8902568 8925309 9825319 1231 322 8902u529 32568W9 898ur5556 988r2199 0336298 8902568 8925309 9825311 1231 322 8902u529 32568w79

0150400 545g8025 450g8543 0155050 1235001 1250032 2150042 012545000 45644655 1235g85 8500102 0125450 1211g8000 211g8422 3000021 123044 1205801 1250032 2150042 01254500

#### RV68153

94889119 0 0009350 00000 4560124 4581965 5481915 10910980 45604185 9012489 454408155 699285 454408155 699285 4568124 4581965 5481915 18910980 45604185 9012489

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## **CS447**

# Potential Field Based Intelligent Vehicle Formation Control for Unstructured Roads

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### Introduction

This paper studies the formation control of intelligent vehicles on unstructured roads. Firstly, the formation planning framework is put forward. Secondly, by introducing fixed-point potential field, a formation model combining artificial potential field with virtual navigator is established. Based on elasticity theory and boundary potential field model, the R value of virtual navigator is improved. Finally, the simulation shows that the formation model can realize formation transformation.

# 3)Formation Stability Analysis $F_{virtual} = \ddot{q}_{i} = f_{vl} + \sum_{i=1}^{4} f_{vv} + f_{oi} + f_{r} - b\dot{q}_{i}$ $V = \sum_{i=1}^{4} \left[ U_{vl}(d_{il}) + \sum_{j=1, j \neq i}^{4} U_{vv}(d_{ij}) + U_{ot}(q_{i}) + U_{r}(q_{i}) + \frac{1}{2} \|\dot{q}_{i}\|^{2} \right]$ $\dot{V} = -\sum b \|\dot{q}\|^{2}$

It can be seen from the equation that V is always non-positive.It will reach stability in dissipationfree form.



# **Research Method**

1.Determination of the Direction and the Position of Vehicles in the Formation

1)The forward direction of the formation is equivalent to the running direction of the virtual leader.

$$F_{ot} = -\nabla(U_{ot}) = -\nabla(\frac{1}{2}k_{at} (q_g - q_v))$$



2)The fixed-point potential field is introduced to determine the position of vehicles in the formation.  $N = \{x \mid ||x - x^*|| < R^*\}$ 



# Results

The simulation results show that four smart cars with different colors form an ideal formation shape under the control of the formation model.

As the vehicle is limited by the maximum longitudinal as well as lateral acceleration of the vehicle, its velocity variation has some differences, but the variation trend is flat, which also meets the vehicle dynamics requirements.



$$U_{oi}(q_i) = \begin{cases} \frac{1}{2}k_{oi}(d_{oi} - L)^2 & \text{if } x_i \in N \\ K & else \end{cases}$$

2.Formation Transformation based on Elasticity Theory

1)Improvement of virtual navigator.

$$U_{vl} = \frac{1}{2} k_{vl} (d_{il} - R')^2 \qquad R' = F / K_v$$

2)Improvement of boundary potential field model.  $U_r(L') = k_r \times \cos(L_f - L') / S_r \times \frac{\pi}{2}$ 

 $F = -\nabla U_r \left( L' \right)$ 

0 5 10 15 20 25 0 5 10 15 20 25 Time(s) Time(s)

# Conclusion

1) By introducing the fixed-point potential field, the target potential field model is established to ensure the accuracy of formation driving.

2) Based on the application of formation transformation, an elastic virtual leader is proposed, and the "road" boundary potential field is established, which avoids the system instability caused by the virtual leader and improves the flexibility of formation. Taking four vehicle formation as an example, the effectiveness of the formation control model is verified by MATLAB.