2 The implemented control scheme.

The subject of this section is the main contribution of [1], namely the external hybrid vision/force control scheme, that is represented in Fig. 6. It is the control scheme that we implemented using MATLAB and V-REP, and now we will describe it in detail.

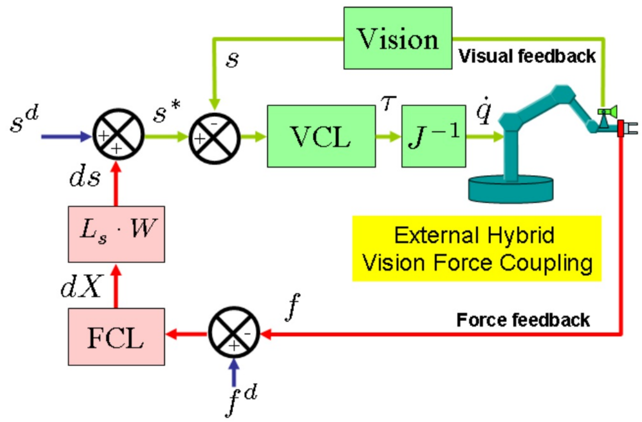

Figure 6. Block-wise representation of the the external hybrid vision/force control scheme.

Firstly, we note that this scheme:

→ is an instance of the ***eye-in-hand***, ***image-based***, ***dynamic look-and-move*** design priciple [5],

→ takes in input f^d, f, s^d and s, namely the desired and the actual contact force and image features, respectively,

→ provides in output the generalized end-effector velocity vector according to the following control law:

$$\tau = \hat{L}^{\dagger} K(s^* - s), \quad \text{with} \quad s^* = s^d - \hat{L}\, WC\,(f^d - f) \tag{7}$$

where $\hat{L}$ is an estimation of the interaction matrix and K, W are standard error-proportional gain matrices and C is a compliance matrix.

2.1 An interpretation.

For the expression 7 we see a clear interpretation, that we now try to explain. Let recall that the generalized end-effector velocity τ w.r.t. the camera frame and the image features velocity $\dot{s}$ w.r.t. the image frame are related linearly by the interaction L, namely

$$\dot{s} = L\tau \tag{8}$$

Using the standard control strategy $\dot{s} = K(s^* - s)$, where s^* is the desired trajectory, we obtain the system

$$K(s^* - s) = L\tau \tag{9}$$

that admits as solution

$$\tau = L^{\dagger} K(s^* - s) \tag{10}$$