DEFECTIVE PRODUCT DETECTION SYSTEM IN STEEL MANUFACTURING FACTORY

BESTEEL JUNIORS, 2024

TEAM MEMBER	ROLE
1. Firstova Anastasia	Leader
2. Sadykov Alisher	Co-Leader
3. Ismatullaeva Gulnur	Presentation
4. 이강민	Researcher
5. Kahal Sweety	Notes Maker
6. Yang Liu	Notes Maker

PARTICIPATING COMPANY

SeAH Besteel is one of South Korea's leading manufacturers of specialty steel products. The company focuses on producing steel bars and wire rods, with a strong emphasis on special bar quality (SBQ) steel, which is commonly used in the automotive and machinery industries.

WOOSONG UNIVERSITY x SeAH

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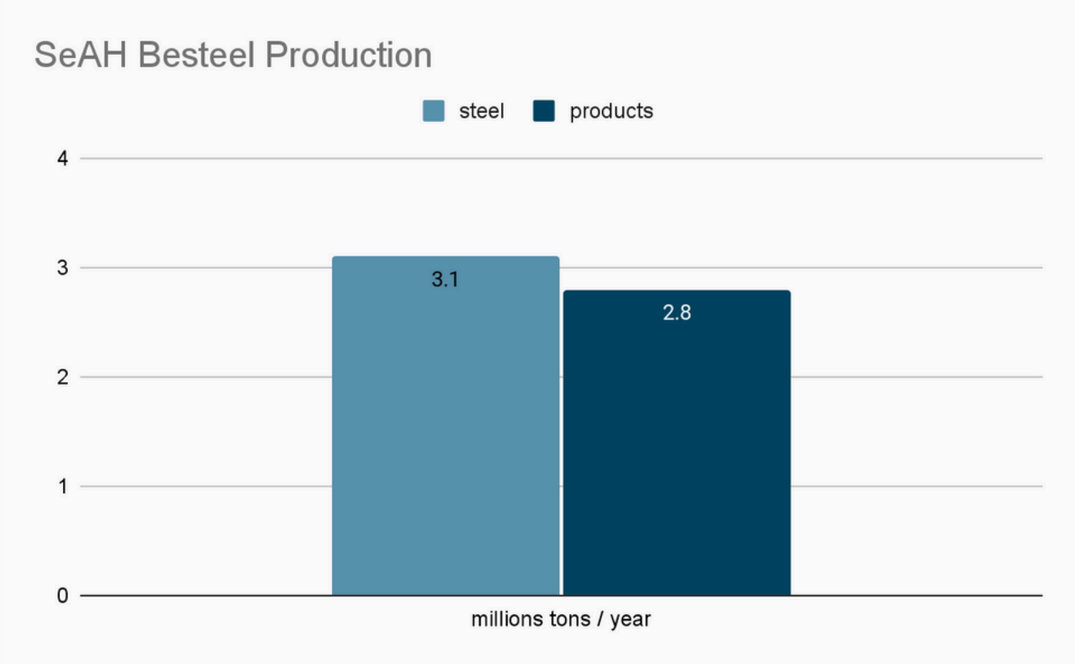
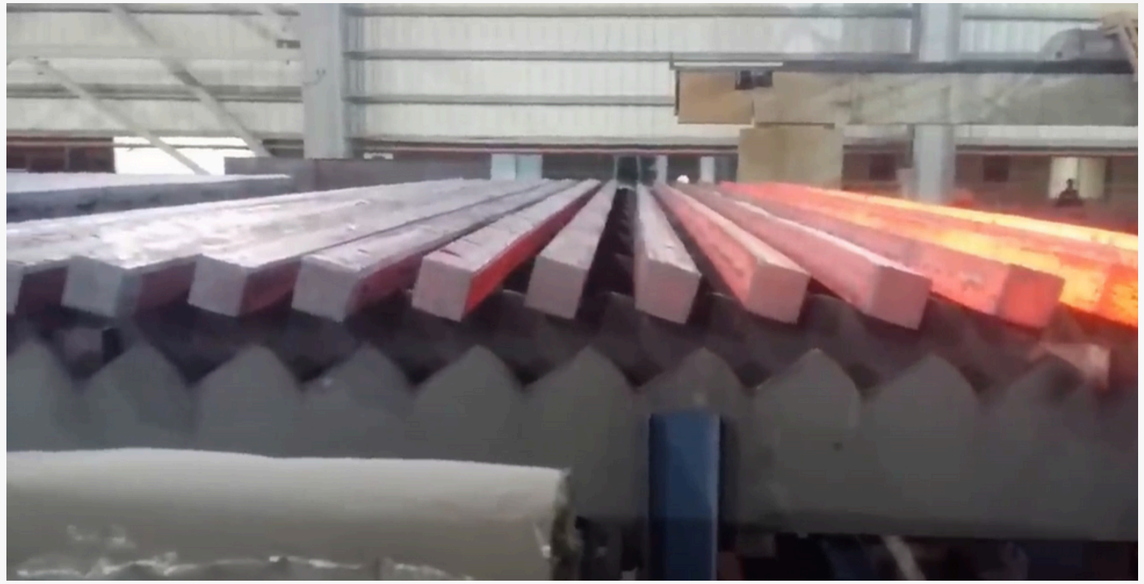
PROBLEM STATEMENT

Defect detection is done by human inspection
during intermediate stage of steelmaking process

Steel Making Process **Cutting Surface** **Intermediate Mistake** **Defected Product**





OUR SOLUTION

An AI computer vision system that will:

1. Reduce Defects: by using **AI to detect overfill areas**, these issues can be detected and minimized early.
2. Improve Data Collection: by using **database to automatically gather and store information** about laser-engravings on billets made during the steel rolling process.

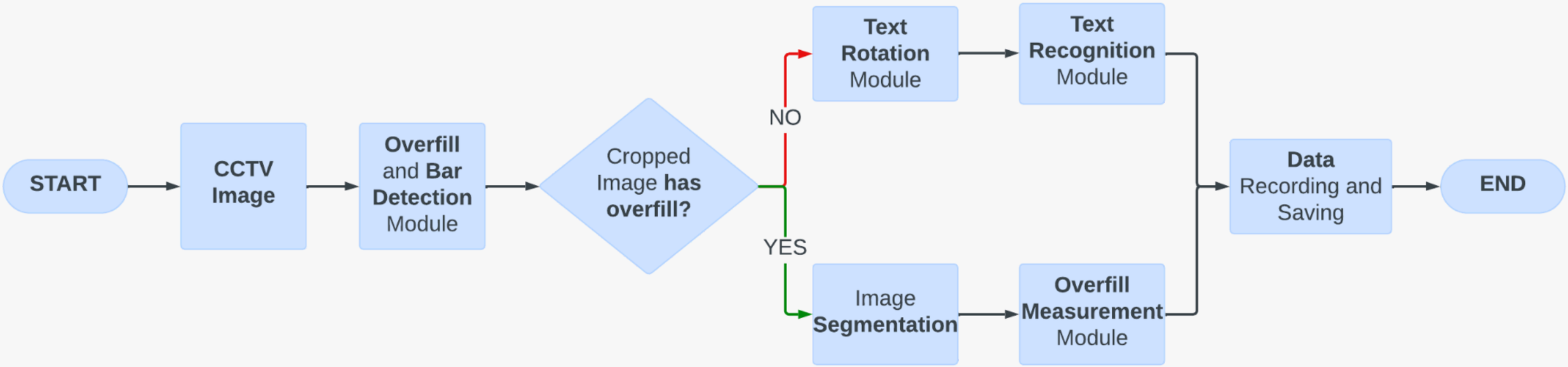
WOOSONG UNIVERSITY x SëAH

OUR SOLUTION

Pipeline:

- Identify Overfill
- Measure Overfill
- Recognize a HEAT and ID number
- Store recording
- Extract database as .csv file

SYSTEM ARCHITECTURE DIAGRAM



MODULES

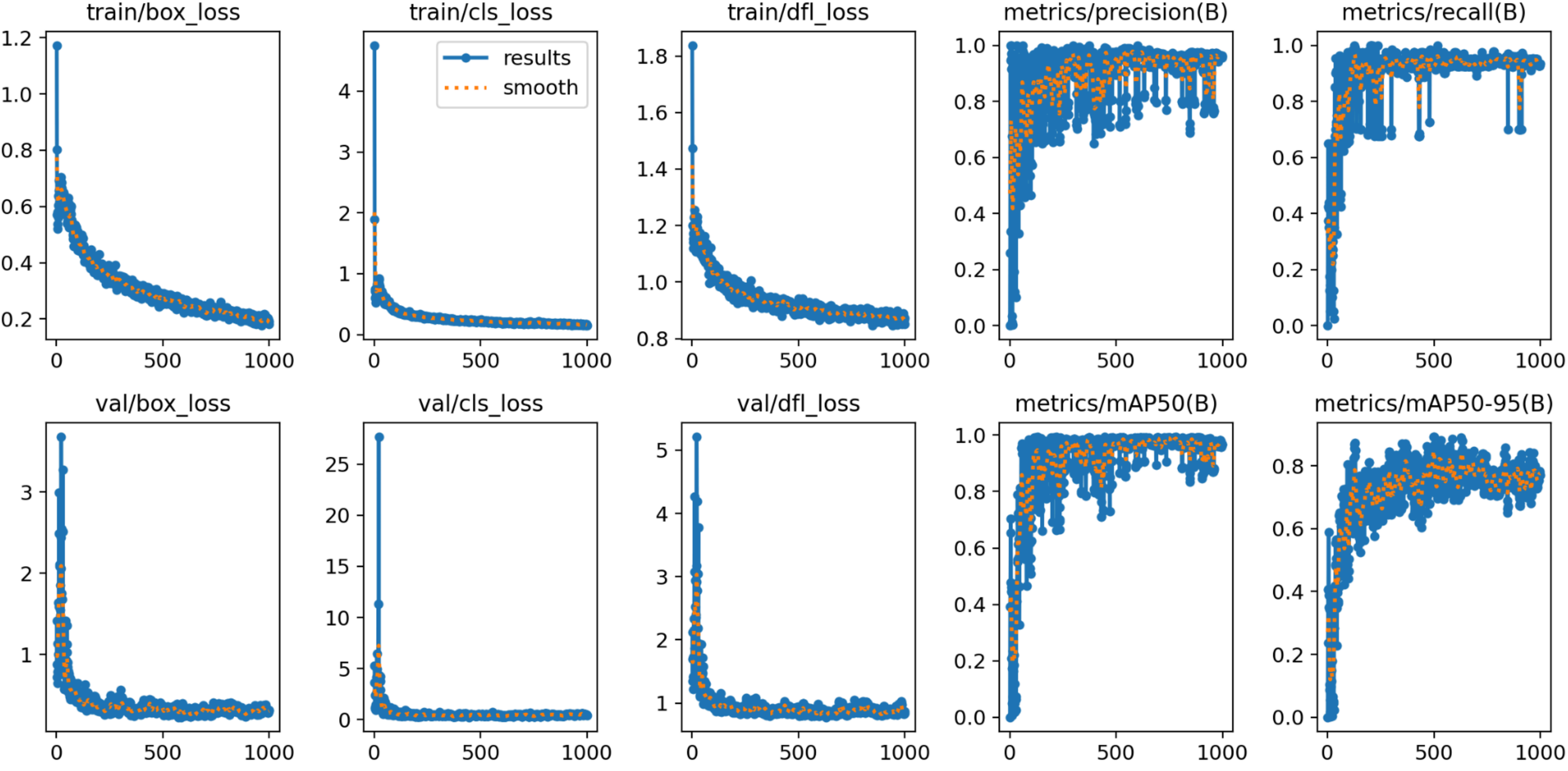
1. Overfill and Bar Detection Module
2. Image Segmentation Module
3. Overfill Measurement Module
4. Text Detection and Rotation Module
5. Text Recognition Module
6. Database
7. User Interface

OVERFILL AND BAR DETECTION MODULE

Model: YOLOv8s-worldv2
Accuracy: 80%

Next Steps:

1)Bar and Overfill cropped images
2)Bar cropped -> Text Recognition
3)Overfill -> Segmentation and
    Measurement

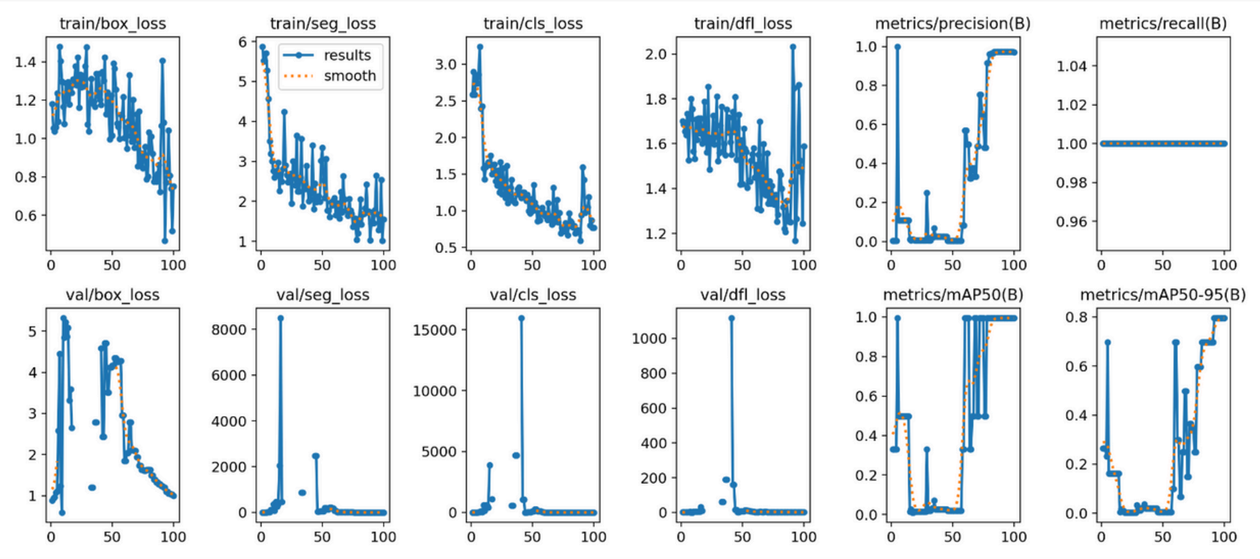

train/box_loss
train/cls_loss
results
smooth
train/dfl_loss
metrics/precision(B)
metrics/recall(B)
val/box_loss
val/cls_loss
val/dfl_loss
metrics/mAP50(B)
metrics/mAP50-95(B)

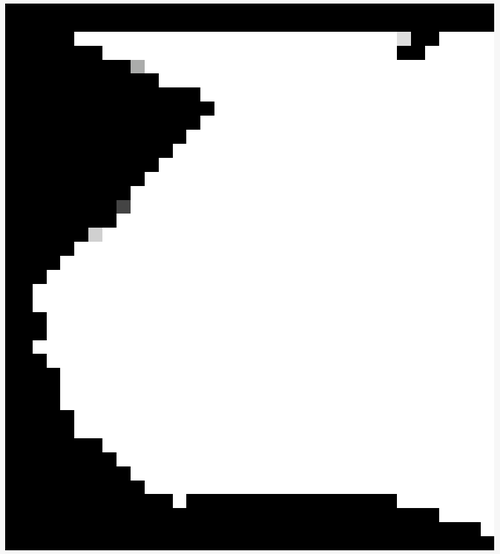
OVERFILL SEGMENTATION MODULE

Model: YOLOv8l-seg

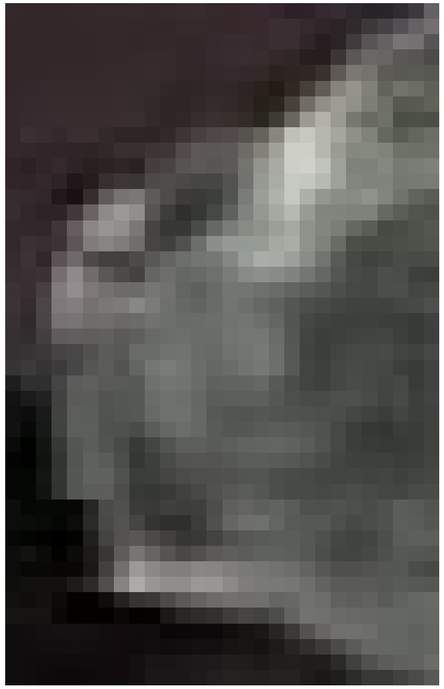
ACCURACY: MAP50 - 99.5%

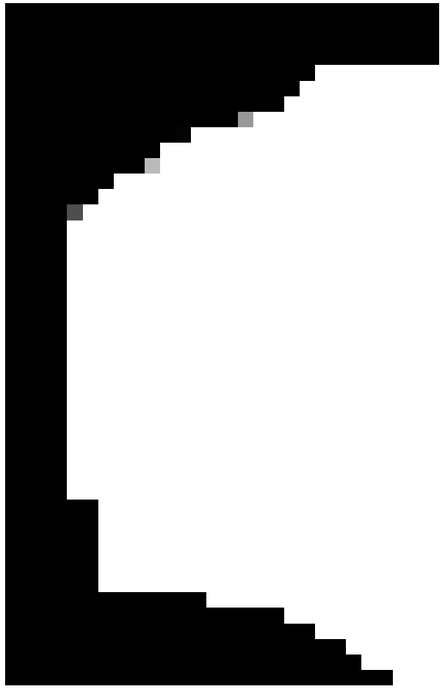
mAP50:95 - 79%





SEGMENTATION EXAMPLES





OVERFILL MEASUREMENT MODULE

Strategy:

1) Calculated scale: how many **cm in 1 pixel of the image**
2) Took **binary mask** from image segmentation module
3)Calculated area in Pixels and converted to Square Meters
4)Calculated maximum distance between boundaries for length and converted to meters
5)Return Area and Length

Severity:

A - no overfill

B - shear transformation

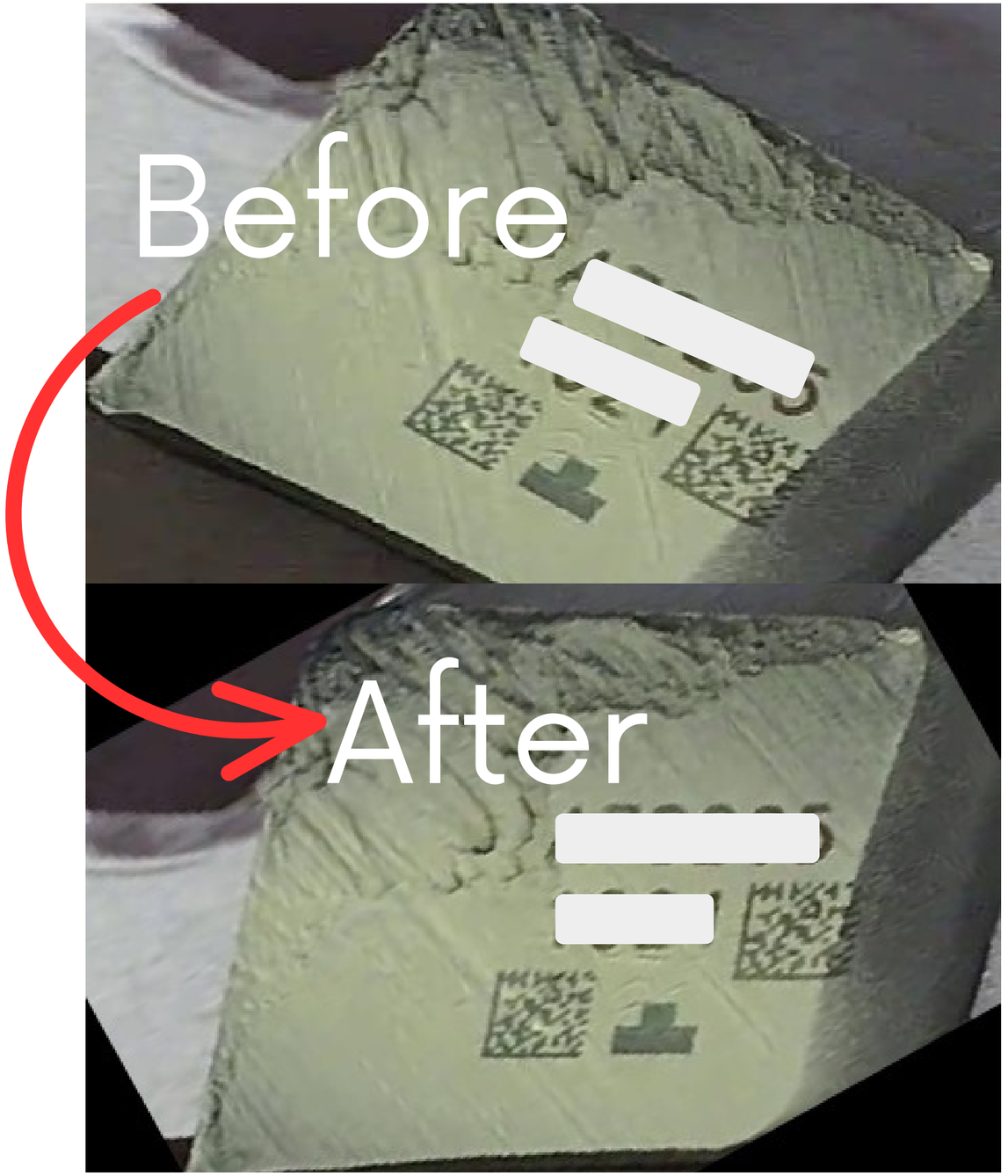
C - overfill

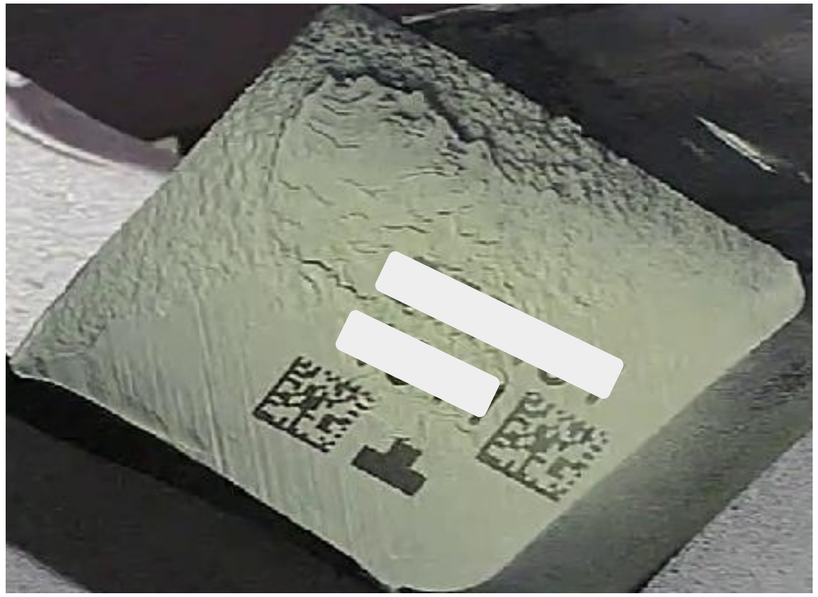
D - NO TEXT RECOGNIZED

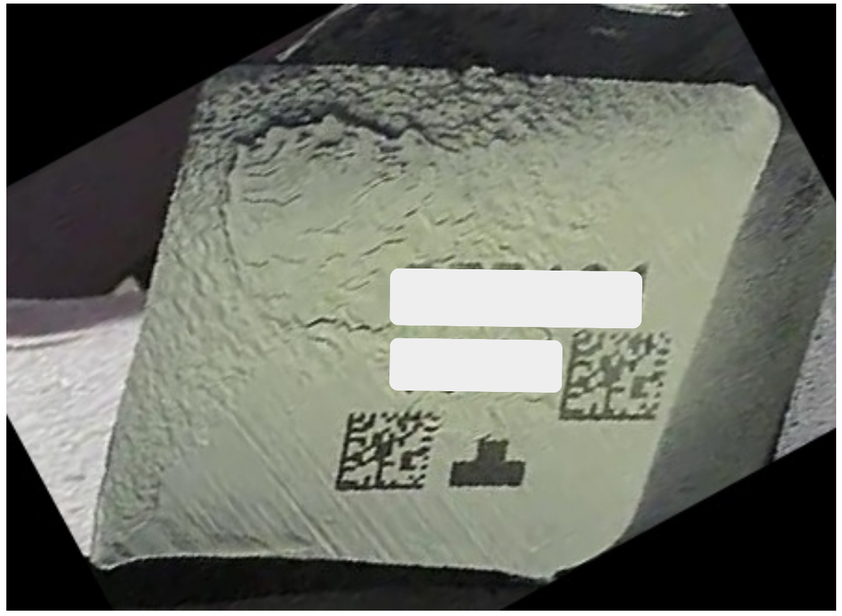
TEXT DETECTION AND ROTATION MODULE

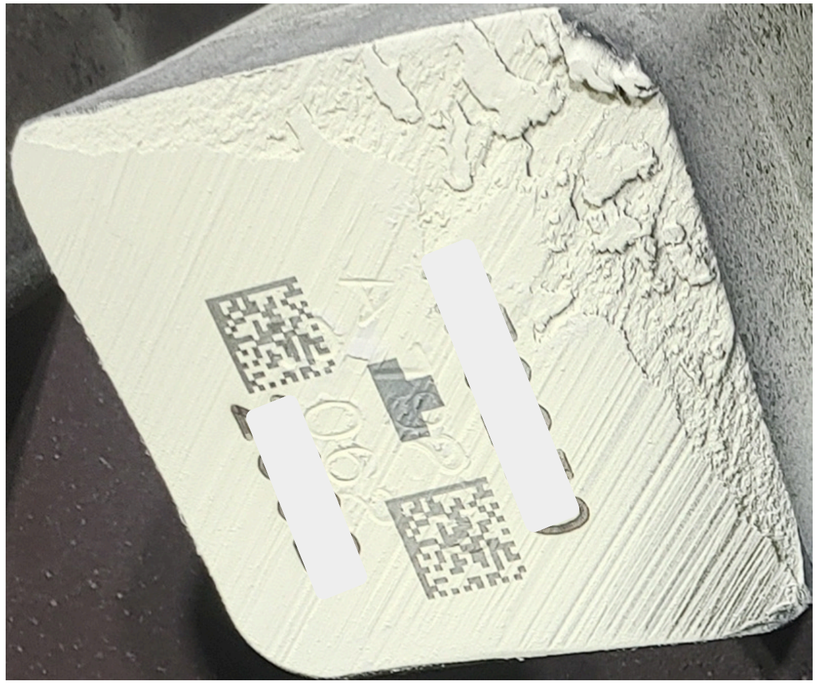
Model: **PaddleOCR**
Accuracy: **95%**
Strategy:

- Calculate angle using text boxes
- Find sinus between longest side
  Of the box and horizontal line
- Rotate image









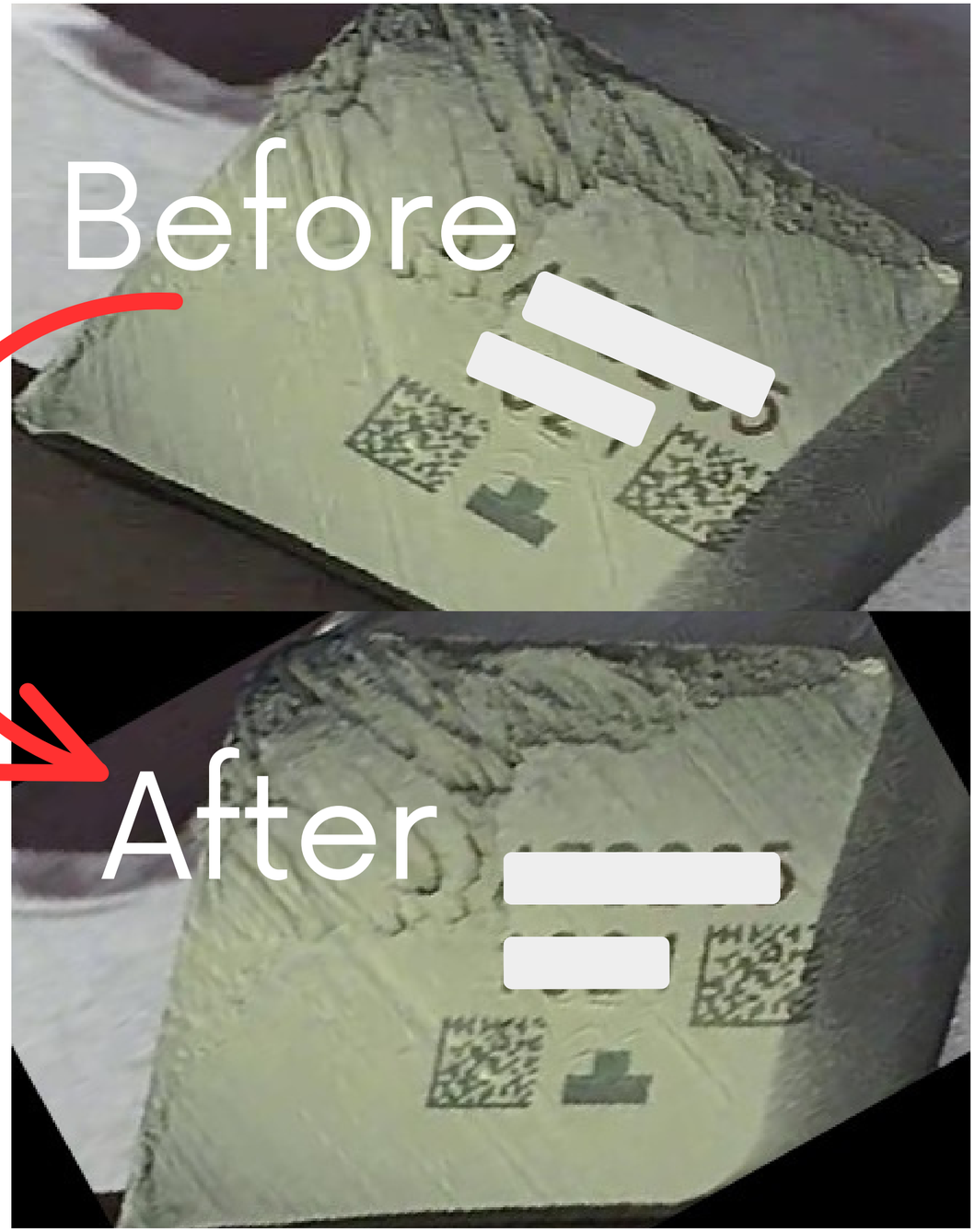
TEXT RECOGNITION MODULE

Model: PaddleOCR

Accuracy: 90%

Additional task:

- IF text is not recognized severity level is “D”



DATABASE

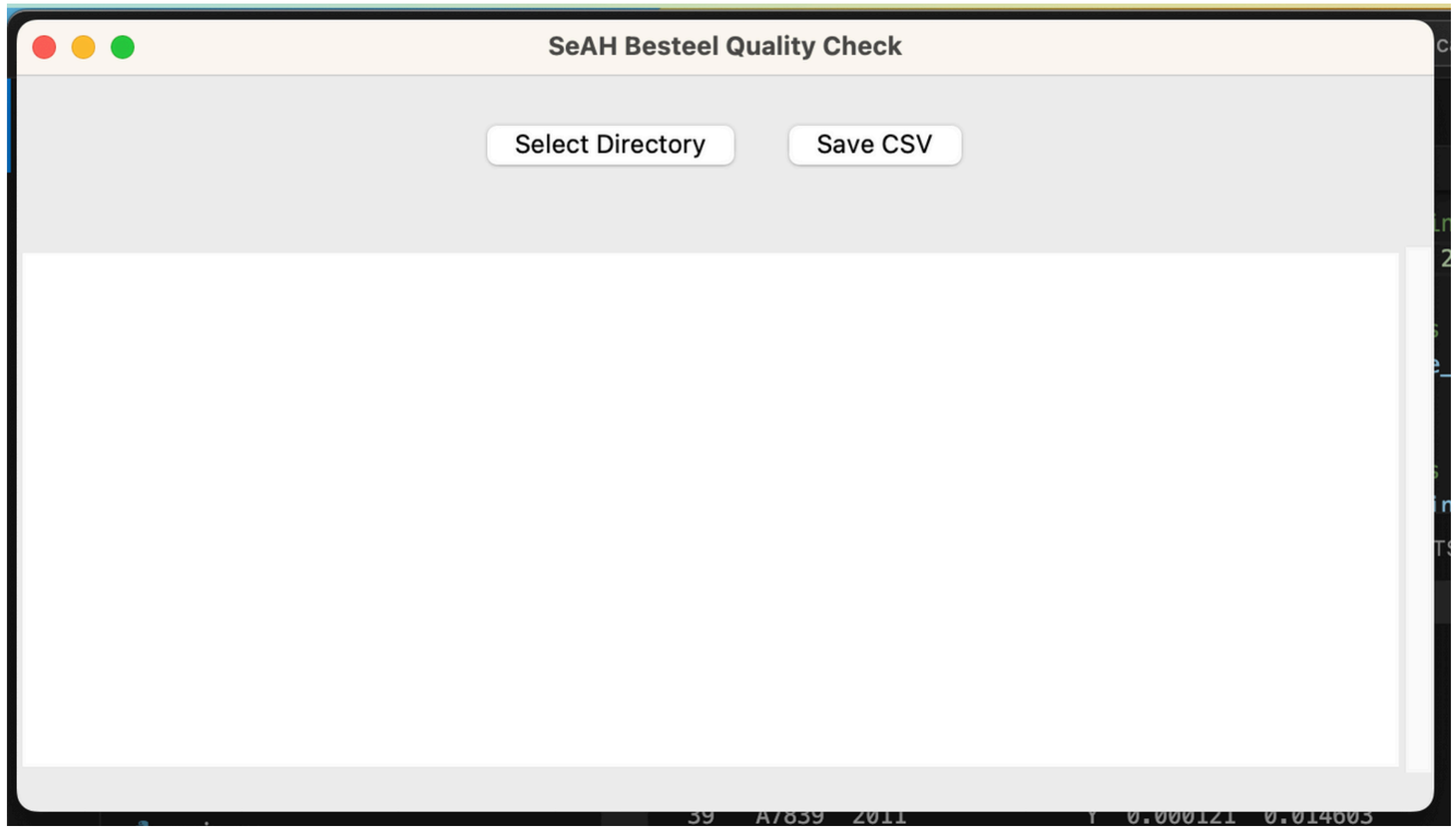
All relevant data is recorded and saved in a CSV file

	HEAT	ID	Overfill(Y,N)	Area	Length	Severity	FileName
0	B77462	3021	N	0	0	A	Good_5.jpg
1	A78151	2051	N	0	0	A	Good_4.jpg
2	A78170	2011	N	0	0	A	Good_6.jpg
3	A78149	2011	N	0	0	A	Good_3.jpg
4	B80697	4061	N	0	0	A	Good_2.jpg
5	A78315	1011	N	0	0	A	Good_1.jpg
6	A78263	1051	N	0	0	A	Good_14.jpg
7	A78205	2041	Y	0.000074	0.014396	C	Overfill_4.jpg
8	A78533	3011	Y	0.000652	0.054777	C	Overfill_20.jpg
9	A78312	1011	Y	0.001443	0.082973	C	Overfill_5.jpg
10	A78274	2011	N	0	0	A	Good_15.jpg
11	A78286	2041	N	0	0	A	Good_17.jpg

USER INTERFACE

Simple UI Design
Library: **Tkinter**

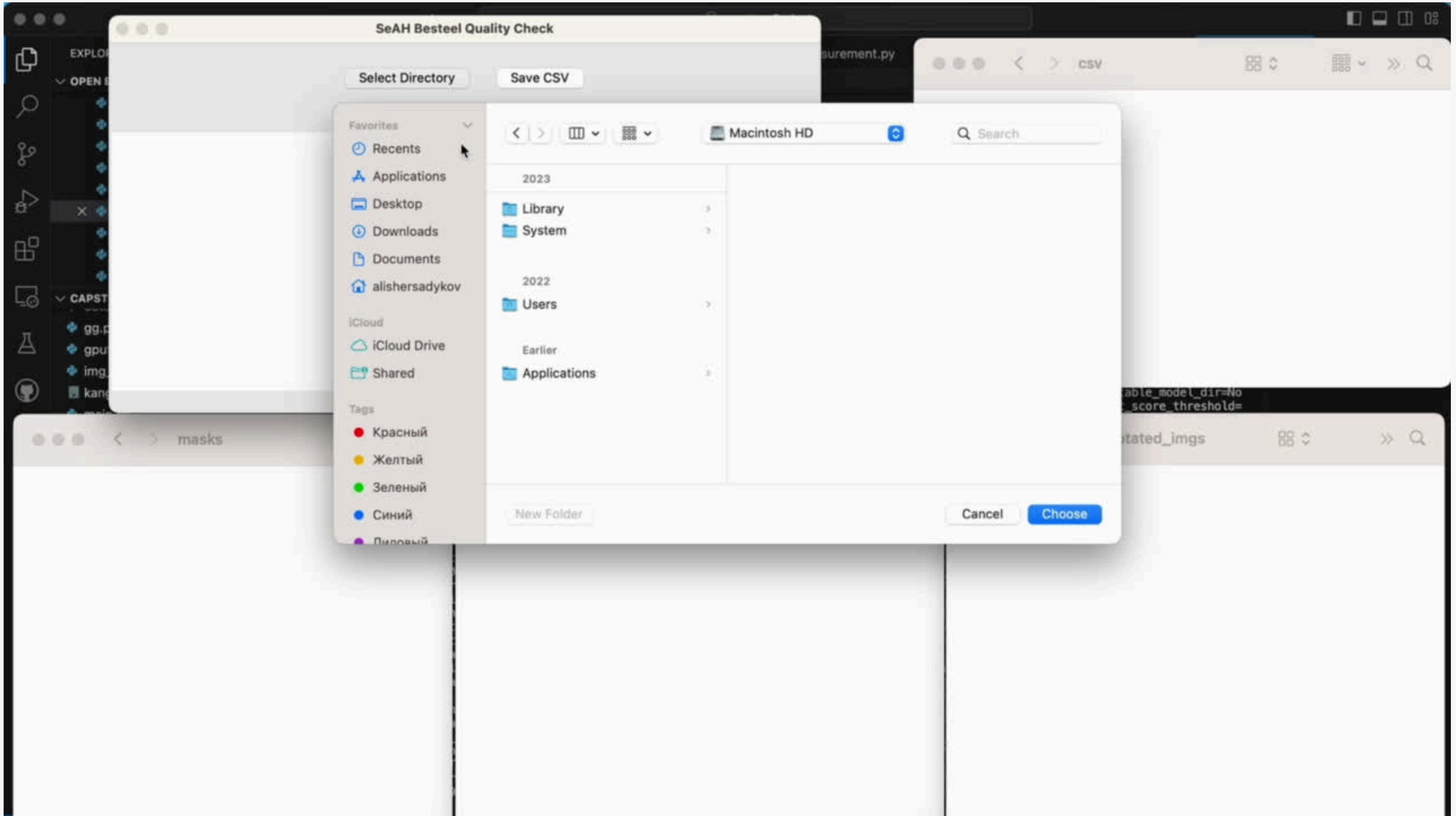
Process:
1)Choose Directory
2)Wait until backend code running
3)Download CSV file



RESULTS

SeAH Besteel Requirements	Our Results
min accuracy of the **Overfill Detection >0.60** for mAP:IoU=50:95, and **>0.80** for mAP:IoU=50	mAP:IoU=50:95 - **80%**
min accuracy of **Overfill Segmentation >0.80** for mAP:IoU=50	mAP:IoU=50:95 - **79%**
min accuracy of **overfill measurement >0.40** for mAP:IoU=50:95, and **>0.60** for mAP:IoU=50	-
min accuracy of **text detection** and **rotation >90%.**	**95%**
mini accuracy of **text recognition >90%**	**90%**

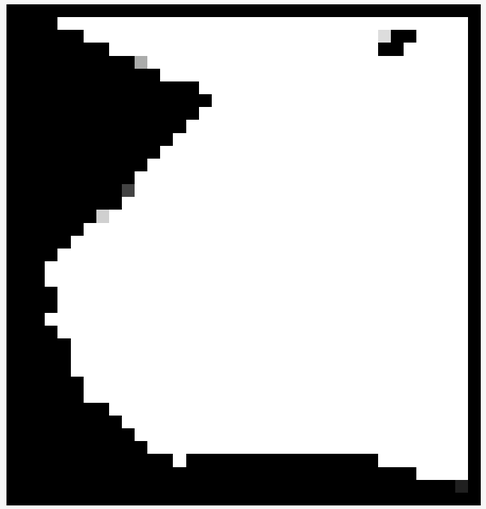
LIVE DEMO


SeAH Besteel Quality Check
Select Directory
Save CSV
csv
masks
Favorites
Recents
Applications
Desktop
Downloads
Documents
alishersadykov
iCloud
iCloud Drive
Shared
Tags
Красный
Желтый
Зеленый
Синий
Macintosh HD
Search
2023
Library
System
2022
Users
Earlier
Applications
New Folder
Cancel
Choose

FINAL CSV

	HEAT	ID	Overfill(Y,N)	Area	Length	Severity	FileName
0	B77462	3021.0	N	0.000000	0.000000	A	Good_5.jpg
1	A78151	2051.0	N	0.000000	0.000000	A	Good_4.jpg
2	A78170	2011.0	N	0.000000	0.000000	A	Good_6.jpg
3	A78149	2011.0	N	0.000000	0.000000	A	Good_3.jpg
4	B80697	4061.0	N	0.000000	0.000000	A	Good_2.jpg
5	A78315	1011.0	N	0.000000	0.000000	A	Good_1.jpg
6	A78263	1051.0	N	0.000000	0.000000	A	Good_14.jpg
7	A78205	2041.0	Y	0.000074	0.014396	C	Overfill_4.jpg
8	A78533	3011.0	Y	0.000652	0.054777	C	Overfill_20.jpg
9	A78312	1011.0	Y	0.001443	0.082973	C	Overfill_5.jpg
10	A78274	2011.0	N	0.000000	0.000000	A	Good_15.jpg
11	A78286	2041.0	N	0.000000	0.000000	A	Good_17.jpg
12	A78338	4041.0	Y	0.000159	0.017270	C	Overfill_7.jpg

PIPELINE



	HEAT	ID	Overfill(Y,N)	Area	Length	Severity
0	B77462	3021	N	0	0	A
1	A78151	2051	N	0	0	A
2	A78170	2011	N	0	0	A
3	A78149	2011	N	0	0	A
4	B80697	4061	N	0	0	A
5	A78315	1011	N	0	0	A
6	A78263	1051	N	0	0	A
7	A78205	2041	Y	0.000074	0.014396	C
8	A78533	3011	Y	0.000652	0.054777	C
9	A78312	1011	Y	0.001443	0.082973	C
10	A78274	2011	N	0	0	A
11	A78286	2041	N	0	0	A

CHALLENGES

Small dataset

Overfill Scaling

Ground Truth with OCR

Limited resources

Q&A SESSION

FEEL FREE TO ASK ANY QUESTION!

THANK YOU

FOR YOUR ATTENTION