ICCSCE 2011
2011 IEEE International Conference on Control System, Computing and Engineering
Penang, Malaysia, 25-27 November 2011

1.0 Introduction

- Earlier vehicle tracking systems are normally based on colour feature because it is a promising feature that can be used to overcome partially occlusion and scale invariant incidents.

- Unfortunately, colour feature will lead to inaccurate results when the background colour is complex or too similar with the target vehicle.

- Hence, shape feature is introduced to the tracking algorithm to enhance the accuracy of the tracking performance.

- Although, shape feature will increase the accuracy of tracking rigid vehicle but it consume of more computation time during the tracking process.

- An enhanced particle filter with adaptive multiple cues overlapping vehicle tracking algorithm is proposed to continuously track the occluded vehicle effectively.

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2.0 Objective

- Continuously tracking vehicle under various occlusion incidents using enhanced particle filter algorithm with multiple cues.

- Robustly tracking the vehicles, and significantly improved the accuracy in tracking the occluded vehicles without compromising the computational time.

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3.0 Methodology

Colour Feature and Distribution Model

- Colour histogram of target vehicle is generated by using 8 x 8 x 8 bins RGB colour space.
- Bhattacharyya coefficient,

$$\rho[p,q] = \sum_{u=1}^{N_c} \sqrt{p_u q_u}$$

$$p = \{p_u\}_{u=1\ldots N_c}$$

$$q = \{q_u\}_{u=1\ldots N_c}$$

- From the coefficient obtained, the Bhattacharyya distance can be calculated.

$$d_c = \sqrt{1 - \rho[p,q]}$$

- Based on Bhattacharyya distance, the weight of the particles will calculate using

$$\varphi_c = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{d_c^2}{2\sigma^2}}$$

3.0 Methodology

Shape Feature and Distribution Model

- After the shape of the vehicle being extracted, the weight of the particles based on shape feature will be computed using Hausdorff distance.
- where $A = \{a_u\}_{u=1\ldots N_c}$ is the set of points obtained from reference vehicle

  $B = \{b_u\}_{u=1\ldots N_c}$ is the set of points obtained from target vehicle

- Hausdorff distance between two points set can be calculated based on

$$H_{dist}(A,B) = \max(h(A,B), h(B,A))$$

$$h(B,A) = \underset{b\in B}{K^{th}} \min_{a\in A} \|a-b\|$$

- where $\underset{b\in B}{K^{th}}$ denotes the K^{th} ranked value in the set of distance computed.

$$\varphi_s = \frac{1}{\sqrt{2\pi\sigma^2}} e^{-\frac{H_{dist}^{\ 2}}{2\sigma^2}}$$

3.0 Methodology

Proposed Particle Filter

- With the purpose of the shorten the computational time while increasing the accuracy of the tracking results, the proposed particle filter algorithm is need to be adaptive.

- Shape feature and colour feature will be calculated separately.

- In this adaptive particle filter algorithm, the shape feature is used to differentiate the target vehicle from obstacles.

- Resampling using colour feature to stronger the estimated position of the target vehicle.

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4.0 Results & Discussions (Before Occluded)

a) Particle filter by using colour feature only

b) Particle filter by using shape feature only

c) Particle filter by using proposed multiple cues

- The single feature and multiple features can both track the moving vehicle accurately.
- Before occlusion occur, the information of the moving vehicle can be clearly obtained and without influenced by others obstacles.

4.0 Results & Discussions (Partially Occluded)

a) Particle filter by using colour feature only

b) Particle filter by using shape feature only

c) Particle filter by using proposed multiple cues

- The accuracy of the tracking by using single feature has been decreased due to the information of the moving vehicle is influenced by the static vehicle.
- With the proposed tracking algorithm, the moving vehicle can be accurately located.

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4.0 Results & Discussions (After Occluded)

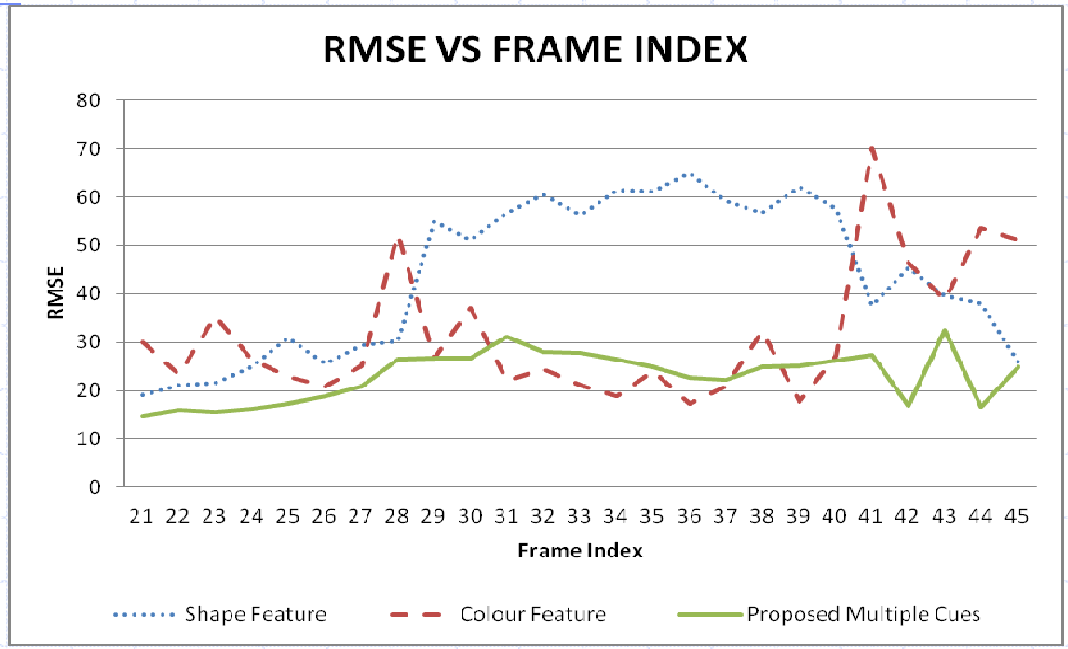
a) Particle filter by using colour feature only

b) Particle filter by using shape feature only

c) Particle filter by using proposed multiple cues

- When occlusion occur, the information of the moving vehicle will be influenced by the obstacle or static vehicle.
- With single feature algorithm, more time will be needed to recover the tracking of the moving vehicle while it is totally lost track.
- With proposed algorithm, the moving vehicle can be located immediately after occlusion occurred.

4.0 Results & Discussions



Graph of root mean square (RMSE) versus frame index

- From the graph shown, the proposed multiple cues algorithm has a more accurate tracking results compared to single feature used.

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5.0 Conclusions

- Tracking algorithm with multiple cues shown a promising result since more information describe the vehicle can be obtained from the experiments.

- Besides, the proposed algorithm with multiple cues is capable of dealing with the efficiency and effectiveness of the tracking performance.