Oct 24, 2016

Active stereo vision system for object position estimation

Lab Seminar

Han Sol Kang

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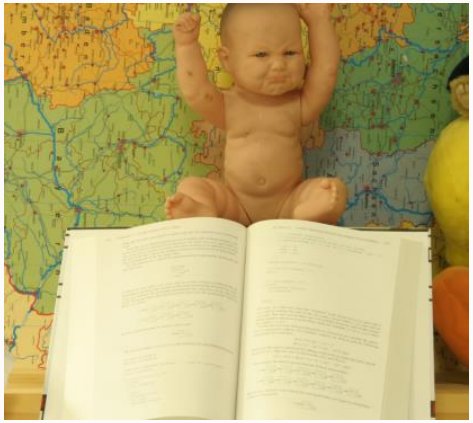
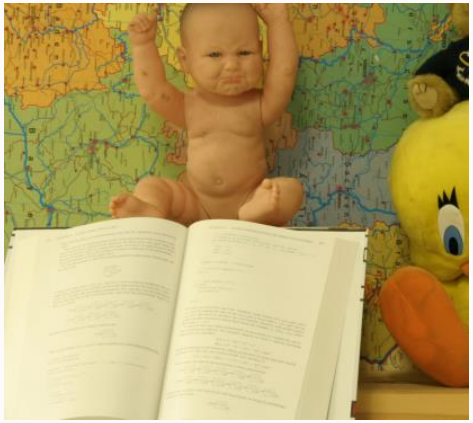
Introduction

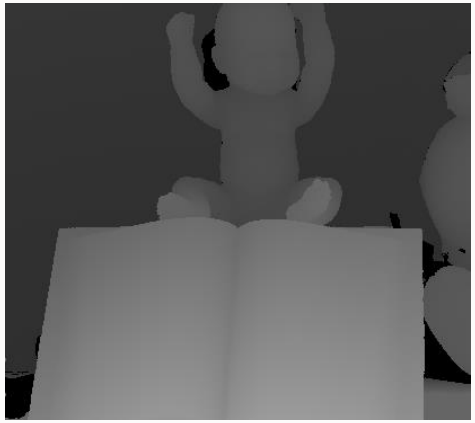
Conventional Stereo Vision

❖ Conventional Stereo Vision

: Stereo vision is the extraction of 3D information from digital images, such as obtained by a CCD camera. **By comparing information about a scene from two vantage points**, 3D information can be extracted by examination of the relative positions of objects in the two panels. This is similar to the biological process **stereopsis**.





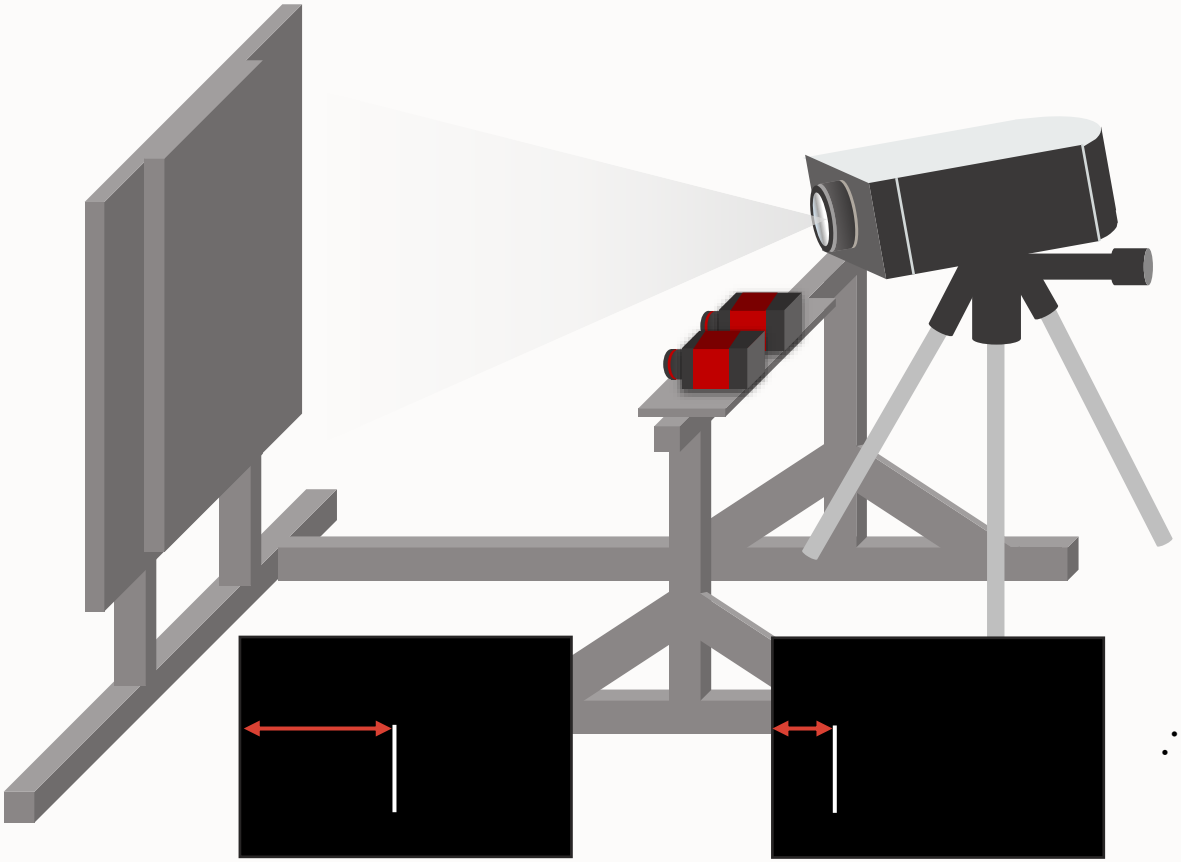


Introduction

Active Stereo Vision

Active Stereo Vision

: The active stereo vision is a form of stereo vision which actively employs a light such as **a laser or a structured light** to simplify the stereo matching problem.



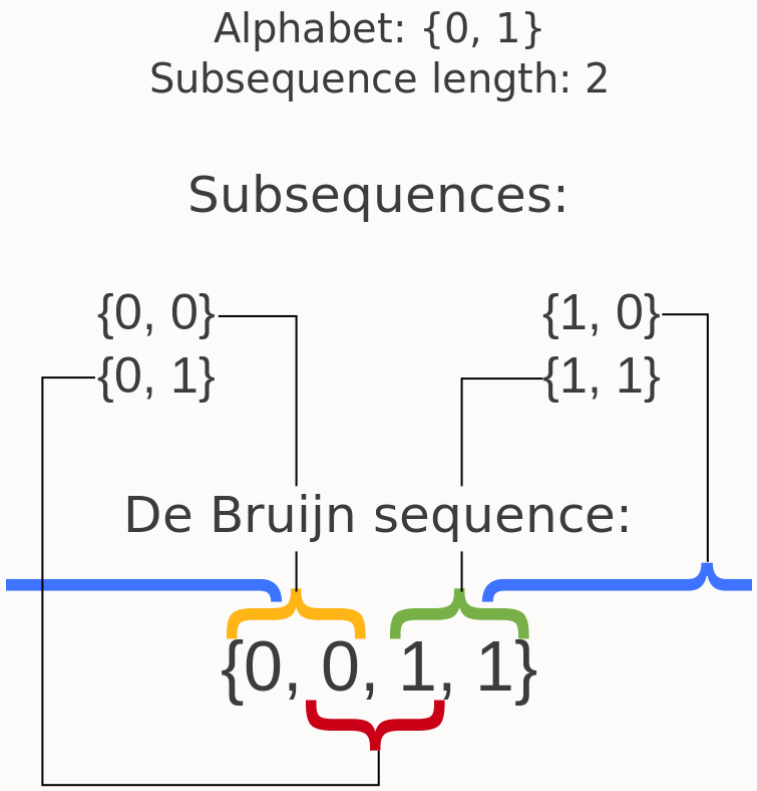
Left Image *Right Image*

$$\therefore Z = \frac{bf}{x_l - x_r}$$

Progress of the Project

Color Code

- **Debruijn sequence**



$$2^2 = 4$$

Progress of the Project

Color Code

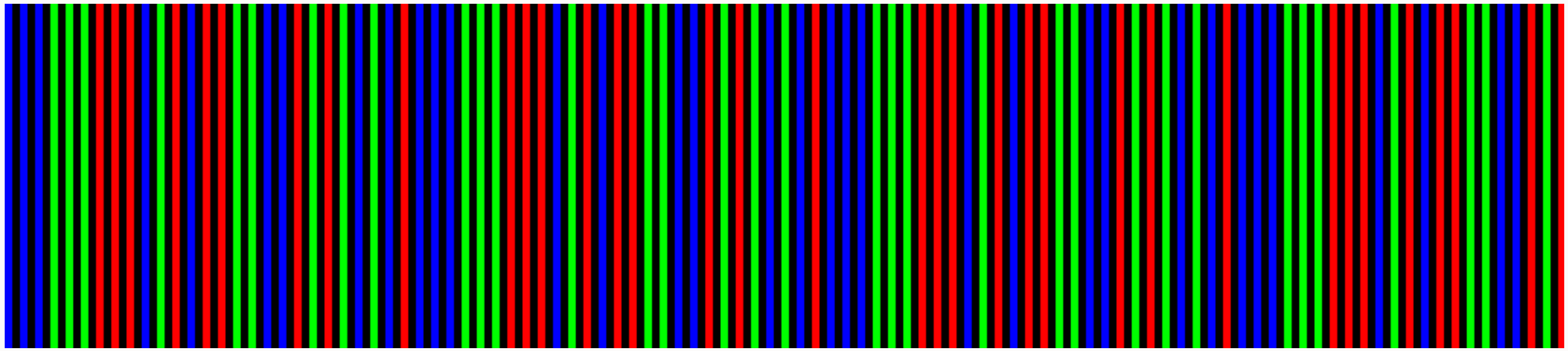
Debruijn sequence

n=3, k=3 (alphabet is {0, 1, 2}) $3^3 = 27$

0 0 0 1 1 1 2 2 2 0 1 2 0 2 2 1 1 0 0 2 1 2 1 0 1 0 2

n=3, k=3 (alphabet is {b, g, r})

b b b g g g r r r b g r b r r g g b b r g r g b g b r



Progress of the Project

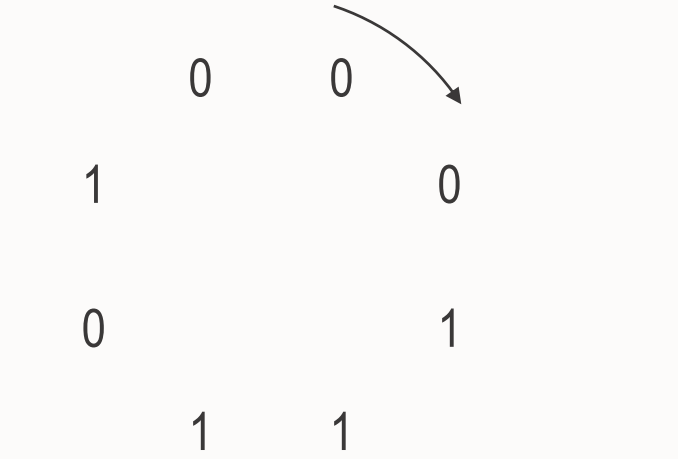
Color Code

- **Debruijn sequence – Occlusion problem**

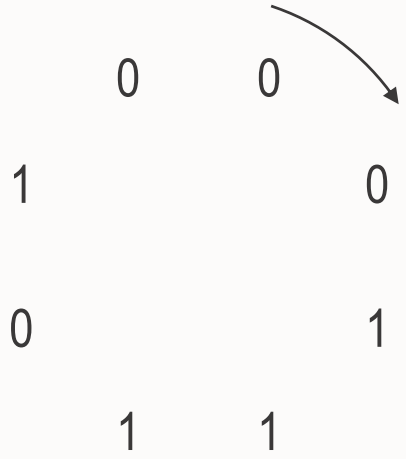
Progress of the Project

Color Code

- **Debruijn sequence – Occlusion problem**



000, 001, 010, 011, 100, 101, 110, 111



000, 001, 011, 110, 101, 010, 100

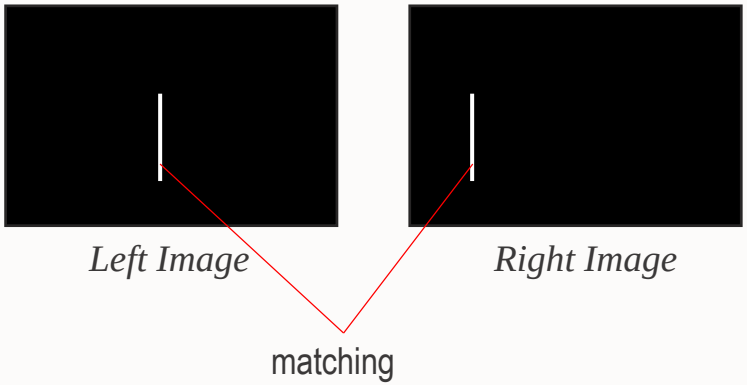
We obtain wrong codes

Progress of the Project

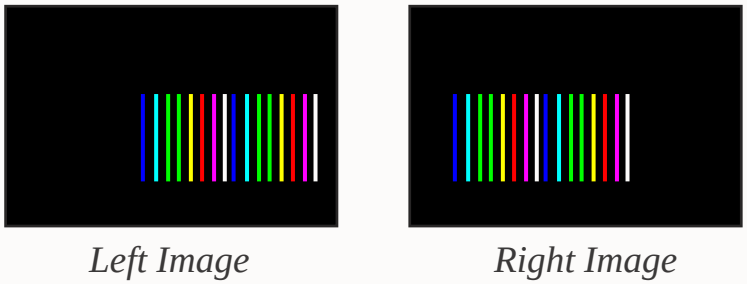
Periodic Color Code

❖ Periodic Color Code

- Stereo matching using line scanning



- Stereo matching using periodic color code

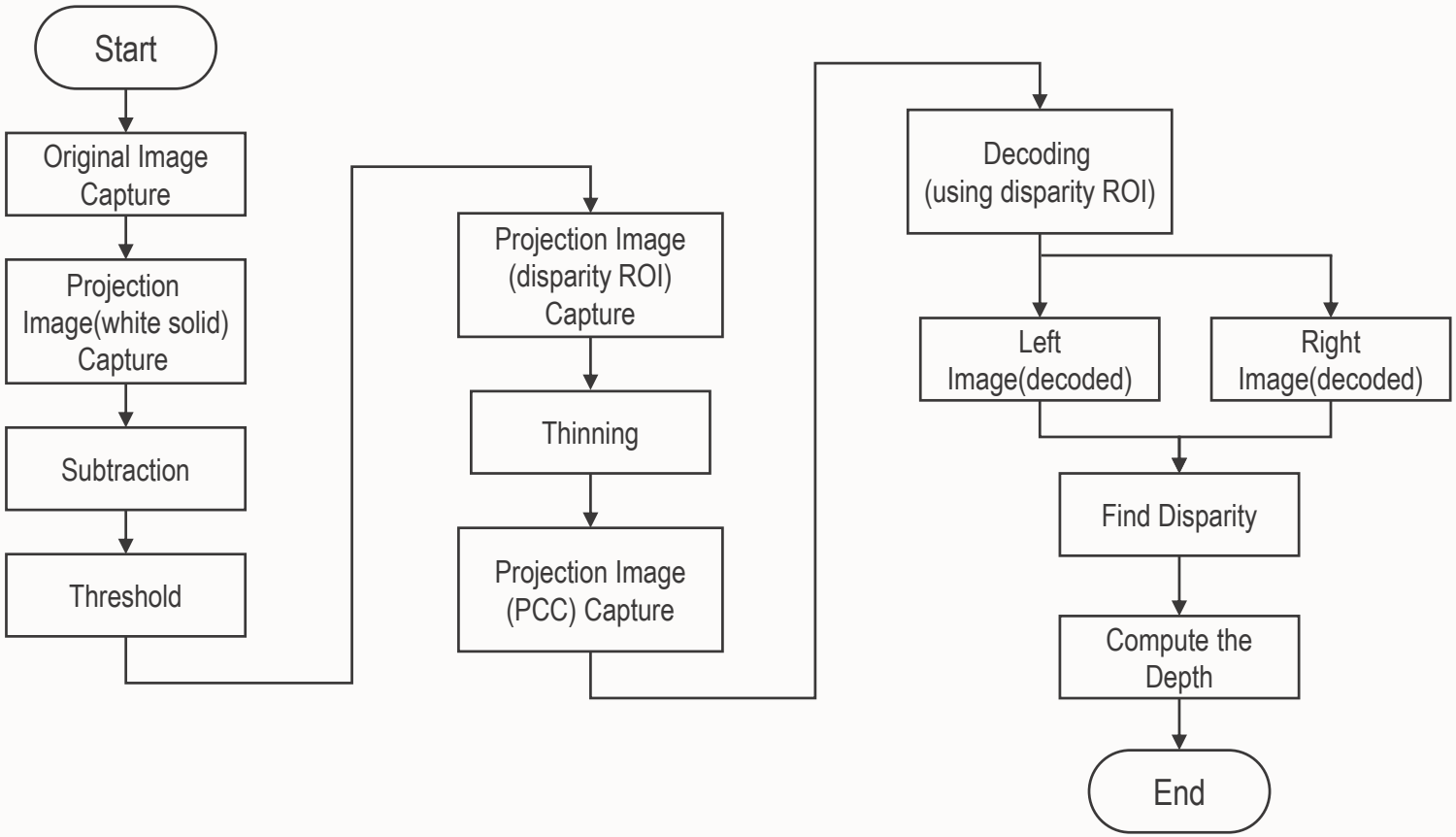


matching using coded pattern

Progress of the Project

Periodic Color Code

❖ Flow Chart

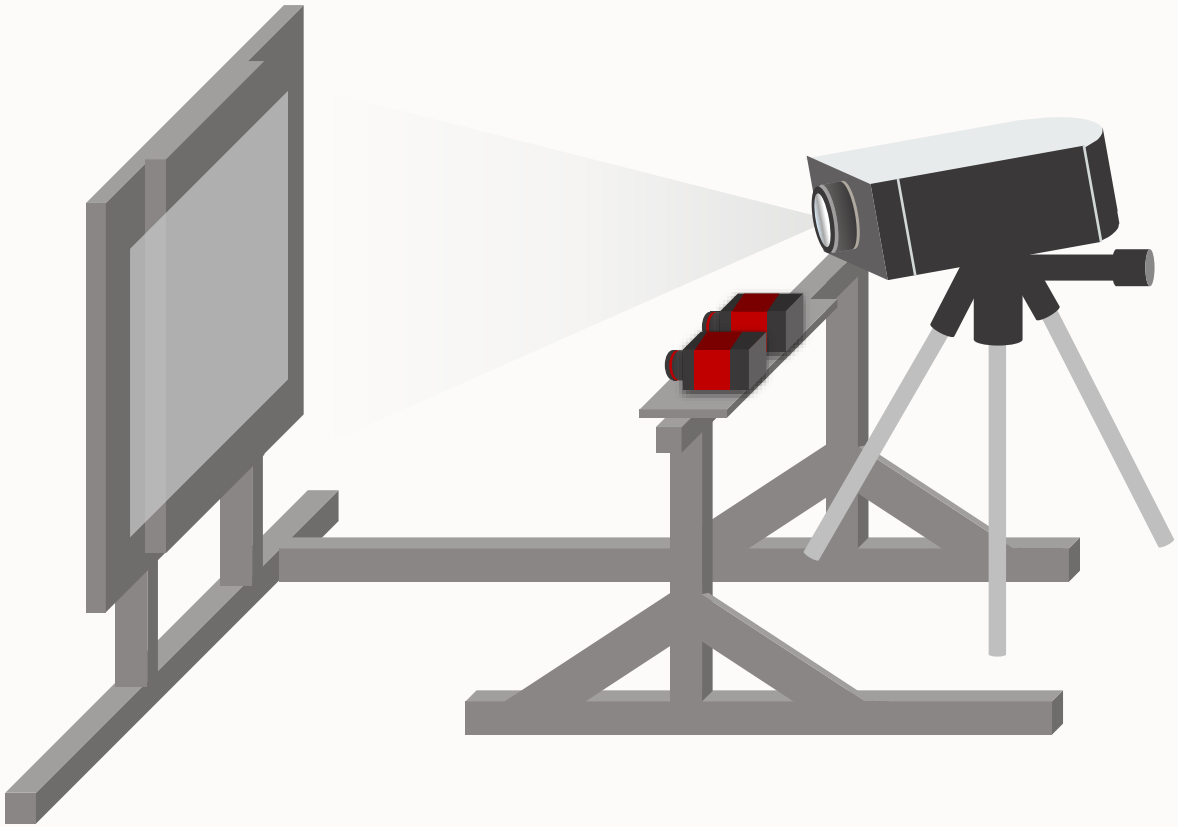


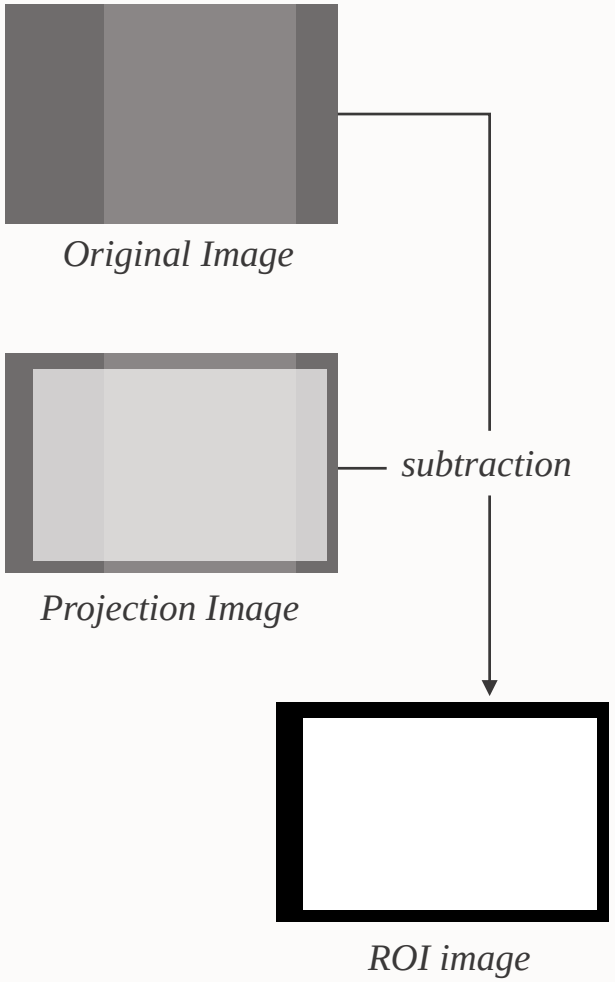
*PCC : Periodic Color Code

Progress of the Project

Periodic Color Code

❖ Processing ROI



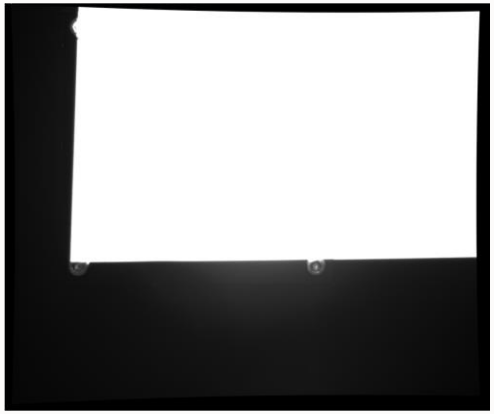


Progress of the Project

Periodic Color Code

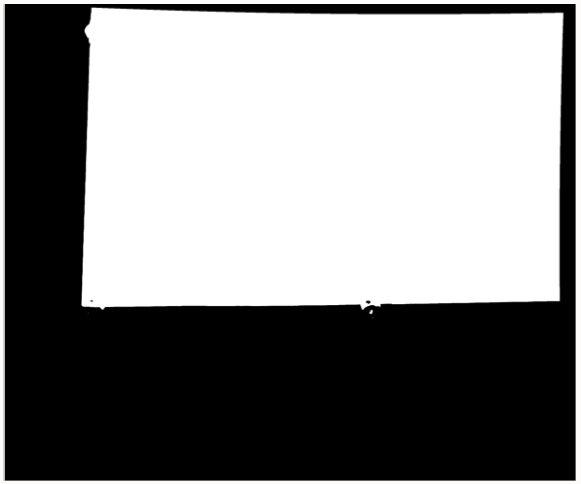
❖ Processing ROI

Original Image



Projection Image

Subtraction & Thresholding

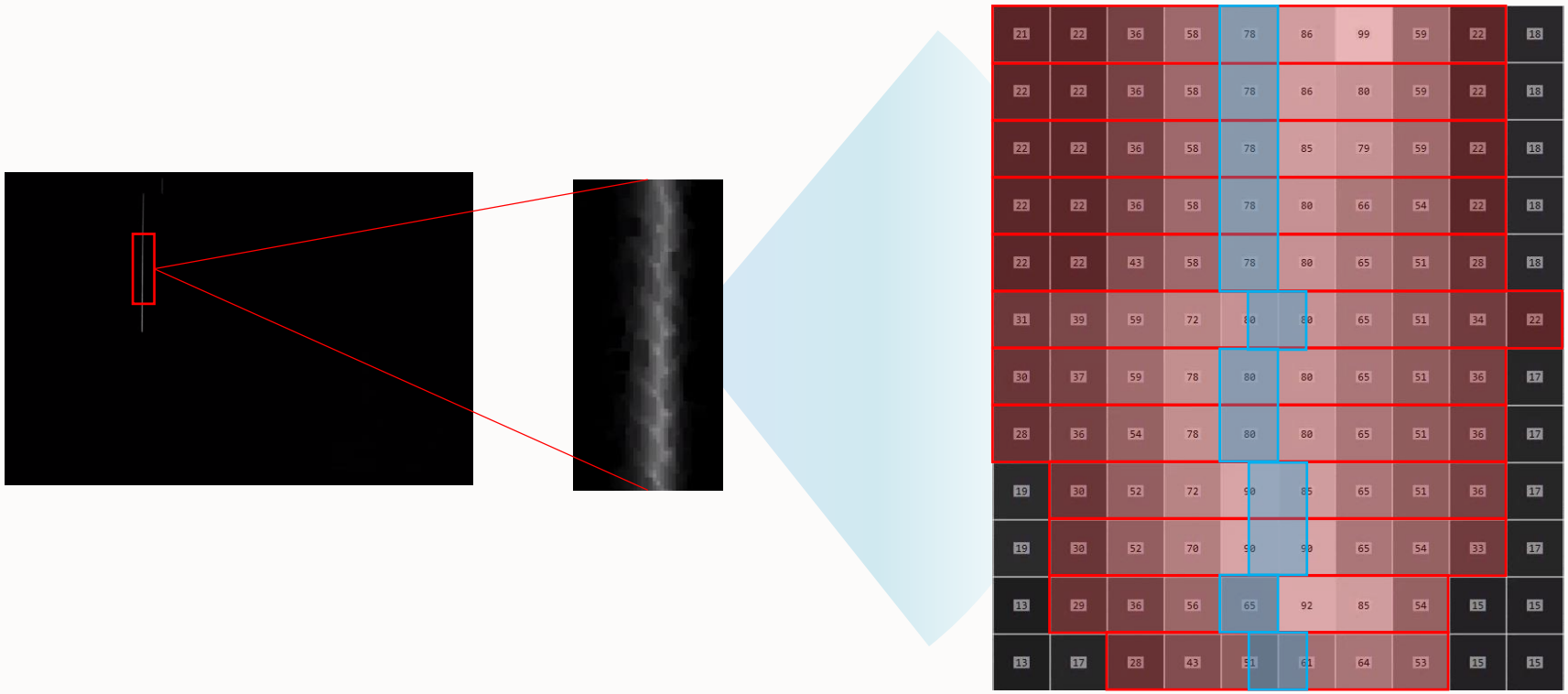


Processing ROI

Progress of the Project

Periodic Color Code

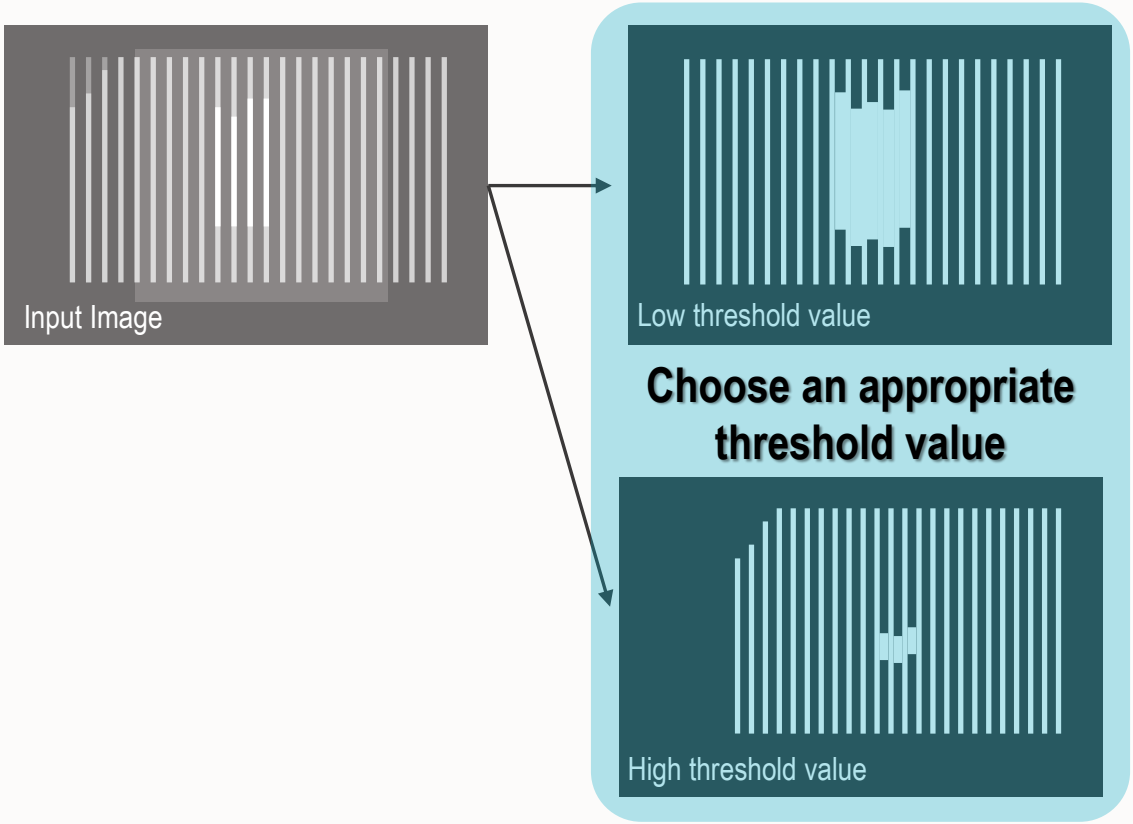
❖ Disparity ROI

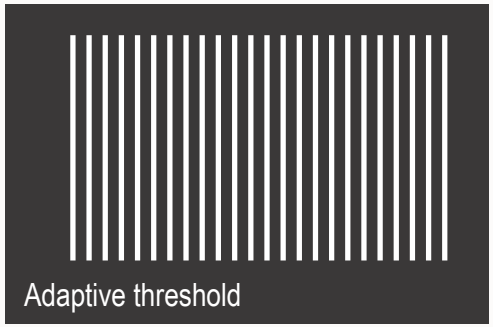


Progress of the Project

Periodic Color Code

❖ Problem of prior threshold



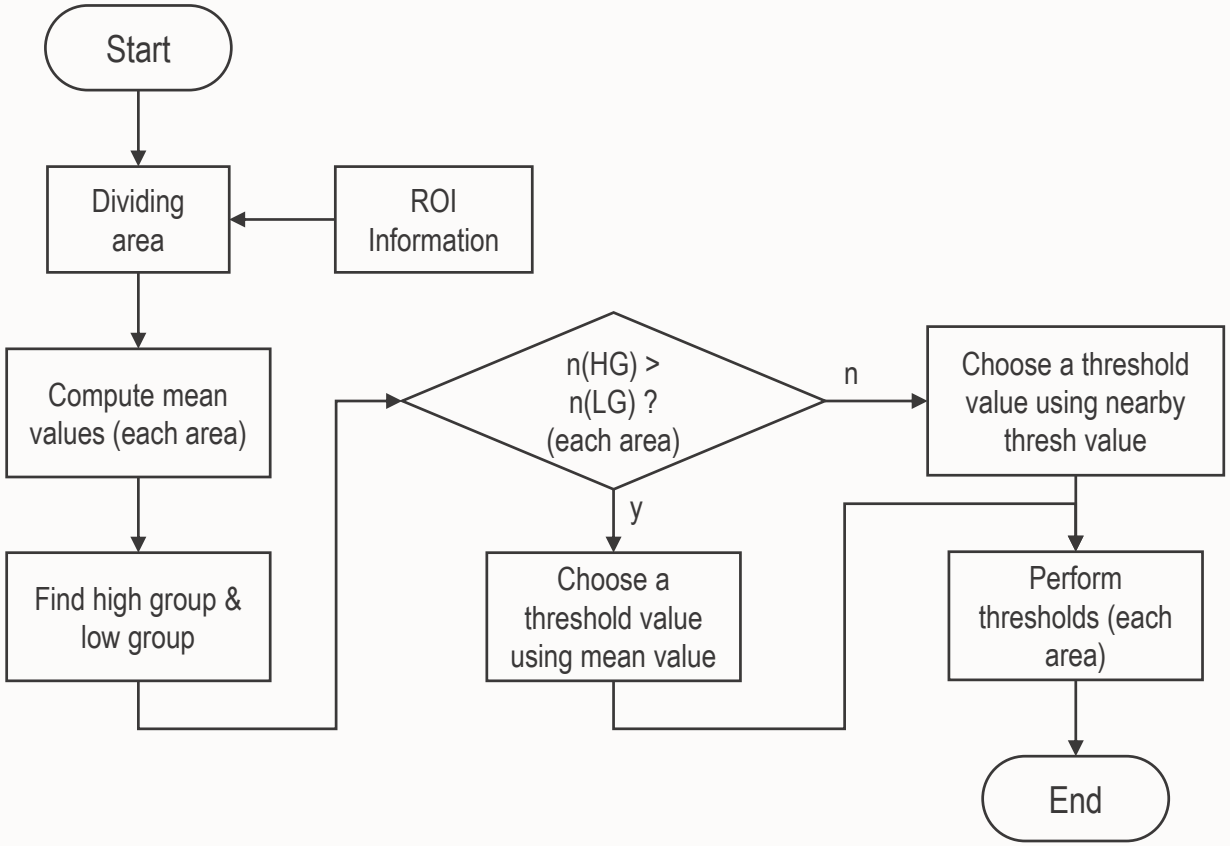


We can obtain a good result using adaptive threshold

Progress of the Project

Periodic Color Code

❖ Adaptive Threshold Flow Chart

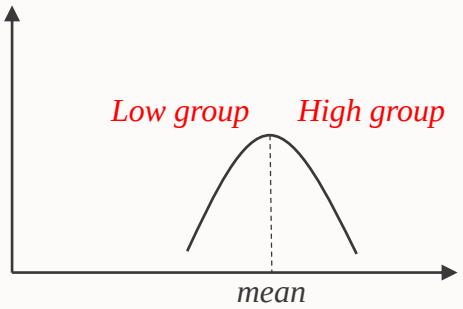


n(HG) : the number of high groups
n(LG) : the number of low groups

Progress of the Project

Periodic Color Code

❖ Adaptive Threshold Example



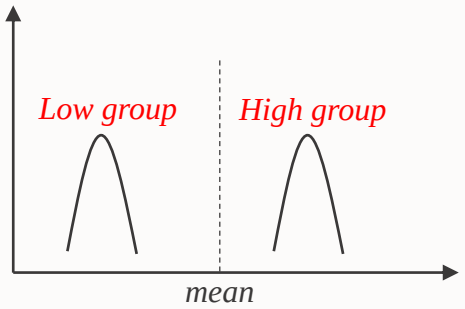
Threshold value : use a nearby threshold value

220	230	240	240	230
220	230	240	240	230
220	230	240	240	230
220	230	240	240	230
220	230	240	240	230

mean : 232

high group mean : 240 low group mean : 226.67

threshold value : -1



Threshold value : use a mean value

20	50	240	240	50
20	50	240	240	50
20	50	240	240	50
20	50	240	240	50
20	50	240	240	50

mean : 120

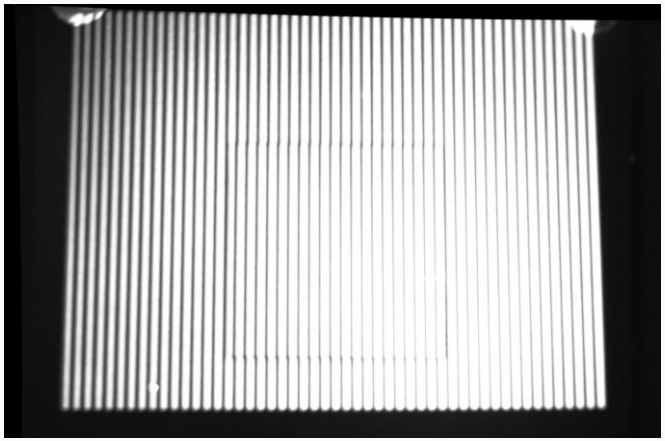
high group mean : 240 low group mean : 40

threshold value : 120

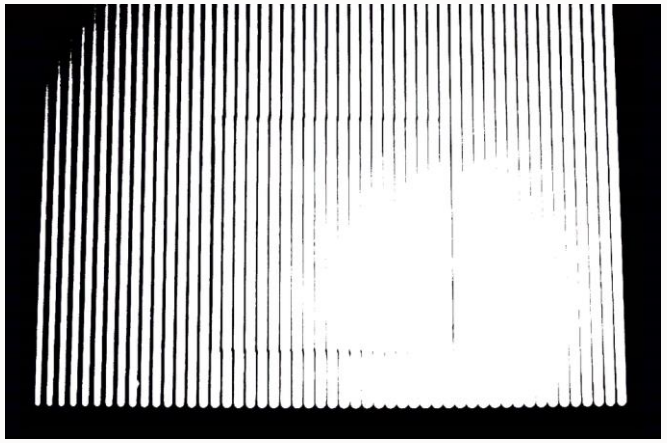
Progress of the Project

Periodic Color Code

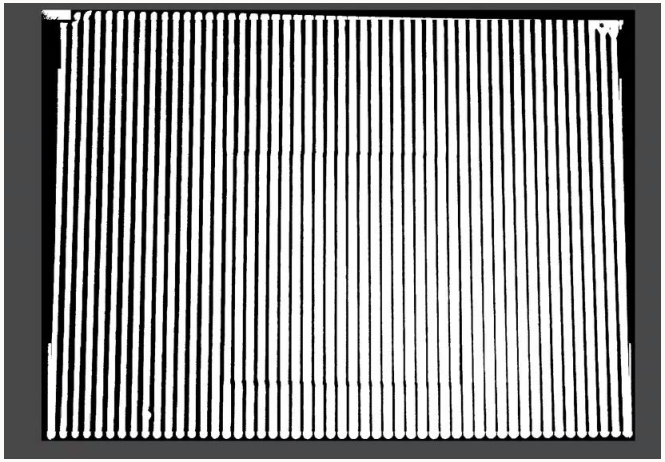
❖ Adaptive Threshold Result



Input Image



Prior threshold method

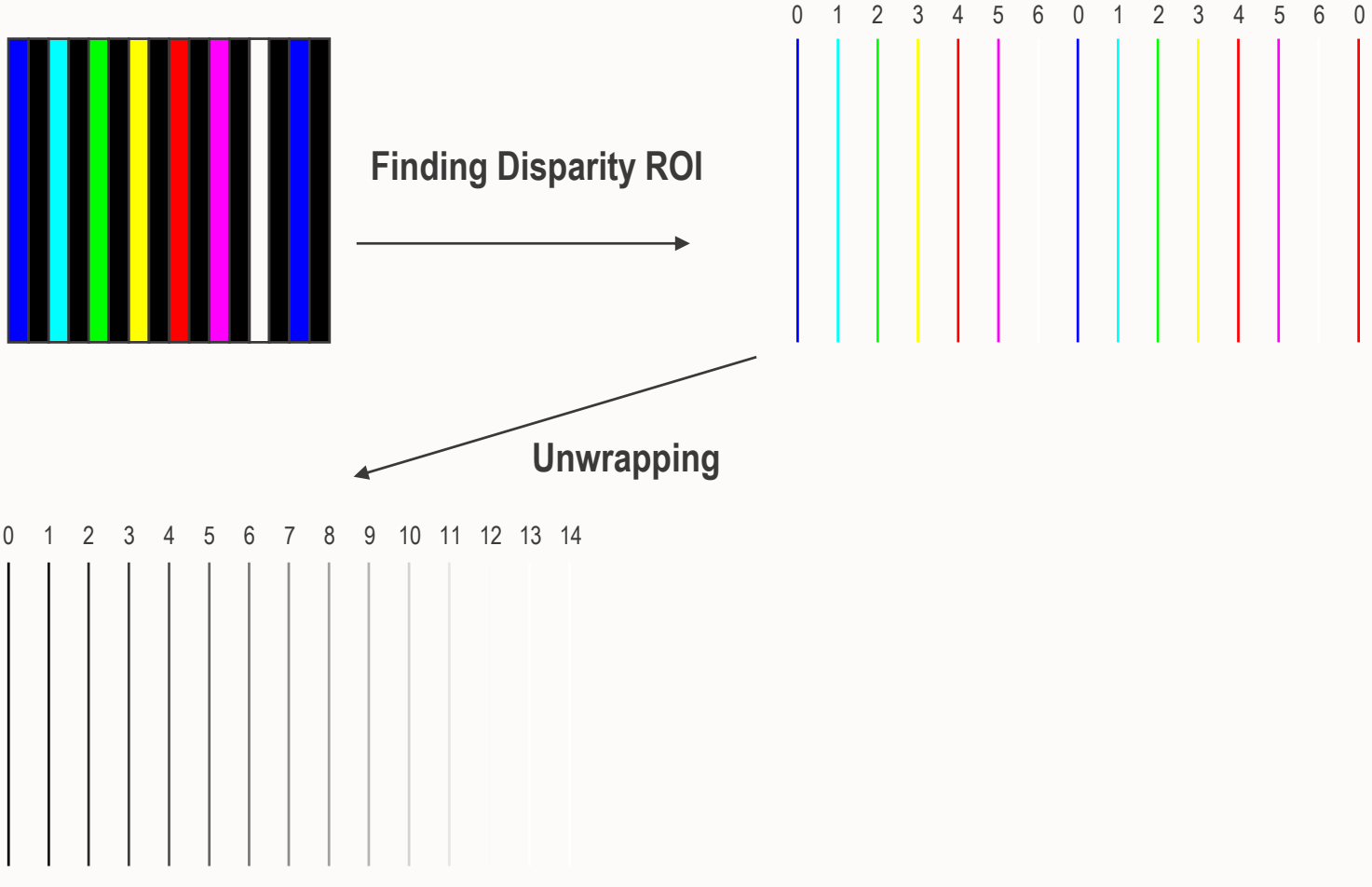


Adaptive threshold method

Progress of the Project

Periodic Color Code

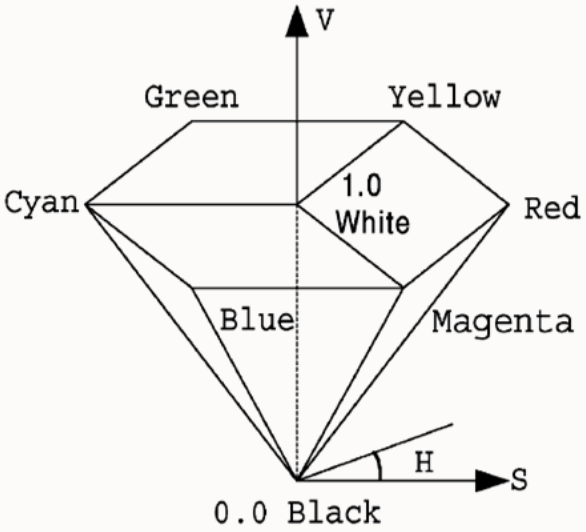
❖ Decoding



Progress of the Project

Periodic Color Code

❖ Decoding - HSV Threshold



$$H = \begin{cases} H1 & if\ B \le G \\ 360° - H1 & if\ B > G \end{cases} \qquad H1 = \cos^{-1}\left\{ \frac{0.5[(R-G)+(R-B)]}{\sqrt{(R-G)^2+(R-B)(G-B)}} \right\}$$

$$S = \frac{Max(R,G,B) - Min(R,G,B)}{Max(R,G,B)}$$

$$V = \frac{Max(R,G,B)}{255}$$

Use hue and saturation value

example

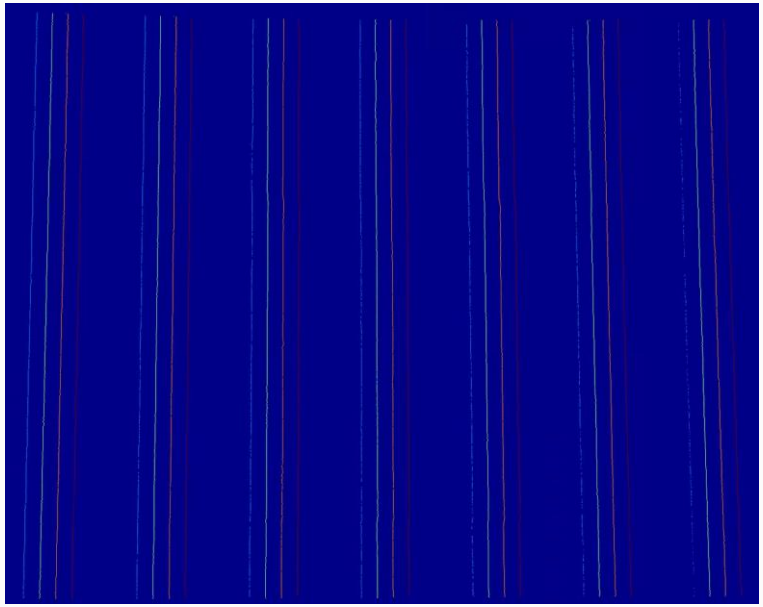
H(i ,j)<Hth1 && H(i, j)>=Hth2 && S(i, j) >Sth

H(i ,j) : hue value at i, j
S(i,j) : saturation value at i, j

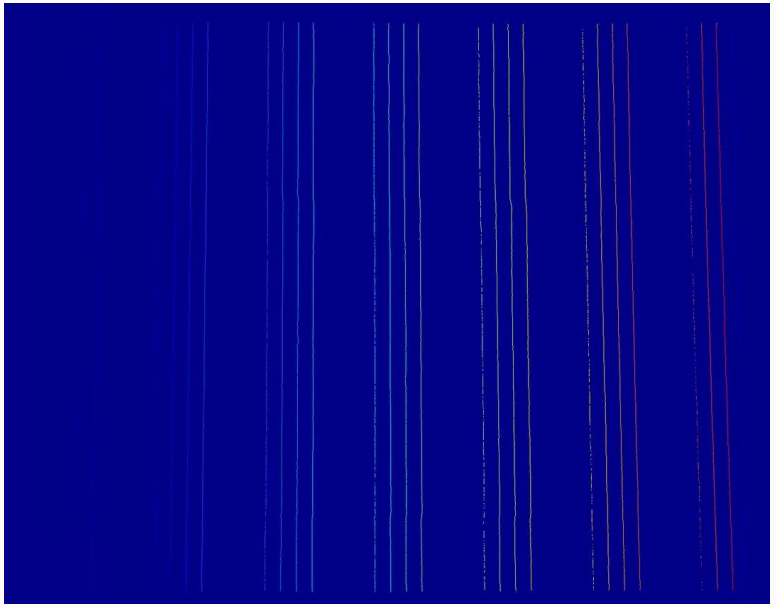
Progress of the Project

Periodic Color Code

❖ Decoding result



before unwrapping

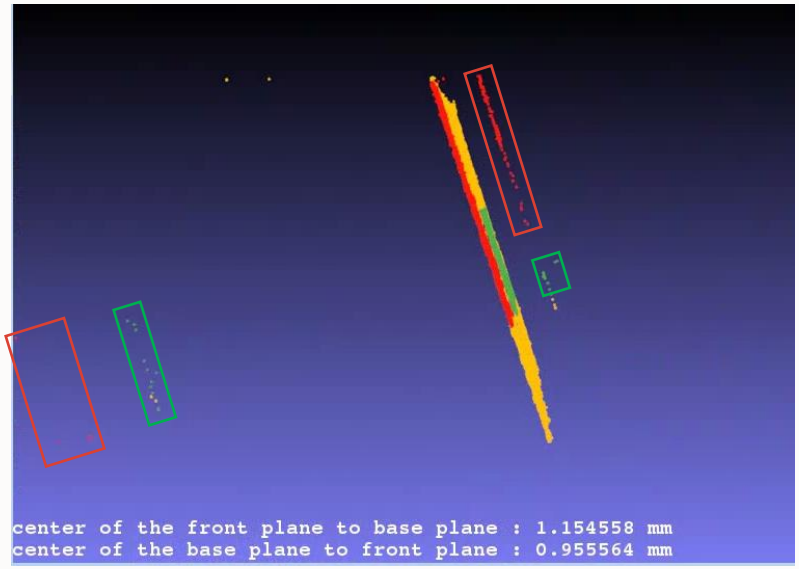


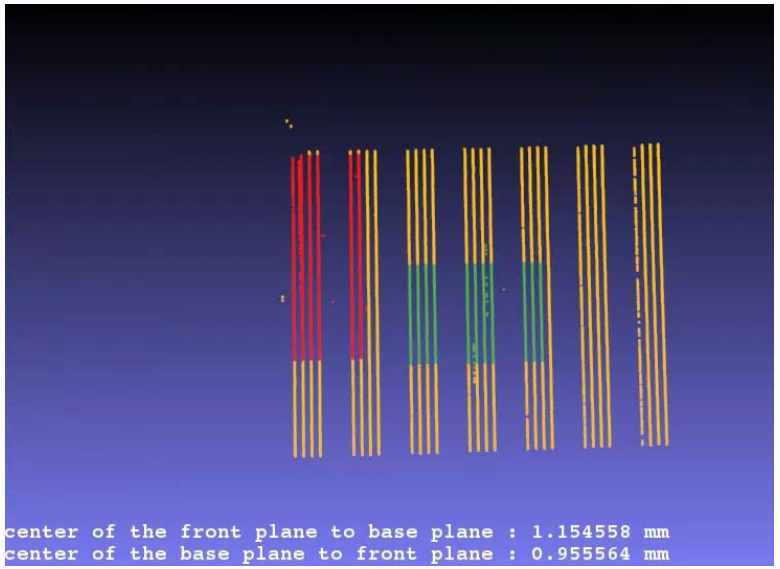
after unwrapping

Progress of the Project

Experimental Results

❖ PCC method



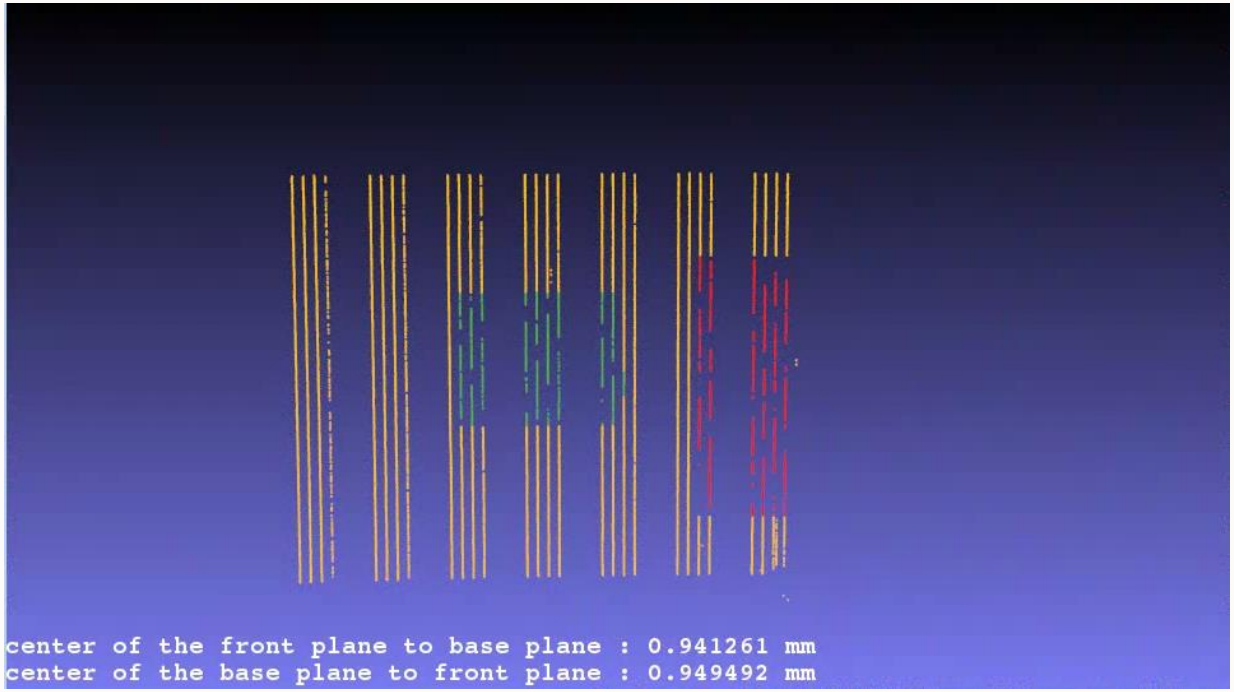


distance btw camera and object : 250mm
base line : 30mm

Progress of the Project

Experimental Results

❖ PCC method – residual error filtering

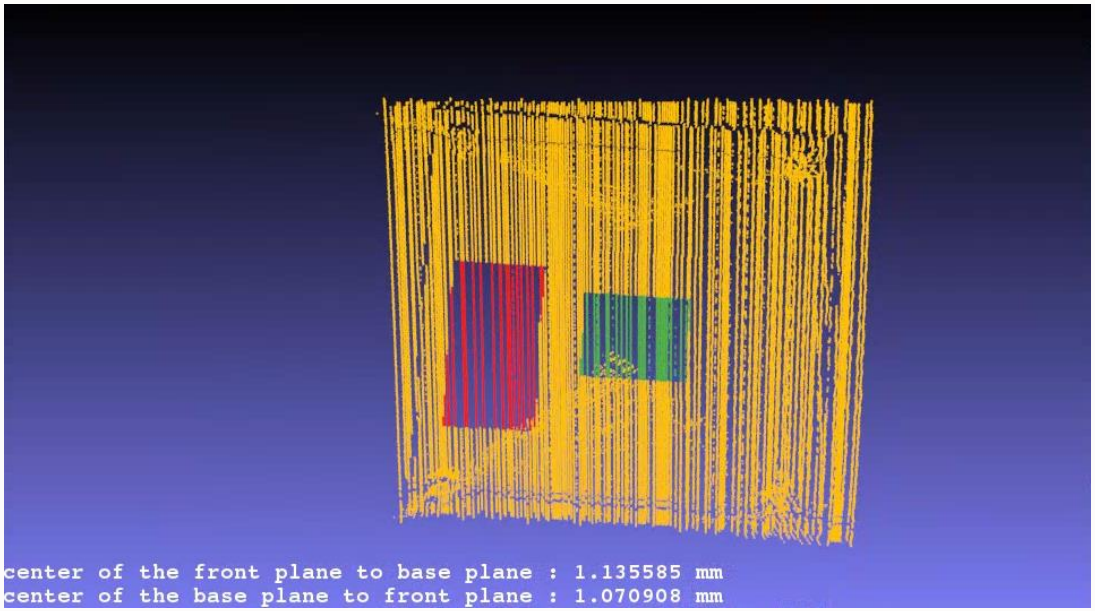


distance btw camera and object : 250mm
base line : 30mm

Progress of the Project

Experimental Results

❖ Line scan method



distance btw camera and object : 250mm
base line : 30mm

Conclusion

- Perform the PCC method
- Use the adaptive threshold for finding disparity ROI
- Use the residual error filtering to reduce the error
- PCC of error is about 0.0568949 mm (f to b and b to f)

Q & A

Thank You!!!