

Using neural networks for robot motion simulation and visual servo

Qingjie Zhao

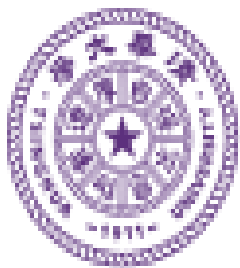
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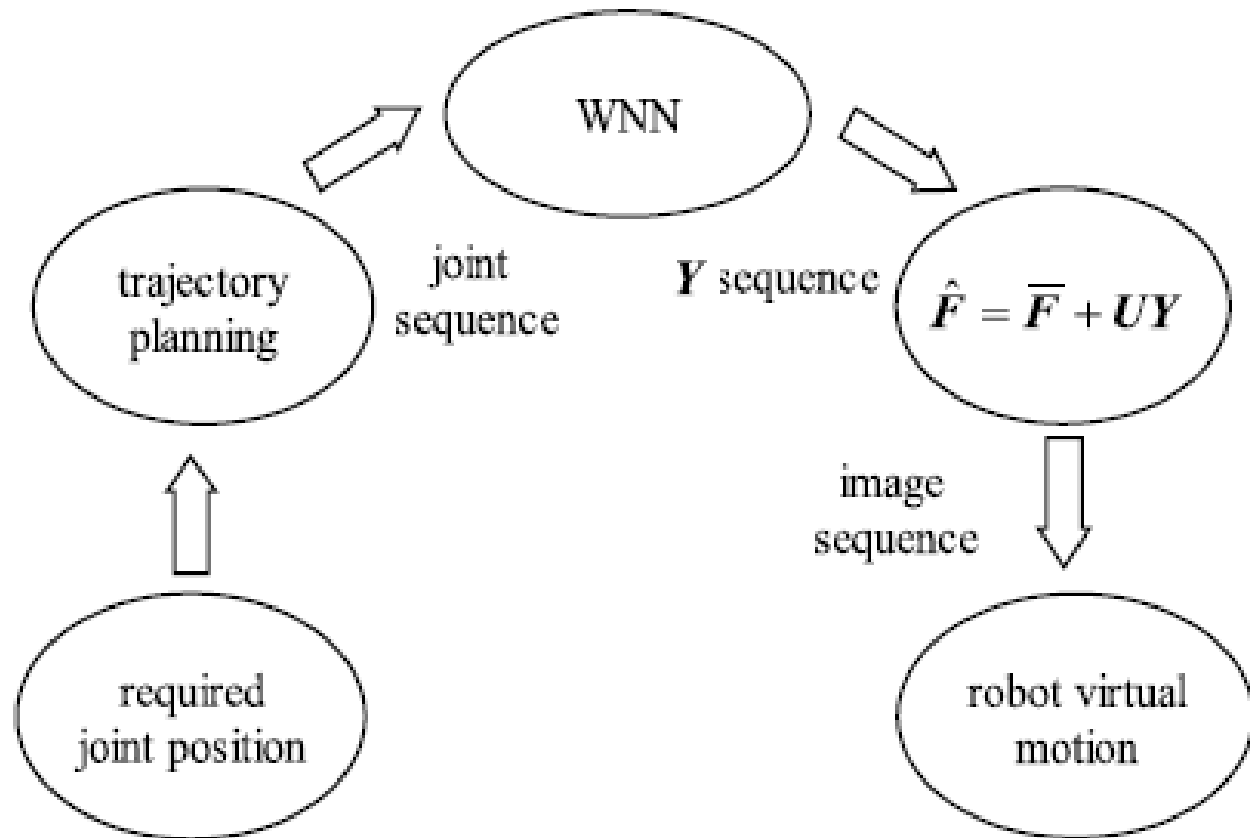
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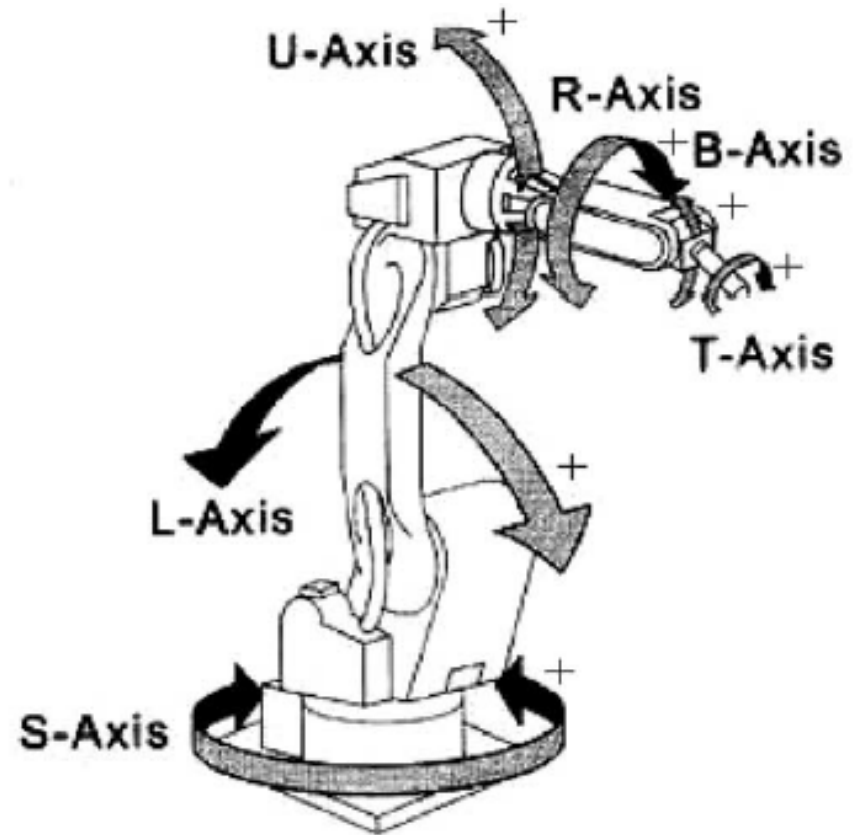
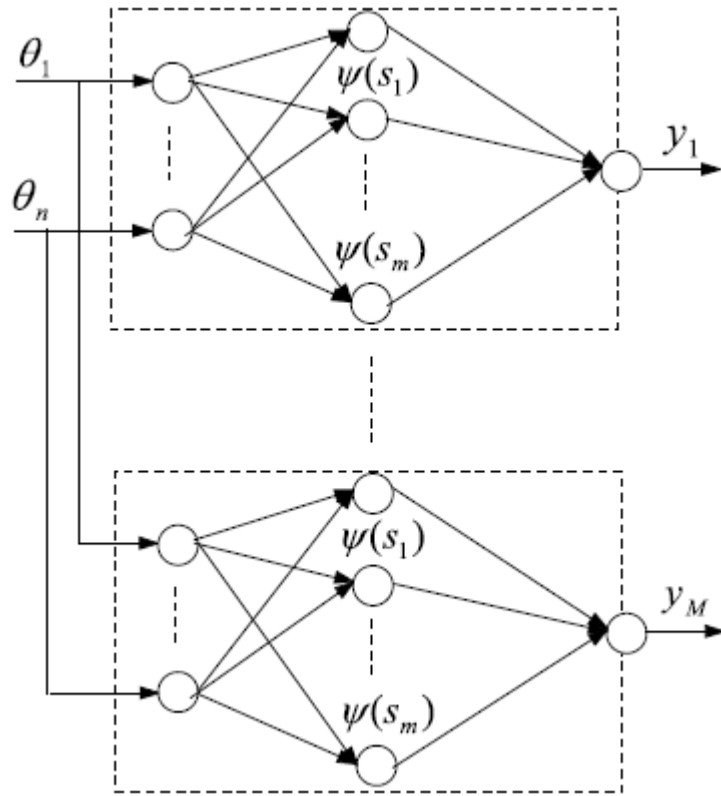
- ❑ A public university mainly on science and technology but now developing into more areas such as management, Economics and humanities.....
- ❑ More than 3,500 faculty members, 25,000 full-time students (14,000 undergraduate students, 8,000 graduate students, 3,000 doctoral students).

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- Qingjie Zhao, Zengqi Sun. **Image-based robot motion simulation**, Optics communications, 2002, 205 (4-6): 257-263
- Qingjie Zhao, Fasheng Wang, Zengqi Sun. **Using Neural Network Technique in Vision-based Robot Curve Tracking**. The 2006 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2006), October 9-15, 2006, Beijing, China, 3817-3822
- Qingjie Zhao, Zengqi Sun, Fuchun Sun, Jihong Zhu. **Appearance-based Robot Visual Servo via a Wavelet Neural Network**, Int. J. of Control, Automation, and Systems. Vol. 6, no. 4, 2008, 607-612.

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----A neural network is used to learn the relationship between world coordinates and image coordinates, instead of computing accurate camera parameters. During the tracking stage, images captured by cameras are firstly changed into binary images. The curve is then thinned and its position on the image is recorded. And the curve's position in the world coordinate frame can be acquired through the trained neural network. The method can be used for robot welding or incising.

□ Qingjie Zhao, Zengqi Sun, Fuchun Sun, Jihong Zhu.
Appearance-based Robot Visual Servo via a Wavelet Neural Network, Int. J. of Control, Automation, and Systems. Vol. 6, no. 4, 2008, 607-612.

----This paper proposes a robot visual servo approach based on image appearance and a wavelet function neural network. The inputs of the wavelet neural network are changes of the appearance elements, and the outputs are changes of robot joint angles. The proposed approach does not need a priori knowledge of the robot kinematics, hand-eye geometry and camera models.

Learning

- 1) Control the robot moving to different positions near to the desired point, capture pictures, save the pictures and the corresponding robot joint angles.
- 2) Compute average image \bar{F} , transform matrix U , and image appearance $\xi = (\xi_1, \dots, \xi_6)^T$ at every sampling position, using the technique introduced in section 2, and save these results.
- 3) Given the desired image appearance and robot joint angle: $\xi^d = (\xi_1^d, \dots, \xi_6^d)^T$, $\theta^d = (\theta_1^d, \dots, \theta_6^d)^T$, at every sampling position compute
$$\Delta\xi = \xi - \xi^d = (\Delta\xi_1, \dots, \Delta\xi_6)^T,$$
$$\Delta\theta = \theta - \theta^d = (\Delta\theta_1, \dots, \Delta\theta_6)^T.$$
- 4) Normalize the data of $\Delta\xi_1, \Delta\xi_2, \dots, \Delta\xi_6$ and $\Delta\theta_1, \Delta\theta_2, \dots, \Delta\theta_6$ to the range $[-1, +1]$, using $x' = 2(x - \min) / (\max - \min) - 1$.
- 5) Train the weights and the biases of the wavelet neural network based on the normalized data.
- 6) Save the results into the computer, including the connection weights and biases of the neural network, and the maxima and the minima of input data and output data.

Servo

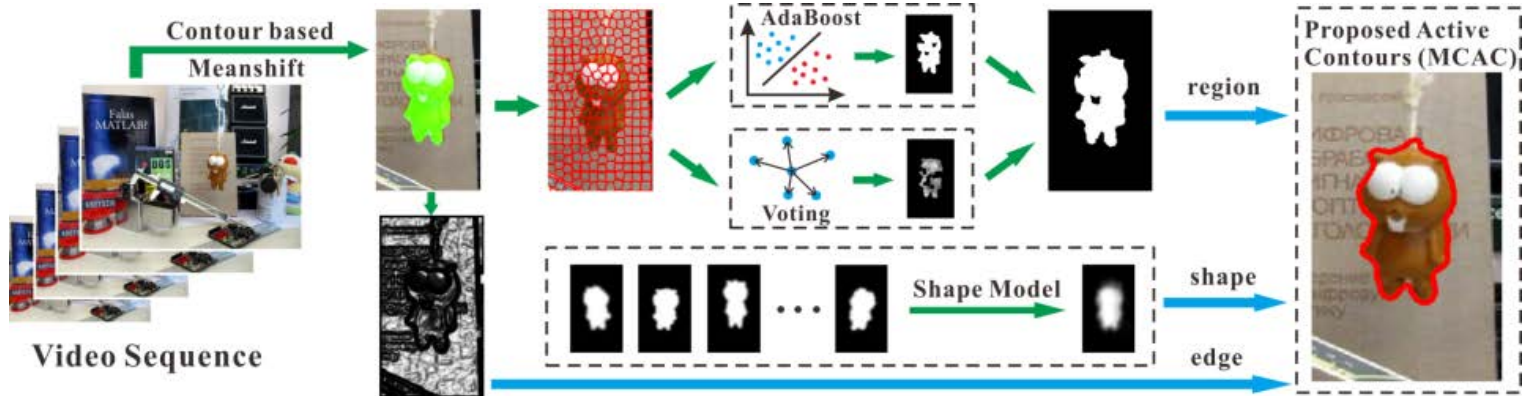
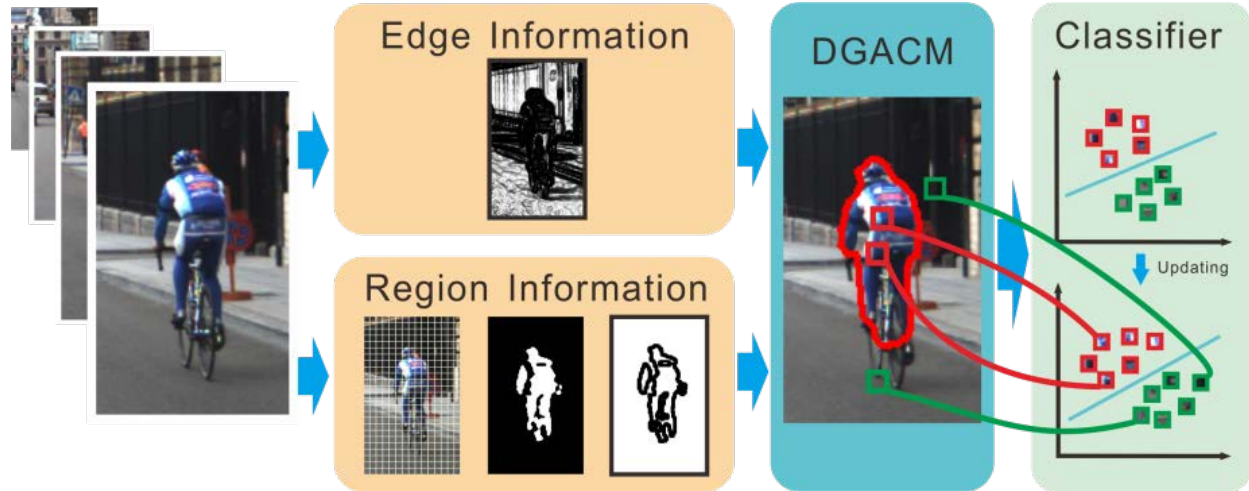
- 1) Load U , \bar{F} , parameters of the neural network, the maxima and the minima.
- 2) Capture current image F , read the corresponding robot joint position $\theta = (\theta_1, \dots, \theta_6)^T$, and calculate image appearance $\xi = (\xi_1, \dots, \xi_6)^T = U(F - \bar{F})$.
- 3) If $\xi \neq \xi^d$, then go to (4); else end.
- 4) $\Delta\xi = 2(\Delta\xi - \Delta\xi_{\min}) / (\Delta\xi_{\max} - \Delta\xi_{\min}) - 1$, $\Delta\xi = \xi - \xi^d$.
- 5) Compute $\Delta\theta$ from the trained wavelet neural network.
- 6) $\Delta\theta^c = (\Delta\theta + 1)(\Delta\theta_{\max} - \Delta\theta_{\min}) / 2 + \Delta\theta_{\min}$.
- 7) $\theta^c = \theta - \Delta\theta^c$.
- 8) θ^c is an input of the robot controller to control the robot moving to the desired position. During the robot moving, pictures are taken every 50ms, and the image appearance ξ is calculated.
- 9) If $\xi \neq \xi^d$, then go to (4); else end.

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Segment

- Peng Lv, Qingjie Zhao; Dongbing Gu. **Segmenting similar shapes via weighted group-similarity active contours**, Source: 2015 IEEE International Conference on Image Processing (ICIP). Proceedings, p 4032-4036, 2015
- Peng Lv, Qingjie Zhao, Yanming Chen, Liujun Zhao, **Multiple cues-based active contours for target contour tracking under sophisticated background**. The Visual Computer, 2017, 33(9): 1103-1119
- Jingjing Ma, Qingjie Zhao, Peng Lv, ea al, **Online Video Object Segmentation Based on Region and Edge Consistency**, 2018 IEEE International Conference on Big Data and Smart Computing, 2018 Int. Conf. on Big data and smart computing, January 15-18, 2018, Shanghai, China

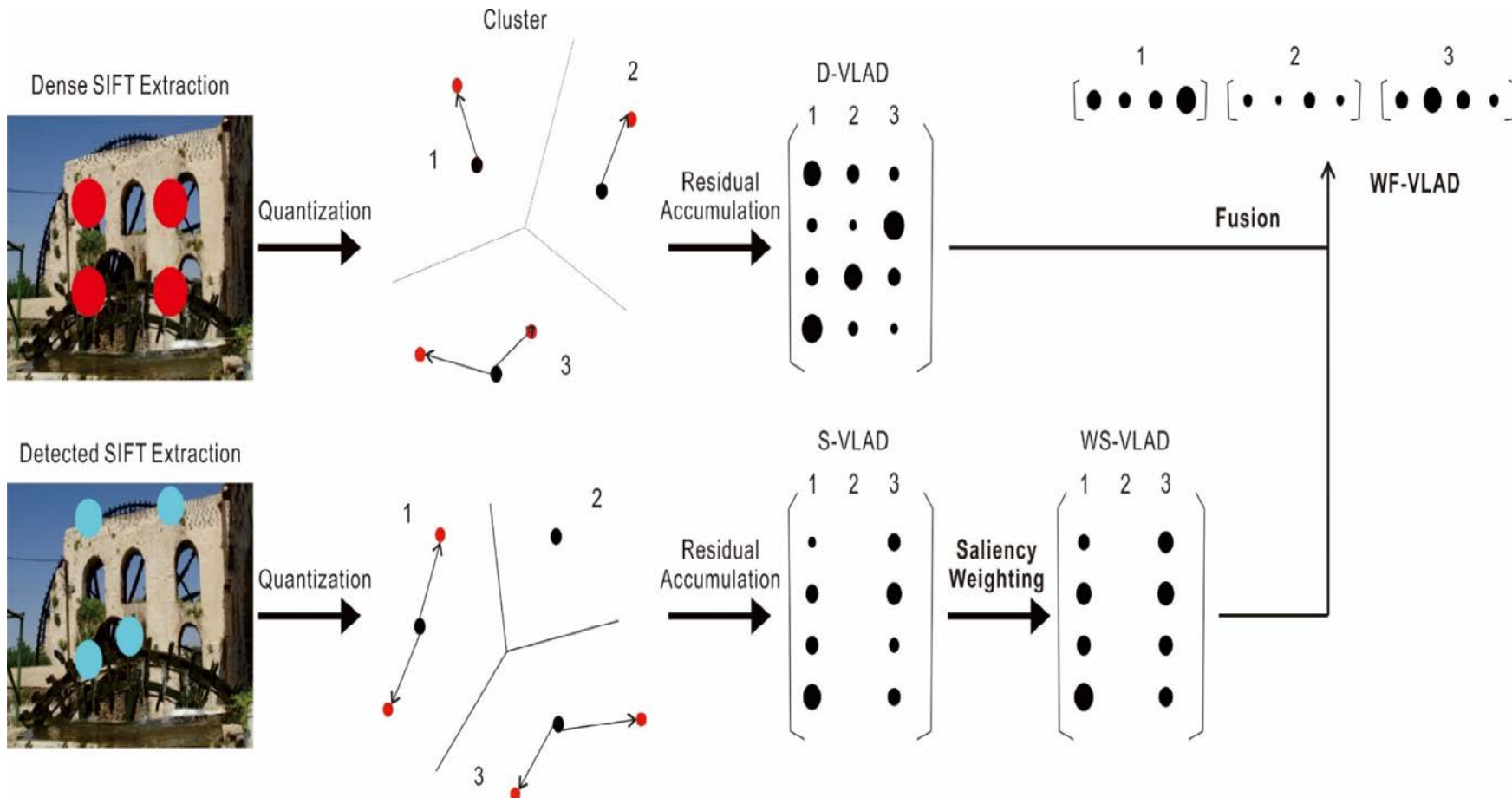
Segment



Video retrieval

- Hao Liu, Qingjie Zhao, Hao Wang, Peng Lv & Yanming Chen, **An image-based near-duplicate video retrieval and localization using improved Edit distance**, Multimedia Tools and Applications, 2017, 76(22), 24435-24456.
- Cong Zhang, Qingjie Zhao, Hao Liu, et al. **Boosting VLAD with Weighted Fusion of Local Descriptors**, 2018 Int. Conf. on Big data and smart computing, January 15-18, 2018, Shanghai, China
- Hao Liu, Qingjie Zhao, Hao Wang, Cong Zhang, **Near-Duplicate Web Video Retrieval and Localization Using Improved Edit Distance**, 18th Asia-pacific Web Conference , 2016 :141-152

Video retrieval



Visual object tracking

- Yanming Chen; Qingjie Zhao; Zhulin An; Peng Lv; Liujun Zhao, **Distributed Multi-Target Tracking Based on the K-MTSCF Algorithm in Camera Networks**, Source: IEEE Sensors Journal, v 16, n 13, p 5481-90, 1 July 2016.
- Liujun Zhao, Qingjie Zhao, **Structure local sparse representation based semi-supervised learning for object tracking**. The Visual Computer, Volume 33 Issue 9, September 2017, Pages 1169-1184
- Lv, Peng; Zhao, Qing-Jie; Gu, Dong-Bing, **Tracking Non-Rigid Target via Dynamic Discriminative Geodesic Active Contours**, Journal of Information Science and Engineering, 2016, vol.32, no. 4, 903-930
- Liujun Zhao ; Qingjie Zhao ; Yanming Chen ; Peng Lv, **Combined discriminative global and generative local models for visual tracking**, Journal of Electronic Imaging. 25(2), MAR 2016.
- Wang Yuxia, Zhao Qingjie, Wang Bo, et al. **A Real-Time Active Pedestrian Tracking System Inspired by the Human Visual System**. Cognitive Computation, 2016, vol.8, no.1, 39-51.
- Wei Guo, Qingjie Zhao, Dongbing Gu, **Visual Tracking Using An Insect Vision Embedded Particle Filter**, Mathematical Problems in Engineering, 2015:1-16
- Yingya Su, Qingjie Zhao, Liujun Zhao, Dongbing Gu, **Abrupt Motion Tracking Using a Visual Saliency Embedded Particle Filter**, Pattern Recognition, 47, 5, 1826-1834, 2014



Following a person



Tracking a fast moving object

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- Recognition and Tracking
 - Retrieval
- + Cross-modal

Thanks 😊