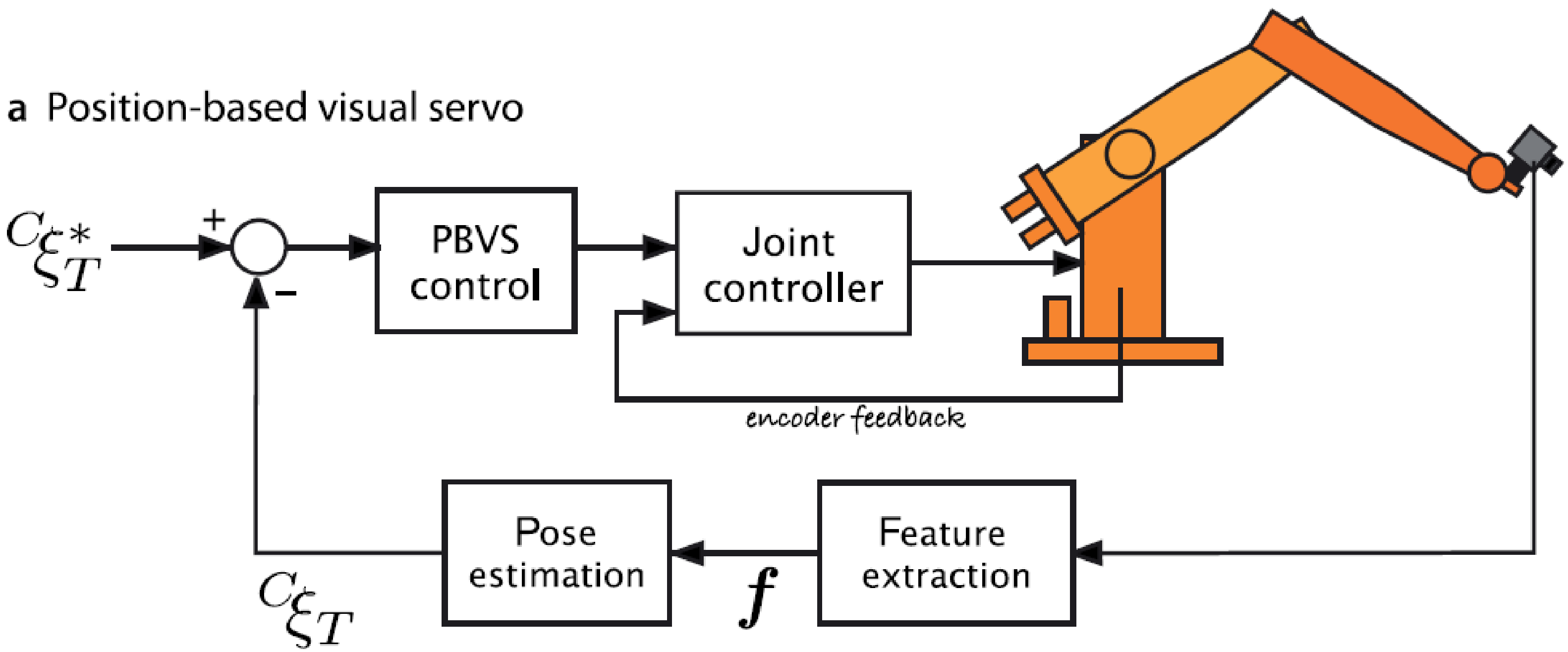
VISUAL SERVOING
(PBVS)

- Lecture Notes: Teresa Vidal Calleja

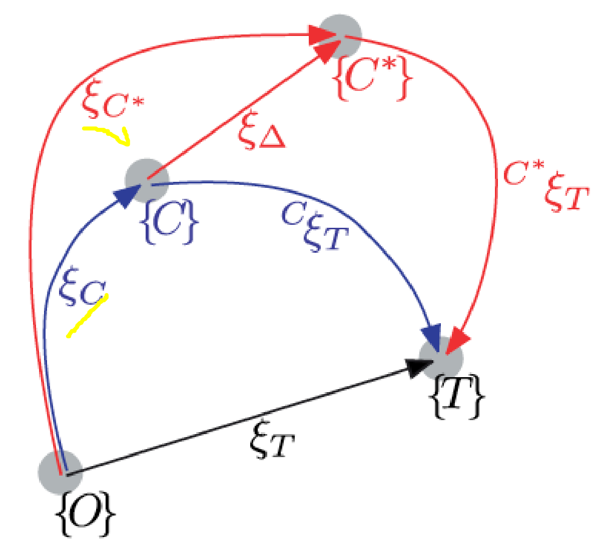
Position Based Visual Servoing

a Position-based visual servo



PBVS

- The aim it to determine the motion required to move from an initial pose ξ_C to ξ_C^* which is called ξ_Δ given the desire relative pose wrt the target ${}^{C^*}\xi_T$



- Given

$$\xi_\Delta \oplus {}^{C^*}\xi_T = {}^{C}\hat{\xi}_T$$

- Then the required motion

$$\xi_\Delta = {}^{C}\xi_T \ominus {}^{C^*}\hat{\xi}_T$$

- Step by step

$$\xi_C\langle k+1\rangle = \xi_C\langle k\rangle \oplus \lambda\xi_\Delta\langle k\rangle$$

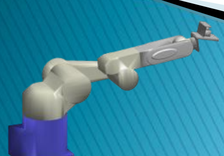
Pose Estimation – PnP

- Determine the pose ${}^{C}\xi_{T}$ of the target's coordinate frame $\{T\}$ wrt to the camera
  - Known geometry of the target (X_i, Y_i, Z_i) wrt to $\{T\}$
  - Camera's intrinsic parameters known (calibration)
  - Known image-plane coordinates (u_i, v_i)
- Estimating the Pose is known as the Perspective-n-Point problem (PnP)

$$\tilde{p} = \underbrace{\begin{pmatrix} f/\rho_w & 0 & u_0 \\ 0 & f/\rho_h & v_0 \\ 0 & 0 & 1 \end{pmatrix}\begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{pmatrix}}_{\text{intrinsic}} \underbrace{\left({}^{0}\mathbf{T}_C\right)^{-1}}_{\text{extrinsic}} \tilde{P}$$

PBVS Remarks

- Features are extracted from the image and used in conjunction with the known model of the target and camera model to estimate the pose of the target with respect to the camera
- Optimal in 3D i.e. the motions of the robot will typically follow a least-distance path goal
- Closely related to recovery scene geometry from one or more camera images problem
- Feedback is computed using quantities that are a function of the system calibration parameters



Model-Based Visual Servoing

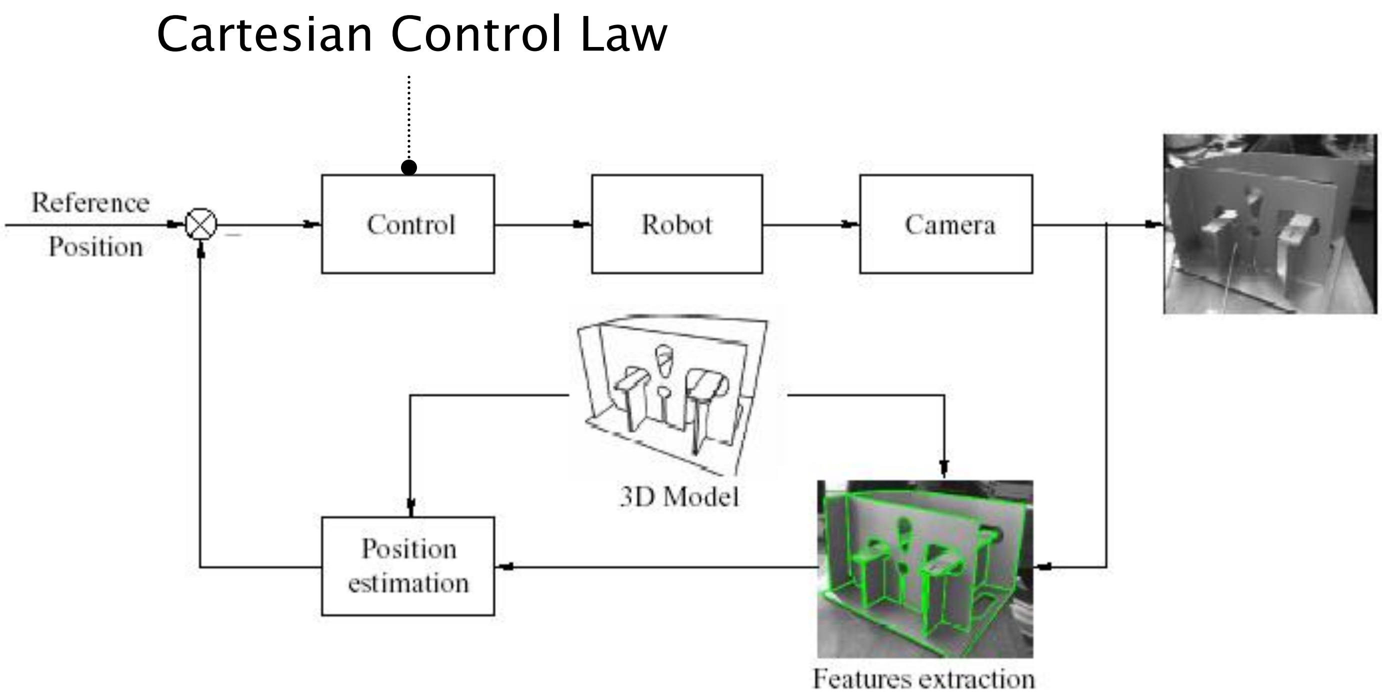


Figure 6: Model-based 3D Visual Servoing

Model Free Visual Servoing

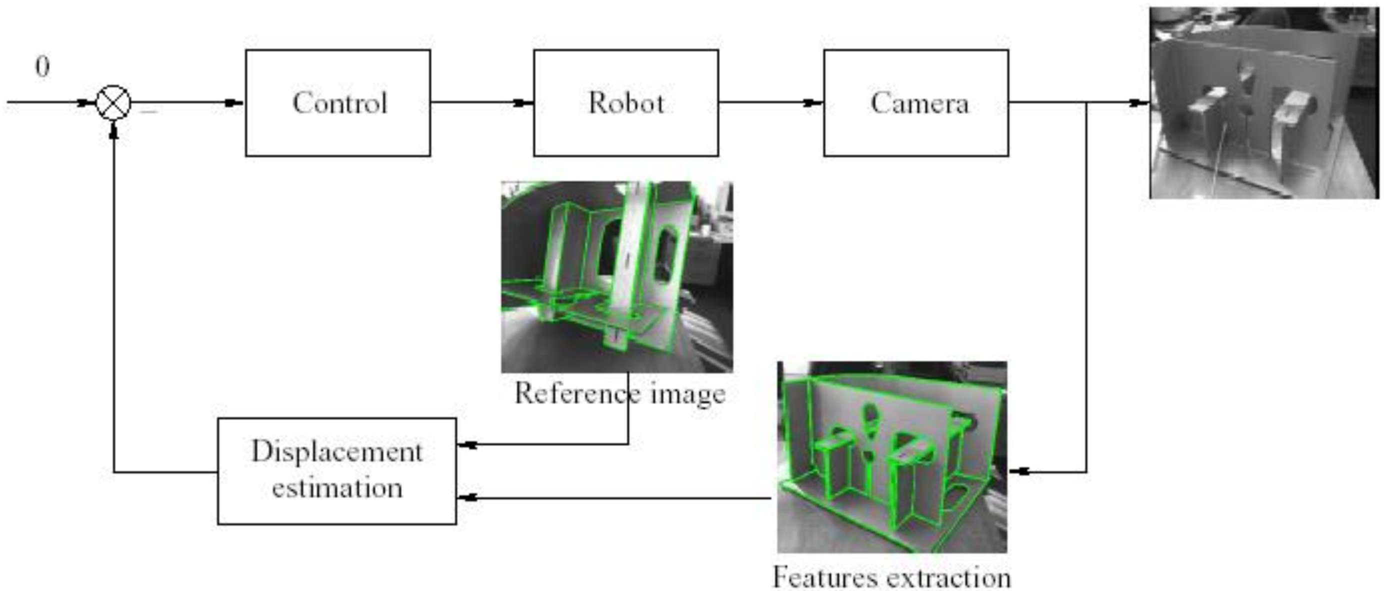


Figure 7: Model-free 3D Visual Servoing

"Teaching by showing"