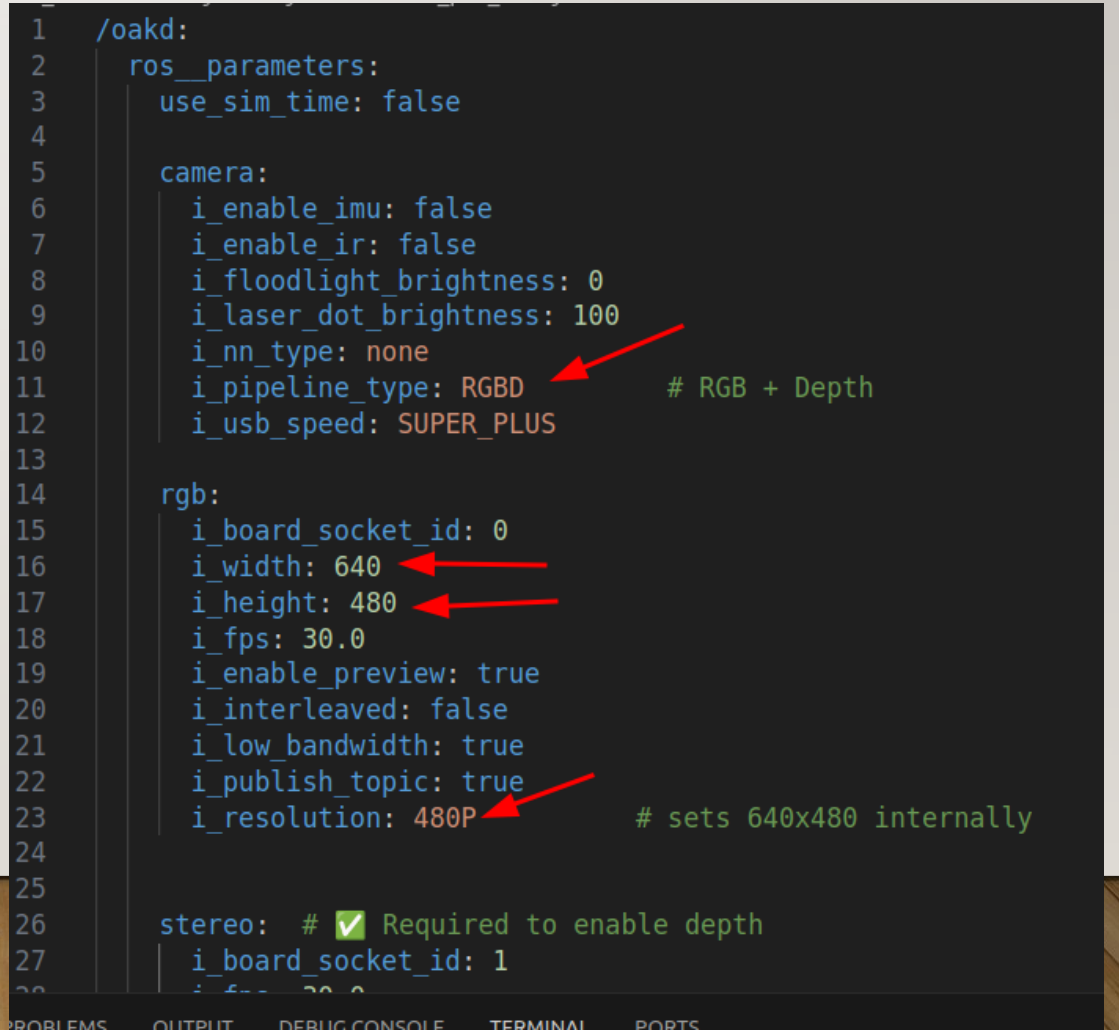
ON TURTLEBOT4:

$ cd /opt/ros/humble/share/turtlebot4_bringup/config

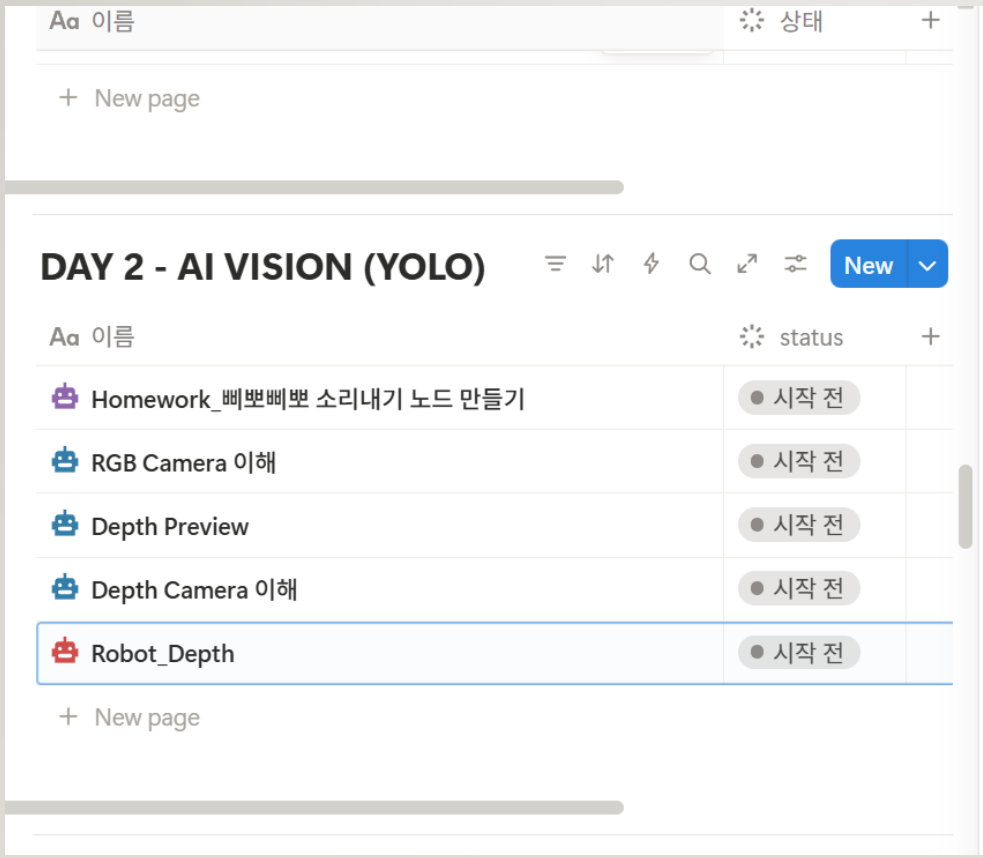
$ sudo cp oakd_pro.yaml oakd_pro_orig.yaml

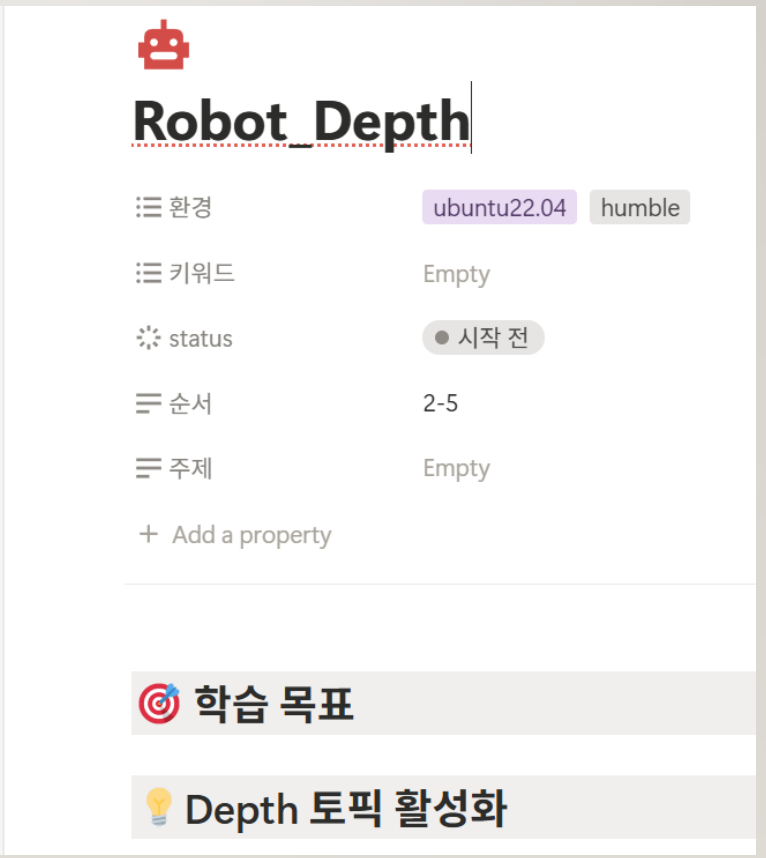
$ sudo cp oakd_pro_new.yaml oakd_pro.yaml

$ sudo reboot



DEPTH VALUE FROM IMAGE



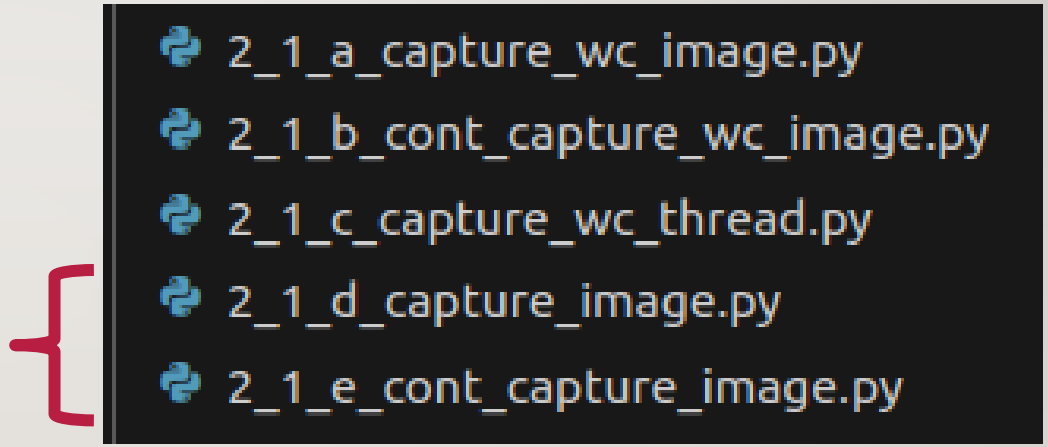


AIM OF THE GOOD OBJ. DET. TRAINING SET

- Training images matches the real inference images as much as possible
  - Lighting
  - Dimensions
  - FOV
  - Backgrounds
  - Objects
  - …
- For RGB and Depth and …

CODING HINTS

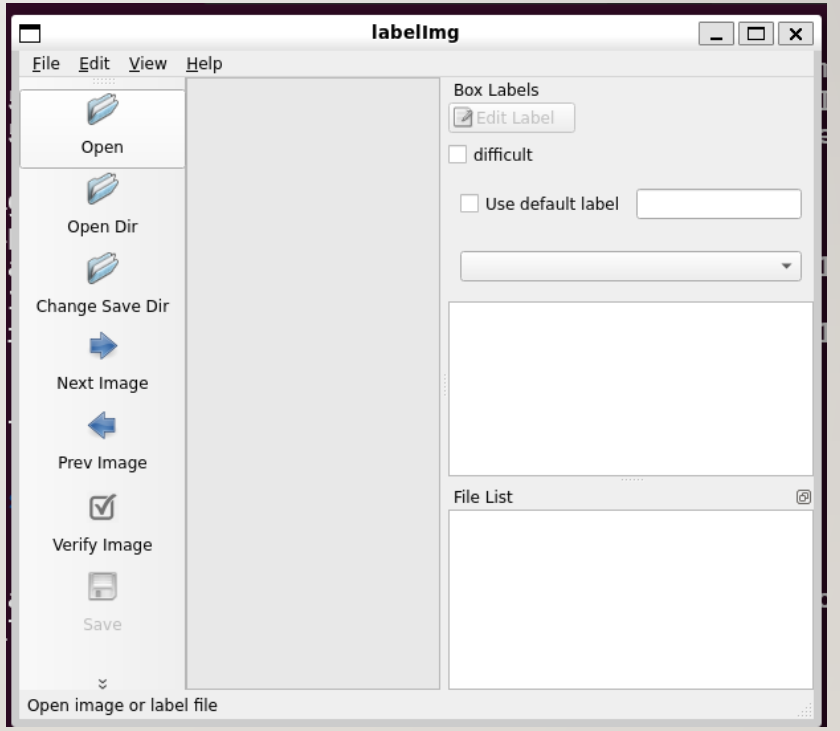
- Image Capture
- Image Capture (AMR)



CODING HINTS

- Image Capture

- Data Labelling
  - Goto the /labelImg/data/ directory
  - Rename the predefined_classes.txt



CODING HINTS

- Data Labelling : LabelImg

라벨링 순서

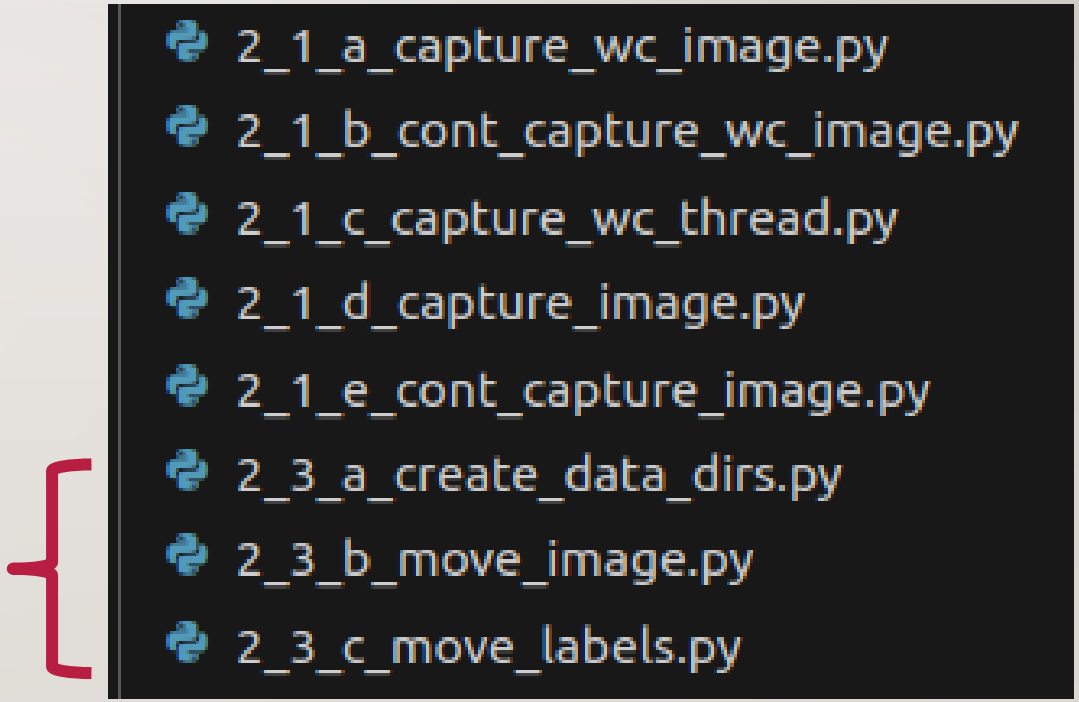
1. 이미지파일 불러오기 (Open Dir)
2. 저장형식 변경 (PascalVOC, YOLO)
3. 이미지 선택
4. 바운딩 박스 그리기(create rectbox)
5. Class 지정
6. 저장경로 생성 및 변경(Change Save Dir)
7. 저장(Save)

단축키

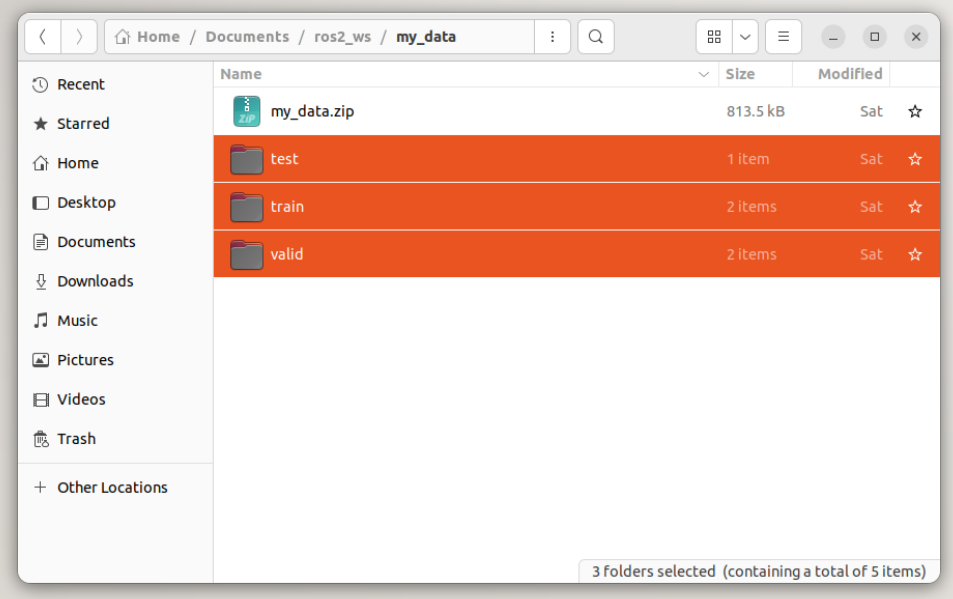
Ctrl + u	Load all of the images from a directory
Ctrl + r	Change the default annotation target dir
Ctrl + s	Save
Ctrl + d	Copy the current label and rect box
Ctrl + Shift + d	Delete the current image
Space	Flag the current image as verified
w	Create a rect box
d	Next image
a	Previous image
del	Delete the selected rect box
Ctrl++	Zoom in
Ctrl--	Zoom out
↑→↓←	Keyboard arrows to move selected rect box

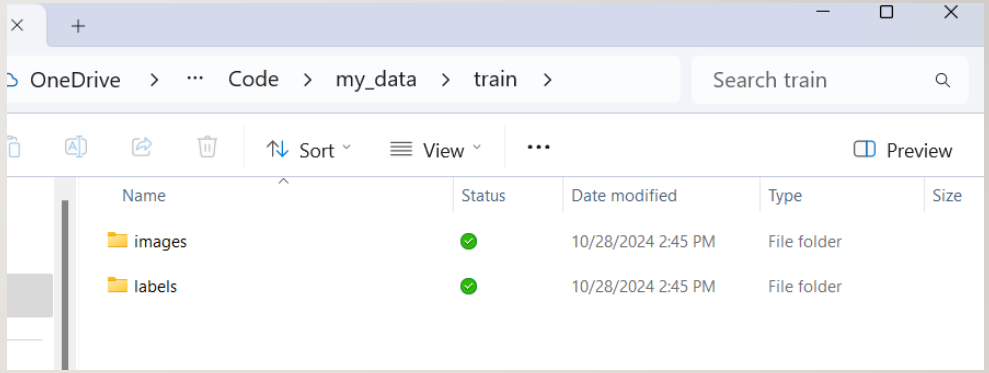
CODING HINTS

- Image Capture
- Data Labelling
- Data Preprocessing



ZIP TRAIN DATA SET



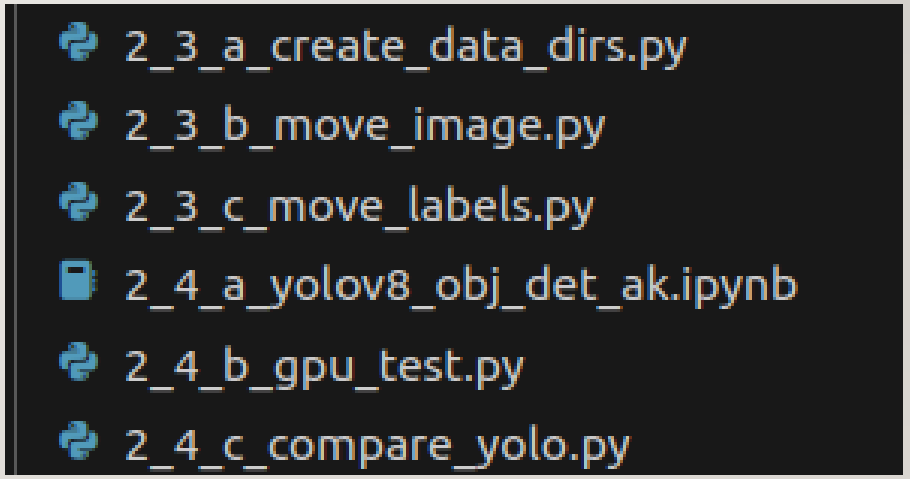


PERFORM YOLO TRAINING & INFERENCE

CODING HINTS

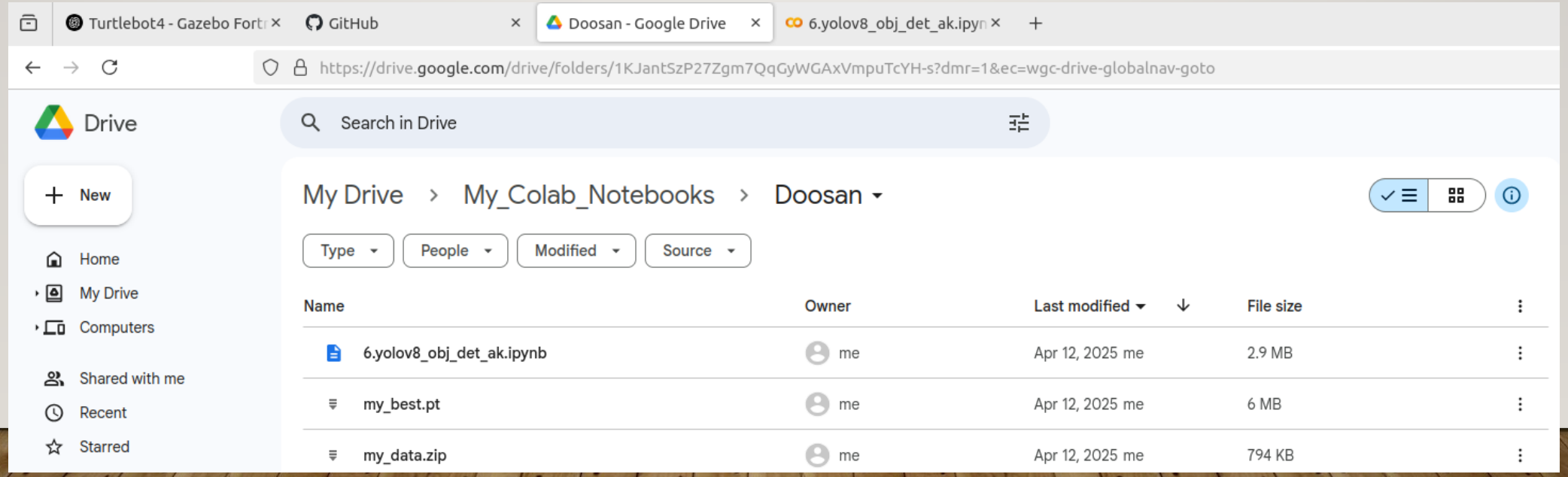
- Image Capture
- Data Labelling
- Preprocessing

- Yolo8 Object Det (Training)



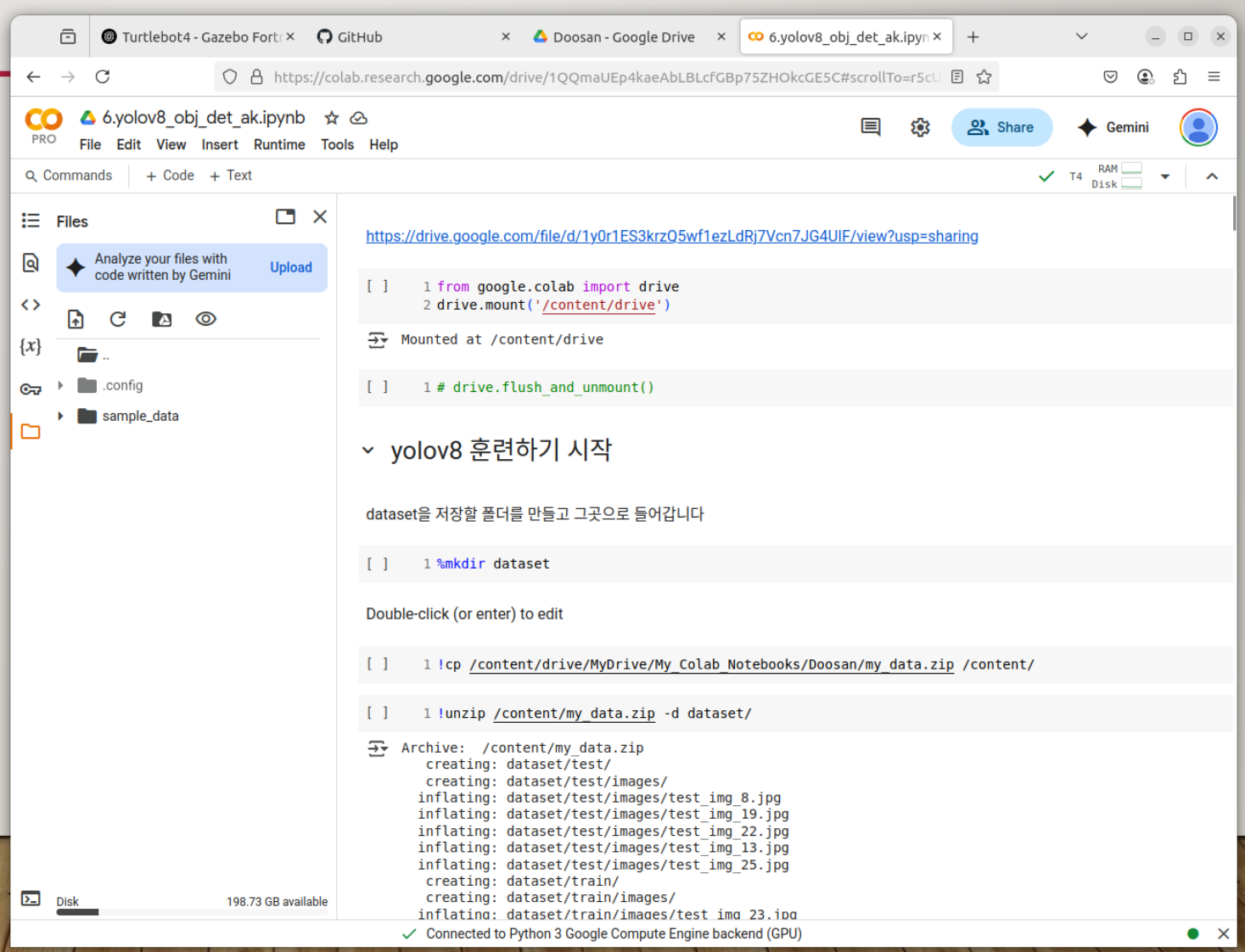
USING GOOGLE COLLAB. TO CREATE CUSTOM MODEL

- Move the files to google drive
  - my_data.zip
  - yolov8.obj.det.ak.ipynb



USING GOOGLE COLLAB.TO CREATE CUSTOM MODEL

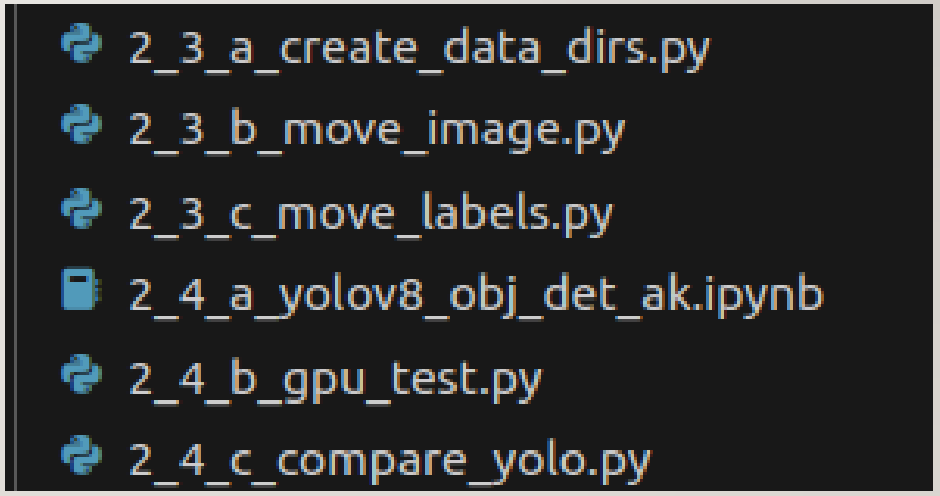
- Move the training script to google collab. and execute line by line



CODING HINTS

- Image Capture
- Data Labelling
- Preprocessing

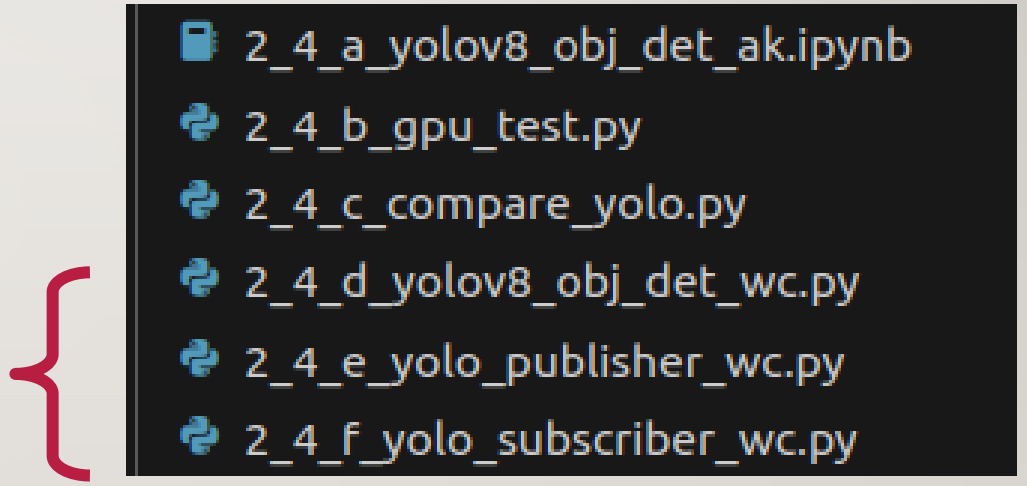
- Yolo8 Object Det (Model)



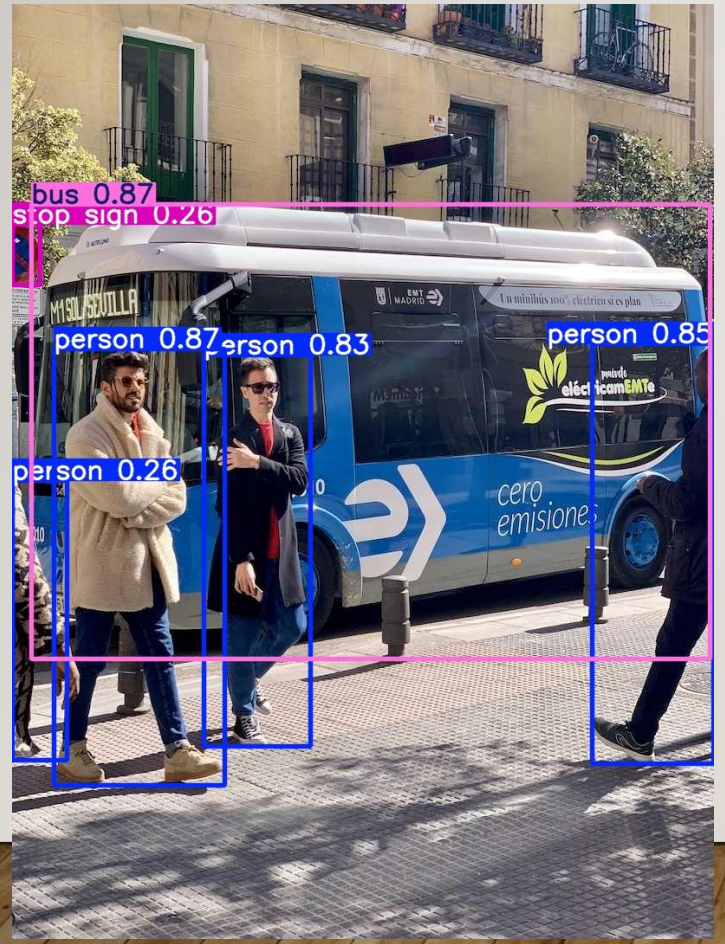
CODING HINTS

- Image Capture
- Data Labelling
- Preprocessing

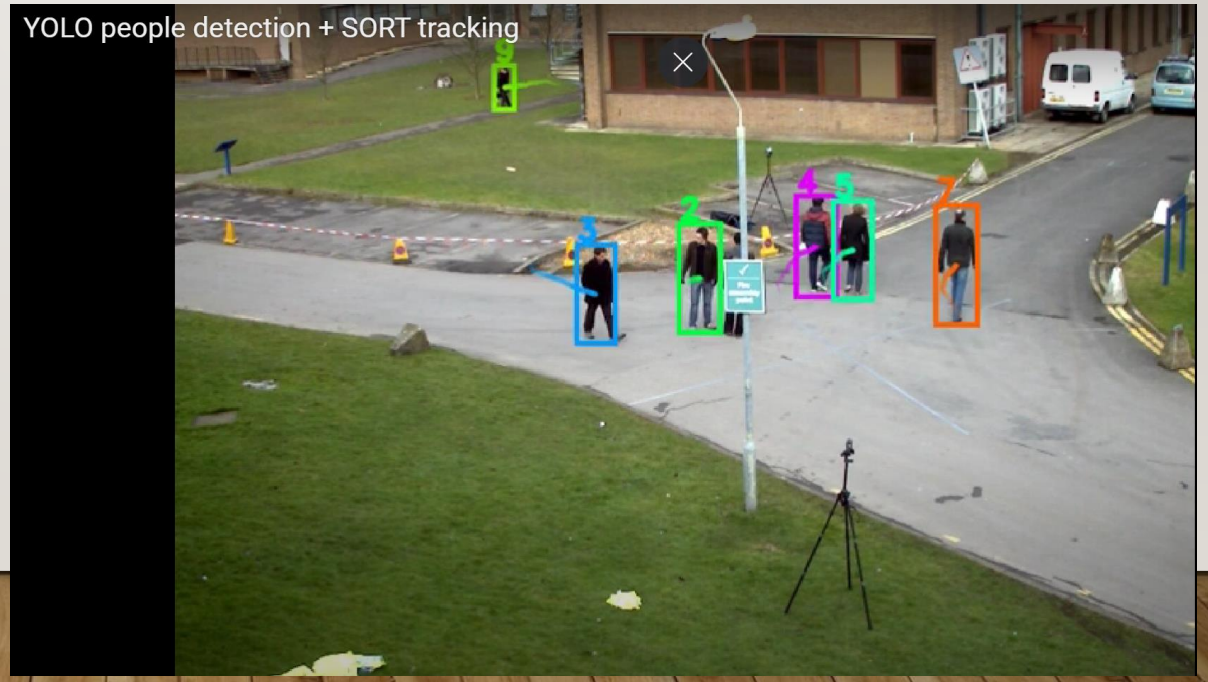
- Yolo8 Object Det (WEBCAM)



YOLO OBJ. DET. VS. YOLO TRACKING



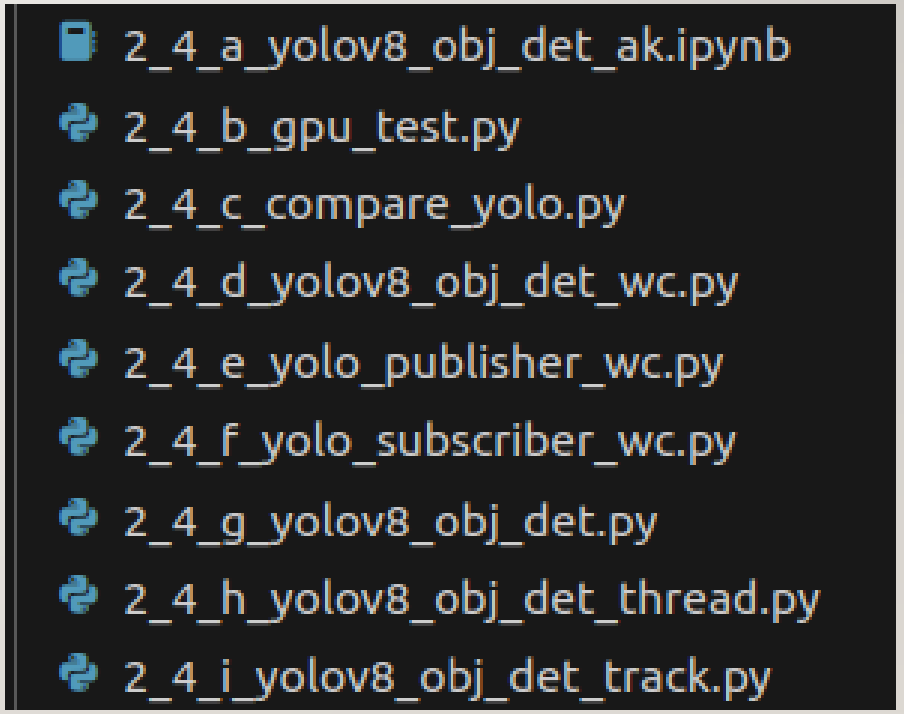
- Track - Ultralytics YOLO Docs
  - (469) YOLO people detection + SORT tracking – YouTube
  - Bing Videos



CODING HINTS

- Image Capture
- Data Labelling
- Preprocessing

- Yolo8 Object Det (AMR)



REQUIRED RESEARCH

1. **왜 yolov8n.pt 모델을 선정하였습니까?**
   - yolo 다른 버전과 비교 분석
   - mAP VS Inference speed
2. **객체 탐지 속도를 높이기 위한 최선의 전략은?**
   - 데이터 사이즈
   - processing 방식
   - 노드 구조
3. **다른 Pre-trained model(Huggingface)을 사용한다면?**
4. **object detection이 아닌 segmentation, pose, obb 등을 활용할 수 없을까?**

HOMEWORK

- Object Detection
  - Collect various datasets (i.e. different topics/images sizes)
  - Create various models (i.e. v5, v8, v11, etc; arg: Epoch, Batch, Imgsz, augmentation, etc)
  - Analyze the results
  - Determine using key metrics which model best fit your solution
  - Using .pt file to predict/inference on pc
- Depth
  - Find and display the distance to the center of the detected objects
- Update System Requirement

프로젝트 RULE NUMBER ONE!!!

Are we still having FUN!