REALTIME INTERSECTION OPTIMIZER (RIO) UNDER CONVENTIONAL AND AUTOMATED VEHICLE TRAFFIC

ASH Oomidvar

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Recursive State Equation for Automated vehicle Trajectory Optimization (ATO):

\[
\text{traj}_i = \left\{ \begin{array}{ll}
\text{FTO}(\text{sig}, \text{sp}_{k+1}, \text{att}_{k+1}, \text{traj}_{k-1}) & \text{for } k \in \mathbb{N} \setminus \{1\}, \ \text{type}_{k+1} = AV \\
\text{FTE}(\text{sp}_{k+1}, \text{att}_{k+1}, \text{traj}_{k-1}) & \text{for } k \in \mathbb{N} \setminus \{1\}, \ \text{type}_{k+1} = CV \\
\text{LTO}(\text{sig}, \text{sp}_{k+1}, \text{att}_{k+1}, \text{sp}_{m}) & \text{for } k \in \{1\}, \ m \in \mathbb{N}, \ \text{type}_{k+1} = AV \\
\end{array} \right.
\]

(1)

Sub-models to ATO model:
- \( \text{FTO}() \) to be Follower vehicle Trajectory Optimizer for AVs
- \( \text{FTE}() \) to be Follower vehicle Trajectory Estimator for CVs
- \( \text{LTO}() \) to be Lead vehicle Trajectory Optimizer for AVs

\[
\Delta t_{k+1} = \frac{v_2 - v_1}{a_1} \quad \forall l \in \mathbb{L}, \ \forall k \in \mathbb{K}_l
\]

\[
\Delta t_{k+1} = \left( \frac{v_2^2 - v_1^2}{2a_1} - \frac{v_2^3 - v_1^3}{2a_3} \right) / v_2 \quad \forall l \in \mathbb{L}, \ \forall k \in \mathbb{K}_l
\]

\[
\Delta t_{k+3} = \frac{v_3 - v_2}{a_3} \quad \forall l \in \mathbb{L}, \ \forall k \in \mathbb{K}_l
\]

\[
T_{ld} = \sum_{m=1}^{n} \Delta t_{k+3} \quad \forall l \in \mathbb{L}, \ \forall k \in \mathbb{K}_l
\]

\[
D_{id}(T_{ld}) = T_{ld} - \frac{d_0}{V_{ld}} \quad \forall l \in \mathbb{L}, \ \forall k \in \mathbb{K}_l
\]

\[
(\text{LTO}) \min_{\dot{x}_l, \ddot{x}_l, a_l, \alpha_l} D_{id}(T_{ld})
\]

subject to

\[
t_x \leq \Delta t_{ld} \leq t_x + G_{x} + Y_{x}
\]

\[
v_2 \leq V_{max}
\]

\[
v_3 \leq V_{max}
\]

\[
a_{max} \leq a_1 \leq a_{max}
\]

\[
a_{max} \leq a_3 \leq a_{max}
\]

10: end procedure
REALTIME INTERSECTION OPTIMIZER (RIO)

Planner Module:
- Database to store arrival info
- Iterate over each time stamp
- Pass data to opt. module & back
- Store and update trajectories
- Maintain vehicle sequence

Optimization Module:
- NLP model to find global optimal solution for each vehicle

Camera/Radar to Obtain Vehicle Arrival Information
DSRC to Obtain AV Arrival Information
Merging Control Algorithm
Optimized AV Trajectories

Vehicle Arrivals
Optimal Signal Decision

Optimized Trajectories

Intelligent Intersection Control Algorithm

Signal Controller
Signal Heads

Conventional Vehicle
Automated Vehicle
Conventional Vehicles
Automated/Connected Vehicles
Proposal

ENDORSEMENTS AND OFFERS FROM MAJOR AUTOMAKERS (Just Kidding!!!)

Asking for the followings in return for 50% of the share of RIO

1. FSITE ANNUAL MEETING 2018 BEST POSTER / SHARKTANK AWARD

2. A JOB OFFER (PLEASE) UPON MY GRADUATION!!
THANK YOU!

REFERENCES