Final Project of Machine Vision

Motion Prediction

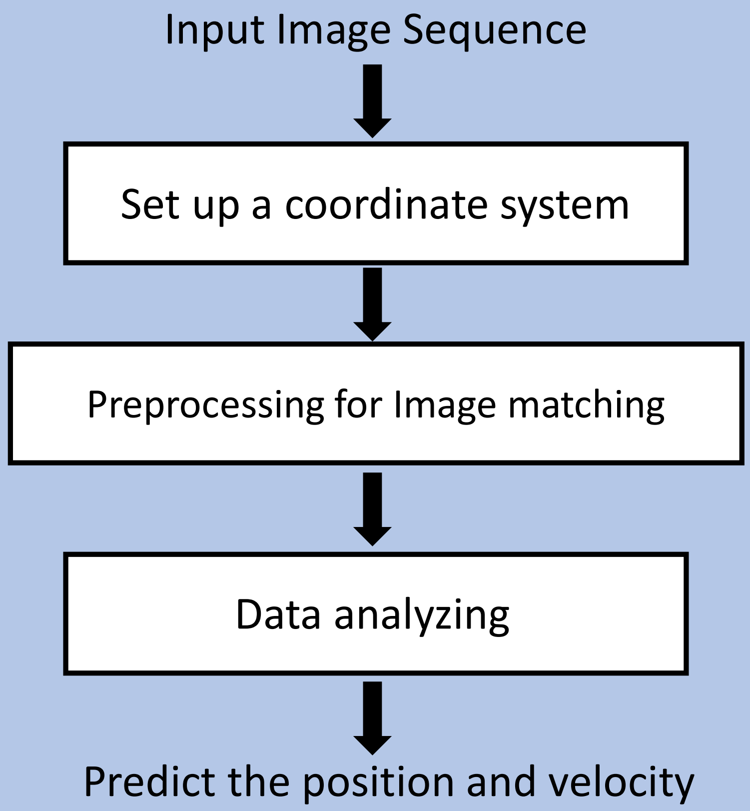
Adviser: Prof. Chi Cheng Cheng
Student: Chia Sheng Kuo
Student ID: M063020037
Dept. of Mechanical and Electro-Mechanical Engineering National Sun Yat-Sen University

Outline

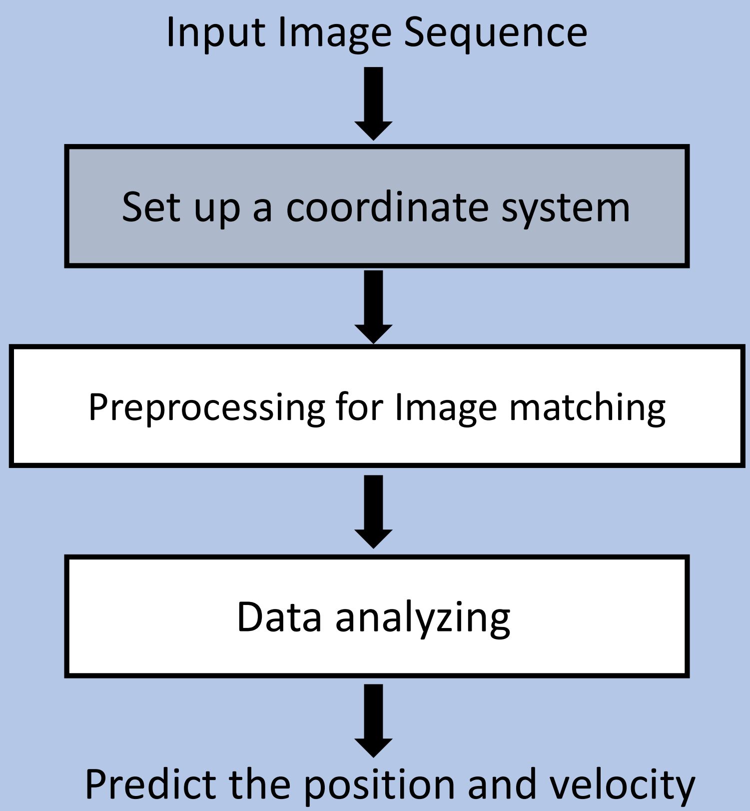
- Strategy
- Method
- Result

Strategy

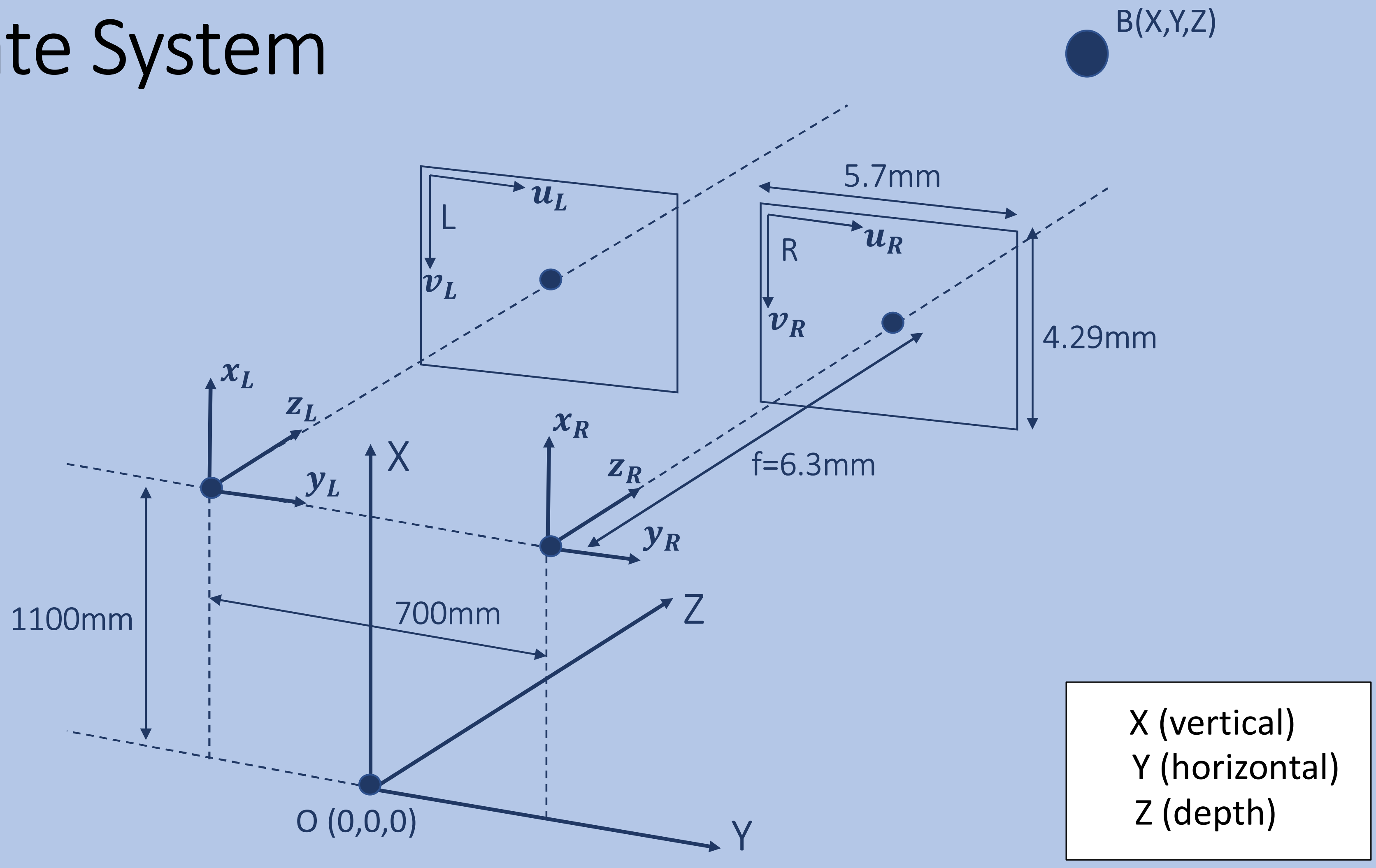
Block diagram of the proposed procedure

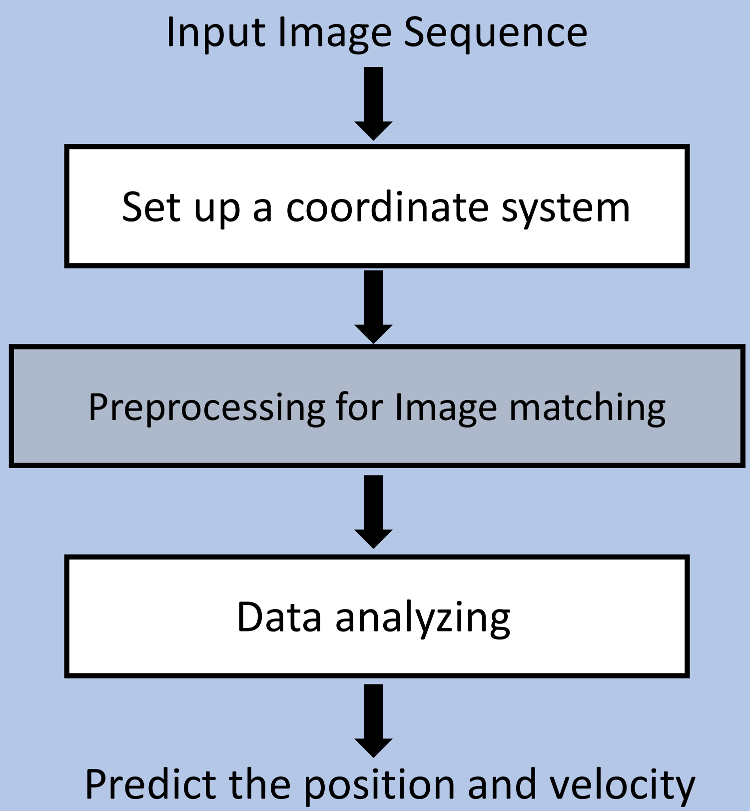


Method

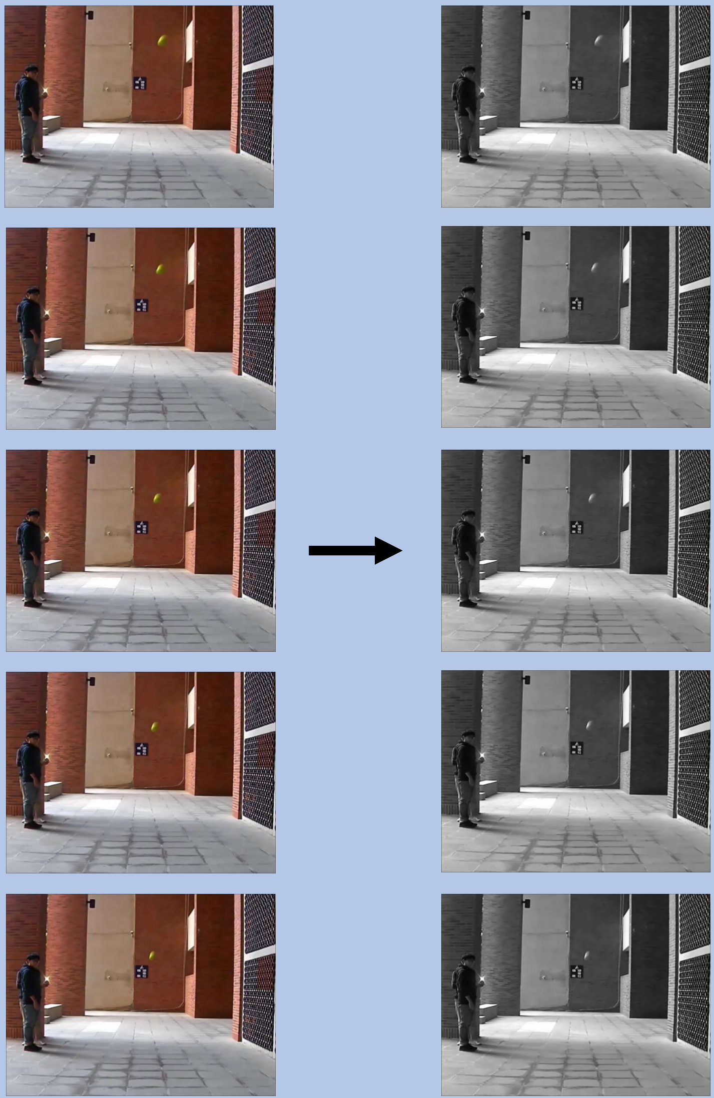

Input Image Sequence
Set up a coordinate system
Preprocessing for Image matching
Data analyzing
Predict the position and velocity

Coordinate System




Input Image Sequence
Set up a coordinate system
Preprocessing for Image matching
Data analyzing
Predict the position and velocity

Get ready for image matching



L1

L2

L3

L4

L5

$$\frac{\sum_{image\ 1}^{image\ 5}(intensity)}{5} =$$

LM

$$|L1 - LM| + |L2 - LM| + |L3 - LM| + |L4 - LM| + |L5 - LM|$$

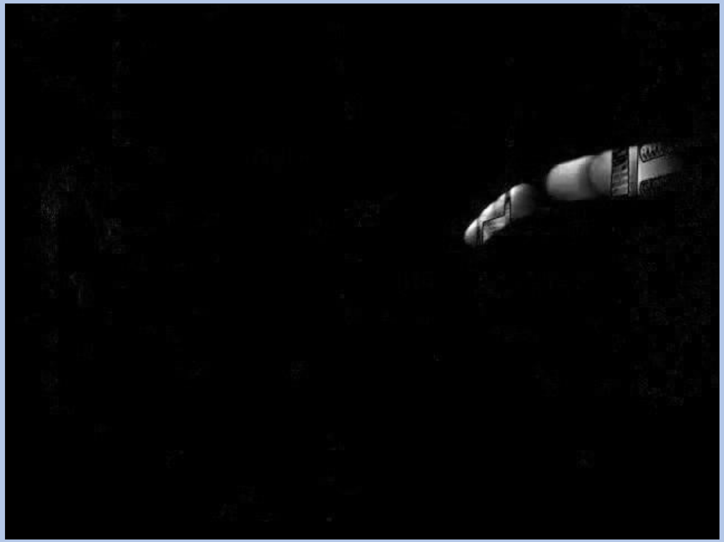
$$\downarrow$$

TAKE_2L

Likewise

TAKE_2R

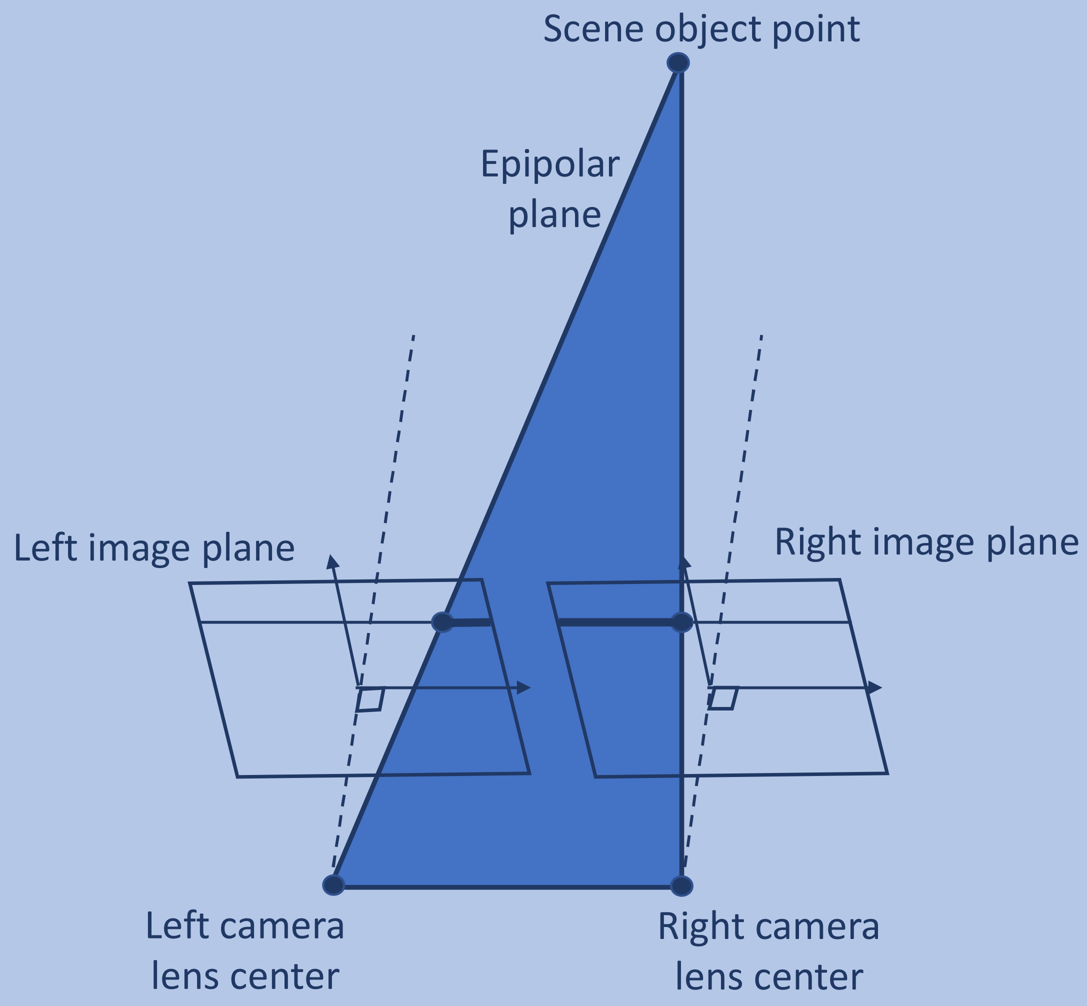
TAKE_1L

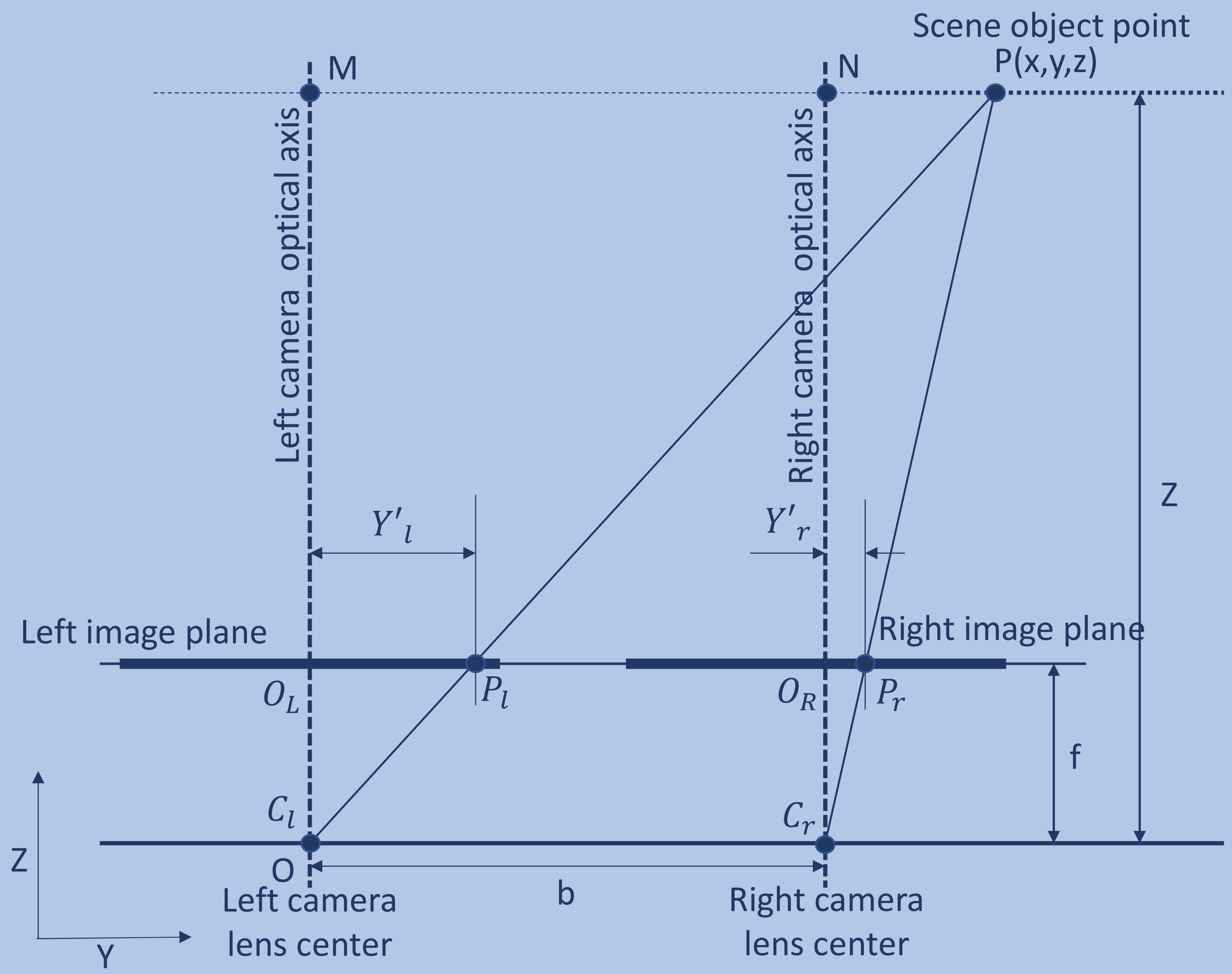


TAKE_1R

Epipolar Constraint

With the epipolar constraint, matching points should lie on the same row of the left image plane and right image plane.





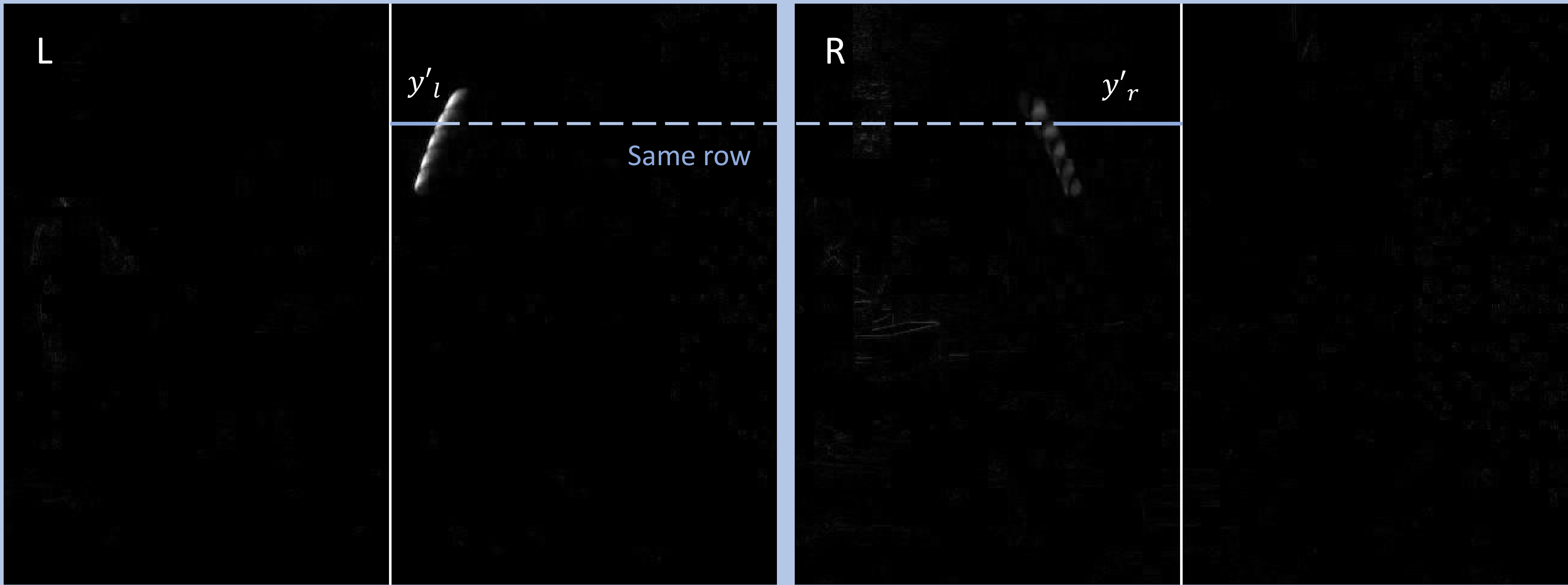
$$\frac{Y}{Z} = \frac{Y'_l}{f} \qquad \text{—— (1)}$$

$$\frac{Y - b}{Z} = \frac{Y'_r}{f} \qquad \text{—— (2)}$$

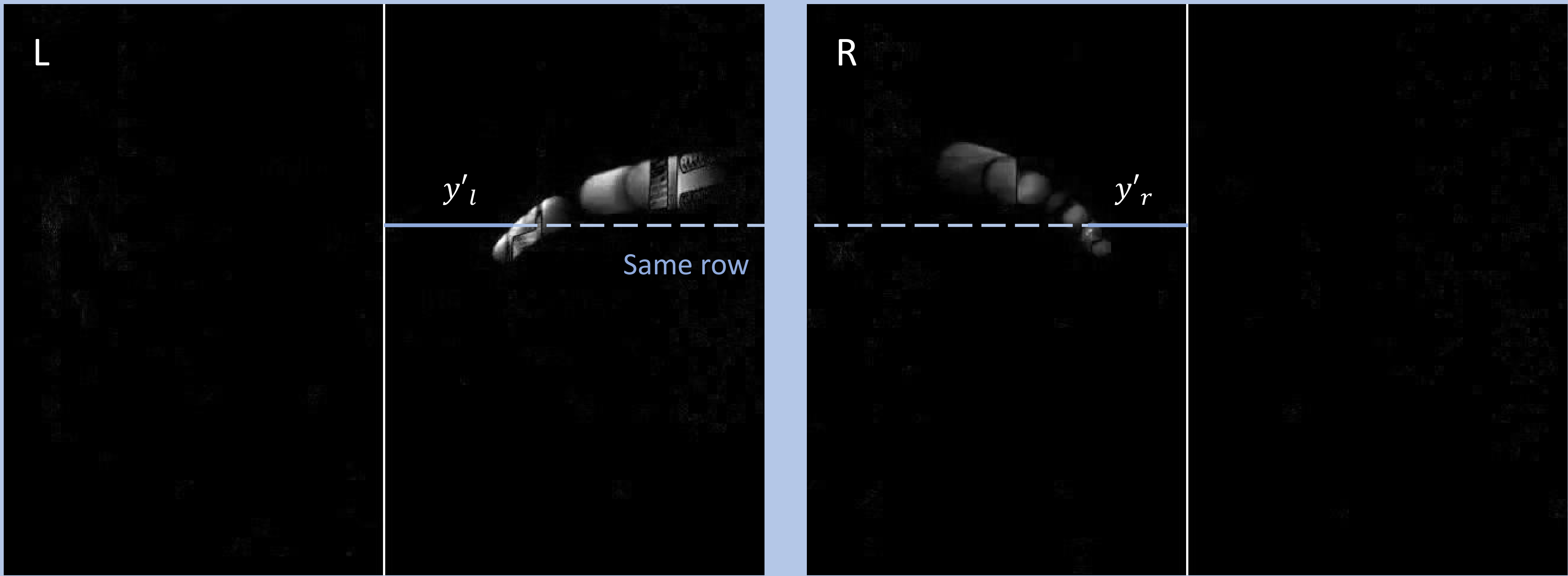
$$Z = \frac{bf}{(Y'_l - Y'_r)} \qquad \text{—— (1) - (2)}$$

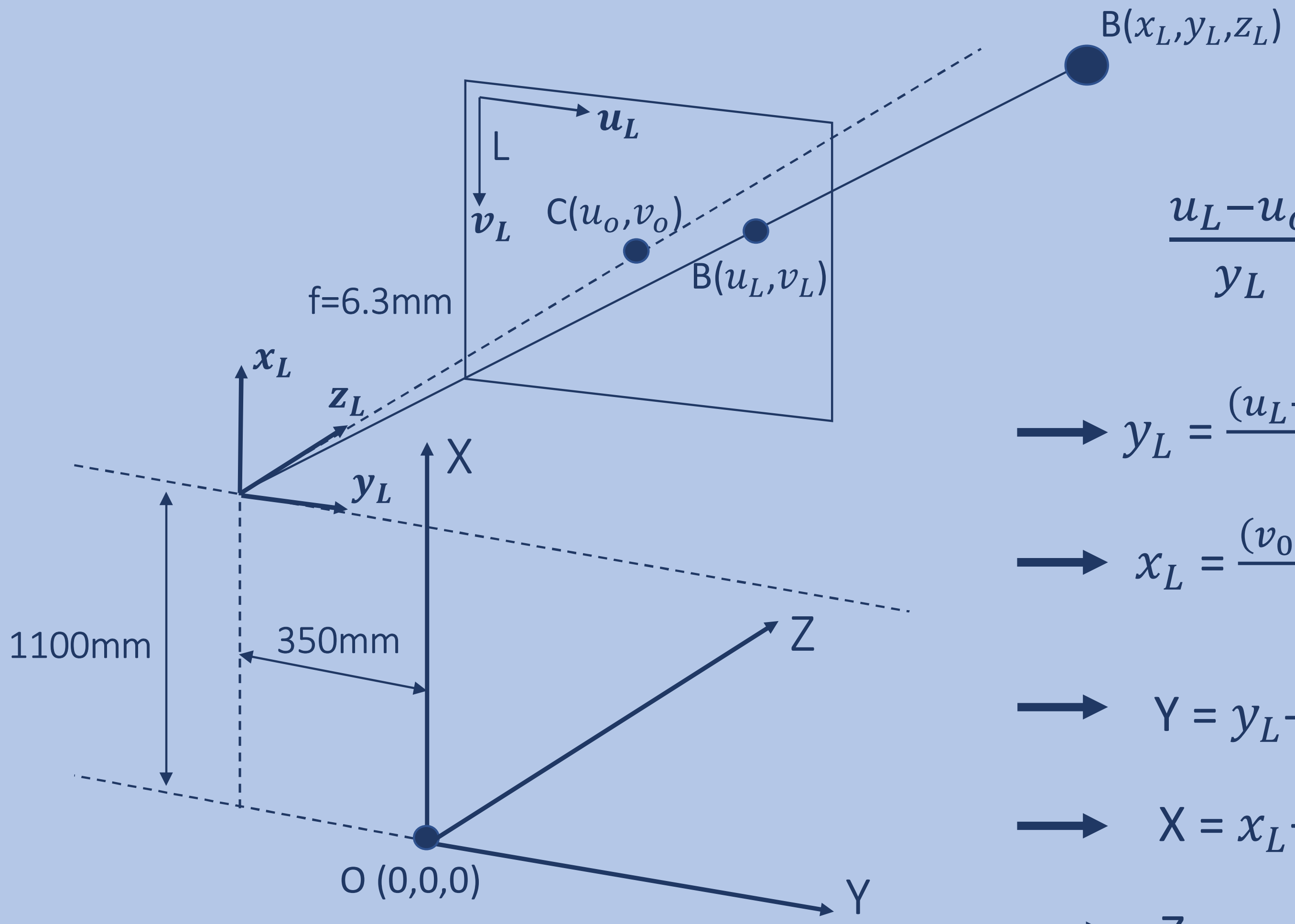
$Y'_l - Y'_r$ is the disparity

OTSU’s thresholding is applied to each row for finding the accurate matching point.



$$Z = \frac{bf}{(Y'_l - Y'_r)} * \left(\frac{5.7}{640}\ {}^{mm}/_{pixel}\right) \qquad (b=700mm, f=6.3mm)$$





$$\frac{u_L - u_o}{y_L} = \frac{v_o - v_L}{x_L} = \frac{f}{Z_L}$$

$$\rightarrow \quad y_L = \frac{(u_L - u_o) * Z_L}{f} * 0.008906 \qquad \left(\frac{5.7}{640}\ {}^{mm}/_{pixel} \right)$$

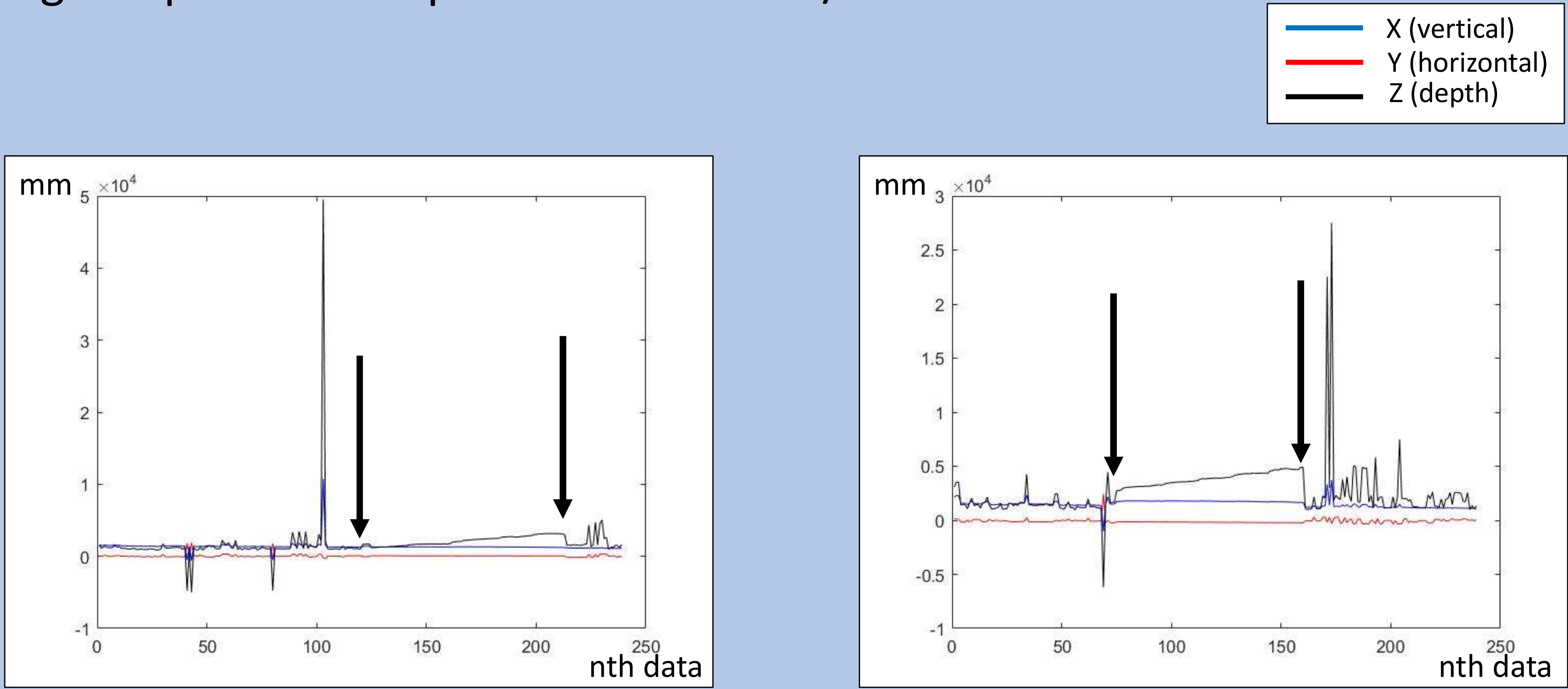
$$\rightarrow \quad x_L = \frac{(v_0 - v_L) * Z_L}{f} * 0.008938 \qquad \left(\frac{4.29}{480}\ {}^{mm}/_{pixel} \right)$$

$\rightarrow$ Y = y_L-350 (mm)

$\rightarrow$ X = x_L+1100 (mm)

$\rightarrow$ Z = z_L (mm)

The linear section is affirmed to be the ball position corresponding to the image sequence. This period should be 4/25 second.

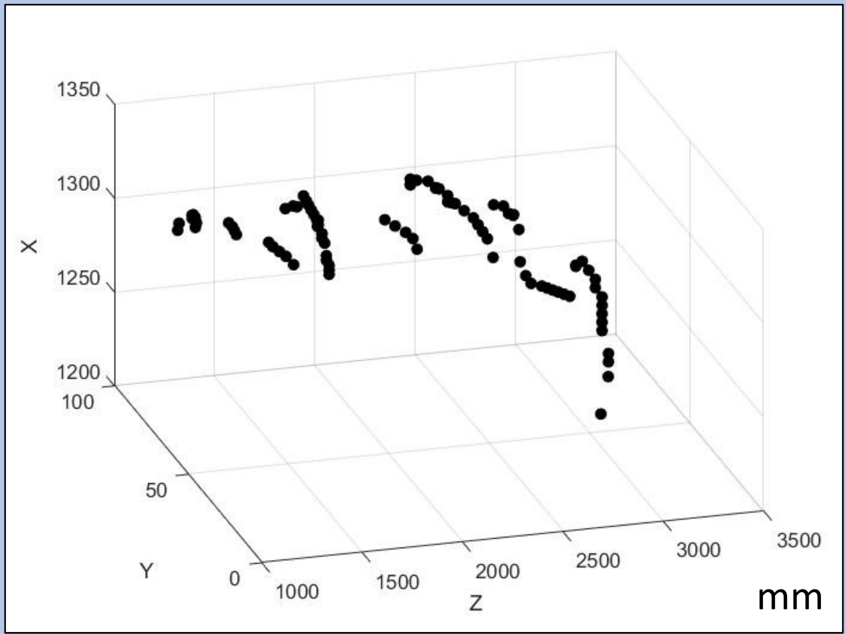


TAKE_1

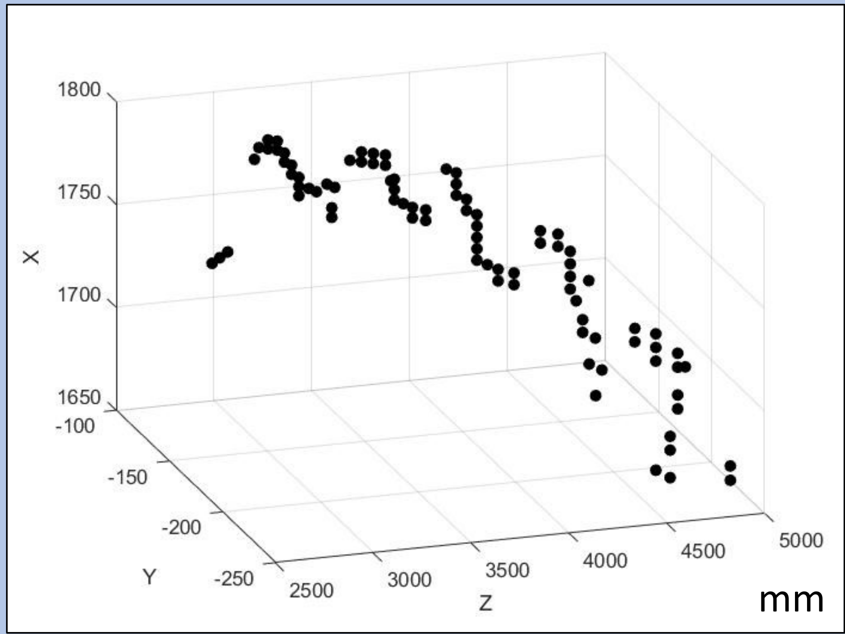
TAKE_2

TAKE_1 has 89 data, therefore, it would be $\frac{4}{25*89}$ s from nth data to (n+1)th data

TAKE_2 has 86 data, therefore, it would be $\frac{4}{25*86}$ s from nth data to (n+1)th data



TAKE_1

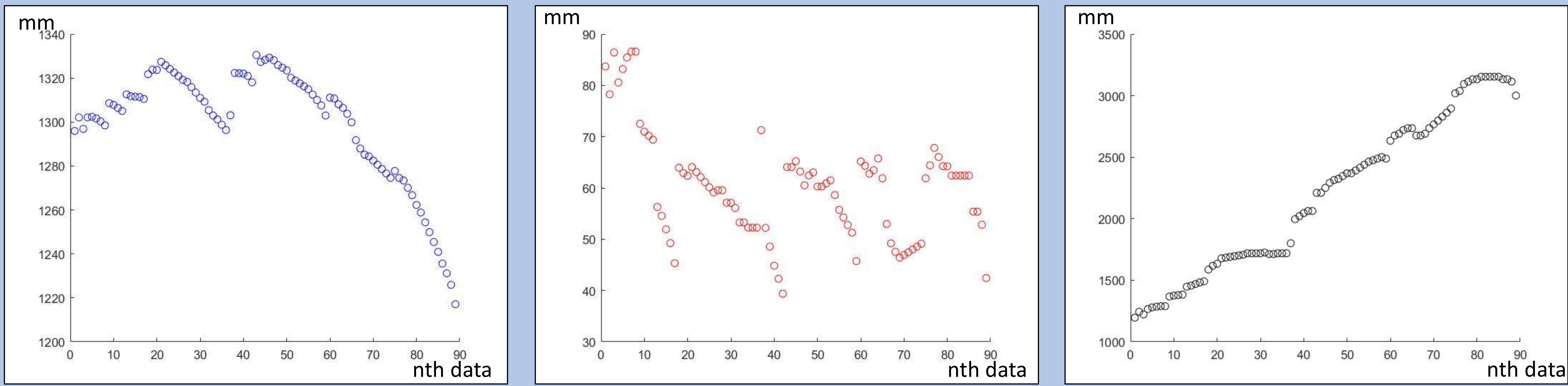


TAKE_2

TAKE_1

Assumed that there is only gravitational force applied on the ball, X plot should be a quadratic curve. Y plot and Z plot should be a straight line.

X (vertical)
Y (horizontal)
Z (depth)



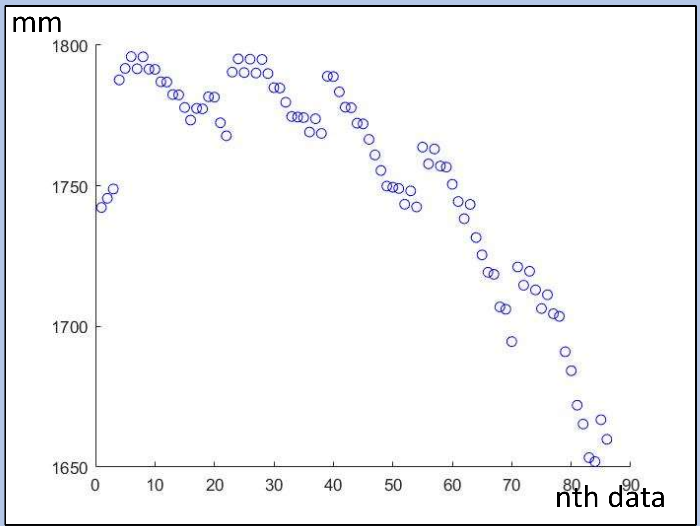
TAKE_2

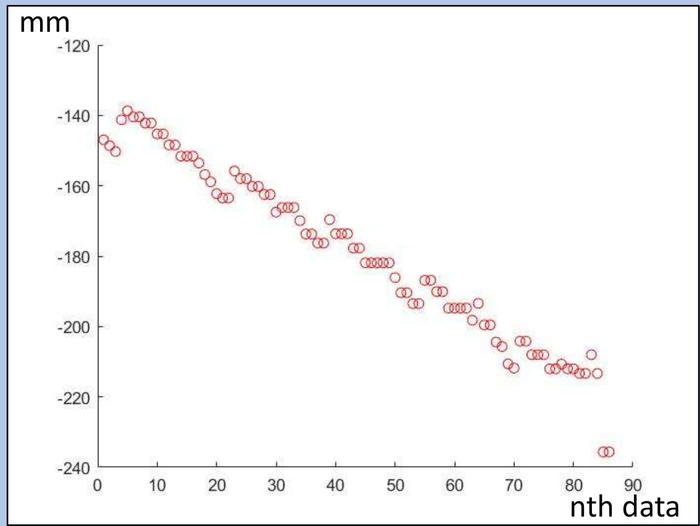
Every two consecutive data can provide a Velocity.

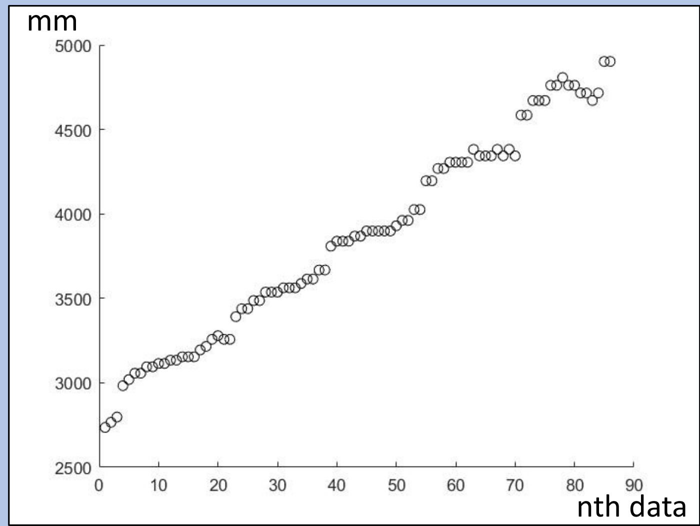
Time period for TAKE_1 is $\frac{4}{25*89}$ s

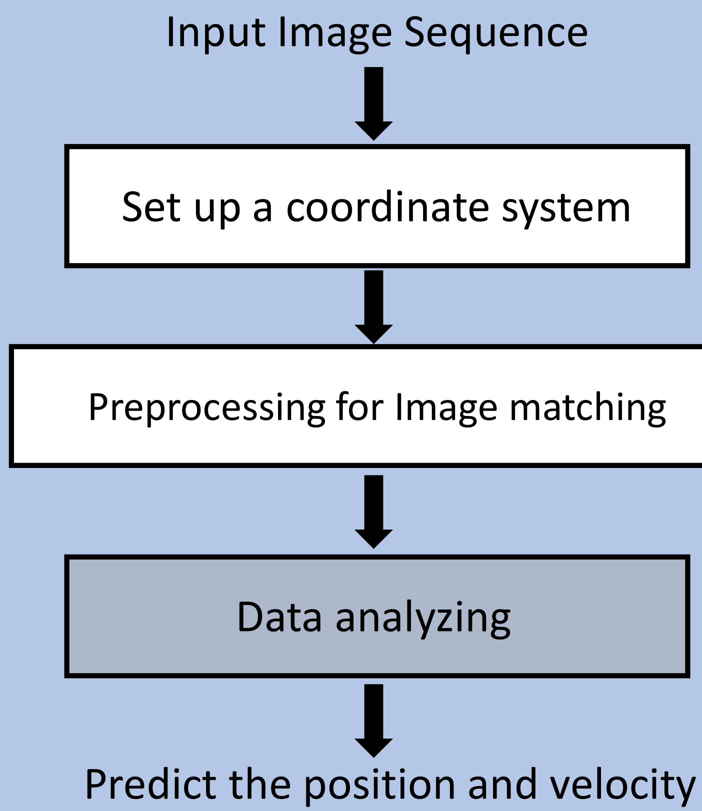
TAKE_2 is $\frac{4}{25*86}$ s

O X (vertical)
O Y (horizontal)
O Z (depth)



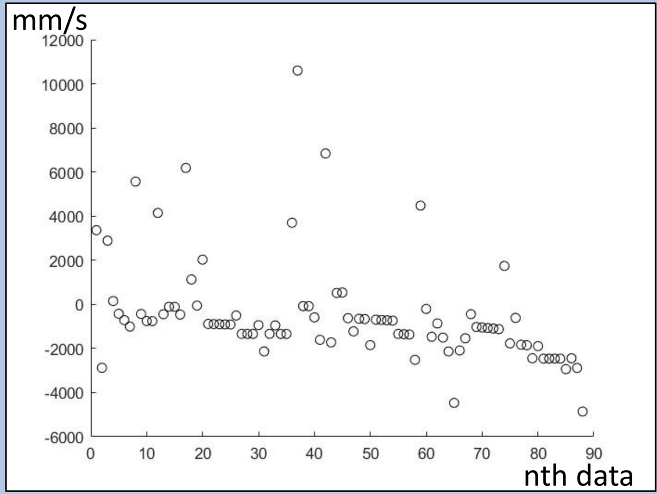





Input Image Sequence
Set up a coordinate system
Preprocessing for Image matching
Data analyzing
Predict the position and velocity

Again, assumed that there is only gravitational force applied on the ball, V_Y (horizontal) and V_Z (depth) should be a constant value. But, V_X(vertical) is varying with time.

V_X (vertical) velocity



To predict the final position of the ball, the vertical velocity of the last position V_{XL}(vertical) is needed. However, there is only one V_{XL} in previous calculation.

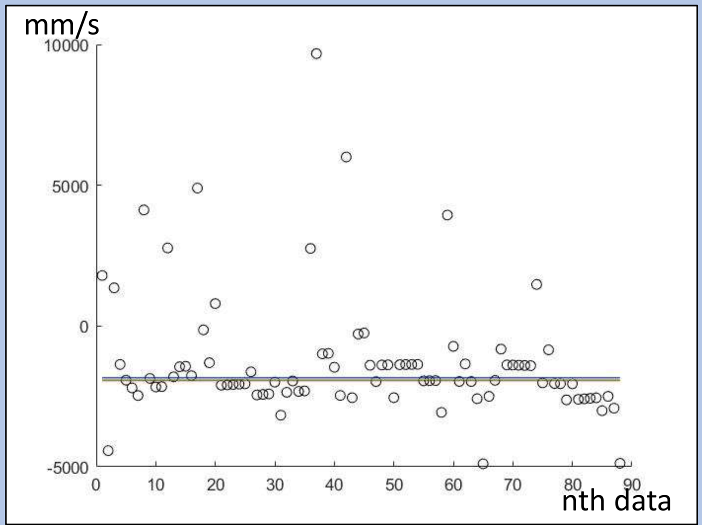
V_{XL}= V_{Xn} - 9810*T_n , T_n is the time from nth data to the last data (n=1 to # of data)

TAKE_1

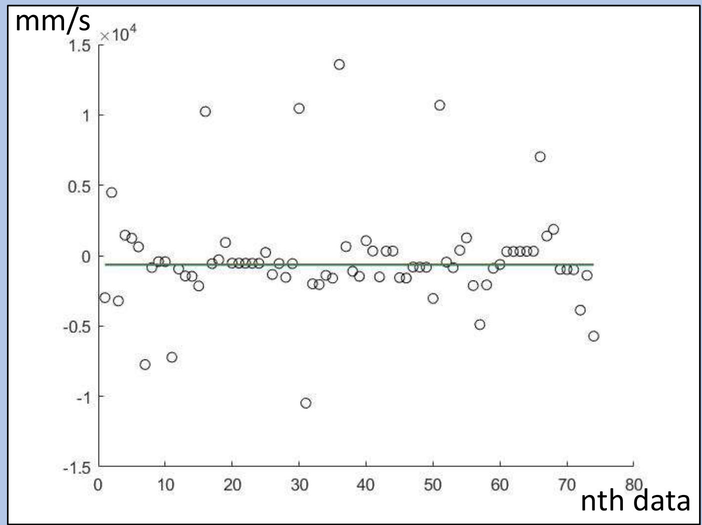
Median(All the data)
Mean(μ-σ < data <μ+σ)
Mean of above two value

Last position's vertical velocity

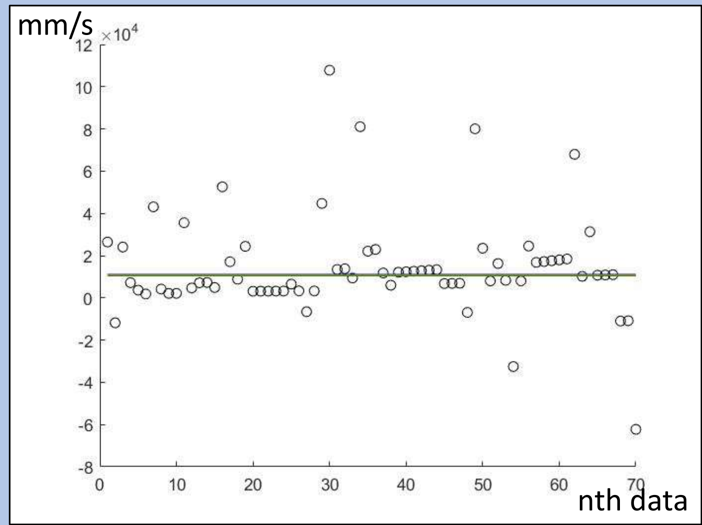
V_{XL} (vertical) velocity



V_Y (horizontal) velocity



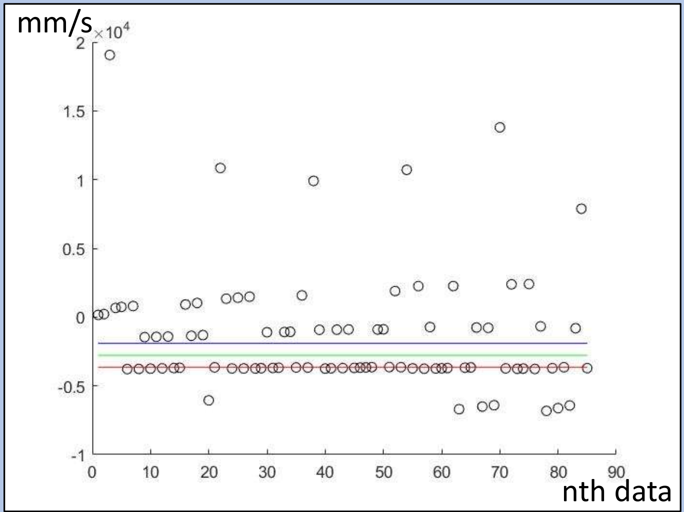
V_Z (depth) velocity



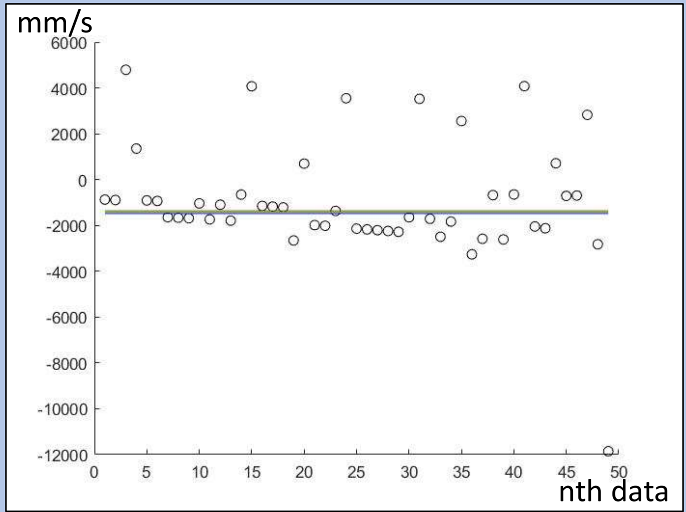
TAKE_2

Median(All the data)
Mean(μ-σ < data <μ+σ)
Mean of above two value

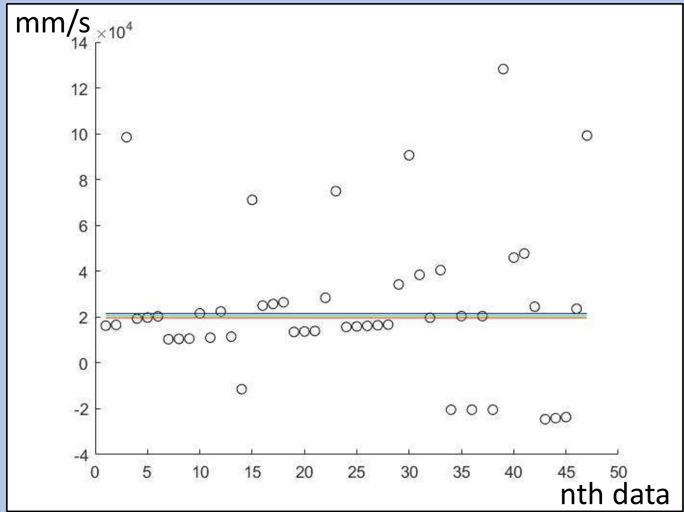
V_{XL} (vertical) velocity



V_Y (horizontal) velocity



V_Z (depth) velocity



Result

TAKE_1

Last position in the image(1.23m, 0.05m, 3.11m)

T = 0.34s (to touch the ground)

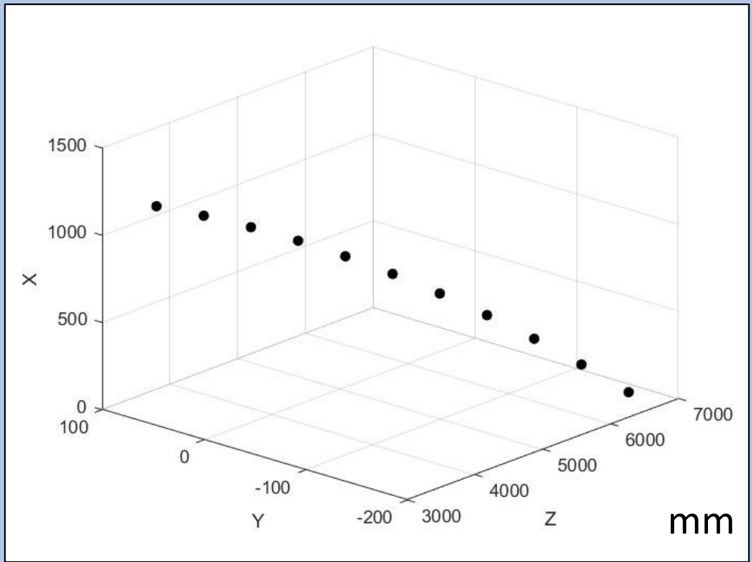
V_X= -1.89 m/s V_{XL}= -5.26 m/s

V_Y = -0.63 m/s

V_Z = 10.77 m/s

Final position (0m, -0.16m, 6.8m)

Final velocity 12.01 m/s



TAKE_2

Last position in the image(1.66m, -0.22m, 4.78m)

T=0.36s (to touch the ground)

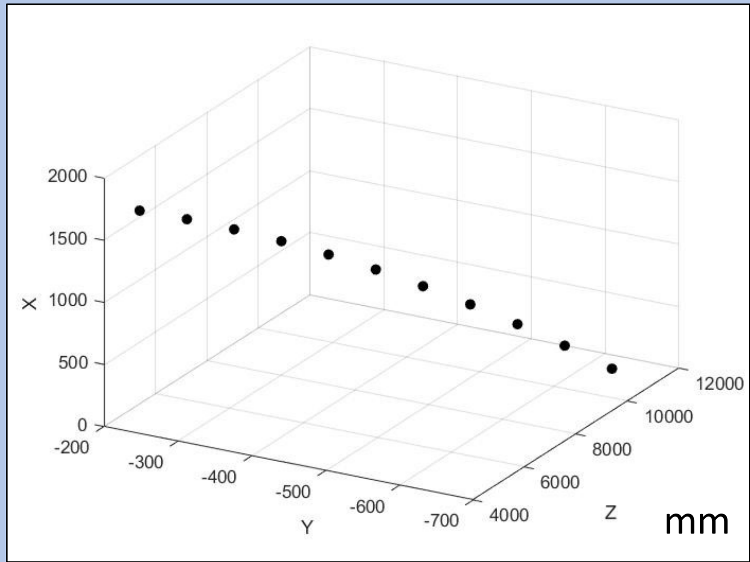
V_X = -2.78 m/s V_{XL}= -6.35m/s

V_Y = -1.13 m/s

V_Z = 18.09 m/s

Final position (0m, -0.63m, 11.36m)

Final velocity 19.20 m/s



X (vertical)
Y (horizontal)
Z (depth)