DEFORMATION MONITORING METHOD BASED ON ADAPTIVE SEGMENTATION AND CORRELATION MATCHING

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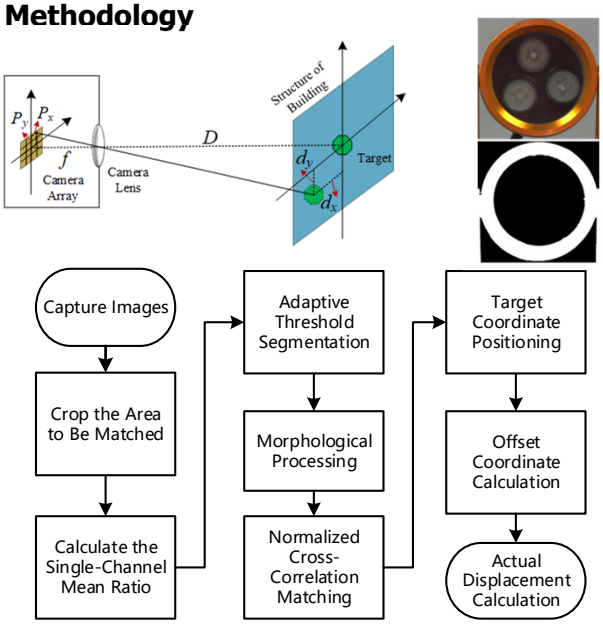
Abstract: Deformation measurement is an important method in the monitoring of structural engineering safety. Most of the traditional measuring methods require humans to conduct surveys and field tests, which is complicated to operate, and the uncertainty of measurement accuracy is difficult to overcome. To solve this problem, this paper designs an automatic monitoring system for deformation and displacement based on adaptive segmentation and correlation matching method. By fixed-point monitoring technology, real time images of bridges/buildings are obtained, and the coordinates of targets are dynamically obtained and converted into deformation data to achieve high-precision non-contact real-time measurement, based on computer vision and target positioning technologies. According to our experiments, the deformation and displacement monitoring system achieves the purpose of all-weather monitoring for structure health.

Methodology



1.Calculate the single-channel mean ratio α.

$$\alpha = \frac{\text{mean}_R + \text{mean}_G}{\text{mean}_B}$$

2.Calculate the adaptive threshold γ of segmentation.

$$\gamma = 19.44 * log(\alpha - 0.45) - 12.52$$

3.Mmorphological processing by mask μ.

$$g = (g \oplus \mu) \ominus \mu$$

4.Find the target coordinates by normalized cross correlation matching algorithm.

$$h(m,n) = \frac{\sum_{i,j}(g(m+i,n+j) - \mu(g))(k(i,j) - \mu(k))}{\sqrt{\sum_{i,j}(g(m+i,n+j) - \mu(g))^2}}$$

Where k is the template image, g is the observed image, $\mu(\cdot)$ is the mean of the image.

5.Calculate the actual displacement by single array element β_x, coordinate shift value n_t.

$$f/D = P_x/d_x = P_y/d_y$$

$$d_x(t) = \frac{D}{f} \times P_x$$

$$= \frac{D}{f} n_t \times \beta_x$$

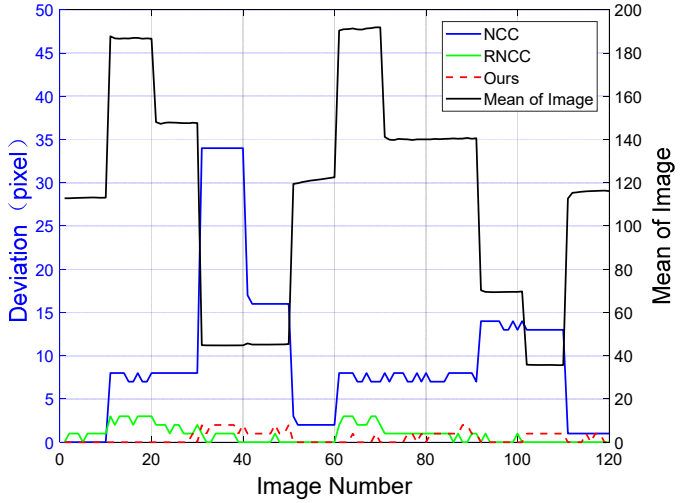
Experiments

DISPLACEMENT MEASUREMENT RESULTS UNDER SAME LIGHT CONDITION

Light Intensity	Method	Move Horizontally 1mm (about 9 Pixels)			Move Vertically 1mm (about 9 Pixels)		
		Mean	Variance	Mean square error	Mean	Variance	Mean square error
Dark	NCC	9.39	0.24	0.4	7	0	4
	RNCC	9	0	0	8.29	0.21	0.7
	Ours	8.69	0.21	0.3	8.09	0.09	0.9
Bright	NCC	8.39	0.24	0.6	10	0	1
	RNCC	8.69	0.21	0.3	9.19	0.16	0.2
	Ours	8.8	0.16	0.2	9	0	0

DISPLACEMENT MEASUREMENT RESULTS UNDER DIFFERENT LIGHT CONDITIONS

Displacement Direction	Method	Mean Error	Variance Error	Mean Squared Error
Horizontal	NCC	4.8	11.27	34.63
	RNCC	0.86	0.98	1.73
	Ours	0.51	0.44	0.71
Vertical	NCC	9.8	75.64	171.68
	RNCC	0.80	0.21	0.84
	Ours	0.59	0.31	0.66



The change curves of image means and displacement