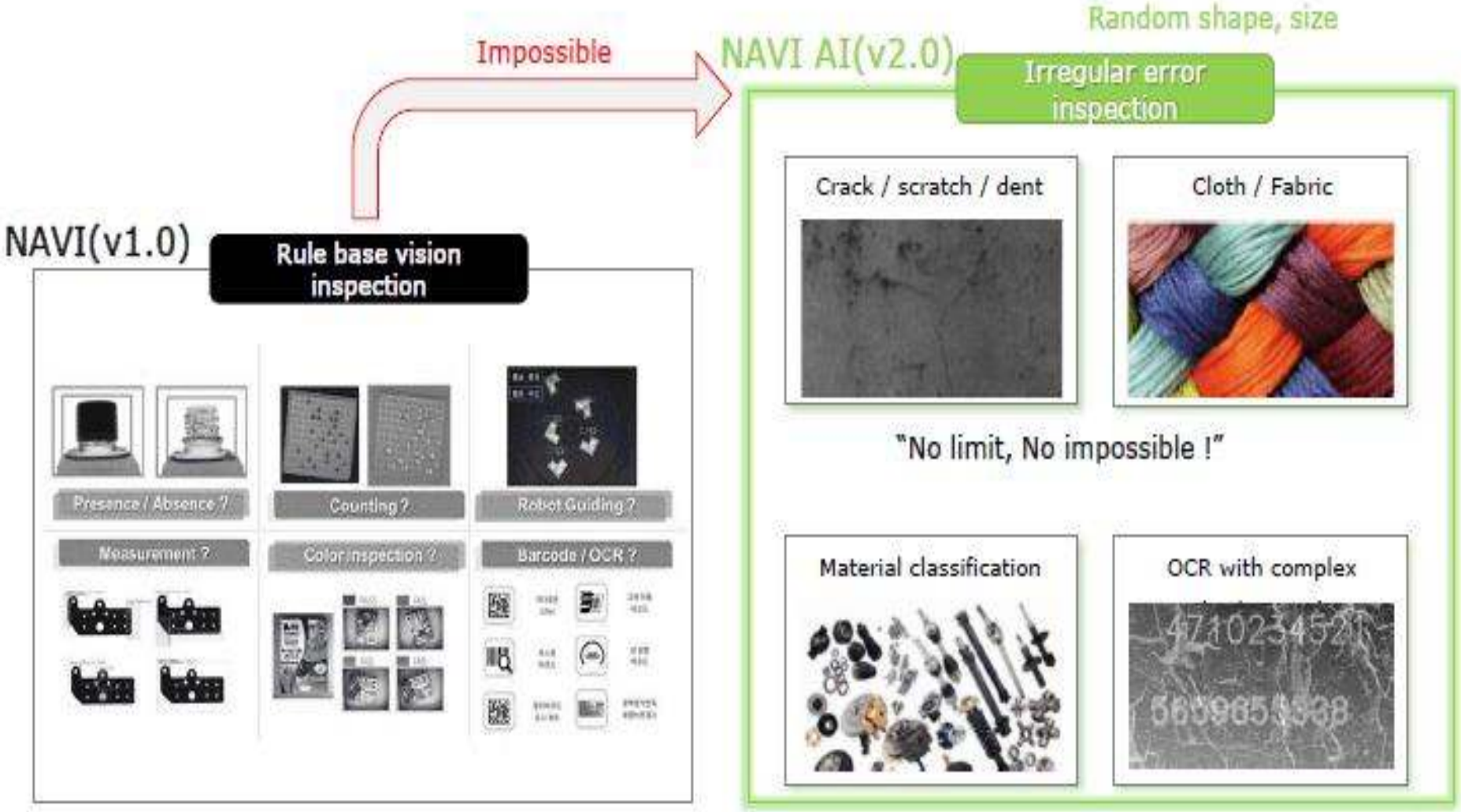
inspiraz TECHNOLOGY

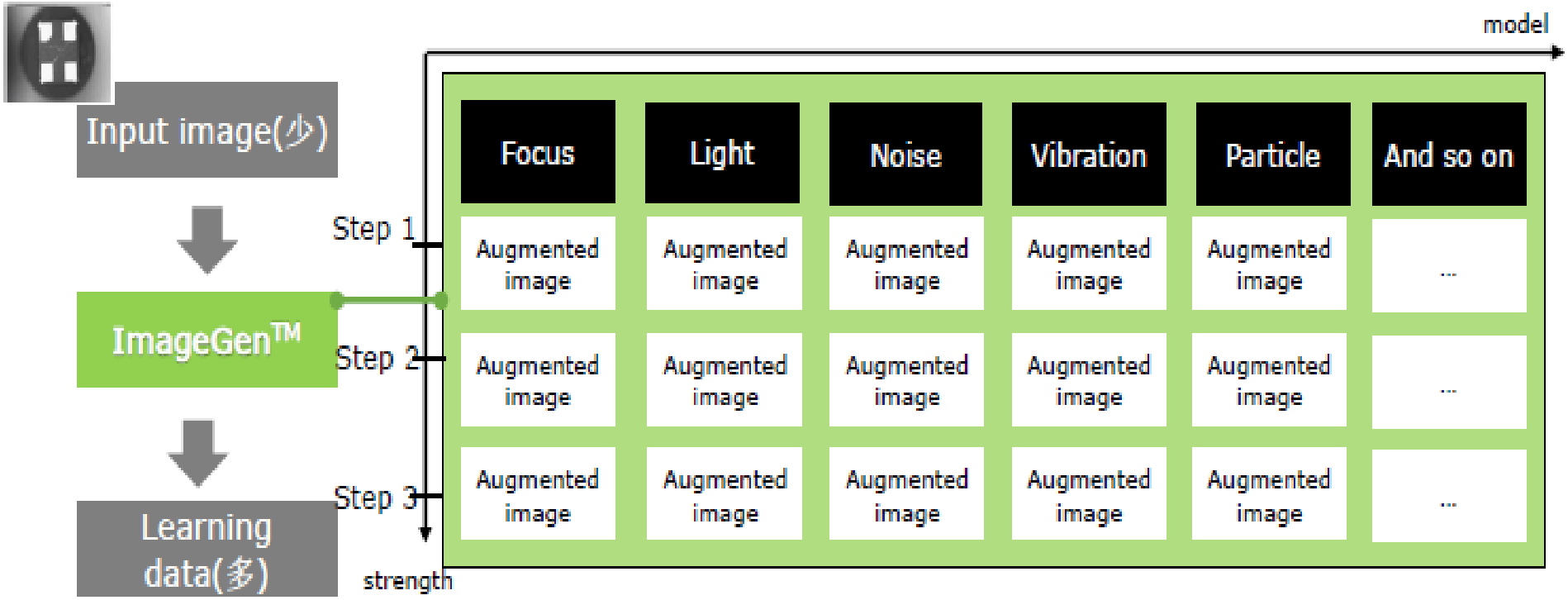
Deep Learning Based Machine Vision – NAVI AI

NAVI AI - Concept



NAVI AI Image Generation

Smallest image data, Smartest learning process.
Real industrial process modeling can achieve reliable augmentation.



NAVI AI Line-Up

NAVI AI Tool

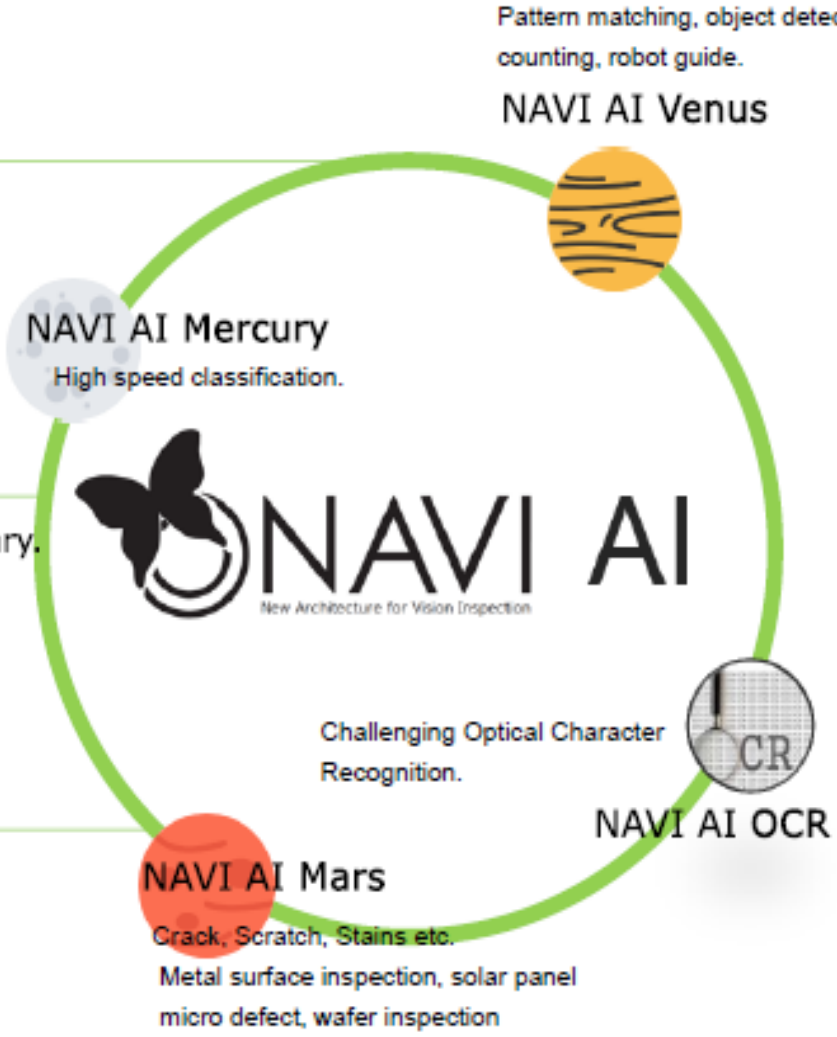
- ✓ Deep Learning Vision inspection tool without programming.
- ✓ Could be solved impossible vision project so far!

NAVI AI Library

- ✓ Ordinary programmer also can use Deep Learning SW Library.
- ✓ Could program without deep learning knowledge!

NAVI AI Trainer

- ✓ Simple and Powerful trainer without expert knowledge.
- ✓ Just put images(OK/NG images) for training !



NAVI AI Toolset

NAVI AI TOOL | **NAVI AI Library**

- **NAVI AI Mercury**
- NAVI AI Venus
- NAVI AI Mars
- NAVI AI OCR

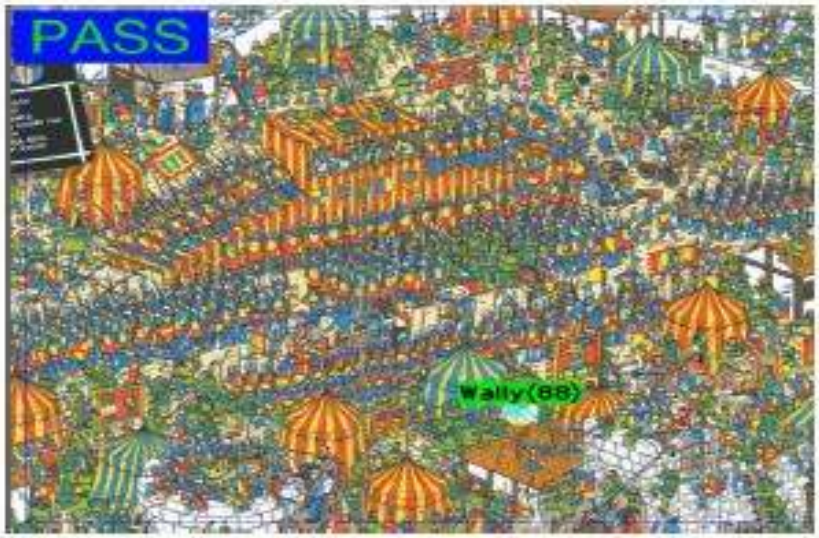
- ✓ [Application] OK vs NG, NG type
- ✓ [Feature] Robust result for target shape, size, color
  Fastest deep learning inspection algorithm

NAVI AI Toolset

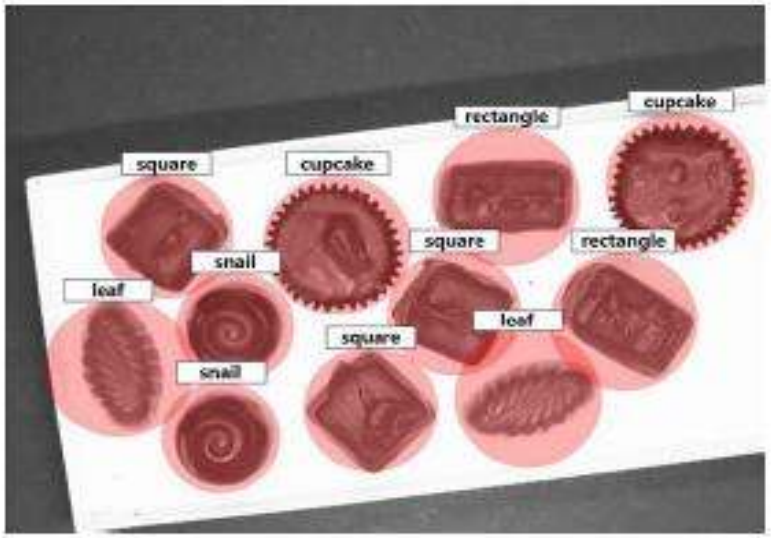
NAVI AI TOOL | **NAVI AI Library**

NAVI AI Mercury	**NAVI AI Venus**	NAVI AI Mars	NAVI AI OCR

- ✓ [Application] Pattern matching, Detect object
- ✓ [Feature] Bounding box result.
  Robust to complex background, Occlusion, Scale variation



Finding wally



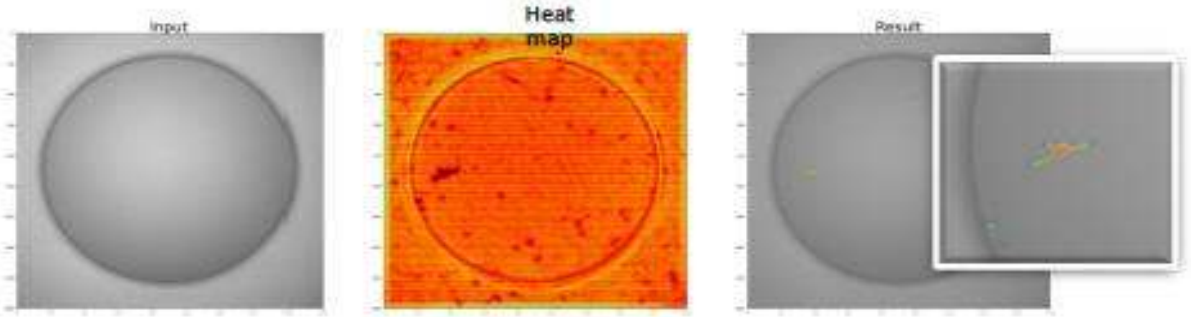
Chocolate detection

NAVI AI Toolset

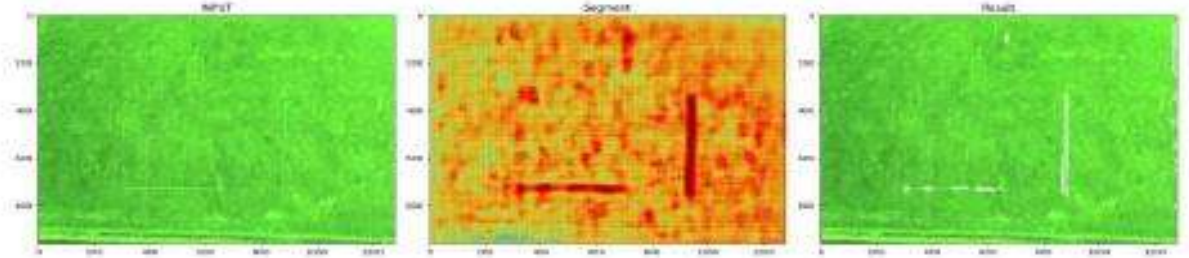
NAVI AI TOOL | **NAVI AI Library**

- NAVI AI Mercury
- NAVI AI Venus
- **NAVI AI Mars**
- NAVI AI OCR

- ✓ [Application] Irregular crack, defect, scratch, stain
  LCD / Metal / Glass / Wafer / Solar panel surface inspection
- ✓ [Feature] Abnormal position detection and segmentation



Wafer surface inspection



Metal scratch detection

NAVI AI Trainer

- ✓ Standalone training tool
- ✓ Basic / Advance mode
- ✓ Database for training results

AI Mercury	AI Venus	AI Mars
30 minutes (1024 x 1024 6000 images)	60 minutes (512x512 6000 images)	30 minutes (1024 x 1024 6000 images)

◎ NAVI AI Training Process

Image acquisition	•Minimum 20 images for each class •Every error class needs separate images
Learning	•NAVI AI(Mercury, Venus, Mars) training process •ImageGen™ generates 10 or 100 times images using realistic models
Inference	•NAVI AI uses trained data •If inspection condition is changed, retrain using pre-trained data

NAVI AI Mercury

Inference

Resolution	Execution time
640x480	About 20 ms
1280x960	About 60 ms
1920x1200	About 100 ms
2560x1600	About 160 ms

* Platform
CPU : intel i7 core,
GPU : Nvidia GTX1060

Training

Resolution	Execution time
640x480	10 - 20 min
1280x960	40 - 50 min
1920x1080	60 – 70 min
2560x1600	90 – 100 min

Resolution	Class	Execution time
1280x960	2	60 ms
	10	60 ms
	100	60 ms

* Iteration
# of image = 100
10000 iteration

* Platform
CPU : intel i7 core,
GPU : Nvidia 1080 TI

NAVI AI Venus

Inference

Resolution	Execution time
640x480	40 ms
1280x960	160 ms

* Platform
CPU : intel i7 core,
GPU : Nvidia GTX1060

Training

Resolution	Execution time
640x480	4 - 5 hour
1280x960	8 - 9 hour

Resolution	Object	Execution time
640x480	1	40 ms
	10	45 ms
	20	50 ms

* Iteration
# of image = 100
10000 iteration

* Platform
CPU : intel i7 core,
GPU : Nvidia 1080 TI

NAVI AI Mars

Inference

Resolution	Execution time
640x480	About 20 - 40 ms
1280x960	About 60 – 120 ms
1920x1200	About 100 – 200 ms
2560x1600	About 160 - 300 ms

* Depends on complexity of network

* Platform
CPU : intel i7 core,
GPU : Nvidia GTX1060

Training

Resolution	Execution time
640x480	20 - 40 min
1280x960	40 - 80 min
1920x1200	60 – 120 min
2560x1600	90 – 180 min

Resolution	Complexity	Execution time
1.2M	Low	40 ms
	Mid	60 ms
	High	80 ms

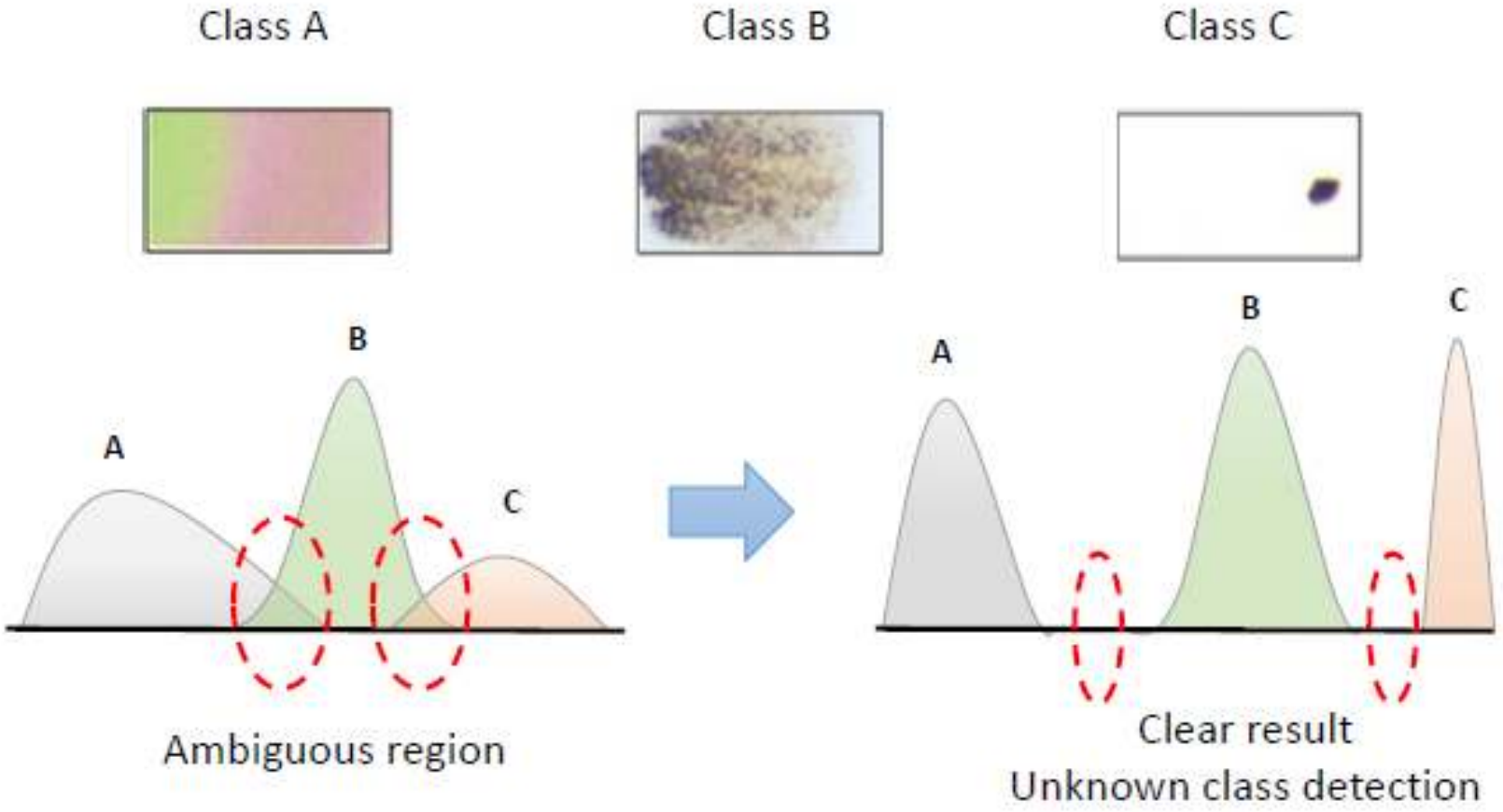
* Iteration
# of image = 100
10000 iteration

* Platform
CPU : intel i7 core,
GPU : Nvidia TitanX

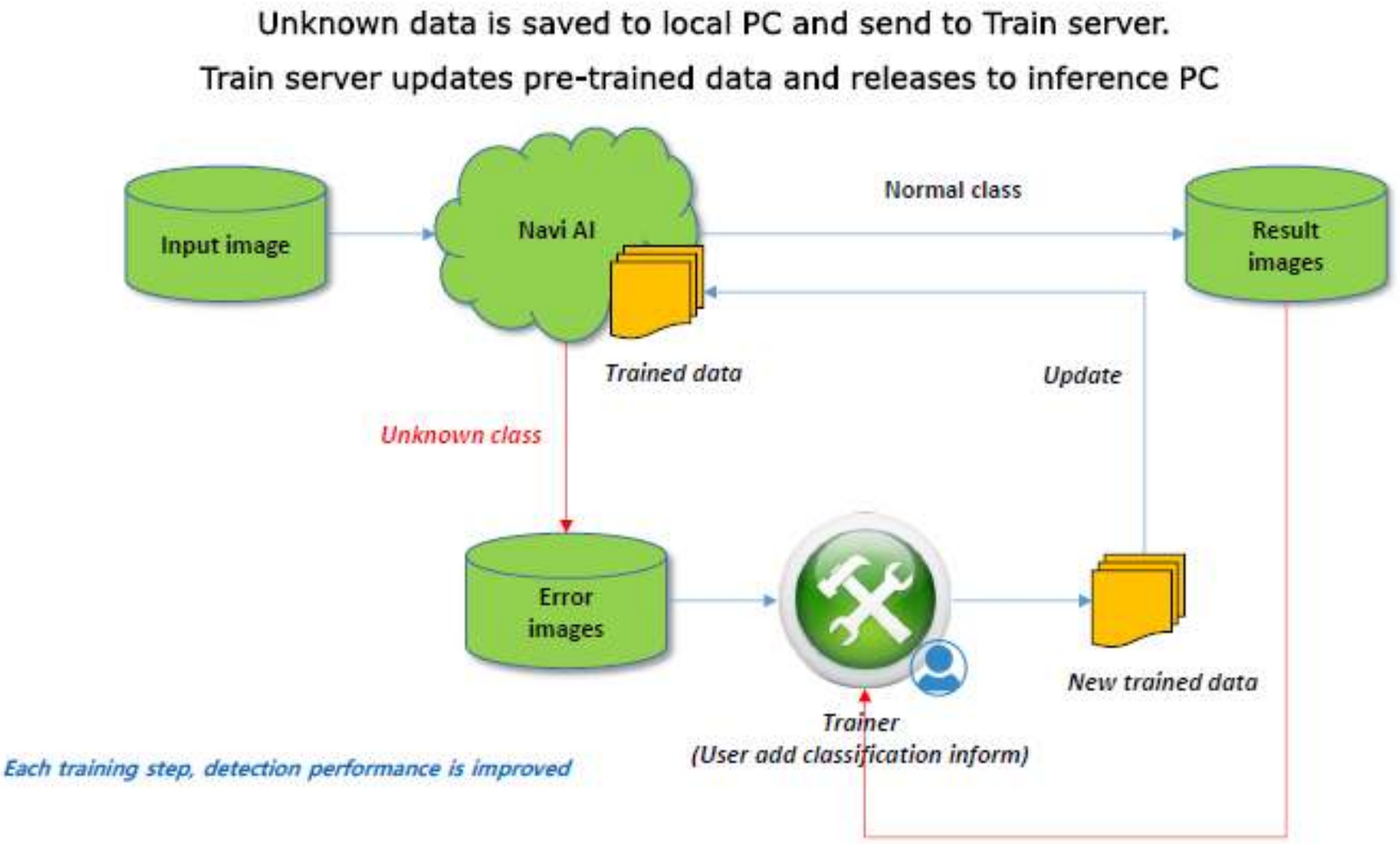
New Defects Classification

Narrow confidence area makes more clear classification and reduce ambiguous.

New defect can be classified to unknown.

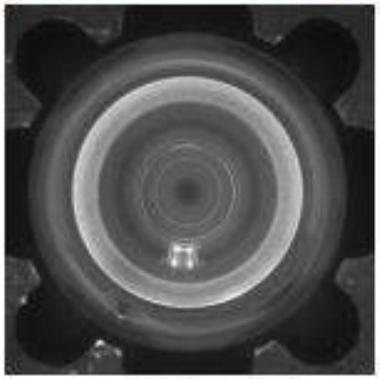


New Defects Classification

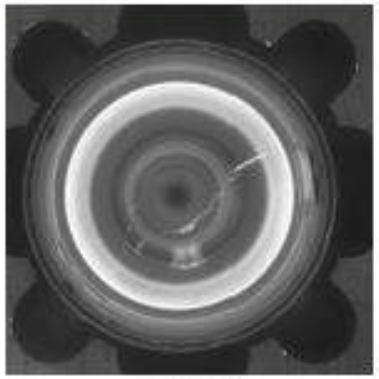


NAVI AI Case Study

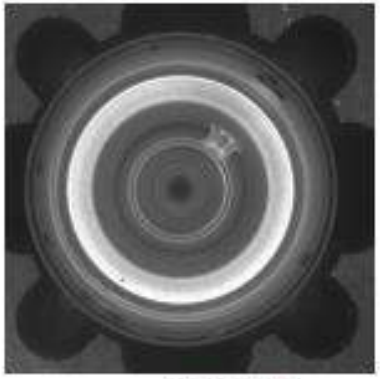
Problems	• Automation is not achieved as manual inspection • Could not detect undefined defect. • Various inspection condition depends on illumination condition.
Lens inspection	• Good Inspection result and classification



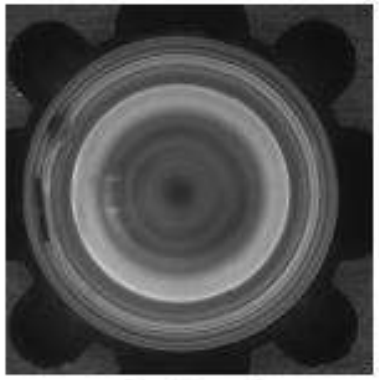
Bonding defect



Scratch

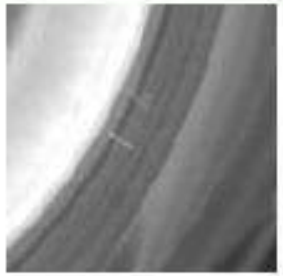


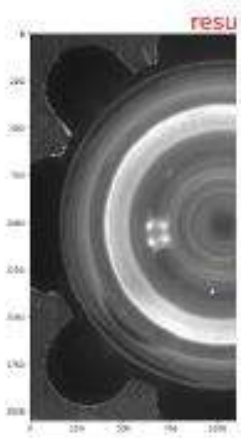
Black particle

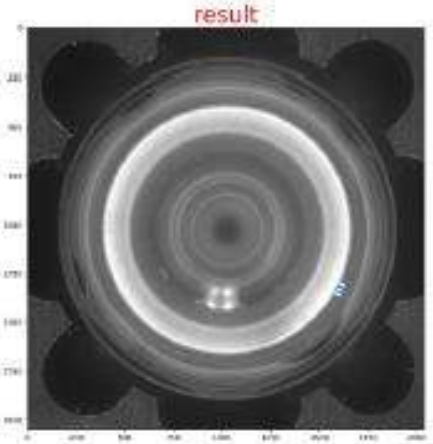


Bond overflow

Training around 350pcs defect and OK images



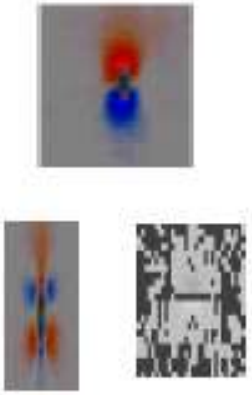




NAVI AI Case Study

Problems	• Automation is not achieved as manual inspection
LCD Glass inspection	• Inspection and classification to glass AOI output image • Reduce human resources

Glass AOI



Dent , hole, bubble
Dirt, particle..
Candidate images

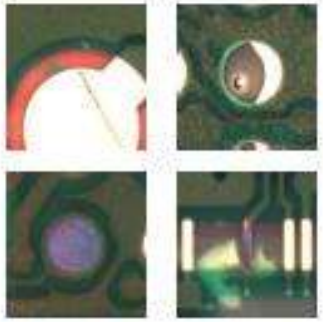
NAVI AI

Deep learning based
Inspection and classification

NAVI AI Case Study

Problems	• Automation is not achieved as manual inspection • Need VRS equipment.
PCB surface inspection	• Inspection and classification to glass AOI output image • Reduce human resources

PCB strip AOI



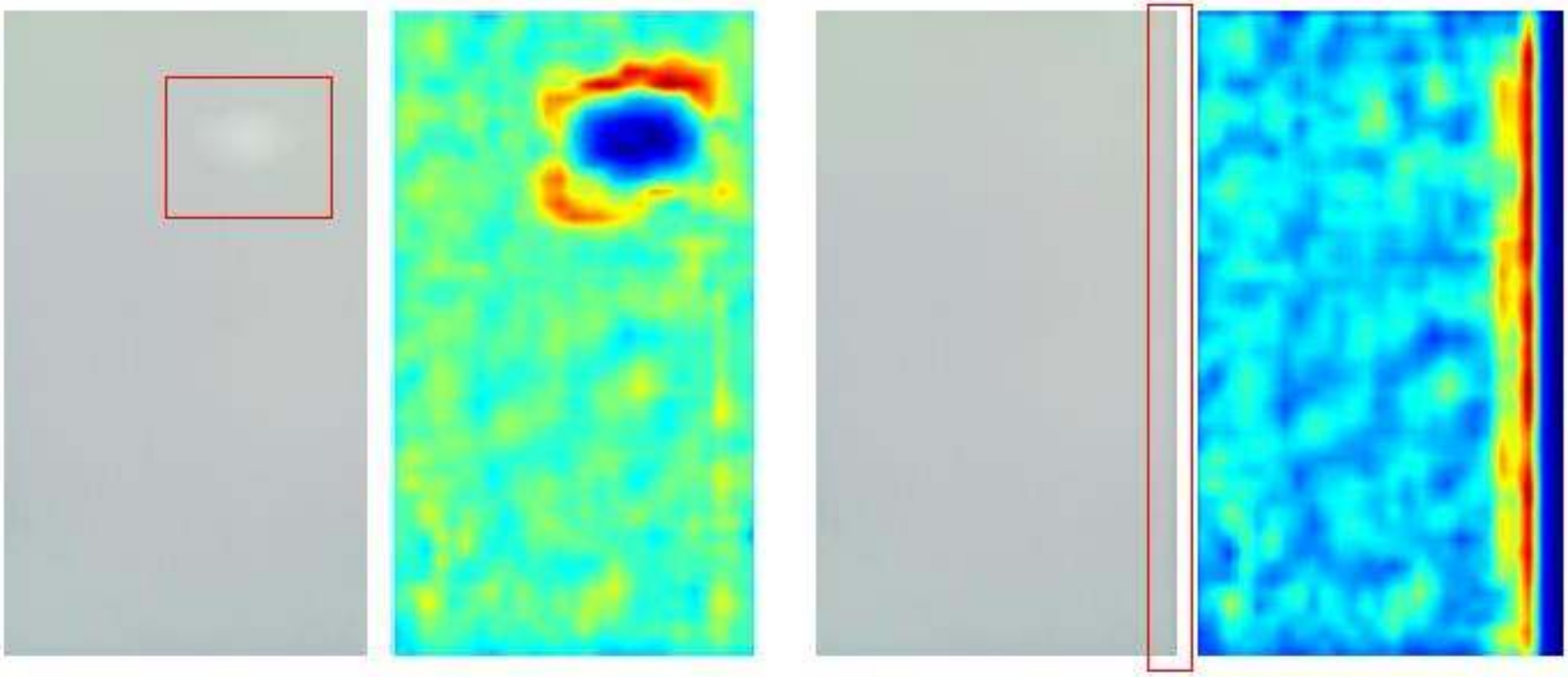
Coating error
Scratch
Abnormal color
Particle

NAVI AI

Deep learning based
Inspection and classification

NAVI AI Case Study

Problems	• Mura is difficult to define. • Rule-based inspection is inflexible to various mura
Display mura Inspection	• Irregular part is detected regardless of brightness, size and shape.



NAVI AI Case Study

Problem	• Wafer surface error is various from very small particle to whole wafer size grinding error.
Solution	• 100% detection (Dust, Stain, Scratch, Chipping) • Huge image size (6576 x 4384) and fast inspection time (12.5fps)

Target

wafer

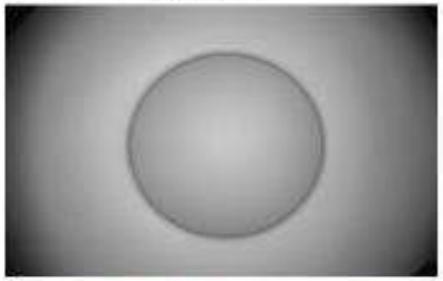
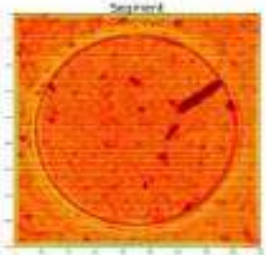
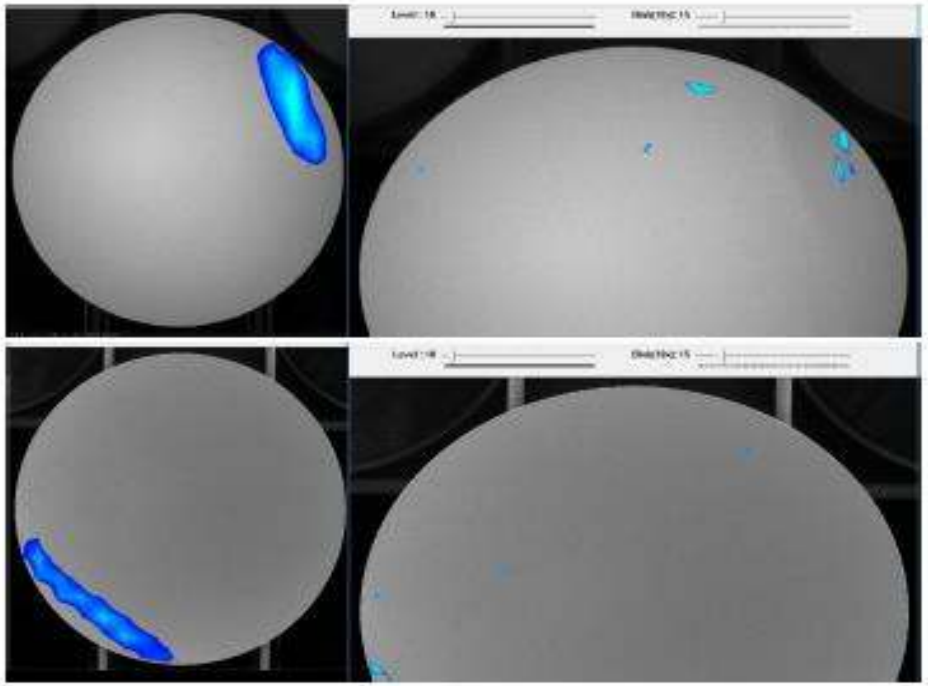


Image Size: 6576 x 4384(grayscale)



<Analysis>

Inspection result

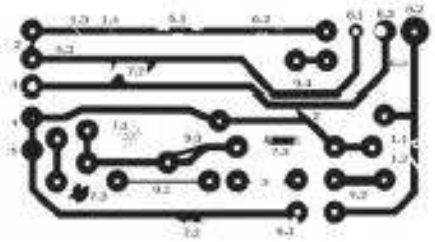


NAVI AI Case Study

Problem	• Classification difficulty
Solution	• No PCB original circuit comparison • Data driven classification

Target

PCB error classification



Inspection result

. Open / Short / particle / stain classification