An Explorative Study of Visual Servo Control with Insect-Inspired Reichardt-model


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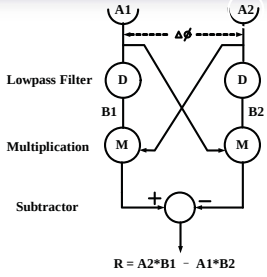
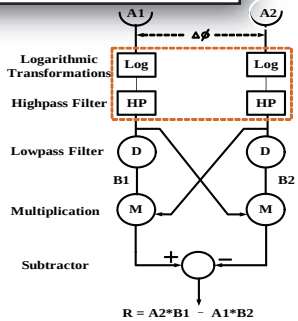
Summary

- Analysis of Reichardt-model: contained in the closed loop of the fly's optomotor system → prevent its system from getting unstable
- Benifits of visual servo control with Reichardt-model: incereased stability margin, high overall gains → better performance
- Real-time experiments demonstration on 1-DOF linear motor module

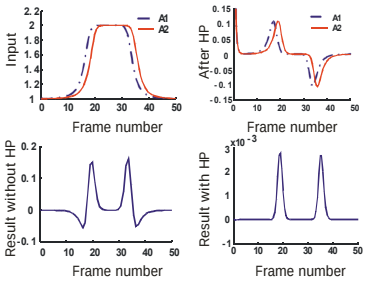
1. Reichardt-model



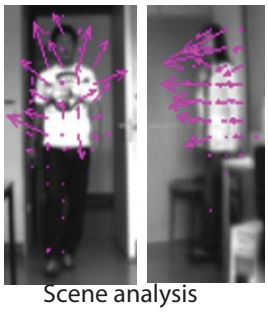
Simple Reichardt-model



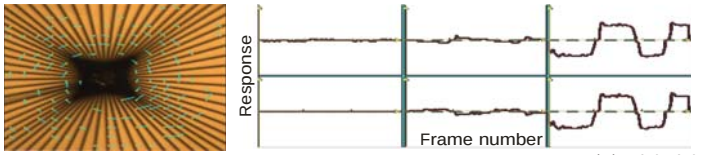
Elaborated Reichardt-model



Response of the model



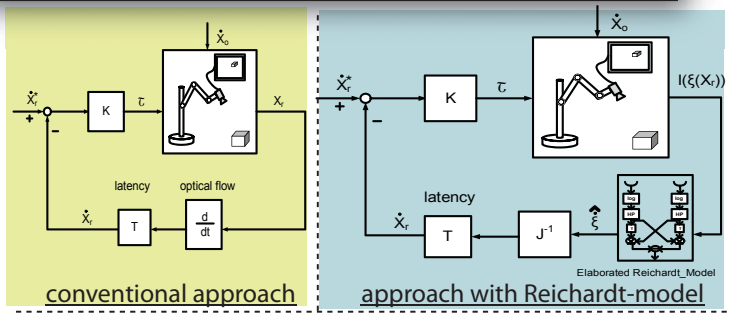
Scene analysis



Real-time ego-motion estimation

Resolution: 256 x 256
Frame rate: 350 fps

2. Visual servo control with Reichardt-model



conventional approach

approach with Reichardt-model

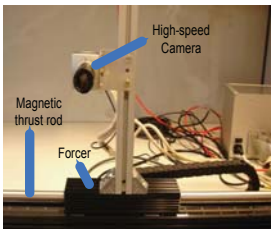
$$\tau = -K(\dot{X}r - \dot{X}r^*)$$

$$\dot{X}r = J^{-1}(q,\xi,Z)\hat{\dot{\xi}}$$

$$J(q,\xi,Z) = J_{image}(\xi,Z)\begin{bmatrix} R_c(q) & 0 \\ 0 & R_c(q) \end{bmatrix}$$

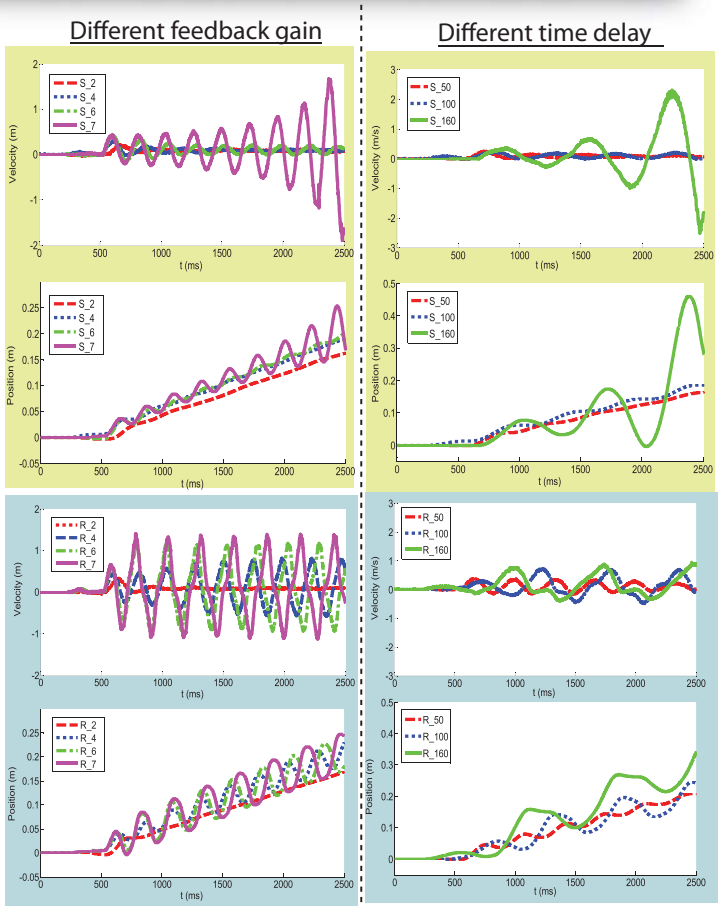
Xr: camera pose with repect to moving object
Xo: object moving velocity
T: time delay
r: joint actuator torques
ξ: image feature
Jimage: image Jacobian
k: symmetric proportional matrix

3. Experimental setup



- 1-DOF linear motor module (STB-2510)
- non-contact position sensor
- control through Simulink/Realtime workshop
- high speed CMOS camera (Mikrotron MC1319)
- focal length: 17mm
- scaling factor: 88,888pixels/m
- framerate: 30fps
- resolution: 640x480 pixels

4. Results



The Reichardt-model prevent the system from getting unstable shen feedback gain increases and large time delay is present.

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