Visual Servoing in Presence of Non-Rigid Motion

What is it about?

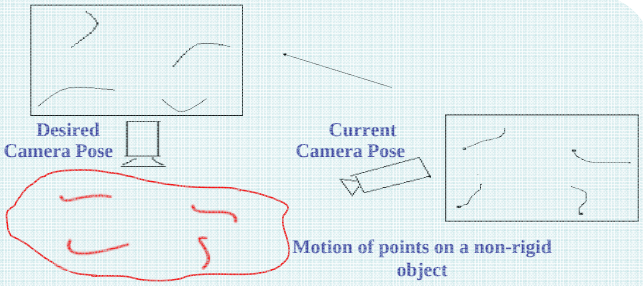
- Visual Servoing (VS) refers to the problem of positioning a robot with respect to a target object using visual feedback
- In this work, we study the problem of VS in presence of non-rigid objects

Motivation

- Most robotic vision algorithms focus only on rigid objects
- But many of the objects that we come across in our day-to-day life are non-rigid in nature. For example: human motion (body parts, organs), flying birds, aquatic animals etc
- Our focus is to develop vision strategies and algorithms to perform the servoing task even in presence of non-rigidity

Why is this problem difficult ?

- Non-rigid object undergoes a continuous change in its pose and no single image can characterize its state
- Motion planned at the current instant might not be valid at the next instant
- Desired pose cannot be defined by using only a single image
- Each feature undergoes a different transformation and thus generates different control signals



Task is to move the camera from its current pose to a desired pose with respect to a non-rigid object

How did we solve it ?

- As the non-rigid object undergoes a continuous change in pose, it is preferable to extract invariant features and use them in the servoing process
- Invariant features (G^t) are extracted by using features from a sequence of images (F^t_i) describing the object state

$$G^t = f(F^t_1, F^t_2, \ldots, F^t_n)$$

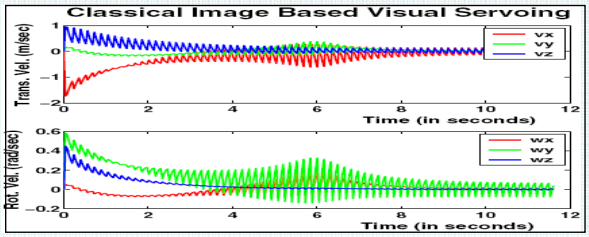
- For computational efficiency, the camera can use its previous knowledge to predictively calculate the next gross appearance of the deforming object i.e.,

$$G^t = f(g(F^{t-n}, \ldots, F^{t-2}, F^{t-1}), F^t)$$

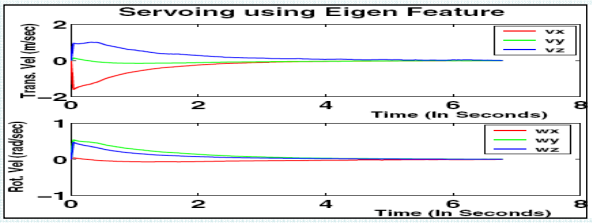
where g() is a function that predicts the features in the new pose

- Two kinds of invariant features were studied namely Mean and Eigen feature

Where are we now? (Results)



(a)



(b)

The use of eigen features generated a stable camera trajectory (Fig b) unlike the classical image-based servoing algorithm (Fig a)

What next ?

- Issues of optimal camera trajectory, object visibility, feature tracking have to be considered
- Future proposal is to model the generic motion of a point on a non-rigid object as a (3D) curve and extract the homography relating the projection of these curves onto the images at the two views
- And use this homography to perform the servoing task by employing a hybrid control algorithm

D Santosh Kumar & C V Jawahar
{Santosh@students.,Jawahar@}iiit.ac.in

CENTRE FOR VISUAL INFORMATION TECHNOLOGY
INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD, INDIA