Appendix B

Comparison to the Previous Version of the Framework

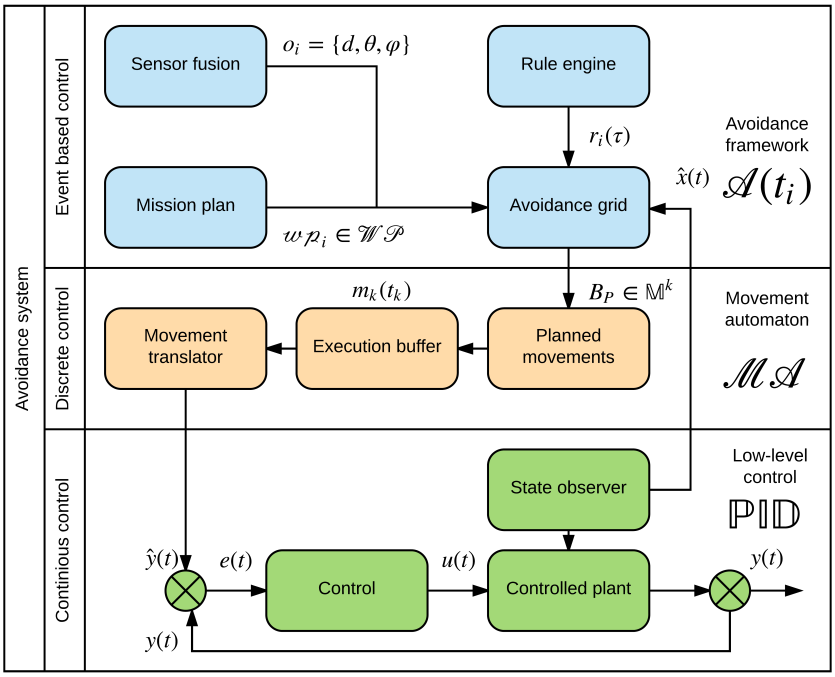

Figure B.1: Obstacle avoidance based on Reach sets concept [1].

Conceptual scheme: The overall concept of *Detect and Avoid Framework* (fig. B.1) is taking architecture from LSTS toolchain [2, 3]. The UAS part is based on *LSTS Dune*, and it can be easily integrated in the future.

1. *Continuous control* - is not solved in this work, its kept in the scheme for reference.

2. *Discrete control* - it bridges event based *Detect & Avoid* core functionality with *Continuous control*. Its covered by *Movement Automaton* (sec. **??**).

3. *Event-based control* - covers major functionalists:

    a. *Sensor (Data) fusion* - the main feed of information, implementation of *sensor fusion* (sec. **??**) and *data fusion* (sec. **??**) contributing the avoidance events, introduced in (sec. **??**).

    b. *Mission plan* - feeding actual goal and objectives to *Navigation Algorithm* (sec. **??**) and obeying *UTM directives* (sec. **??**).

    c. *Avoidance Grid* - using mainly *Approximation of Reachable Space* (sec. **??**) in *Avoidance Maneuver Estimation.*

    d. *Rule engine* - enforcing UTM directives (sec. **??**).

Surveillance Improvements in Our Work: *Hierarchical calculation* is addressed in *Mission Control run* (sec: **??**) where threats are hierarchically applied based on *severity.*

Source reliability evaluation is addressed in *Static Obstacles* (sec. **??**) and *Moving Obstacles* **??**). The main rating for *Detected obstacle, Map Obstacle* and *Visibility* of space are established there.

Clear rating definition - the *Reachability* of space portion and *Safety* rating for trajectory are established in *Avoidance Grid Run* (sec. **??**)

Reach Set Improvements in Our Work: *Limited system dimension* - the discretization due to the higher system dimension and increased maneuver complexity goes hand-in-hand with *pre-calculation* of the *Reach Set.* This shortcoming is addressed in (sec. **??**).

Real-time optimization - replaced by *Discrete offline optimization problem.* The *general cost function* is given in (eq. **??**). The optimization problem solved in this work is defined in (eq. **??**).

Continuous space disparity - The *pre-calculated reach set estimation* can be valid with a small *marginal error* for some region in *system state space.* The dynamic method for state space segmentation can be used [4]. This aspect is not addressed in this work, because it strongly depends on the system behind movement automaton.

Trajectory Tracking - The *movement automaton* (def. **??**) in Control Mode can be used to track a reference trajectory in form of the *Movement Buffer*(def. **??**). Another option is to use *thick waypoint trajectory tracking for UAS* like in [5] or [6]. The work will use only *Movement Automaton* as controller/predictor.

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