Control and fusion schemes for embedded and real-time contexts

1 Goals and guidelines

The goal of this project is to develop control and fusion schemes that can adapt to varying environments. We thus define the environmental context from

- Objects in scenes. The method of target detection we use is based on the a contrario detection principle[1].
- Road marks. The proposed method is a Markov model based one, with road surface marking classification[2].

Considering an automotive case, the schemes should adapt to the scene complexity and to its supposed danger level. More precisely, one needs

- A temporal adaptation, i.e. the evolution speed of the whole system should be adapted to the external context (e.g., for a car to be alone on a motorway or to be in a cloudy street with many children);
- To change behavior in a very fast manner; this can be done by pre-computing several possible trajectories to be tracked, being able to commute from one to another at any time.

2 Previous work

2.1 Detect object using a contrario approach

2.2 Road surface marking classification based on a hierarchical Markov model

3 Temporal horizon hierarchy

Throughout the tracking several temporal ranges are considered: short term ones, within a second; mid term ones, within 10 second; and long term ones, within a minute and above. Several associated objectives reflect the growing semantic complexity:

1. Tracking a single trajectory in the short term
2. Evolving in a trajectory sheaf in the mid term
3. Deciding among a sheaf of sheaves in the long term

In 1 a stabilizing tracking scheme shall is developed, using differential flatness and model free control. In 2, switching from an element of the sheaf to another is allowed, according to appropriate decision criteria.

4 Differential flatness of the kinematic car

Let us recall the kinematic model of a car:

\[ \dot{x}(t) = v(t) \cos \psi(t) \]
\[ \dot{y}(t) = v(t) \sin \psi(t) \]
\[ \dot{\psi}(t) = \frac{v(t) \tan \delta(t)}{L} \]

(1a) (1b) (1c)

Where the controls are the propulsion speed \( v(t) \) and the steering angle \( \delta(t) \).

The kinematic model (1) is differentially flat [3] with \( [x, y] \) as a flat output. Indeed, \((1a)^2 + (1b)^2 \) and \( (1b)/(1a) \) respectively lead to \( v = \sqrt{x^2 + y^2} \), and \( \psi = \text{Atan}(y/x) \) And (1c) yields \( \psi \). Finally, one has

\[ v = \sqrt{x^2 + y^2}, \quad \psi = \text{Atan}\left(\frac{y}{x}\right), \quad \delta = \text{Atan}\left(\frac{y^2 - y_0^2}{x^2 + y_0^2}\right) \]

(2)

Bibliography