

P&ID

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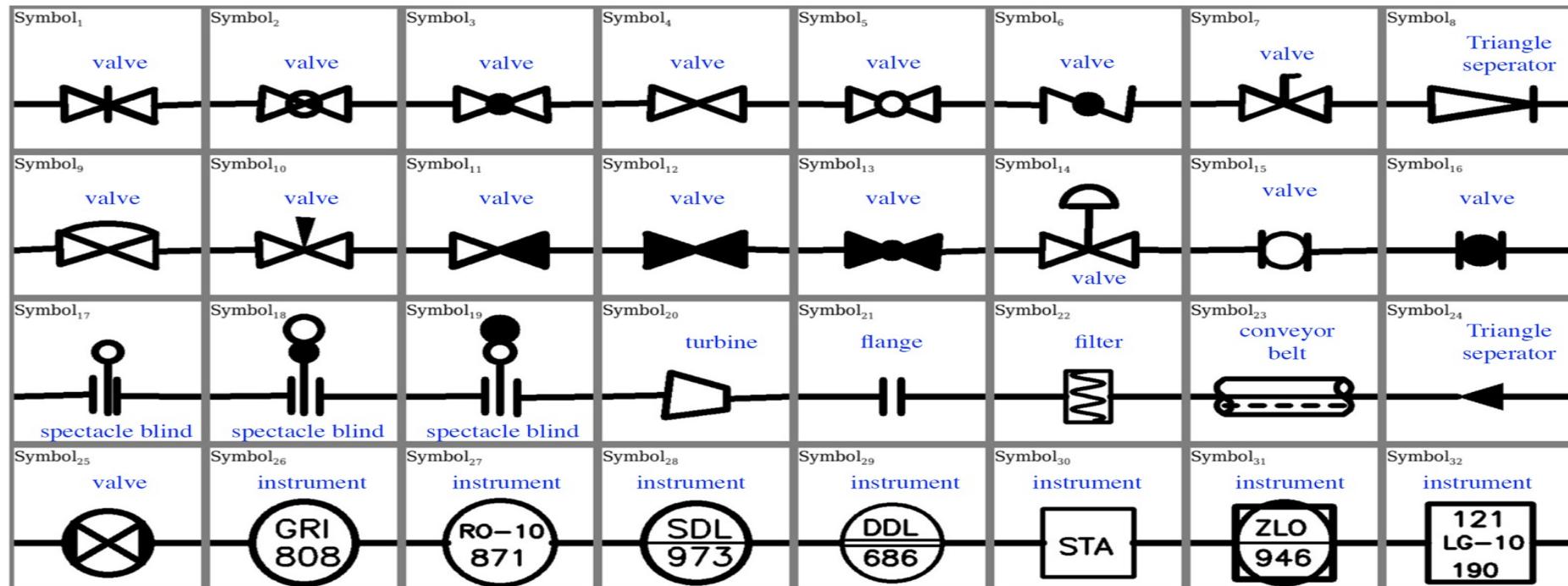
SCOPE OF THE PROJECT

- To develop a solution in computer vision to detect the P&ID components from the given schematic diagram image files.
- To annotate images with its respective class.
- To extract the tag names associated with the components.
- To create a master list (csv file) that contains all the components identified from the image.
- Initially focussing on five components : Gate valve, Rotary valve, Flange, Diaphragm, Plug.

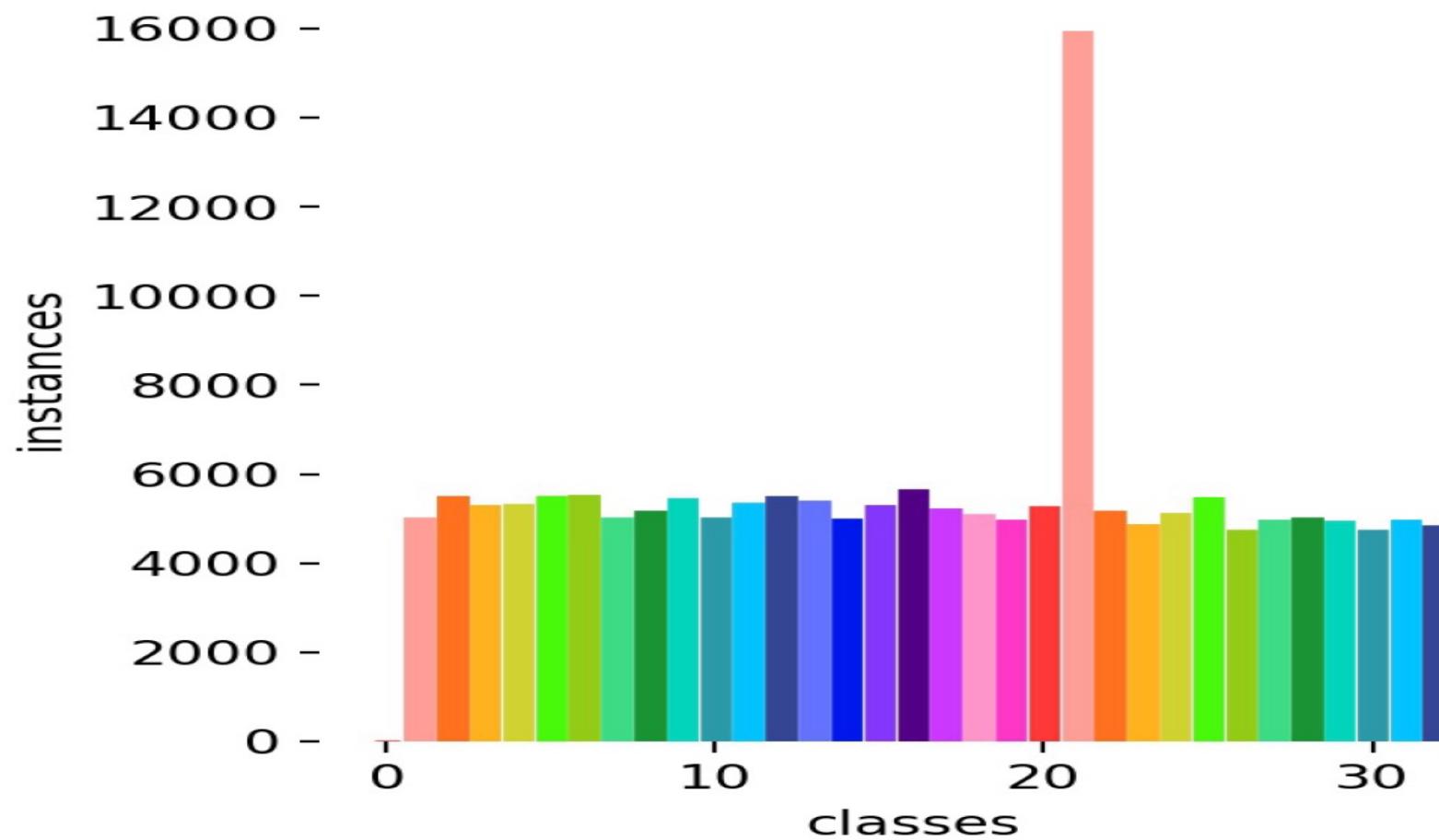


DATASET

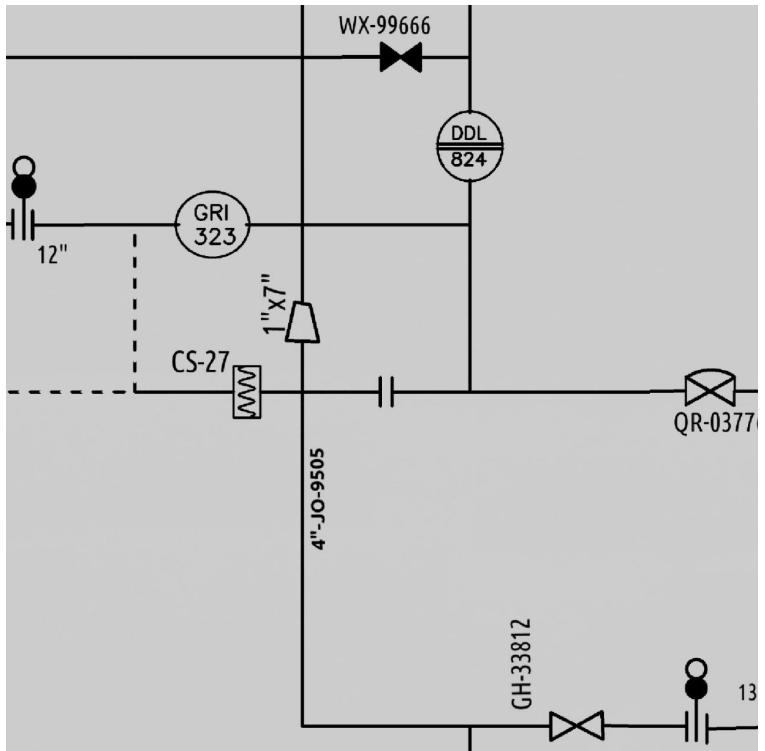
- Obtained 30000 images of schematic diagrams .
- These 32 components are present in those images with various instances.
- [Link to dataset](#)



DISTRIBUTION OF THE COMPONENTS



EDA



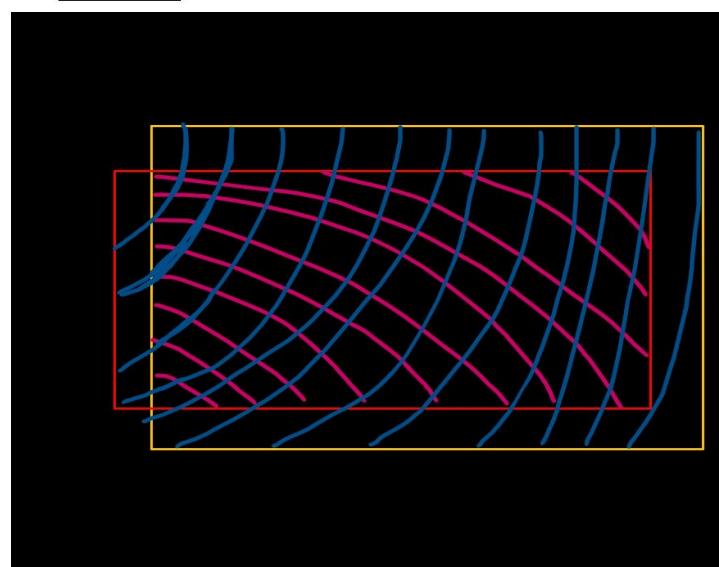
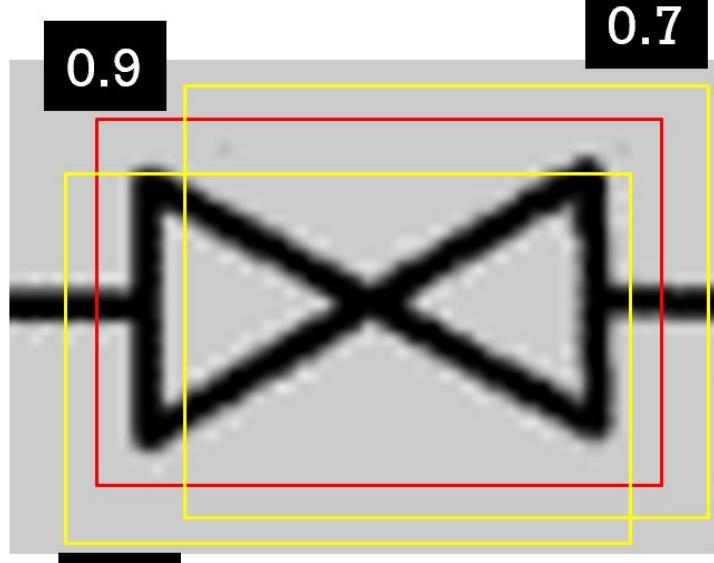
Good quality images.



Tag names for components
are mentioned.



All images are of size – 640
x 640 pixels.



IOU= intersect area /
union area

MODEL – YOLOV8

- YOLO (You Only Look Once) takes an input image and divides it into a grid, with each grid cell responsible for predicting bounding boxes and class probabilities.
- For each grid cell, YOLO predicts multiple bounding boxes.
- It selects the most confident bounding box based on the class probability and removes overlapping boxes that have high intersection over union (IOU) with the selected box.
- We chose **YOLOV8** because it was accurate, simple and faster than other models. It is the latest version of YOLO , being better than all its previous versions.



DATASET for Training 1

Initial - 30000
Schematic
images

8222 schematic
images taken

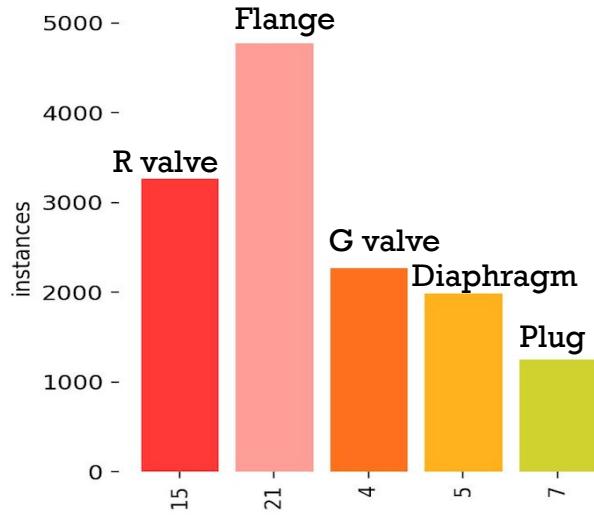
7509 individual
images
cropped out
from it

$8222 + 7509 =$
15731 images

Flange : 2904
Plug : 1108
Diaphragm : 1163
Gate valve : 1174
Rotary valve : 1160



TRAINING - 1



Ratio -

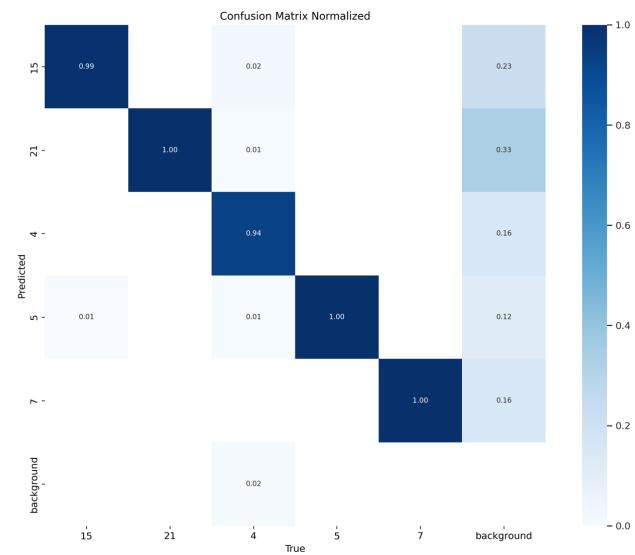
Train : Test: validation - 80
:10 :10

No augmentations
applied.

Epoch - 20

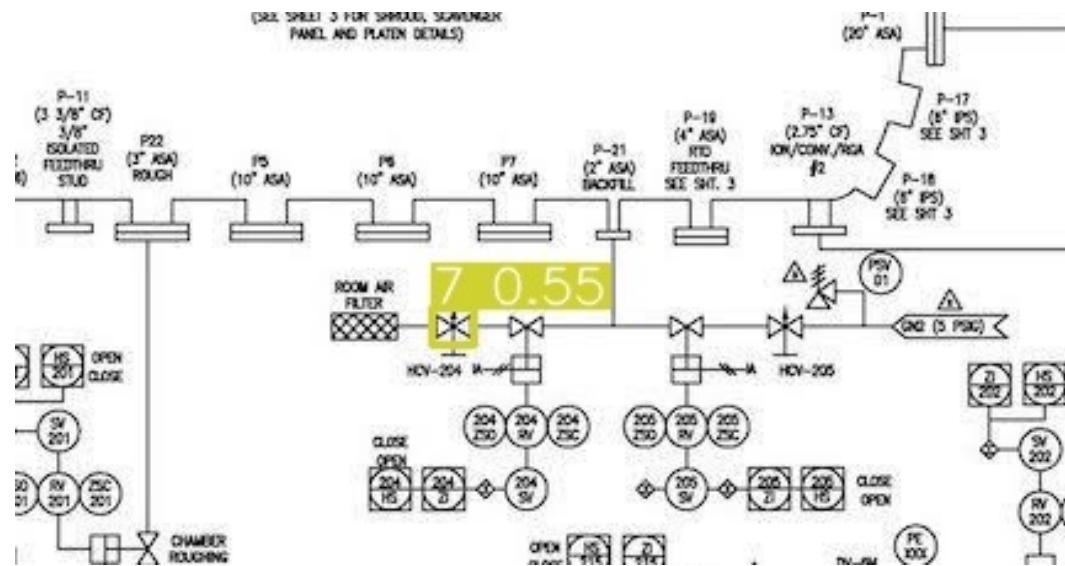
Batch size - 8

Class	Images	Instances	Box(P)	R	mAP50	mAP50-95):
all	2154	3178	0.976	0.983	0.985	0.901
15	2154	582	0.972	0.99	0.984	0.908
21	2154	1284	0.986	0.995	0.993	0.854
4	2154	462	0.97	0.937	0.967	0.894
5	2154	490	0.964	1	0.987	0.912
7	2154	360	0.986	0.993	0.995	0.937



CHALLENGES FACED

- Some of the predictions were bad because of the individual images which were of bad quality.
- When the input image was of bad quality, it wasn't able to detect the components.
- Model was not able to perform well when there were variations in the images. Augmentations were required.



DATASET FOR TRAINING 2

Initial - 30000
Schematic
images

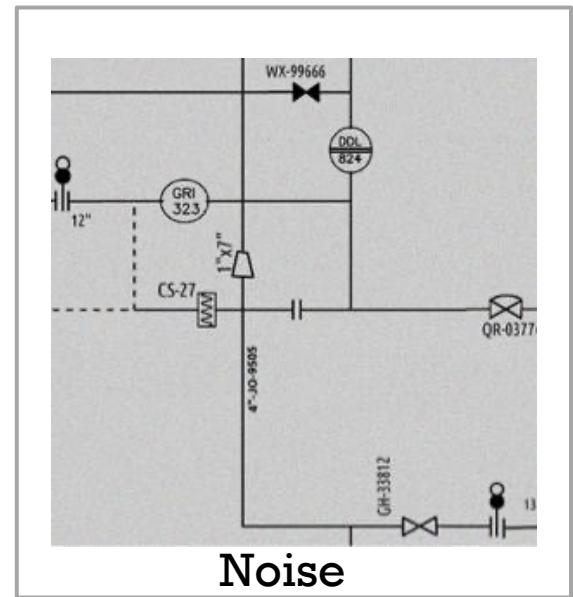
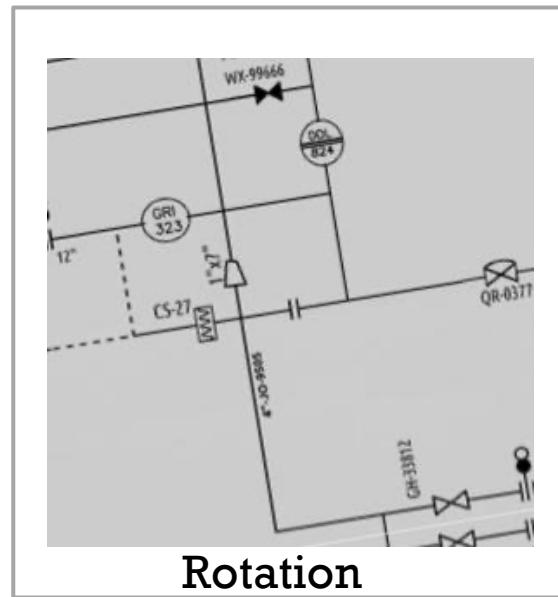
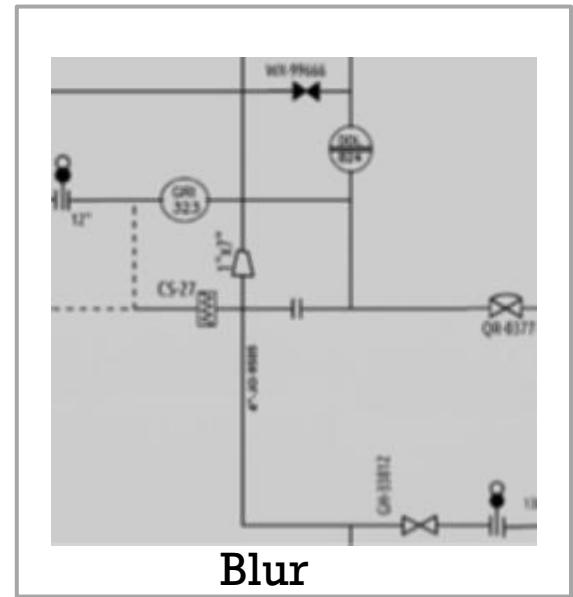
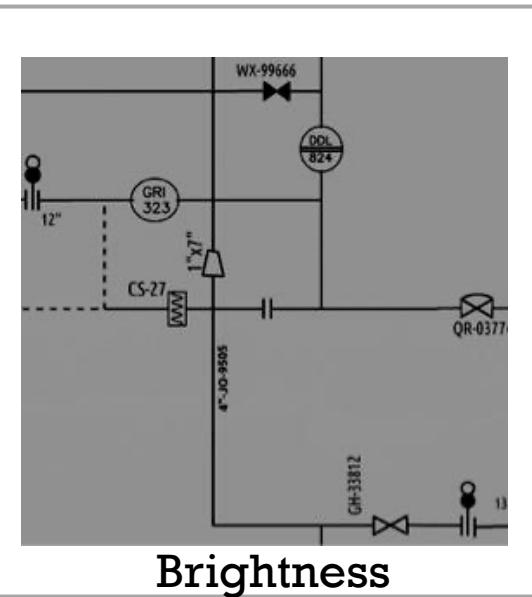
16622
schematic
images taken

Generated
43318 images
with
augmentations



AUGMENTATIONS

- Rotation: Between -10° and $+10^\circ$
 - simulates variations in image orientations.
- Brightness: Between -25% and +25%
 - simulates variations in image lighting conditions.
- Blur: Up to 2.5px
 - simulates variations in image sharpness.
- Bounding Box: Noise: Up to 5% of pixels
 - simulates variations in accuracy and precision.



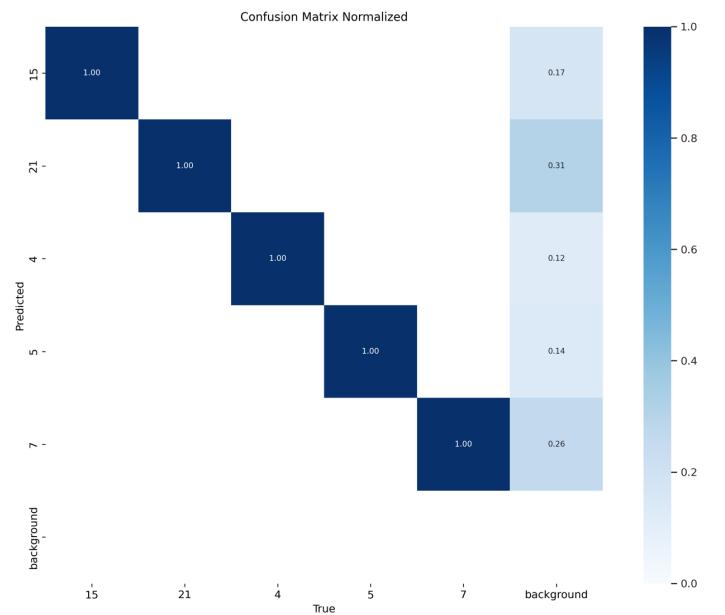
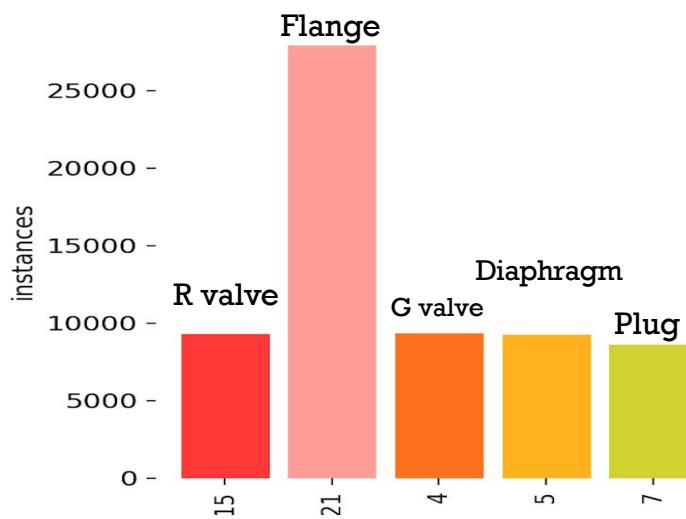
TRAINING - 2

Class	Images	Instances	Box(P)	R	mAP50	mAP50-95):
all	1675	2711	0.991	0.998	0.992	0.948
15	1675	387	0.987	0.999	0.988	0.935
21	1675	1153	0.985	0.996	0.994	0.935
4	1675	395	0.999	0.997	0.995	0.951
5	1675	399	0.994	1	0.995	0.953
7	1675	377	0.989	1	0.99	0.966

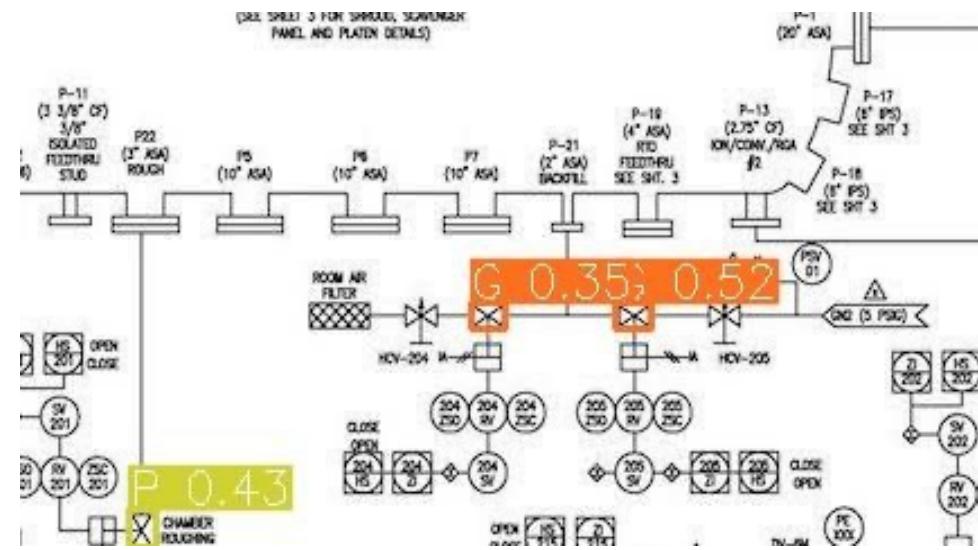
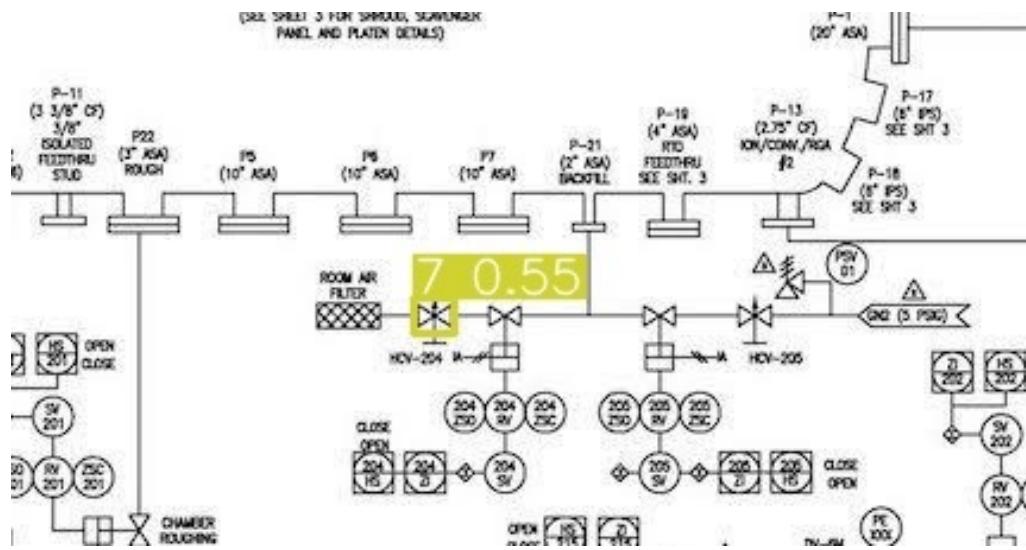
- Train : Test: validation (ratio) 90 :5 :5

- Epoch – 15 , batch size - 8

- Augmentations were applied

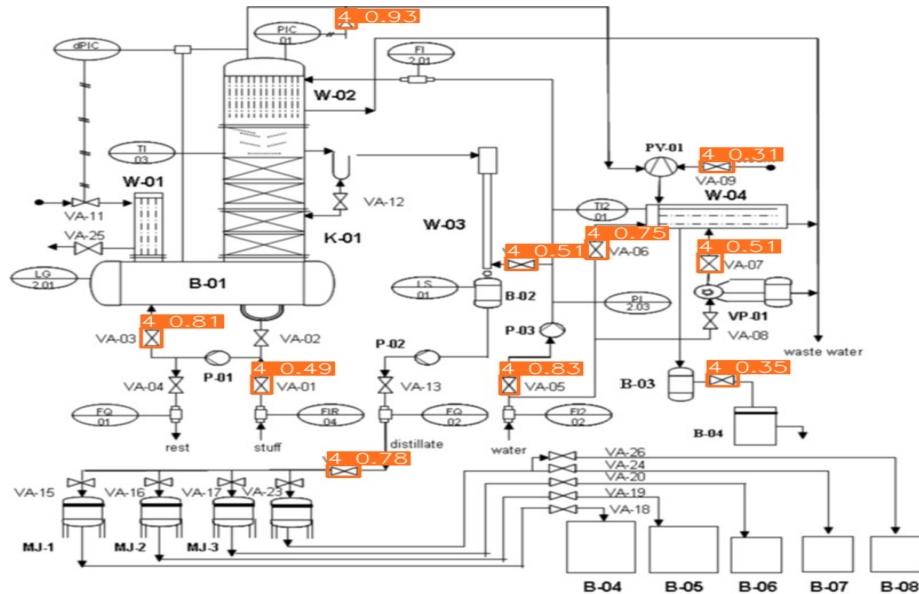


POST AUGMENTATIONS

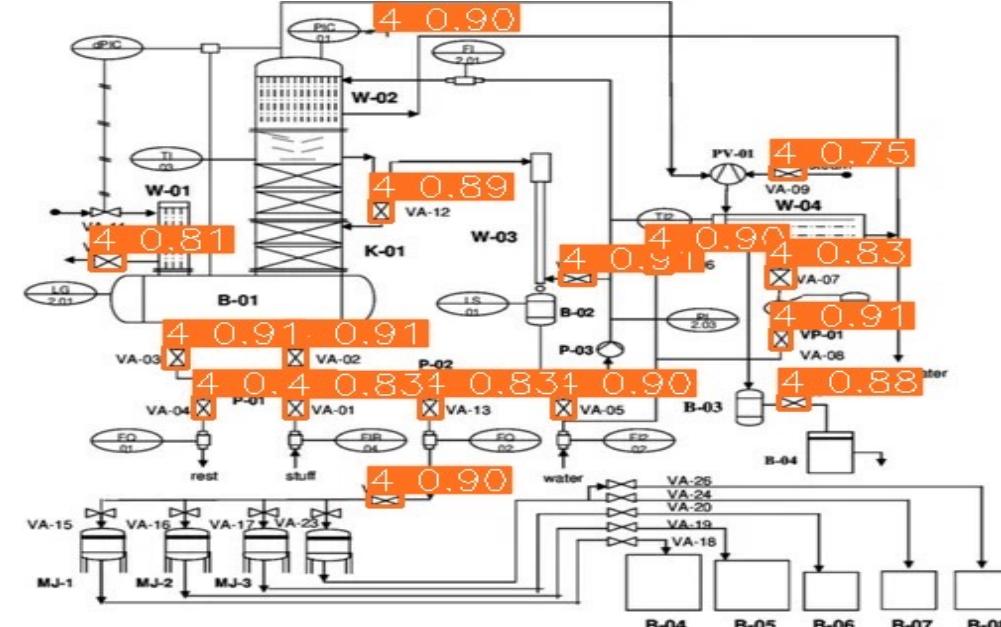


STEPS TO IMPROVE ACCURACY

- Since P&ID components are small , we used the SAHI library .
- The concept of sliced inference is basically; performing inference over smaller slices of the original image and then merging the sliced predictions on the original image.
- The model detected more no. of components with a better confidence score



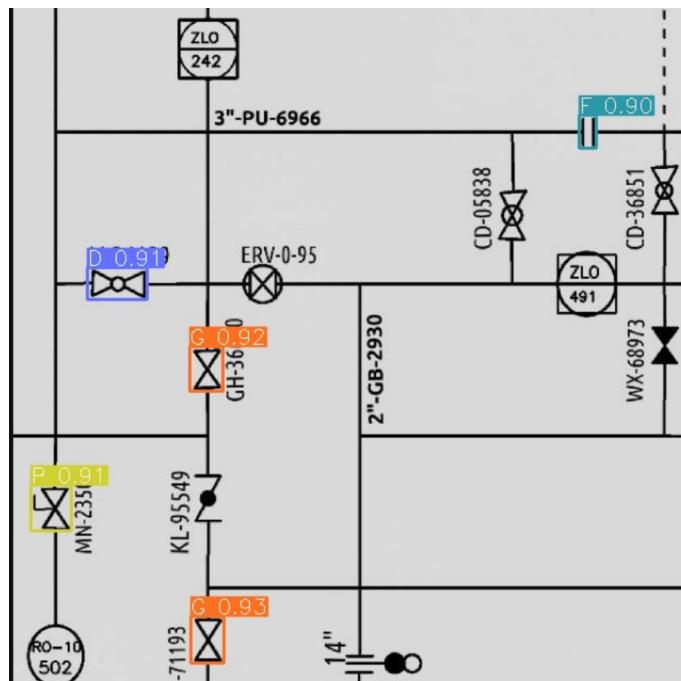
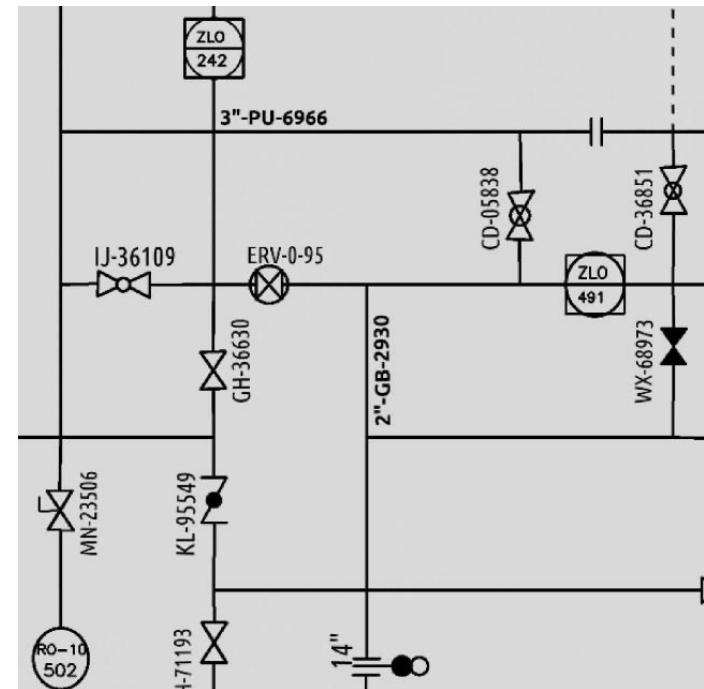
Before SAHI



After SAHI

TAG NAME EXTRACTION

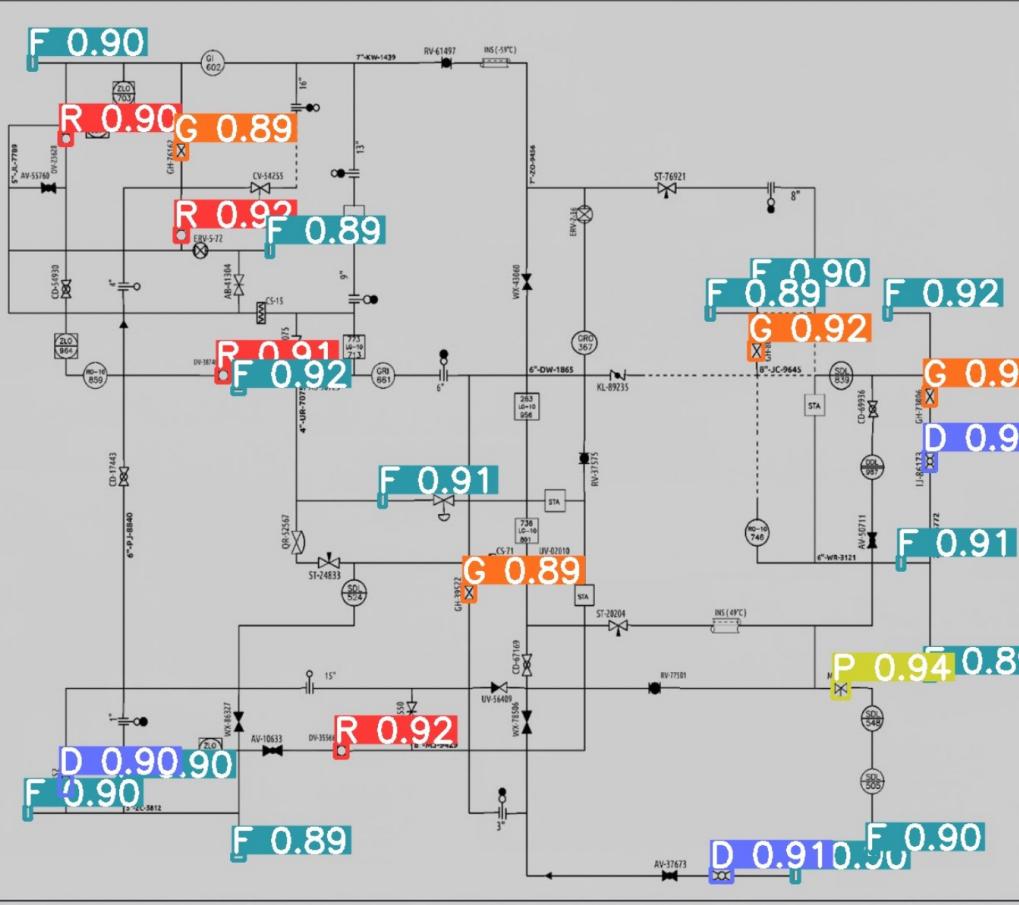
- EasyOCR is a Python library that provides a simple and convenient way to perform Optical Character Recognition (OCR) on images.



Class	Tag Name
0	Flange
1	Gate valve
2	Gate valve
3	Diaphragm
4	Plug

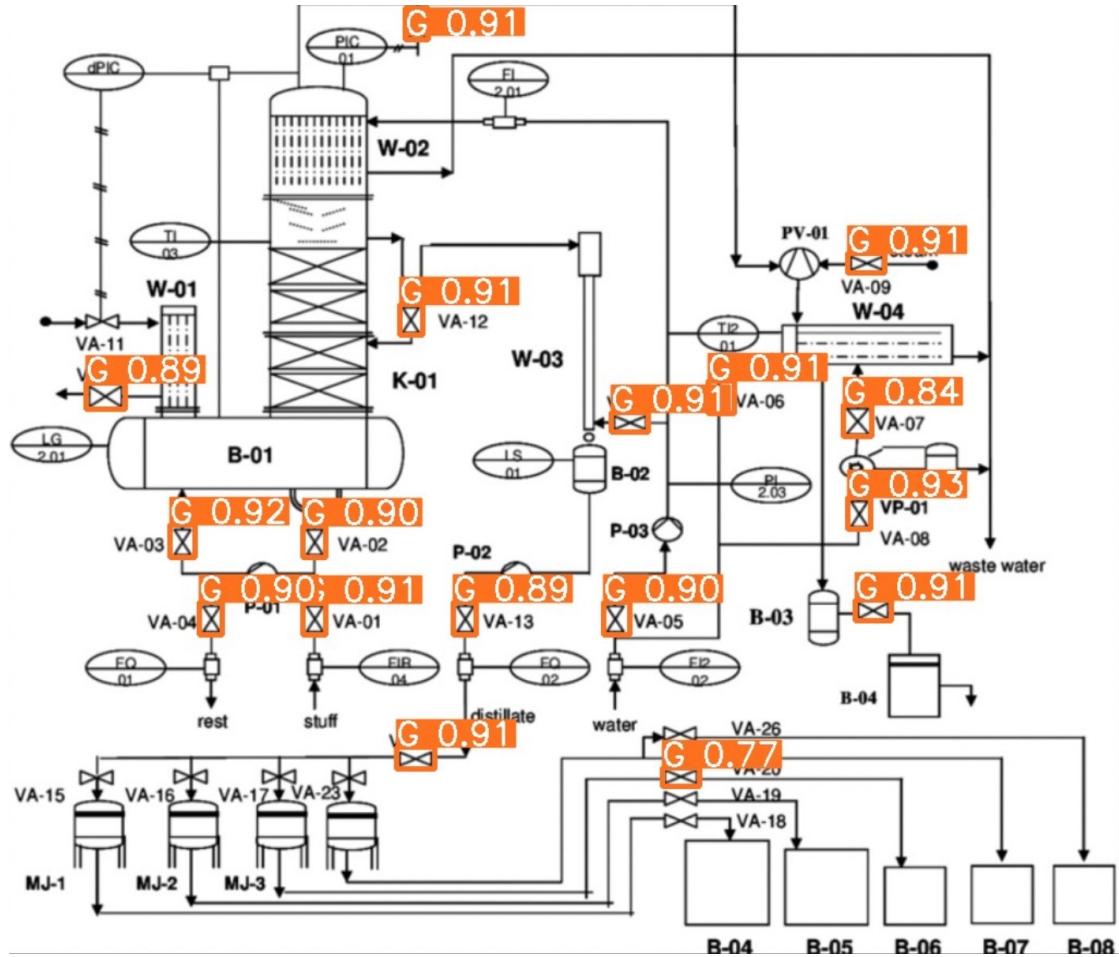


METRICS FOR SAMPLE PREDICTIONS



Gate valve	Rotary valve	Flange	Plug	Diaphragm
4	4	14	1	3
4	4	14	1	3



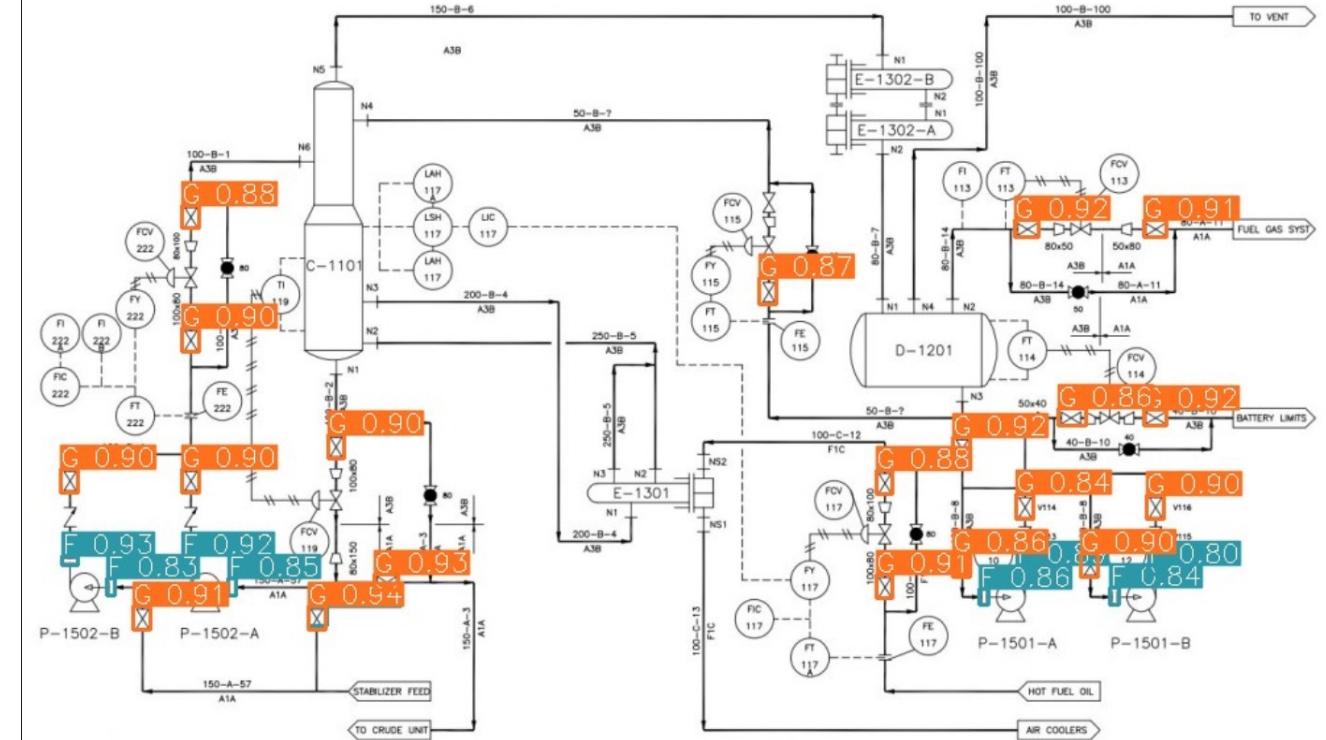


Gate valve

26

17





Gate valve

21

20

Flange

8

9

