**Appendix B**

**Simplified Framework Conceptual Scheme**

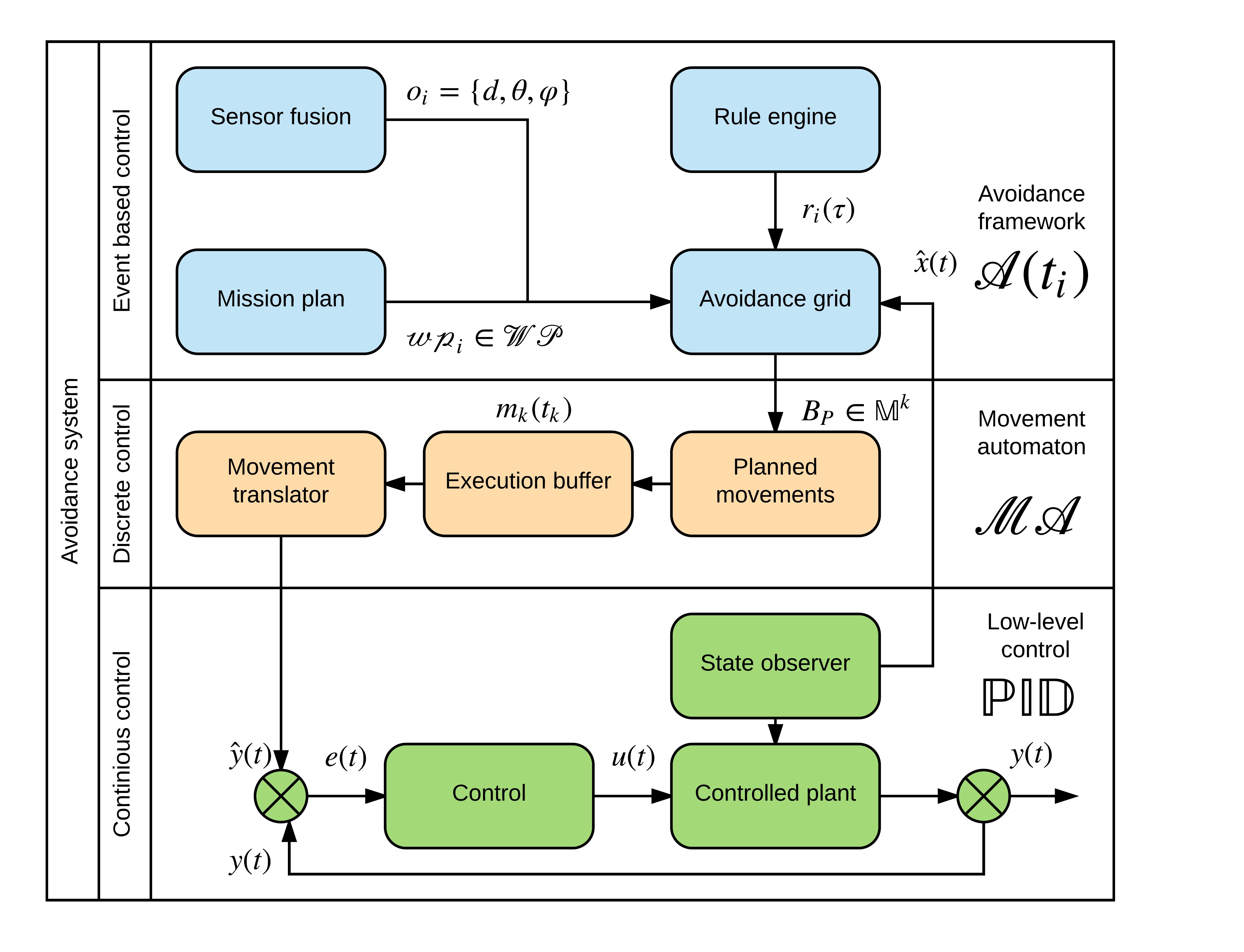


Figure B.1: Obstacle avoidance based on Reach sets concept [1].

**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 and Avoid* core functionality with *Continuous control*. Its covered by *Movement Automaton* (sec. **??**).
3. *Event-based control* - covers major functionalists:

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2 Appendix B. Simplified Framework Conceptual Scheme 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. **??**).

1. *Mission plan* - feeding actual goal and objectives to *Navigation Algorithm* (sec. **??**) and obeying *UTM directives* (sec. **??**).
2. *Avoidance Grid* - using mainly *Approximation of Reachable Space* (sec. **??**) in *Avoidance Maneuver Estimation*.
3. *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 the form of *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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