SCREEN

Input Resource Reduction in Development for Industrial Measurement Systems, using GPUs

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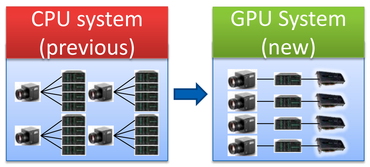
1. Abstract

- ✓ Industrial inspection/measurement systems, our products, handle large volume data such as very high resolution images over GB size.
  And, they must inspect/measure these data with rapidity.
- ✓ As a solutions, we have been applying GPUs to our existing systems in the figure below, and reduced input resource in development.
- ✓ We present a new case of application development process.

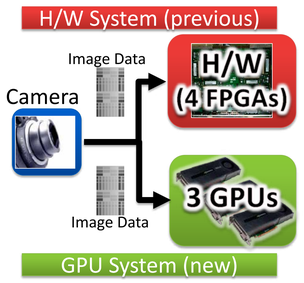
[Application for PC cluster]



4 PCs per a camera, Up to 16 PCs with 4cams.

1 PC with 1 GPU per a camera, Up to 4 PCs with 4 cams.

[Replacement for H/W system]



2. Application

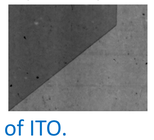
2.1 Transparent Electrode Monitor

- ✓ A monitoring system processes optical images of specimen surface acquired with cameras.
- ✓ Our Transparent Electrode monitor “TM-series” targets transparent electrodes equipped touch panel devices, such as smartphones and tablet PCs.
- ✓ “TM-series” acquire the transparent electrode images to measure widths in their conductor line patterns.

Appearance of TM-series.

Previous optical system

New optical system



Acquired Image of ITO. (ITO: Indium Tin Oxide)

2.2 Motivation & Goal

[Motivation]

- ✓ User needs requires quick response through flexible and continuous development of algorithms.
- ✓ But the conventional FPGA-based H/W does not respond with enough flexibility and rapidity in development.
- ✓ Therefore we develop on GPUs.

[Goal]

- ✓ To develop the algorithms concurrently with the whole development including mechanical, electrical, and optical process and so on.
- ✓ To reduce the input resource in development for flexibility and rapidity.
- ✓ To achieve the performance to measure a large image (max:23GB) within 70 seconds with the GPU system.

3. Details of Development

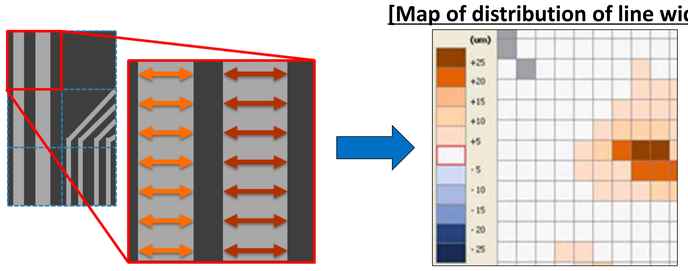
3.1 Basic Image Processing

- ✓ The following methods is developed with GPU.
  - Luminance correction
  - Distortion correction
  - Enhancement of contrast …etc.

3.2 Measurement the Distribution of Width in Conductor Line

- ✓ This system measures widths in conductor line of the whole film, and make a map of line width distribution (thin/bold) for each area.
- ✓ The map is used for a rough error check of the transparent electrode.
- ✓ Because the detection range is over 100 pixels, high performance method is required.

[Map of distribution of line width]



[An Example of performance evaluation]

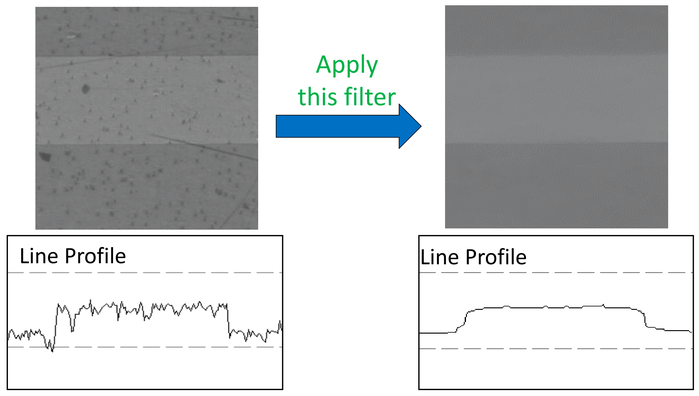
Performance of **CPU** 11.3[hour/23GB] → About 1200 times faster → Performance of **GPU** 33.4[second/23GB]

CPU: Core-i7 960 ※Detection range: around 250pixel ※Parallelization using OpenMP

GPU: Quadro K5000 ※Detection range: around 250pixel ※Optimization for GPU

3.3 Filter to Remove the Particulate Elements

- ✓ An original filter algorithm was required to remove the particulate elements in the image while keeping edge of transparent electrode.
- ✓ The cause of particulate elements includes filler, rough surface of films and measurement noise.
- ✓ A high performance method is required to apply the filter based on a bilateral filter with notoriously very large calculation volume.



[An Example of performance evaluation]

Performance of **CPU** 5.7[hour/23GB] → About 530 times faster → Performance of **GPU** 38.7[second/23GB]

CPU: Core-i7 3770K ※Filter size: 40×40pixel ※Parallelization using OpenMP

GPU: GTX680 ※Filter size: 40×40pixel ※Optimization for GPU

4. Resource Reduction Result

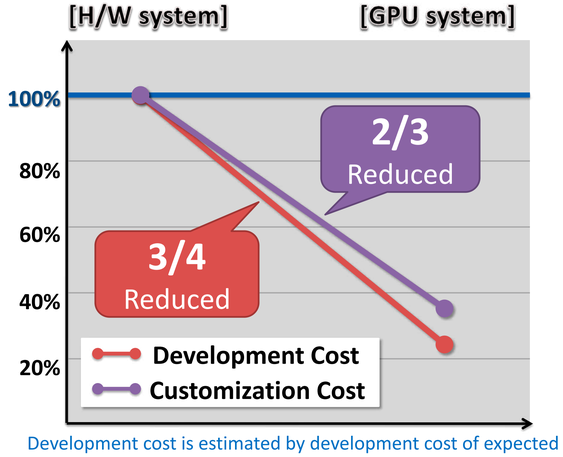
- ✓ The reduction of input resource - human resource and development period - is estimated by comparison with the conventional development on FPGA-based H/W.

[Development Cost]

- ✓ Utilizing the GPU has reduced image processing development cost by 3/4 enabling quick response to user needs.

[Customization Cost]

- ✓ The flexible development process utilizing the GPU has lowered image processing customization cost by 2/3 even handling unexpected problems.



Development cost is estimated by development cost of expected image processing (see section3.1, 3.2).
Customization cost is estimated by development cost of additional Image processing filter (see section3.3.).

5. Summary

- ✓ We have demonstrated a result of input resource reduction in development process with GPUs through an actual application in a monitoring system for the transparent electrode.
- ✓ Development process with GPUs has reduced development cost by 3/4 and customization cost by 2/3 compared to one with FPGA-Based H/W system.
- ✓ This system has attained expected performance.
- ✓ This result proves effectiveness in acceleration of development process with GPUs for the industrial inspection/measurement systems.
- ✓ We will keep applying GPUs to new applications in various ways.