Inline 3D Scanning Prototype System for Industrial Part Inspection with 2D Camera and Line Laser

Handong Global University

School of Mechanical & Control Engineering

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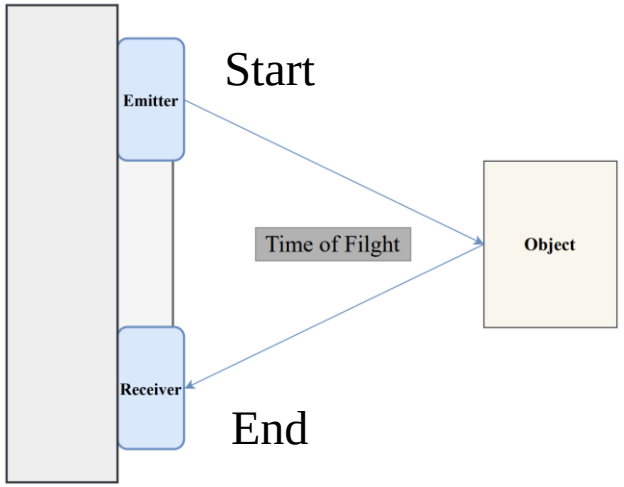
CONTENTS

1. Background: Optical 3D Scanning Methods

3D Camera VS 2D Camera

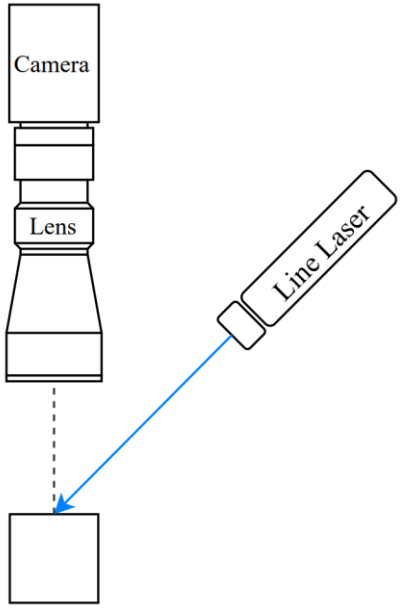
ToF (Time of Flight)

- Using Time of Flight
- Lower Precision
- Out Door Scanning



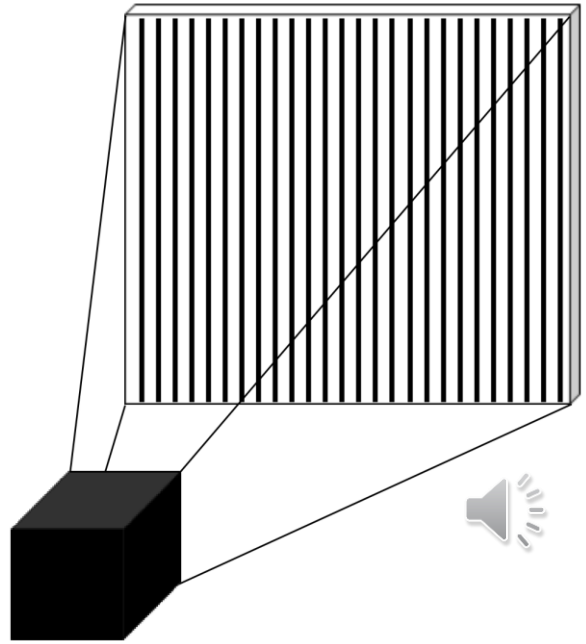
Laser Triangulation

- Using Displacement of Laser
- The Most Precision (micrometer)
- Inspection for Small Industrial Part

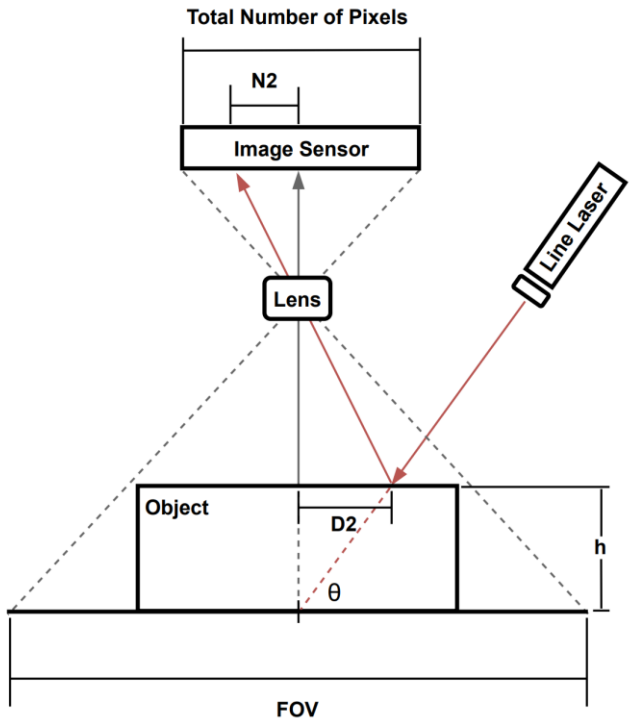


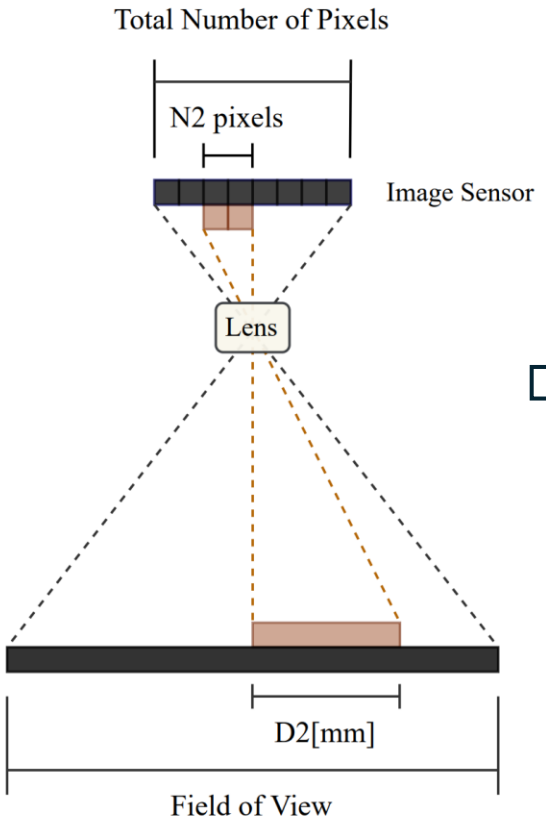
Structured Light

- Using Structured Light
- Middle Precision
- VR, Automatic Driving etc.



2. Method Description: Laser Triangulation





$$Unit\ Distance\ of\ FOV = \frac{FOV}{Total\ Number\ of\ Pixels}$$

$$D2 = N2 * Unit\ Distance\ of\ FOV$$

$$h = D2 * \tan(\theta)$$

$$\rightarrow h = \frac{FOV}{Total\ Number\ of\ Pixels} * N2 * \tan(\theta)$$

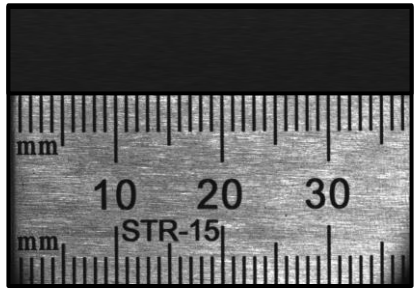
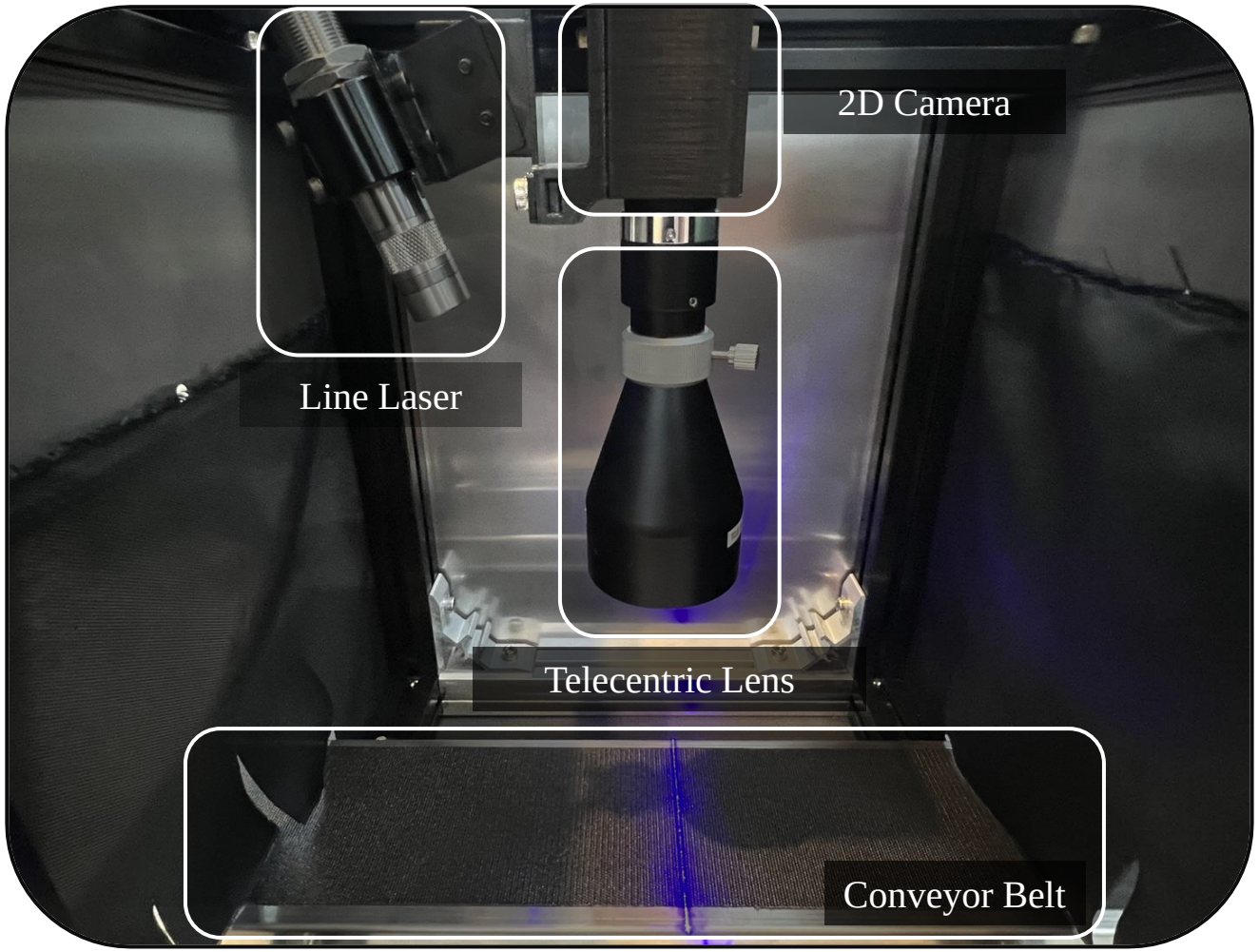


Image captured by 2D camera

FOV(Field of View): The whole range of view which camera can capture
Unit Distance of FOV: Unit Distance which each pixel of image sensor performs about FOV

3. Hardware: Overview



Internal

External

3. Hardware: Camera, Lens, Laser

2D Machine Vision Camera

GS3-U3-41C6NIR-C

-Resolution: 2048x2048

-Pixel size: 5.5 μm x 5.5 μm

-Image sensor size: 11.26 mm x 11.26 mm

Telecentric Lens

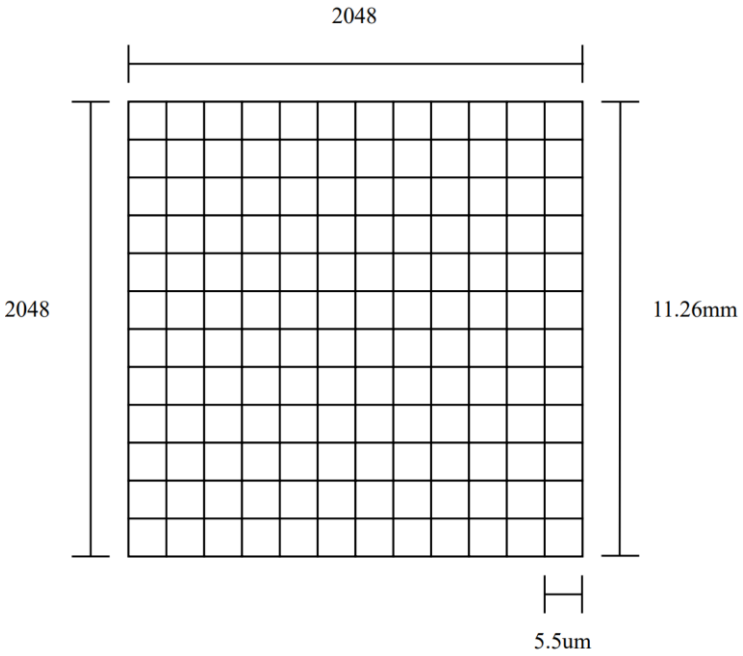
TCL0.3X-130I-HR

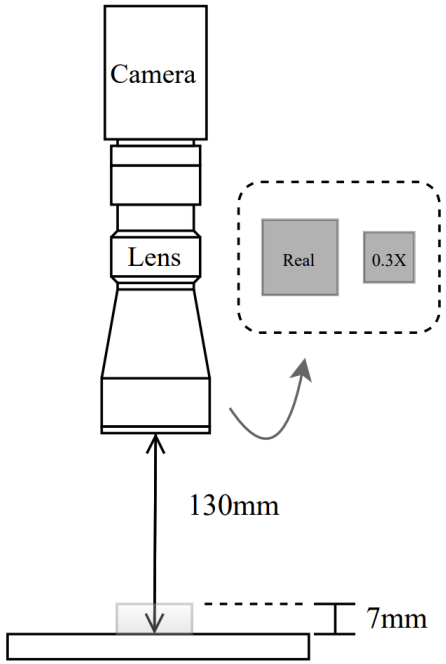
- W.D(mm): 130
- D.O.F(mm): 7
- Mag: 0.3X

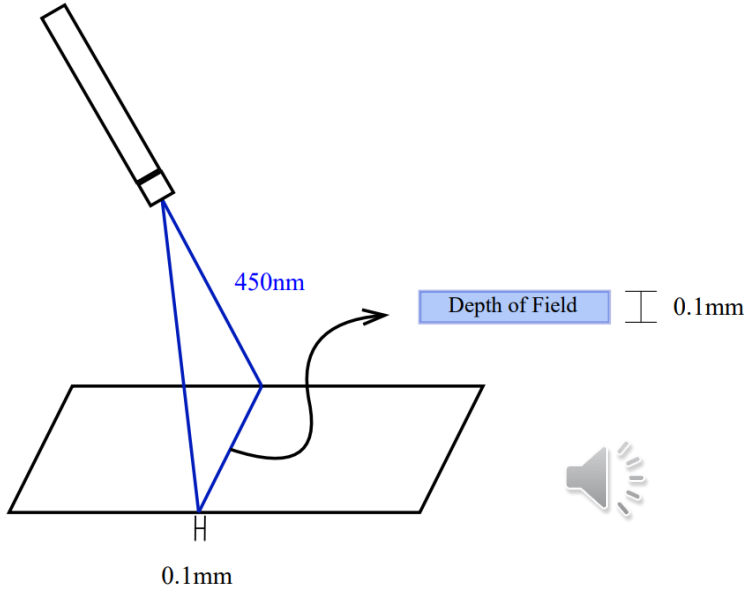
Line Laser

ZX20

- Wavelength: 450nm
- Line width: 0.1mm(350mm)
- DOF: 0.1mm(400mm)

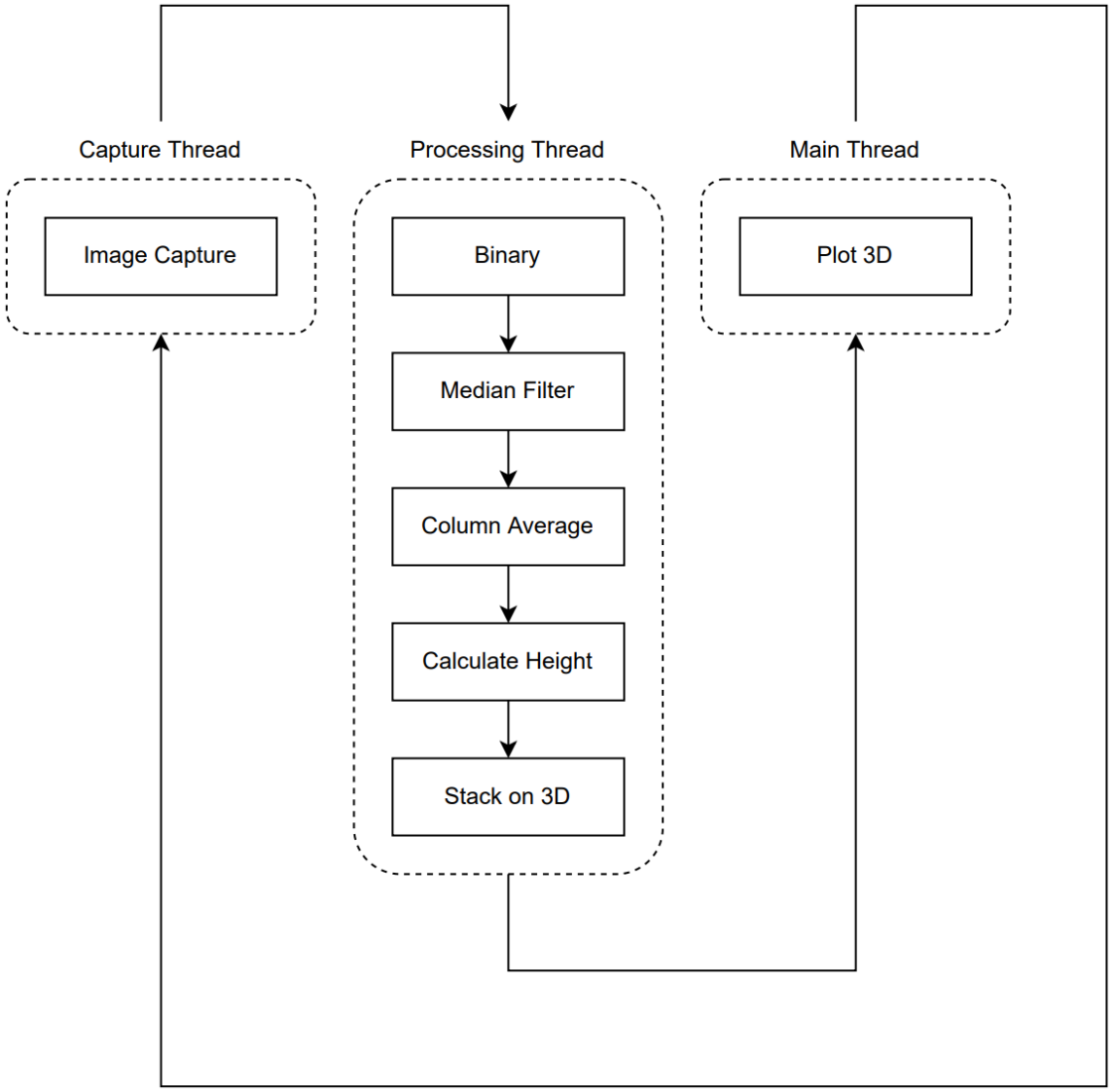




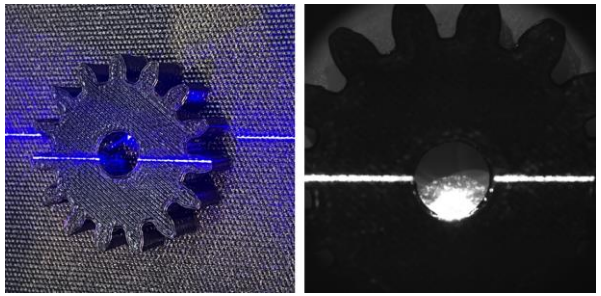


D. O. F(Depth of Field): Focusable Depth
W.D(Working Distance): Focus Distance
Mag: Magnification

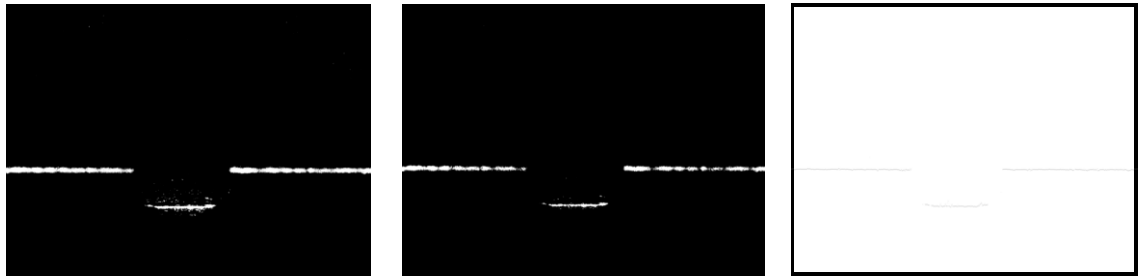
4. Software: Overview



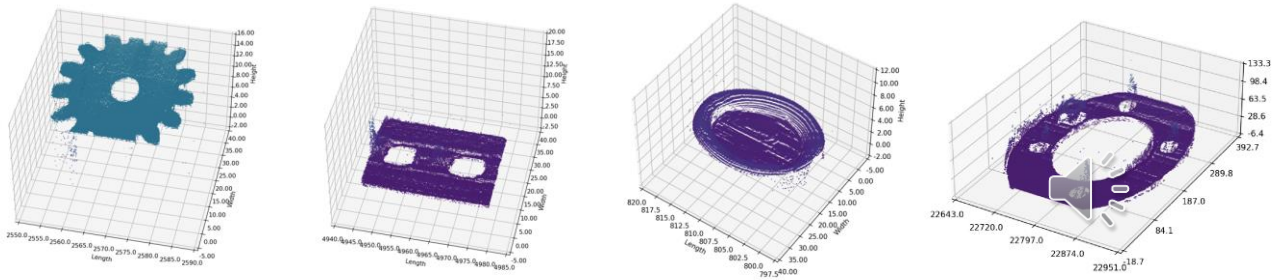
1.Image Capture



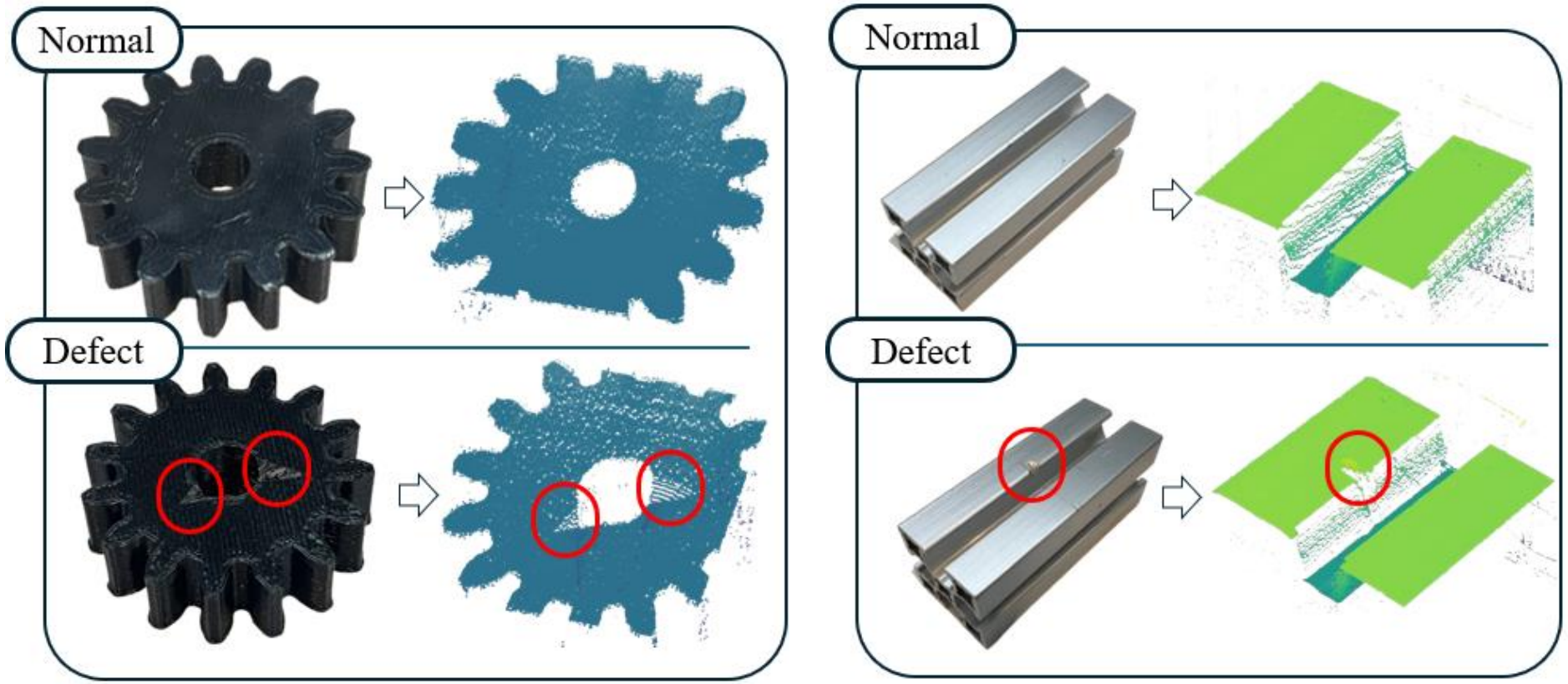
2.Image Processing



3.Plot 3D

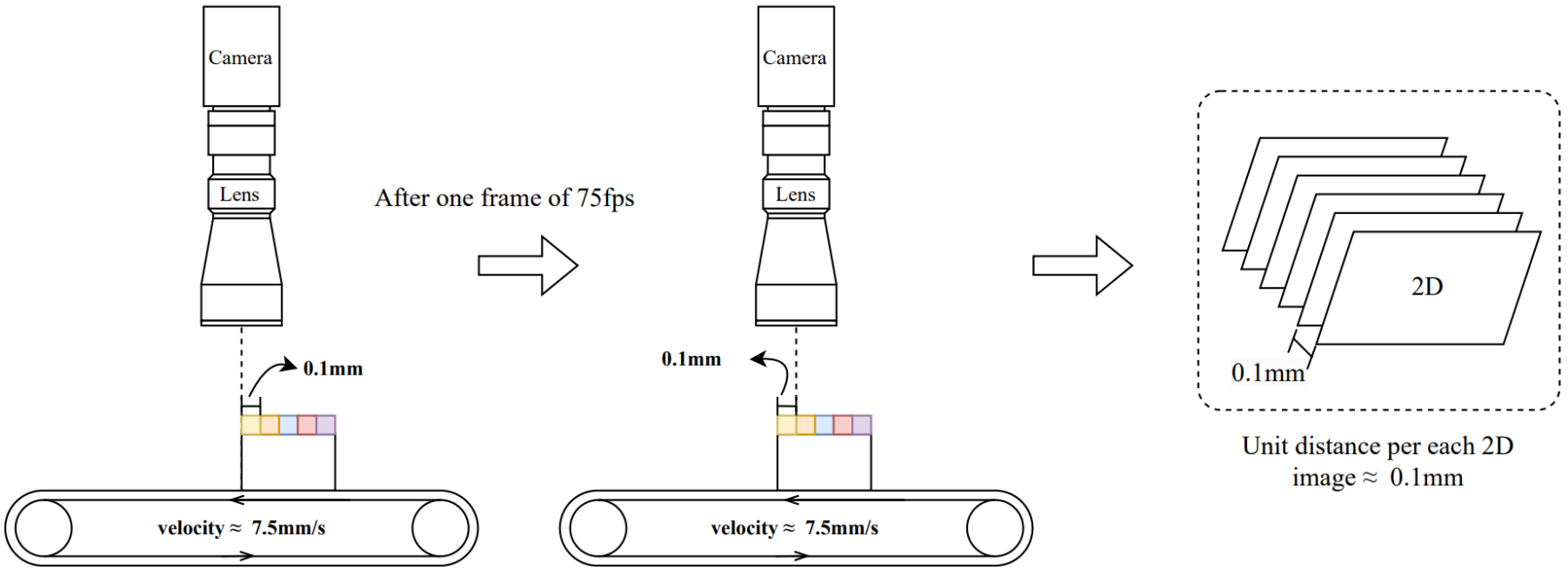


5. Result: Defect Inspection



Overall possibility about defect inspection of this system is verified

6. Limitations & Suggestions



Limitation 1: Unstable Velocity of The Conveyor Belt

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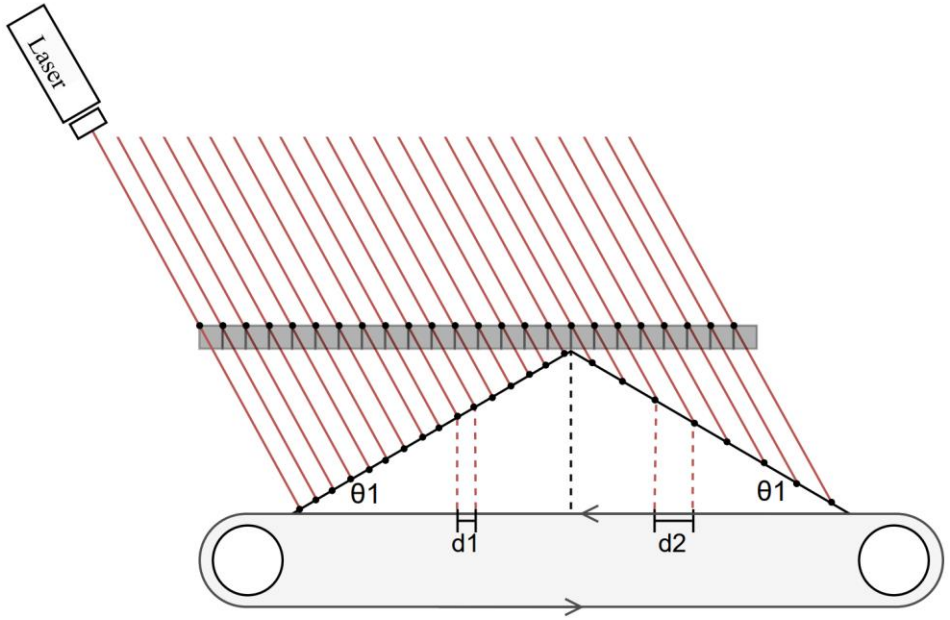
Development:

Other conveyor belts which would be able to manipulate velocity precisely needs to be applied

6. Limitations & Suggestions



Limitation 2: Slope Distortion

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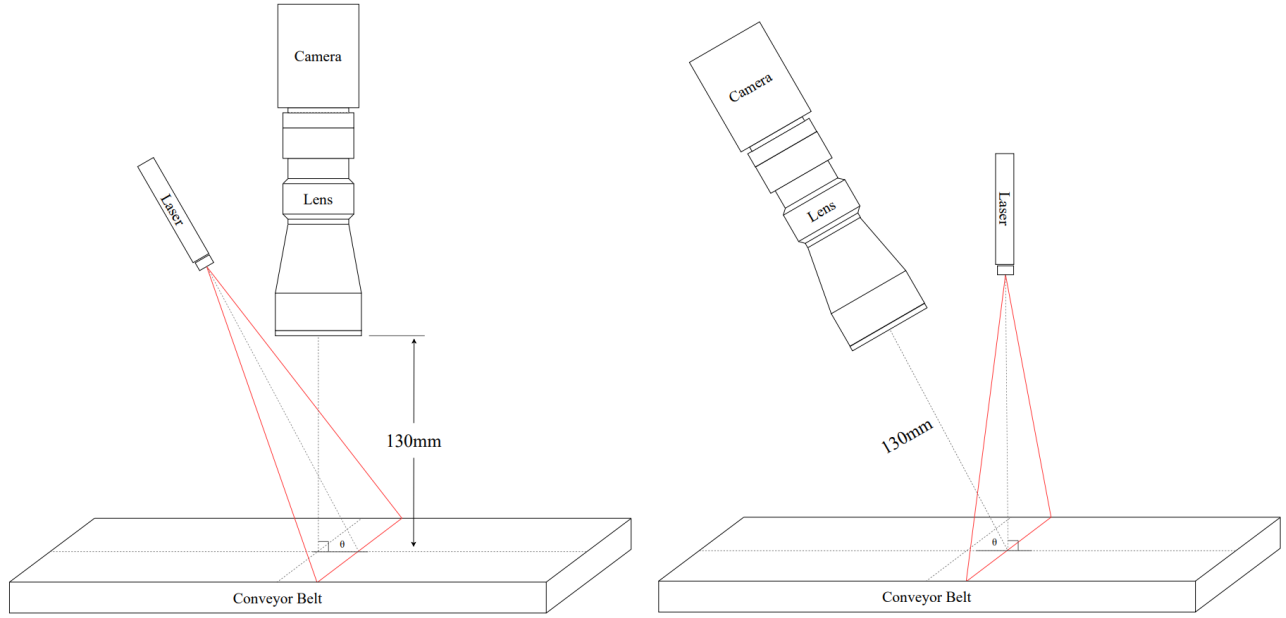

Development:

Change the Location of Camera and Laser

7. Reference

[1] Automation Technology GmbH. (2021). *C5 series user manual for high speed 3D cameras* (Rev. 1.6). Automation Technology GmbH.