

2021 동계 현장실습 개발 보고서

최우석

목차

- 1. AICamera
 - 1-1. 개발환경
 - 1-2. 적용 기술 개요
 - 1-3. Flow Chart
 - 1-4. UML
 - 1-5. 문서
 - 1-6. 스크린샷

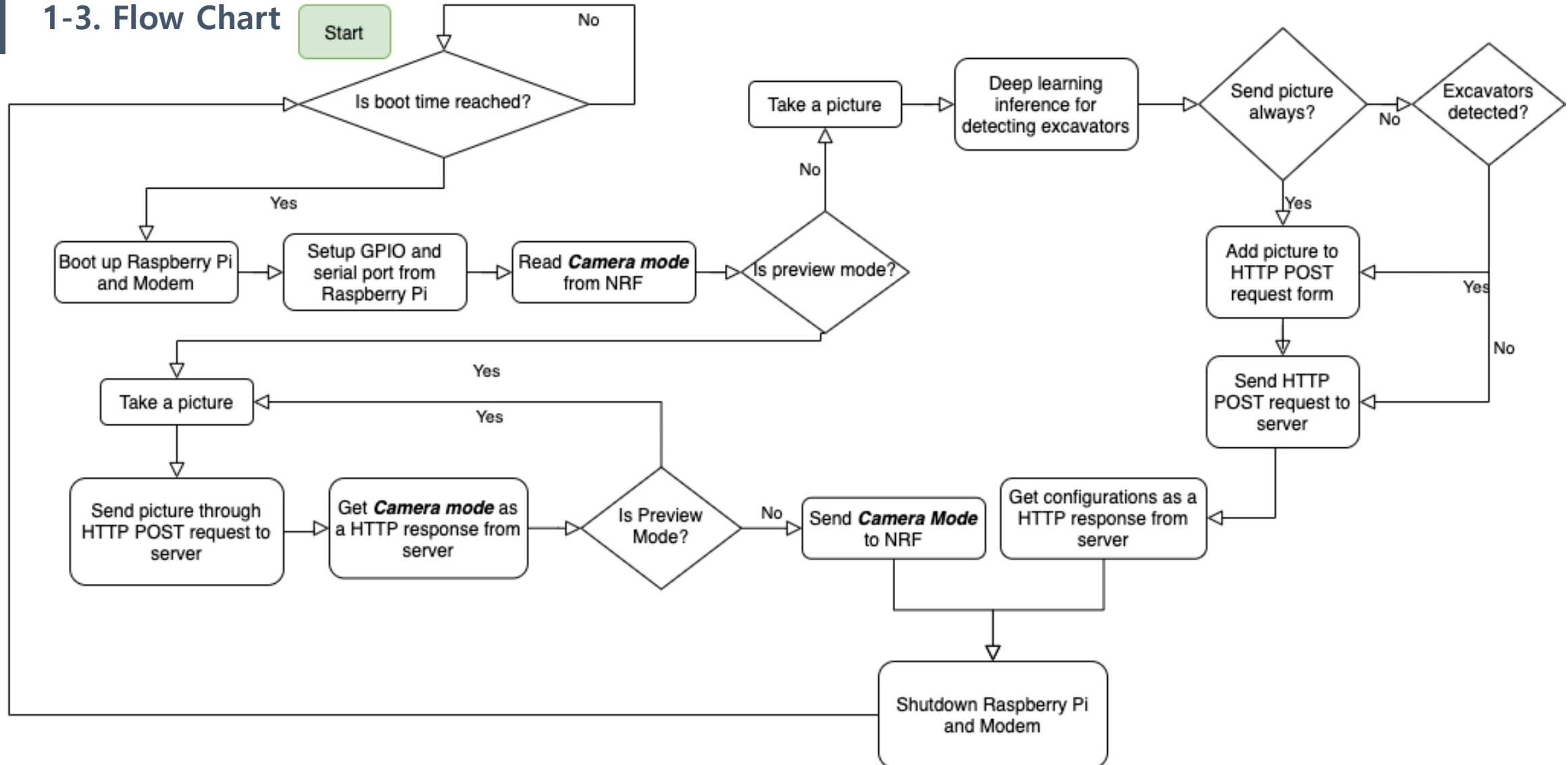
1-1. 개발환경

개발도구	Git, vscode, vim, cmake
언어	C++
OS 환경	Raspberry Pi OS
Target Device	Codezoo CAT.M1 Modem, NRF Board, Raspberry Pi 4B with Camera
프로젝트 위치	https://github.com/wooseokyourself/object-detection-camera

1-2. 적용 기술 개요

패키지명	버전	설명
WiringPi	2.52	Raspberry Pi GPIO control
OpenCV	4.5	Image processing and deep learning
JsonCpp	1.9.4	Json parser library for C++
Date	3	Date library for C++
Darknet		Deep learning training framework

1-3. Flow Chart



1-4. UML

GPIO			
Methods			
Name	Parameters	Type	Return
+ GPIO	_rpiOffPin	const int	
+ ~GPIO			
+ shutdownRpi			
+ isDetectingMode			bool
+ setDetectingMode			
Fields			
Name	Type		
rpiOffPin	int		
rpiModePin	int		

Serial			
Methods			
Name	Parameters	Type	Return
+ Serial			
+ Serial	port baudRate	const char* const int	
+ ~Serial			
+ flush			
+ remaining			int
+ puts	s	const char*	
+ puts	s len	const char* const size_t	
+ getchar			int
+ release			
Fields			
Name	Type		
fd	int		

Config			
Methods			
Name	Parameters	Type	Return
+ Config			
+ readFromJsonFile	filePath	const std::string	
+ readFromJsonString	jsonString	const std::string	
+ write	filePath	const std::string	
+ getID			std::string
+ getConfThreshold			float
+ getNmsThreshold			float
+ getCaptureWidth			int
+ getIntervalSecs			int
+ sendPictureAlways			bool
+ isPreviewMode			bool
Fields			
Name	Type		
- deviceId	std::string		
- sendInterval	int		
- sendOnDetectedOnly	bool		
- confidenceThreshold	float		
- nmsThreshold	float		
- resizeResolution	int		
- result	int		
- previewMode	bool		

YoloObjectDetector				
Methods				
Name	Parameters	Type	Return	
+ YoloObjectDetector				
+ setModel	weightsPath cfgPath namesPath	const std::string const std::string const std::string		
+ getFrameRef			cv::Mat&	
+ cloneFrame			cv::Mat	
+ extractFrameBytes			std::string	
+ extractImagefileBytes	outBytes filePath	std::string& const std::string		
+ resizeFrame	width	const int		
+ writeFrame	filePath	const std::string	bool	
+ capture	width	const int		
+ detect	target confThreshold nmsThreshold resize	const int const float const float const int	int	
- netPreProcess	resize padSize	const int cv::Size& padSize		
- netPostProcess	target confThreshold nmsThreshold padSize outs	const int const float const float const cv::Size& std::vector<cv::Mat>&	int	
Fields				
Name	Type			
- isSet	bool			
- target	int			
- frame	cv::Mat			
- net	cv::dnn::Net			
- outNames	std::vector<cv::String>			
- classes	std::vector<std::string>			

NRF			
Methods			
Name	Parameters	Type	Return
+ NRF			
+ NRF	port baudRate	const char* const int	
+ NRF	port baudRate	const std::string const int	
+ ~NRF			
+ getBattery			int
+ setPowerInterval	intervalSecs	const int	
Fields			
Name	Type		

BG96				
Methods				
Name	Parameters	Type	Return	
+ BG96	port baudRate	const char* const int		
+ BG96	port baudRate	const std::string const int		
+ ~BG96				
+ getRssi				int
+ postMultipart	host uri fields timeoutSecs	std::string std::string HttpPostFormData int	std::string	
# putATcmd	cmd	const char*		
# putATcmd	cmd	const std::string		
# putATcmd	cmd len	const char* const size_t		
# putATcmd	cmd len	const std::string const size_t		
# getResponse				std::string
# getResponseUnti	expected timeoutSecs	const std::string const int	std::string	
Fields				
Name	Type			

HttpPostFormData			
Methods			
Name	Parameters	Type	Return
+ size			
+ clear			
+ addField	_contentType _contentName _content	const std::string const std::string const std::string	
+ changeField	i _contentType _contentName _content	const int const std::string const std::string const std::string	bool
+ getContentType	i	const int	const std::string&
+ getContentName	i	const int	const std::string&
+ getContent	i	const int	const std::string&
Fields			
Name	Type		
contents	std::vector<MultipartContent>		

MultipartContent	
Fields	
Name	Type
type	std::string
name	std::string
data	std::string

1-5. 문서

NRF Class Reference

```
#include <NRF.hpp>
```

Inheritance diagram for NRF:



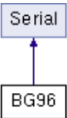
Public Member Functions

	NRF ()
	NRF (const char *port, const int baudRate)
	NRF (const std::string port, const int baudRate)
	~NRF ()
int	getBattery () const
void	setPowerInterval (const int intervalSecs) const

BG96 Class Reference

```
#include <BG96.hpp>
```

Inheritance diagram for BG96:



Public Member Functions

	BG96 (const char *port, const int baudRate)
	BG96 (const std::string port, const int baudRate)
	~BG96 ()
int	getRssi () Get RSSI of modem through AT command. Try 10 times to get RSSI if AT response is invalid value as RSSI. More...
std::string	postMultipart (const std::string host, const std::string uri, const HttpPostFormData &fields, const int timeoutSecs) Send HTTP Post request through AT command. More...
void	putATcmd (const char *cmd) Send AT command. All AT syntax must be followed. There shouldn't be null character in the command. If it is, use an overridden method that includes "len" in the parameter. More...
void	putATcmd (std::string cmd) Send AT command. All AT syntax must be followed. There shouldn't be null character in the command. If it is, use an overridden method that includes "len" in the parameter. More...
void	putATcmd (const char *cmd, const size_t len) Send AT command. All AT syntax must be followed. More...
void	putATcmd (std::string cmd, const size_t len) Send AT command. All AT syntax must be followed. More...
std::string	getResponse () Get AT response. More...
std::string	waitResponseUntil (const std::string expected, const int timeoutSecs) Wait AT response until it has sub-string of "expected". More...

1-5. 문서

Serial Class Reference

List of all members

```
#include <Serial.hpp>
```

Inheritance diagram for Serial:

```
graph BT; BG96 --> Serial; NRF --> Serial;
```

Public Member Functions

Serial ()
Serial (const char *port, const int baudRate)
~Serial ()

Protected Member Functions

void flush ()	Flush the serial buffers. (both tx & rx) More...
int remaining ()	Return the number of bytes of data available to be read in the serial port. More...
void puts (const char *s)	Send a string to the serial port. More...
void puts (const char *s, const size_t len)	Send a string to the serial port. More...
int getchar ()	Get a single character from the serial device. Note: Zero is a valid character and this function will time-out after 10 secs. More...
void release ()	Release the serial port. More...

Protected Attributes

int fd

1-5. 문서

Config Class Reference

```
#include <Config.hpp>
```

Public Member Functions

	Config ()
void	readFromJsonFile (const std::string filePath) Read json from .json file and save it in this object. More...
void	readFromJsonString (const std::string jsonString) Read json from string and save it in this object. More...
void	write (const std::string filePath) const Write json from this object to file. Not checking for invalid values. More...
std::string	getID () const
float	getConfigThreshold () const
float	getNmsThreshold () const
int	getCaptureWidth () const
int	getIntervalSecs () const
bool	sendPictureAlways () const

GPIO Class Reference

```
#include <GPIO.hpp>
```

Public Member Functions

	GPIO (const int _rpiOffPin, const int _rpiModePin)
void	shutdownRpi () Write HIGH into GPIO::rpiOffPin pin for shutting down Raspberry Pi. More...
bool	isDetectingMode () Read GPIO::rpiModePin. More...
void	setDetectingMode () Write LOW into GPIO::rpiModePin pin. More...

1-5. 문서

HttpPostFormData Class Reference

```
#include <HttpPostFormData.hpp>
```

Classes

struct **MultipartContent**

Public Member Functions

int	size () const
void	clear () Remove all fields. More...
void	addField (const std::string _contentType, const std::string _contentName, const std::string _content) Add one field. Invalid values are not be checked. More...
bool	changeField (const int i, const std::string _contentType, const std::string _contentName, const std::string _content) Change one field. Invalid values are not be checked. More...
const std::string &	getContentType (const int i) const
const std::string &	getContentName (const int i) const
const std::string &	getContent (const int i) const

HttpPostFormData::MultipartContent Struct Reference

```
#include <HttpPostFormData.hpp>
```

Public Attributes

std::string	type
std::string	name
std::string	data

YoloObjectDetector Class Reference

```
#include <YoloObjectDetector.hpp>
```

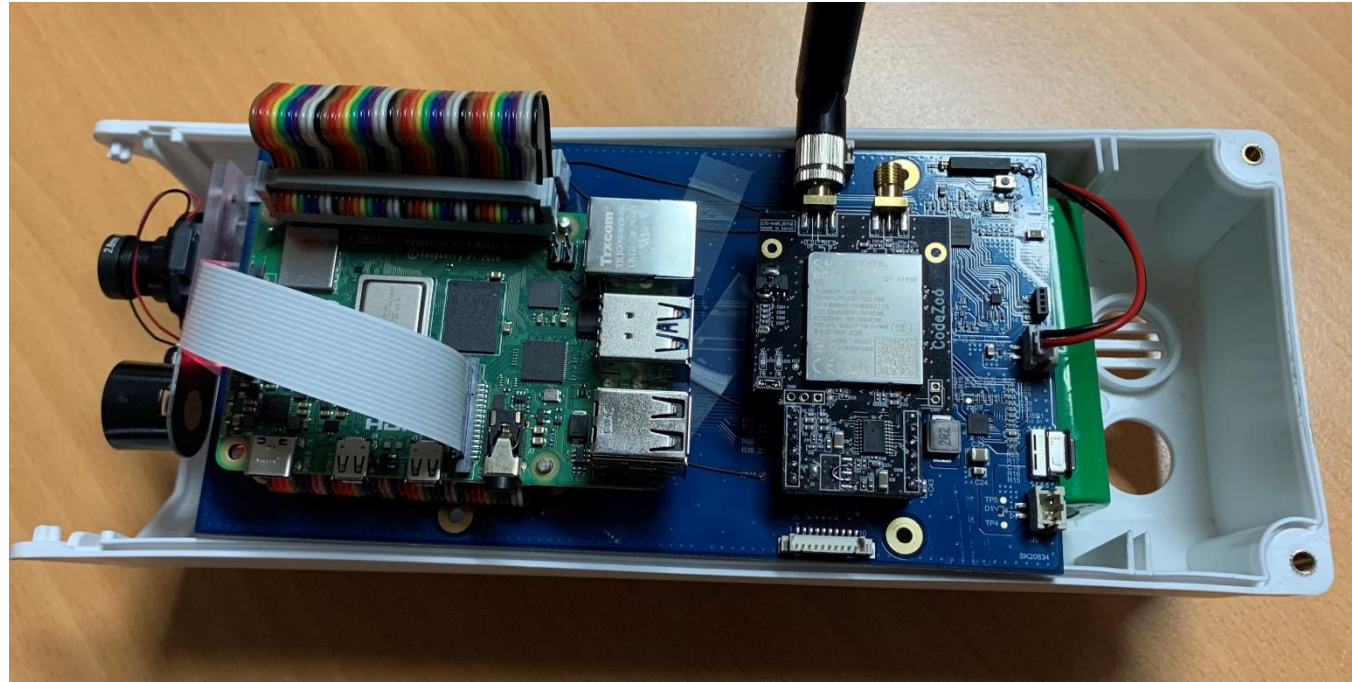
Public Member Functions

YoloObjectDetector ()	
void	setModel (const std::string weightsPath, const std::string cfgPath, const std::string namesPath) Import YOLOv4 model into this object. More...
Mat &	getFrameRef ()
Mat	cloneFrame () const
std::string	extractFrameBytes () 아직 미작동으로 사용 불가. More...
void	extractImagefileBytes (std::string &outBytes, const std::string filePath) Load image file and get its bytes binary. More...
void	resizeFrame (const int width) Resize frame with 4:3 ratio. More...
bool	writeFrame (const std::string filePath) const Write YoloObjectDetector::frame into file. More...
void	capture (const int width) Take a picture of raspi camera with 4:3 ratio and save into YoloObjectDetector::frame. More...
int	detect (const int target, const float confThreshold, const float nmsThreshold, const int resize) Run YOLOv4 inference with YoloObjectDetector::frame image. Result image with detected boxes and inference time is saved into YoloObjectDetector::frame. YoloObjectDetector::setModel() should be called first. More...

1-6. 스크린샷



<제품 외형>



<제품 내부 구조>

1-6. 스크린샷

```

CUDNN_HALF=1
net.optimized_memory = 0
mini_batch = 1, batch = 64, time_steps = 1, train = 0
nms_kind: greedy_nms (1), beta = 0.600000
nms_kind: greedy_nms (1), beta = 0.600000
nms_kind: greedy_nms (1), beta = 0.600000

seen 64, trained: 384 K-images (6 Kilo-batches_64)

calculation mAP (mean average precision)...
Detection layer: 139 - type = 28
Detection layer: 150 - type = 28
Detection layer: 161 - type = 28

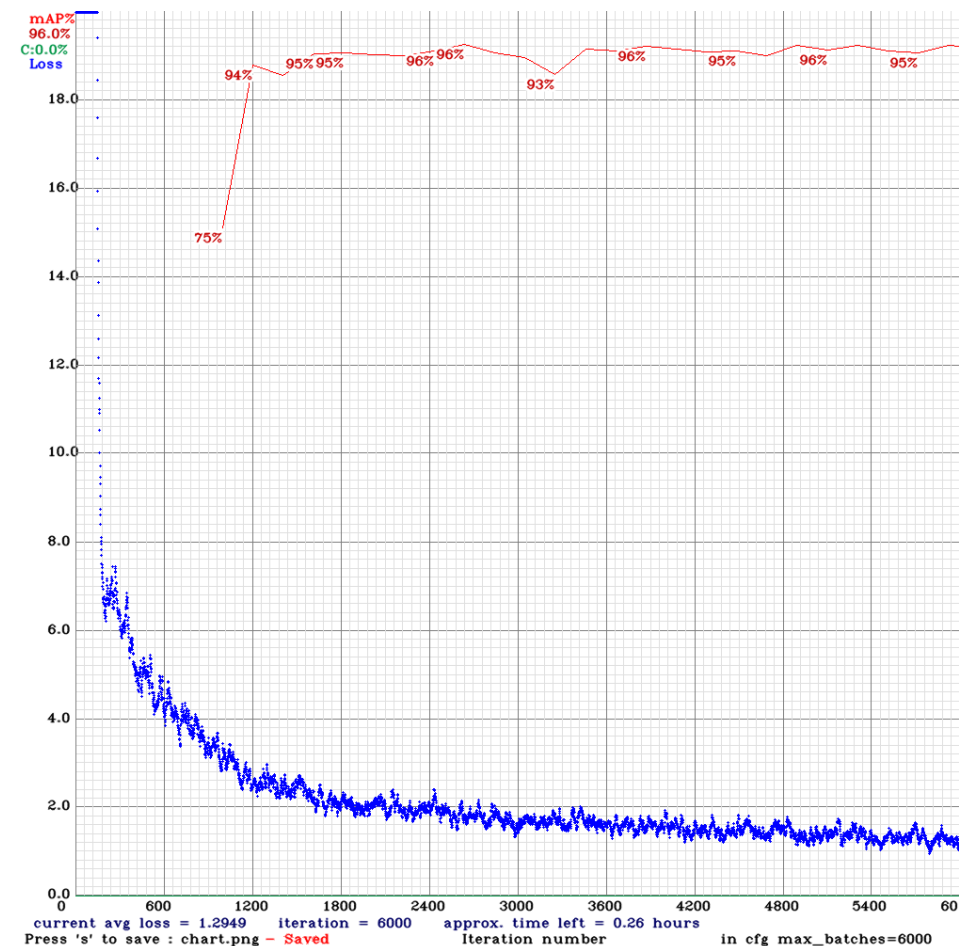
detections_count = 1029, unique_truth_count = 578
rank = 0 of ranks = 1029
rank = 100 of ranks = 1029
rank = 200 of ranks = 1029
rank = 300 of ranks = 1029
rank = 400 of ranks = 1029
rank = 500 of ranks = 1029
rank = 600 of ranks = 1029
rank = 700 of ranks = 1029
rank = 800 of ranks = 1029
rank = 900 of ranks = 1029
rank = 1000 of ranks = 1029
class_id = 0, name = excavator, ap = 98.15% (TP = 224, FP = 14)
class_id = 1, name = dump_truck, ap = 92.66% (TP = 238, FP = 35)
class_id = 2, name = concrete_mixer_truck, ap = 97.13% (TP = 78, FP = 5)

for conf_thresh = 0.25, precision = 0.91, recall = 0.93, F1-score = 0.92
for conf_thresh = 0.25, TP = 540, FP = 54, FN = 38, average IoU = 78.74 %

IoU threshold = 50 %, used Area-Under-Curve for each unique Recall
mean average precision (mAP@0.50) = 0.959766, or 95.98 %

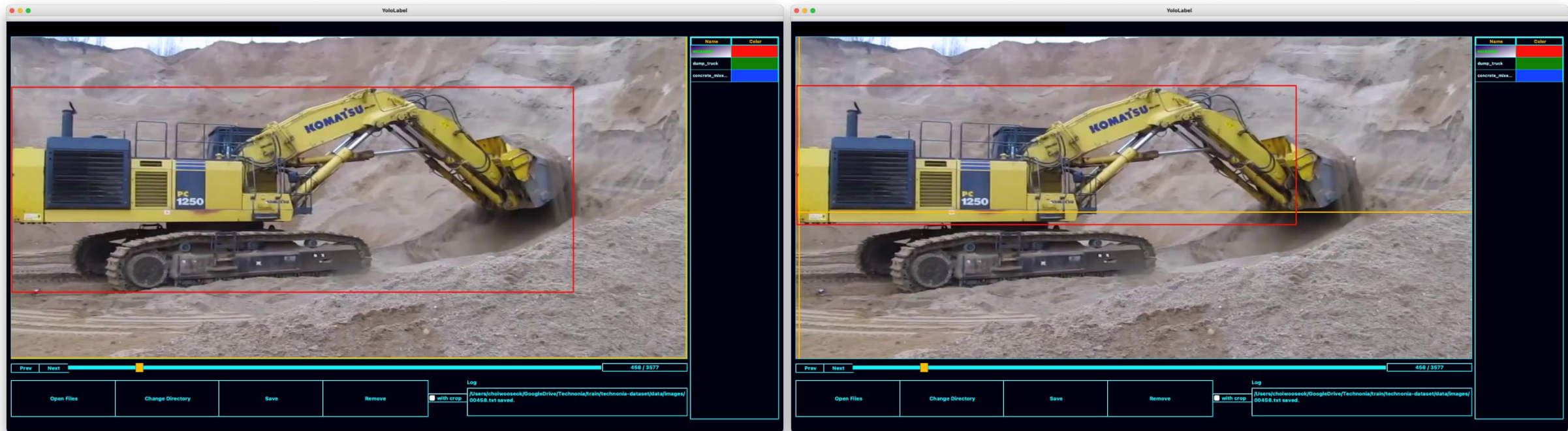
Set -points flag:
`-points 101` for MS COCO
`-points 11` for PascalVOC 2007 (uncomment `difficult` in voc.data)
`-points 0` (AUC) for ImageNet, PascalVOC 2010-2012, your custom dataset
    
```

<딥러닝모델 테스트 결과>



<딥러닝 모델 학습 그래프>

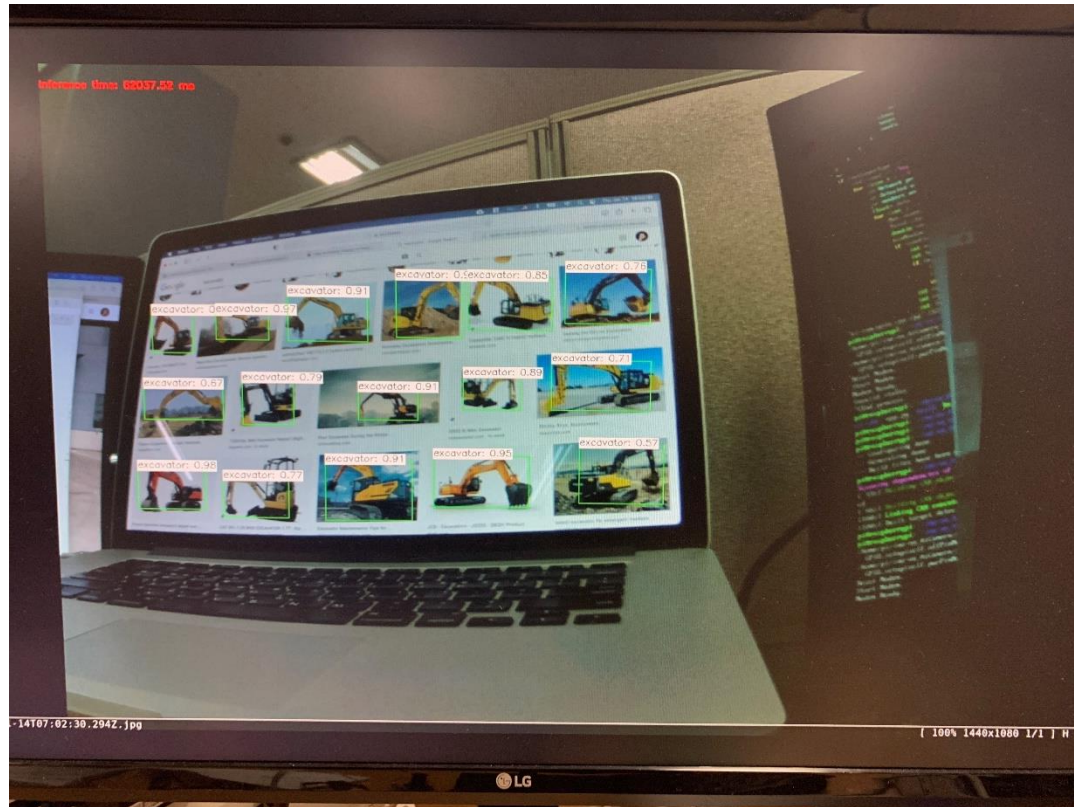
1-6. 스크린샷



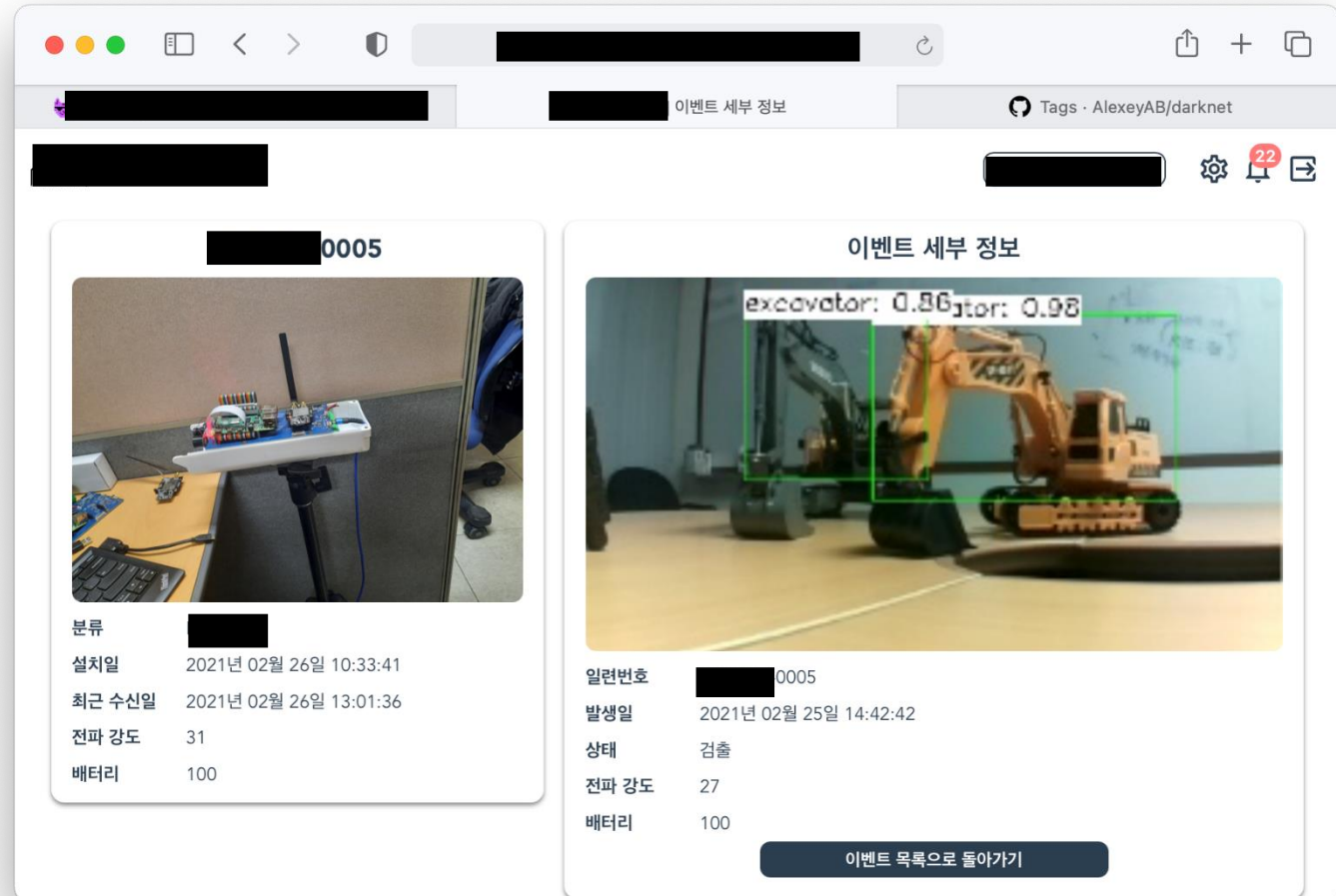
<딥러닝 모델의 최적화를 위한 데이터 라벨링 수정 예>

굴착기의 특징 중 하단의 바퀴와 헤드를 제외하여 학습한 모델을 통해 AI 카메라의 검출 능력 향상

1-6. 스크린샷



<포크레인 검출 결과>



<서버에서 카메라 작동 결과 조회>