Motion Planning for Urban Driving Including Evasive Maneuvers Using iLQR

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Introduction

- There exist a lot of challenges in motion planning for autonomous driving, especially in the case of sudden motion of dynamic obstacles.
- A real-time implementation of spatial and temporal planning that can handle nonlinear vehicle model and dynamic obstacle avoidance is needed.

Motivation

- The majority of road accidents are caused by vehicle collision. The aim of the collision avoidance system is to avoid imminent accidents using longitudinal (emergency braking) or lateral control (active steering).
- However, emergency braking is not possible for every situation, as there might not be enough distance or time to stop before an obstacle.

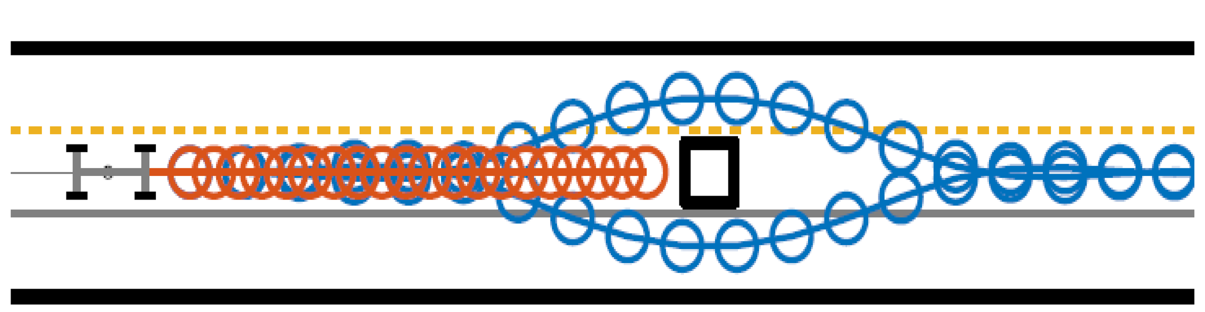
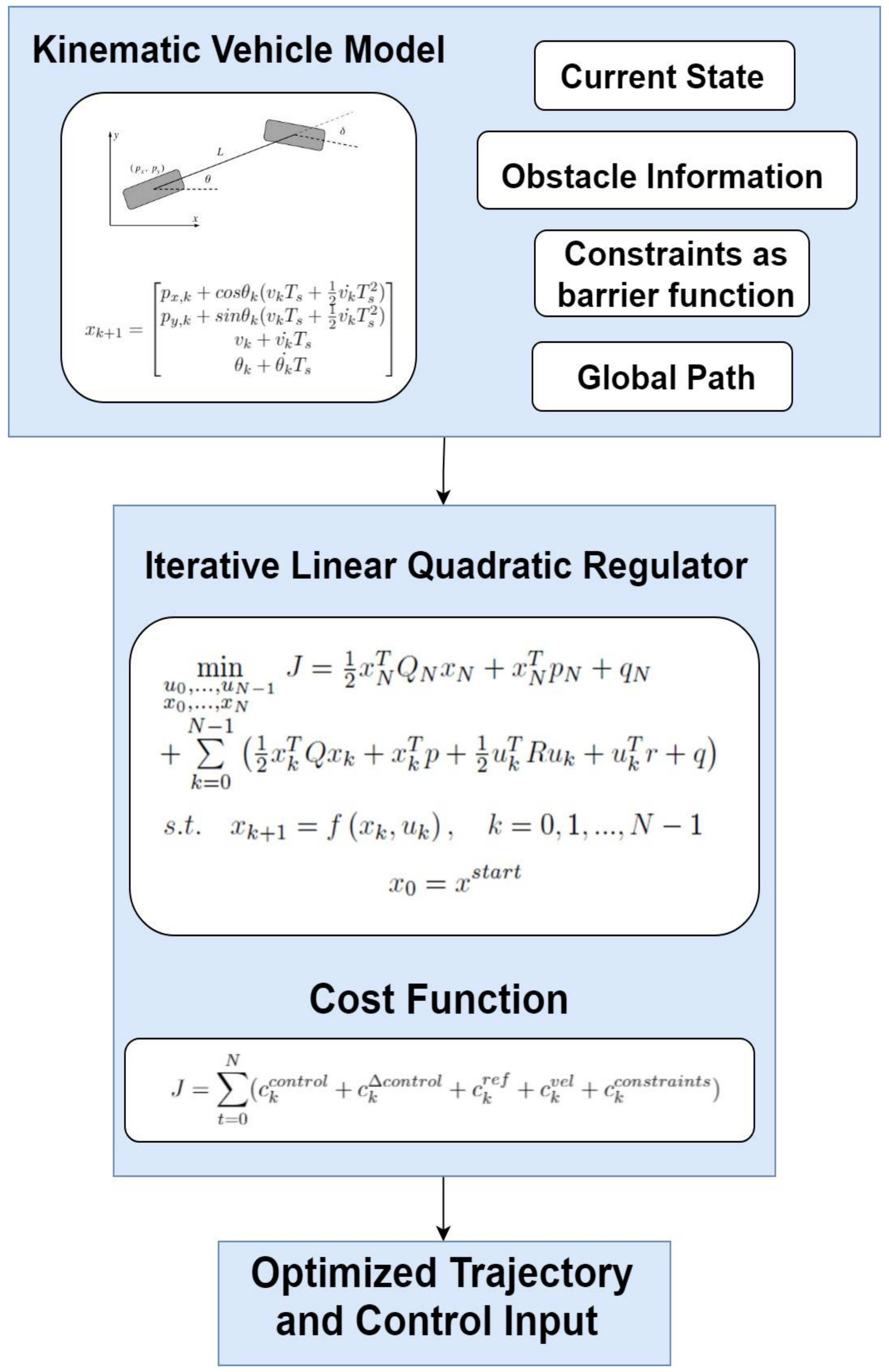


Fig. 3. Possible trajectories for ego vehicle depending upon the distance of obstacle, the current velocity and deceleration limits of ego vehicle

- Our approach focuses on integration of emergency obstacle avoidance scenarios and tuning technique for cost weights.

Methodology

- Iterative Linear Quadratic Regulator is used for motion planning that can handle a nonlinear model. Constraints are handled as barrier functions and added in the cost function.[1]
- A constant acceleration model is assumed to predict obstacle trajectories and used in cost function.
- Adaptive cost weights are a linear function of the distance of the obstacle from the vehicle.



Results

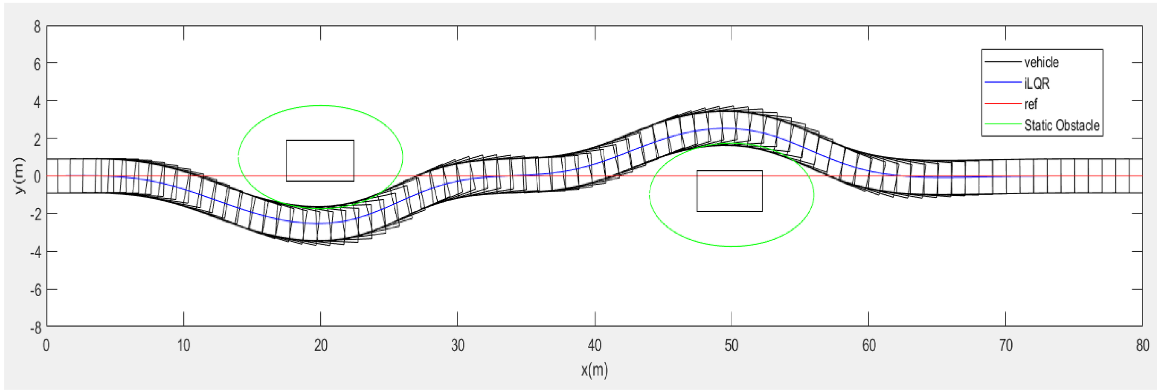


Fig. 1. Ego Vehicle avoiding static obstacles on its way.

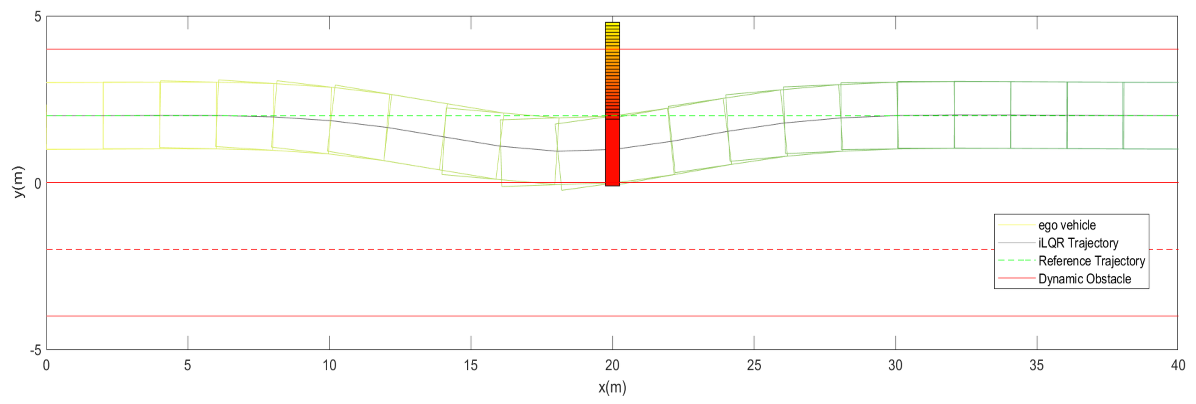


Fig. 2a

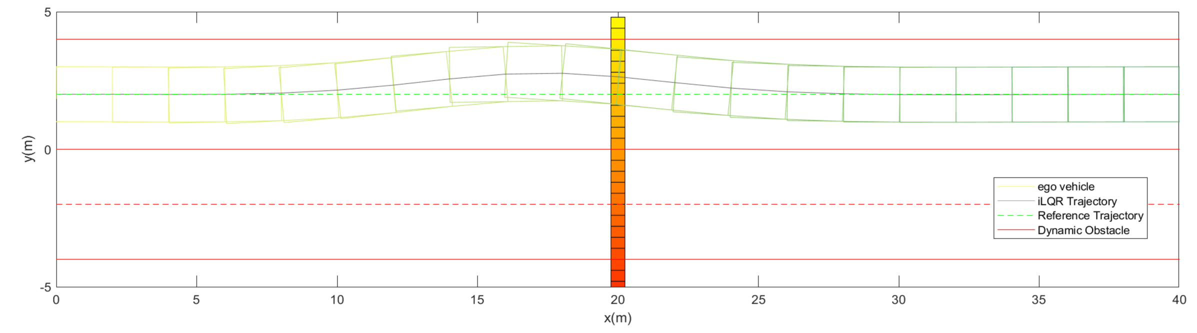


Fig. 2b

Fig. 2a and 2b show ego vehicle avoiding obstacle moving in lateral direction at different speeds within a zone where ego vehicle cannot stop with the available maximum deceleration.

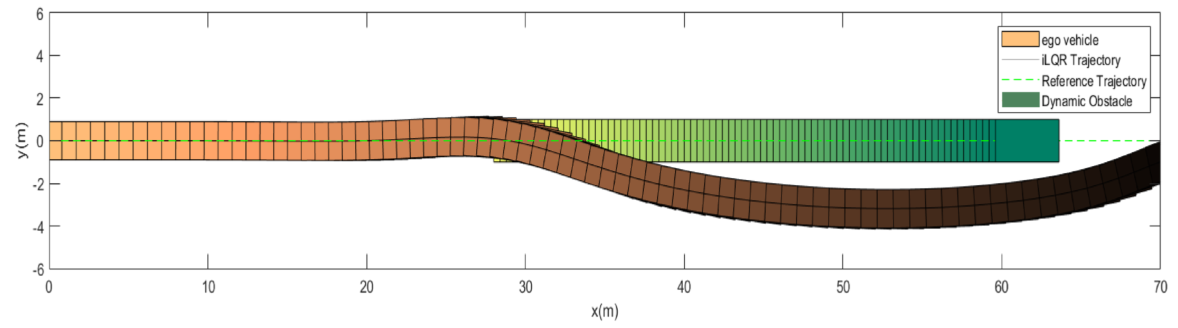


Fig. 3. Ego vehicle overtaking the dynamic slow obstacle.

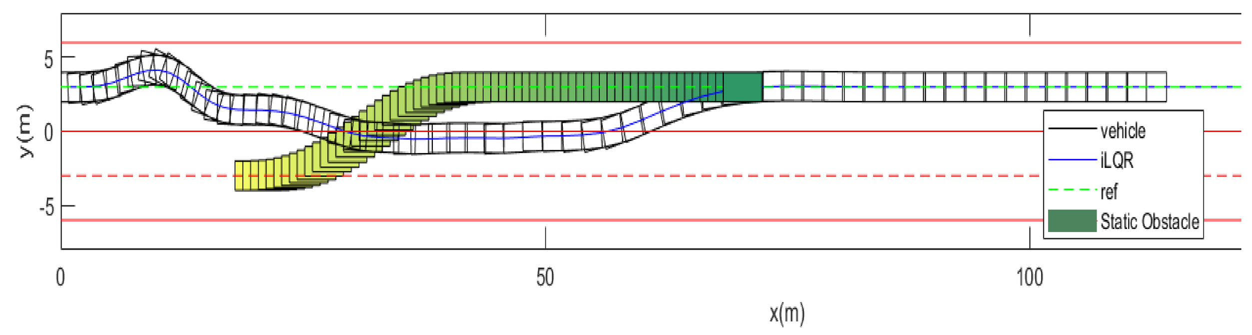


Fig. 4. Ego vehicle dealing with obstacle vehicle suddenly cutting into its lane.

Conclusion

- We have shown that Iterative LQR with cost weight tuning technique is capable of motion planning for urban areas including evasive maneuvers and emergency situations.
- Efficient solvers for taking the dynamic model of the vehicle into consideration for better implementation at high speeds.
- As a part of future work, the cost weights can be learned to adapt according to the situation through a better function.

References

[1] Jianyu Chen, Wei Zhan, and Masayoshi Tomizuka. Constrained iterative lqr for on-road autonomous driving motion planning.
[2] Aliasghar Arab, Kaiyan Yu, Jingang Yi, and Dezhen Song. Motion planning for aggressive autonomous vehicle maneuvers.

Acknowledgments

The authors would like to thank the Federation of Indian Chambers of Commerce and Industry (FICCI) for their generous financial support and would also like to acknowledge the support of the RISS and its organizers: Dr. John Dolan and Ms. Rachel Burcin.

FICCI Federation of Indian Chambers of Commerce and Industry

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