Selected Topics of Control & Dynamic Systems
Automated Driving: Motion Planning and Control

Navigation

driving direction reference

Mission planning (Strategic)

Given start location and target calculate optimal route using street-maps.
Covers: entire trip on geographical level. Resolution: Street-Network, Road-segments/Lanes, (Makro)
Methods: Graph based search on existing street-map
→ *Tells lane/direction/change reference and reference travel velocity, recalculation triggered on leaving route*

Guidance

final pose & constraints

Behavioral planning (Tactical)

Given a driving reference (direction, lane), responsible for reactions obeying traffic rules and reaching reference
Covers next action/maneuver. Resolution: street on coarse level (Meso), tactical, stops, crossings, lanes, yield,
Methods: Finite State Automata for selecting maneuver (mostly reactive)
→ *Tells intention (final pose(s)) and constraints (waypoints, velocity), Selects maneuver (impact on stabilization)*

Stabilization

trajectory

Trajectory planning (Reactive Hi-Level)

Given final pose(s) and mandatory waypoints finds feasible driving path/trajectory, avoid collisions in planning
Covers next action/maneuver or part of it (next 1-10 sec). Resolution: exact state in lane (Micro)
Method: maneuver specific planner (e.g. sampling based, optimization based, ...)
→ *Tells absolute trajectory to follow ($x, y, \theta, \kappa, \dot{\kappa}, s, v, t, a$) in for e.g. equidistant steps in time*
   (+ possibly reference line (frenet coordinate system) & trajectory according to reference (frenet coordinates))

Trajectory tracking (Reactive Lo-Level)

Given the trajectory, responsible for tracking & short-term collision avoidance
Covers error tracking (next 0-0.5 sec). Resolution: error of position/orientation relative to reference
Method: maneuver specific tracking
         error model + vehicle model + control approach = combined to tracking (long. / lat. or combined)
→ *Tells reference for steering & braking/acceleration, actuator abstraction may be in between tracking and control*

steering and (de)acceleration reference

Safety override (ESP, AEB, ...) →

Actuation

Actuator Control

Error Model

Vehicle Model

Desired Motion Model