

# Water Level Monitoring Method of Channel Water Gauge Image Based on Unet and ResNet50

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# Content

- Introduction
- Basic Principles
- Experimental test results and analysis

# Water Level Monitoring

Traditional monitoring techniques

Float type water level gauge

Pressure water level gauge

Laser water level gauge



- 1) Installation is complex
- 2) Environmental requirements are high

Machine vision water level recognition

Calibration of Water Level Gauge

Water level recognition calculation

Water level lines recognition

Character recognition

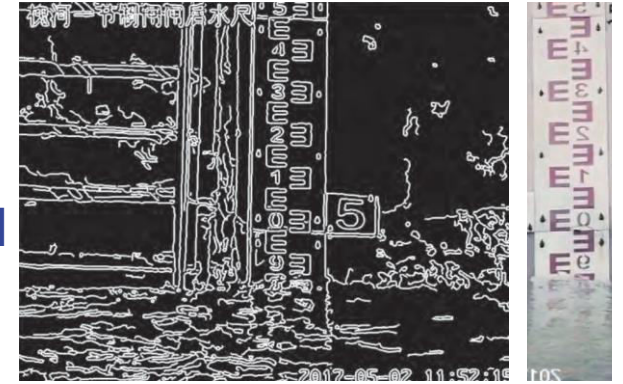
Water level calculation

# 1. Calibration of Water Level Gauge

## 1) Image Processing

a. Set edge connectivity threshold to select water level gauge -Sun et al

**DA:** Not suitable for complex environments, relies on accuracy of edge detection, lacks universality.

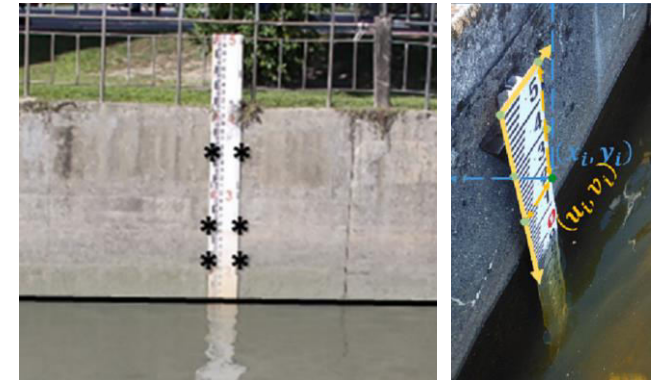


## 2) Manual Calibration

a. Determine initial orientation of camera on-site -Lin et al

b. Determine initial orientation of gauge on-site -Zhang et al

**DA:** Requires human participation, significant recognition errors can occur when the camera position changes.



## 3) Deep Learning

a. YOLOv5s Model - Qiao et al



## 2. Water level recognition calculation:

combined with water level lines, character recognition, unit pixel actual length calculation

### 1) Identification of water level lines

a. Marginal features - Sun et al., Lin et al., 2018

**DA:** Errors are easier to identify in more complex environments

b. Projection method - Lin et al., 2013, Li et al., Qiao et al

**DA:** Errors are easier to identify in more complex environments

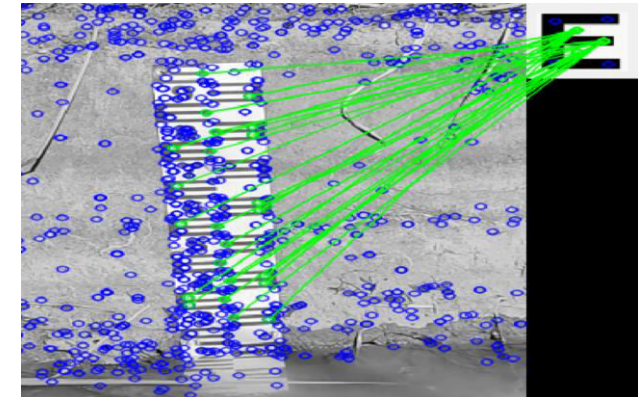
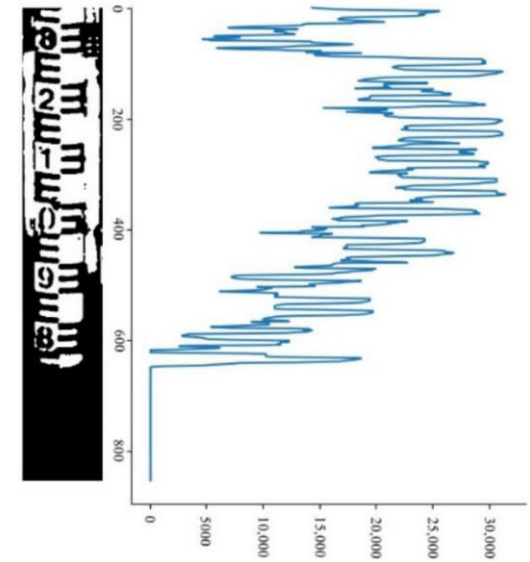
### 2) Recognition of characters

a. Template matching algorithm - Lin et al., 2013

**DA:** Poor accuracy and adaptability

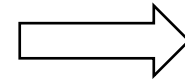
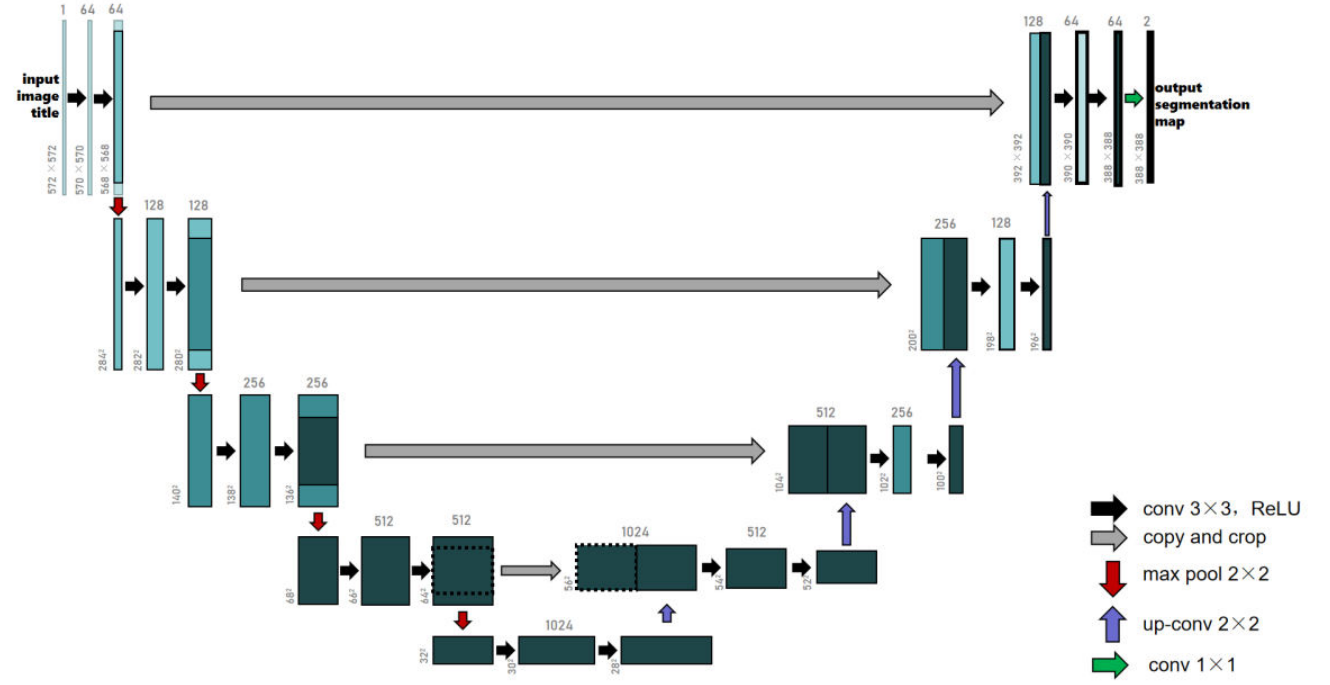
b. Neural network algorithms

**DA:** Heavy workload



## Advantages:

- 1) Reduced model complexity
- 2) Better preserved image features
- 3) Able to handle complex environment scale images well
- 4) No longer requires the recognition of edge and water level lines compared to YOLO.



## 1.Canny Operator Pros:

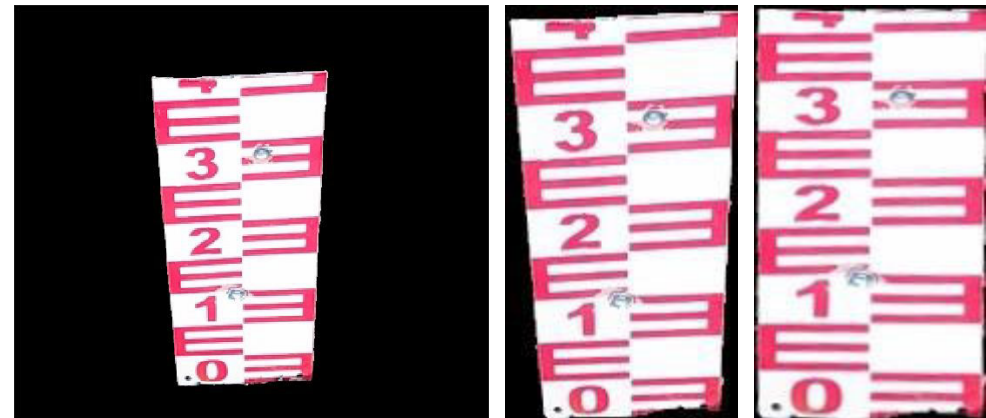
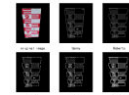
- 1)Refine the edges of an image,
- 2)Automatically connect discontinuities
- 3)Enhance the edge detection's noise resistance ability, and accurately detect edges.

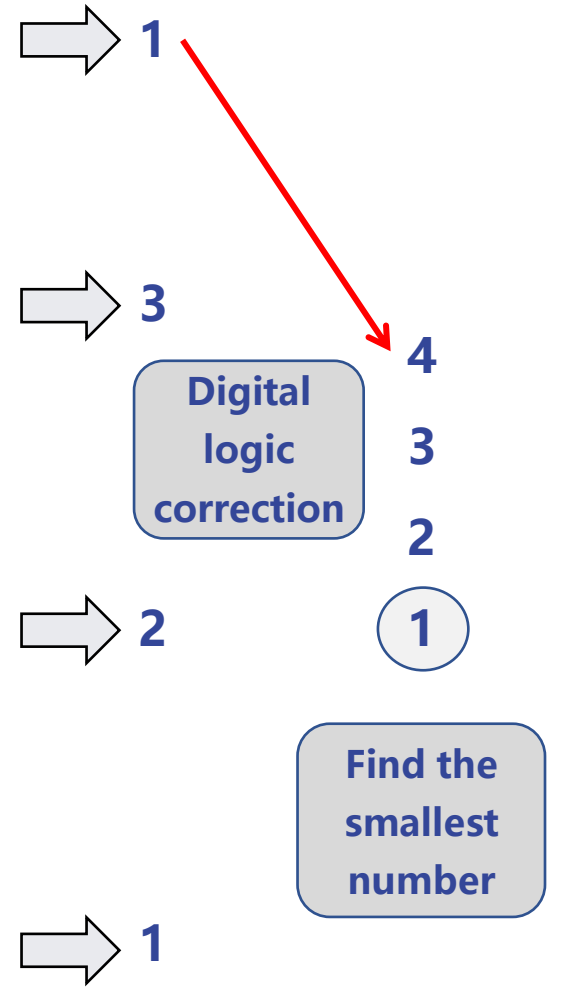
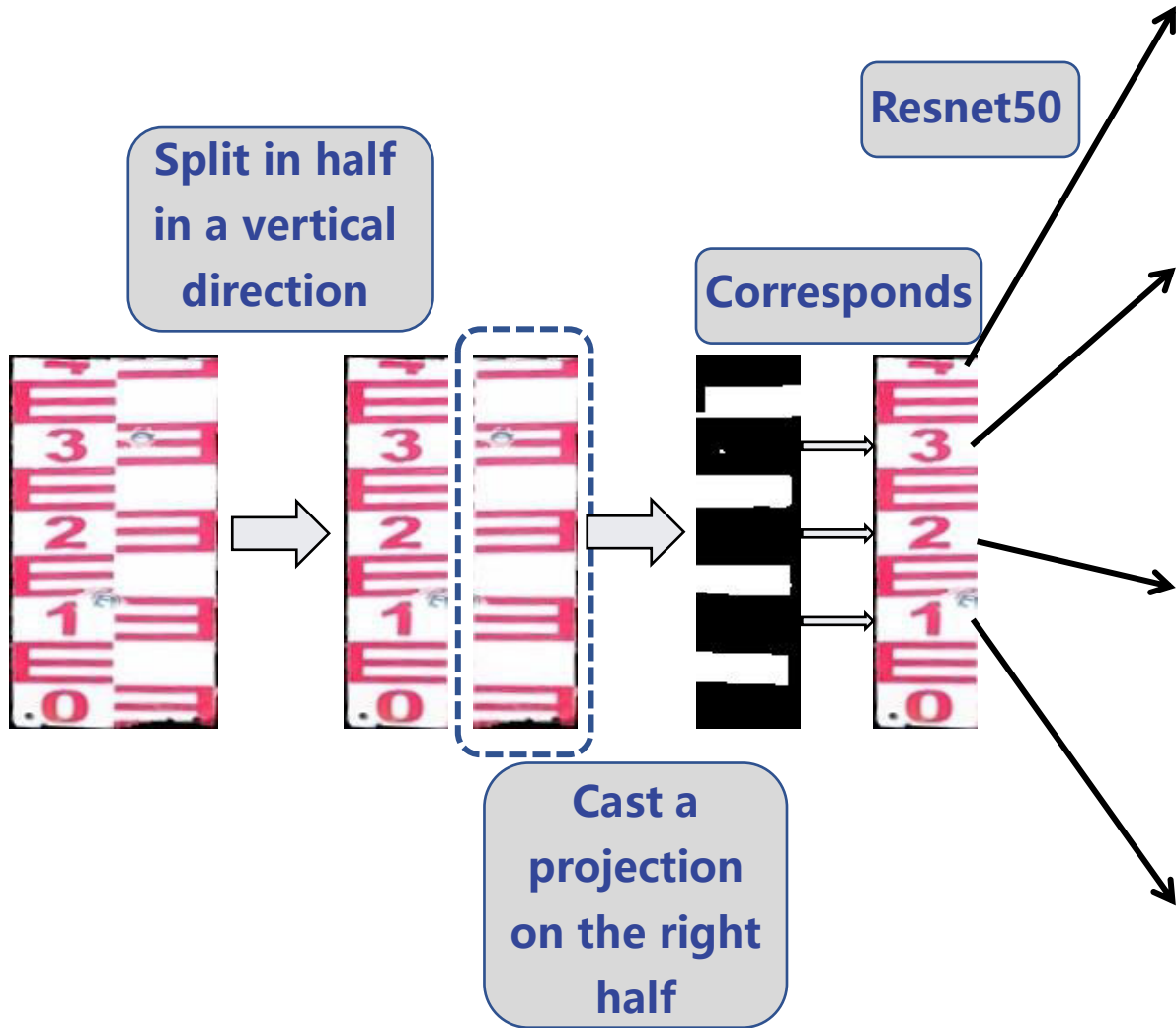
## 2.Geometrically Correct Steps

- 1)Determine the pre-correction draft vertex coordinates
- 2)Generate a perspective transformation matrix
- 3)Geometrically correct

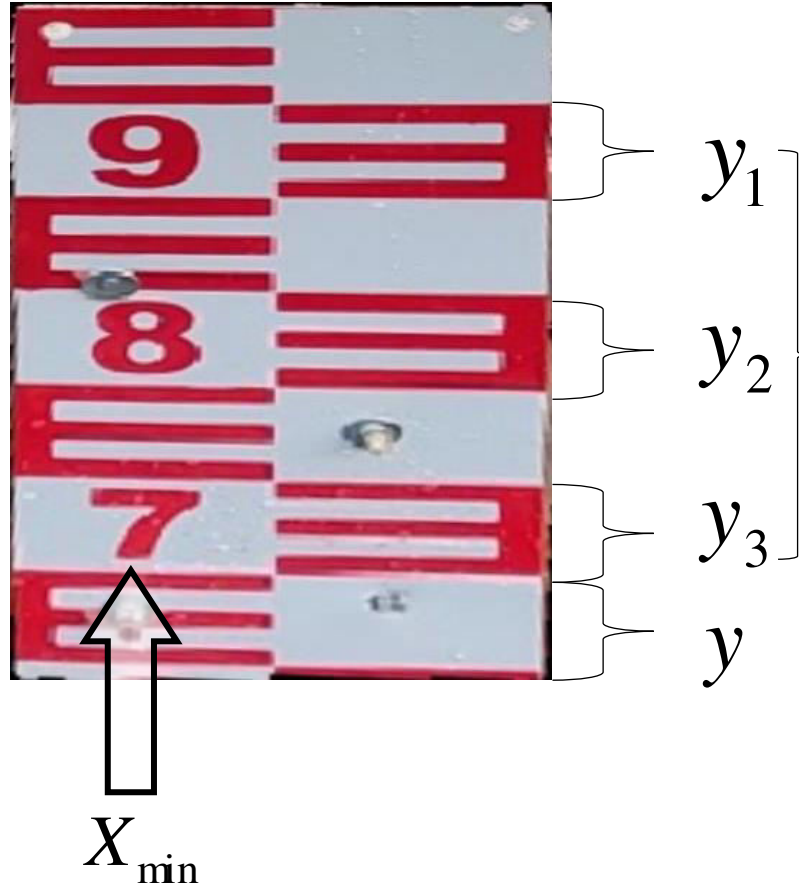
The formula for perspective transformation is:

$$[x', y', 1] = [u, v, 1] \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}$$



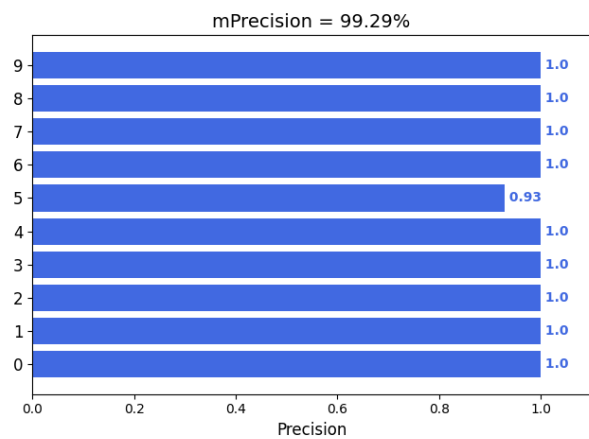
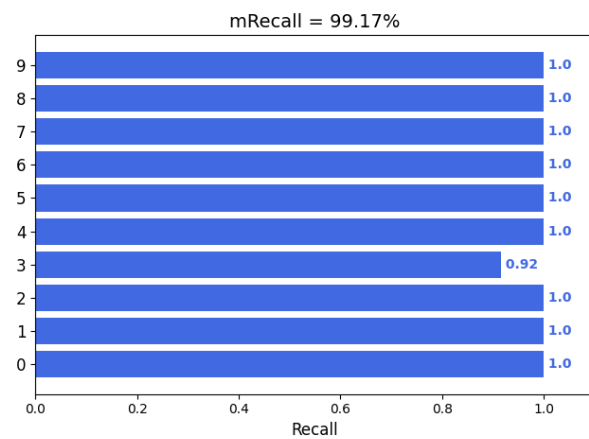
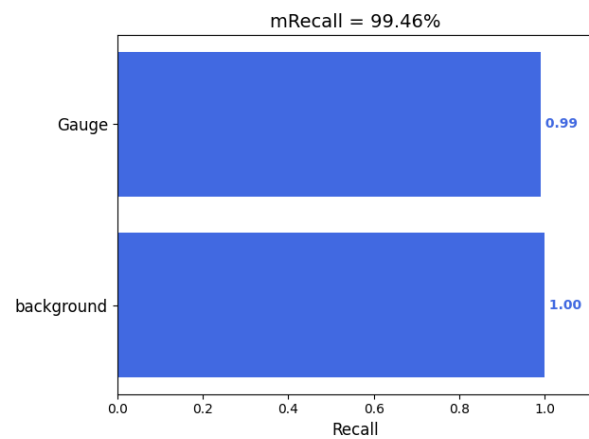
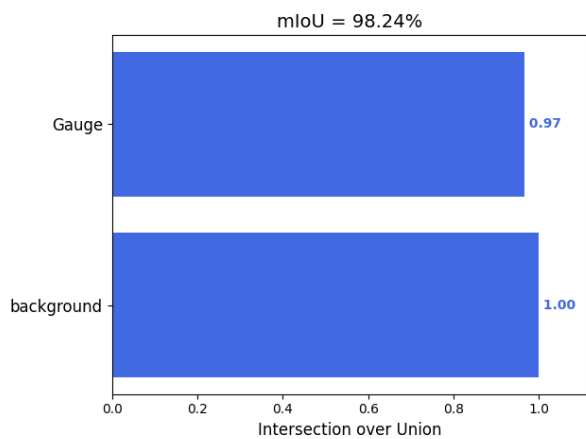
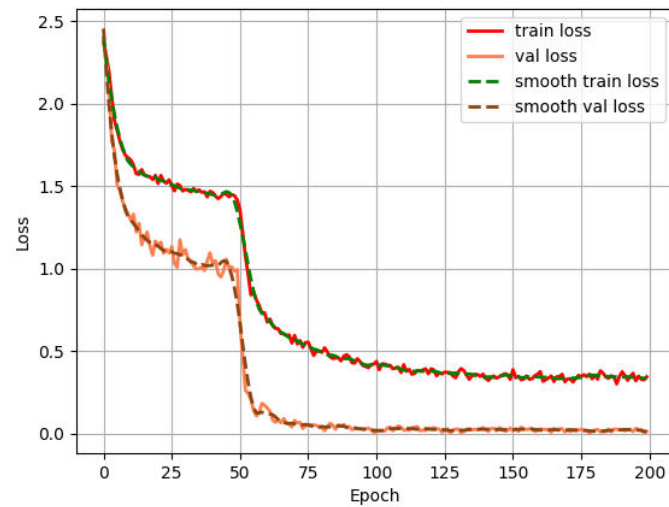
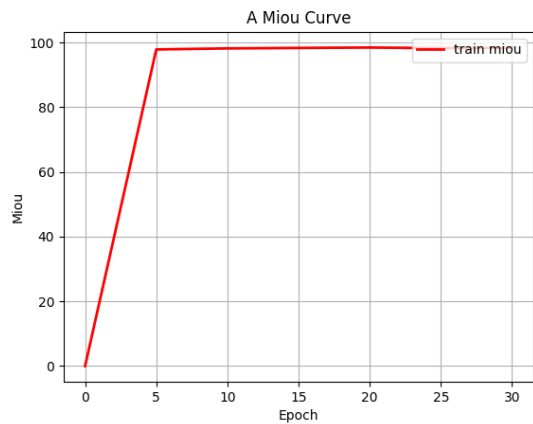
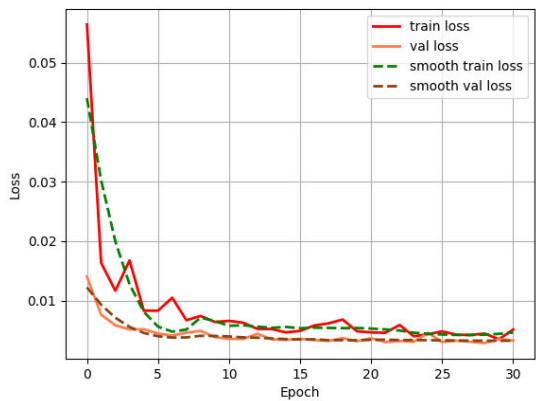






$$\frac{1}{n} \sum_{i=1}^n y_i = \frac{1}{3} (y_1 + y_2 + y_3)$$

$$H = 10X_{\min} - \frac{5y}{\frac{1}{n} \sum_{i=1}^n y_i}$$

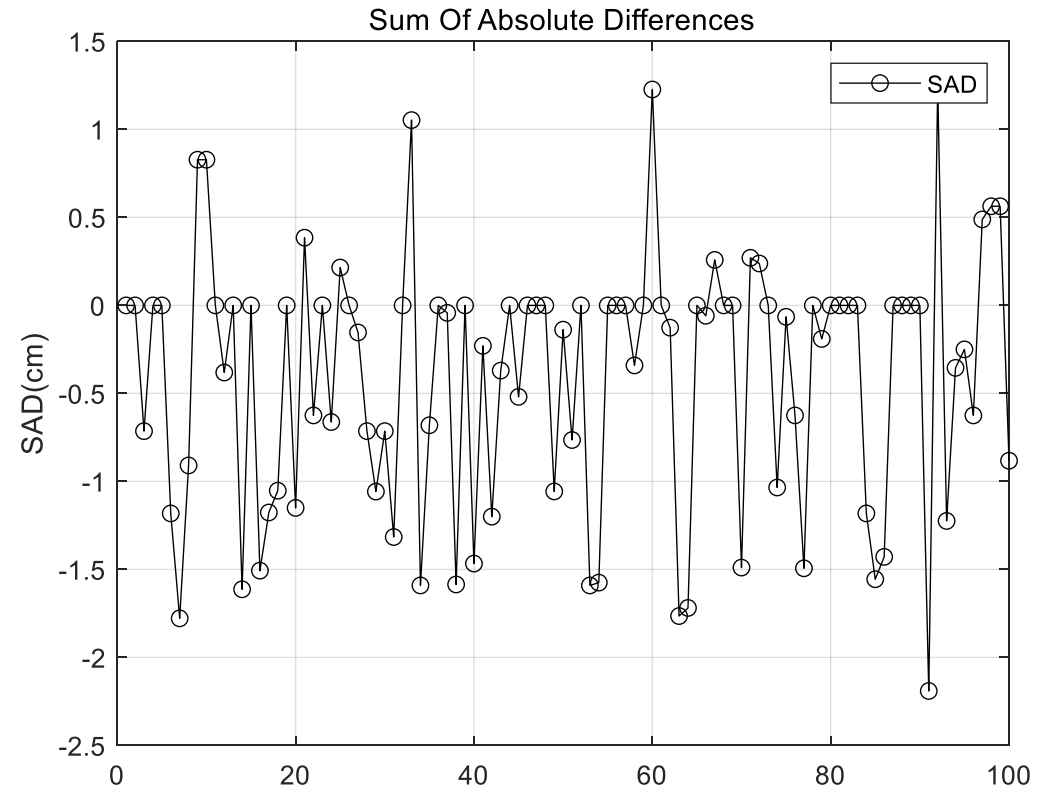


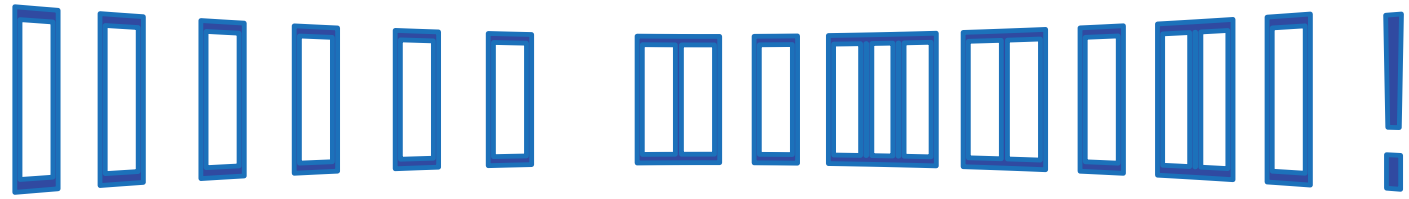
	mIoU	mPrecision	mRecall	Accuracy	top-1 Accuracy
VGG16	98.24	98.76	99.46	99.84	\
ResNet50	\	99.29	99.17	\	99.59

The test results show :

The water level reading error is basically below 2cm,

The average absolute error is about 0.5595cm





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