- Tool Name:

ReachModelPlex

- Short Summary (1 sentence)

This work Integrates ModelPlex monitor and reachability analysis for monitoring reinforcement-learning based Dubin path following controller and recovering from unsafe control.

- Description (one or two paragraphs):

ModelPlex uses theorem proof and differential dynamic logic to generate a safe condition offline. In the online part, such a condition can be used as a monitor to check state for model compliance and check safety of control. However, such a condition is normally conservative. In our RL-based Dubin path following control problem, it requires the vehicle to follow a path with very small deviations. In this work, we allow the controller to have a mild violation with the safe condition but not allow a significantly large violation. Forward reachability analysis is used to predict if the violation will lead the vehicle to enter a forbidden state in the short-term future. We also leverage a robust model predictive controller to recover the vehicle’s pose from potentially dangerous situations to the safe zone defined by the ModelPlex monitor.

To sum up, 1) If we only use ModelPlex monitor, we can have safety and liveness (the waypoint will be eventually reached) guarantees. But the safe condition is over-conservative, a fallback controller will be frequently invoked even for a small violation. 2) If we only use reachability analysis, we can only have a short-term safety guarantee. Our integration work can still provide safety guarantee and mitigates the over conservative problem with minimum fallback control interventions.

- Keywords associated with the tool:

ModelPlex monitor; forward reachability analysis; recovery tube; robust tube mpc

- Video Tutorial / Demonstration of the Tool(Links):

All important videos can be found in the slides.

https://drive.google.com/file/d/1kOFmrvzbWG\_8\_fqGcjRSfAGy74NGrG2i/view?usp=sharing

- Links to the Tool Tutorial/ Documentation:

Please find the installation instruction in the readme file:

<https://github.com/qinlincmu/ReachModelPlex/tree/master>

- Links to Github/Source Code:

<https://github.com/qinlincmu/ReachModelPlex/tree/master>

- Publications List(Bibtex format):

None pub for this work, but some our relevant works:

RL-learning work:

@mastersthesis{Ahn-2019-117213,

author = {Edward Ahn},

title = {Towards Safe Reinforcement Learning in the Real World},

year = {2019},

month = {July},

school = {},

address = {Pittsburgh, PA},

number = {CMU-RI-TR-19-56},

}

Reachability work:

@inproceedings{lin2020,

title={ReachFlow: An Online Safety Assurance Framework for Waypoint-Following of Self-driving Cars},

author={Lin, Qin and Chen, Xin and Khurana, Aman, Dolan, John},

booktitle={2020 International Conference on Intelligent Robots and Systems (IROS)},

pages={6627--6632},

year={2020},

organization={IEEE}

}

ModelPlex monitor work:

@article{bohrer2019formal,

title={A formal safety net for waypoint-following in ground robots},

author={Bohrer, Brandon and Tan, Yong Kiam and Mitsch, Stefan and Sogokon, Andrew and Platzer, Andr{\'e}},

journal={IEEE Robotics and Automation Letters},

volume={4},

number={3},

pages={2910--2917},

year={2019},

publisher={IEEE}

}

- Presentation Slides, videos, etc. :

https://drive.google.com/file/d/1kOFmrvzbWG\_8\_fqGcjRSfAGy74NGrG2i/view?usp=sharing

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