U-RME: Underwater Refined Motion Estimation in hazy, cluttered and dynamic environments

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Introduction

- Optical Flow is a popular method of computer vision for motion estimation.
- Motion estimation in marine videos is a challenging task due to complex underwater environment.
- In this paper, we present a refined optical flow estimation method.
- Our approach is exploiting contour information as most of the motion lies on the edges.
- Further, we have formulated it as sparse to dense motion estimation.
- Proposed method has been evaluated on real life image sequences of Fish4Knowledge database.

Methodology

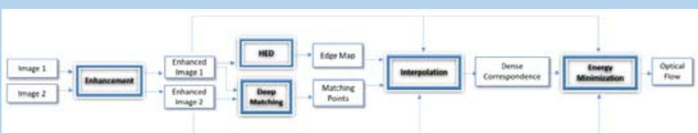


Fig. 1. Flow Chart

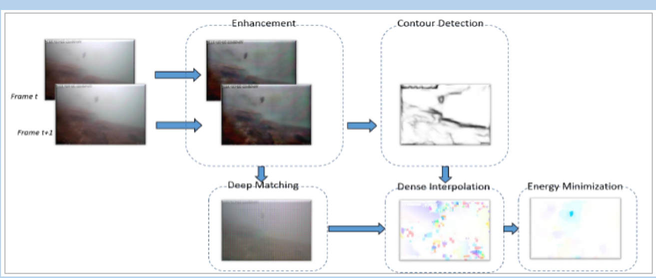


Fig. 2. Pipeline of the proposed flow method

Image Enhancement

(a) (b) (c)

Fig. 3. (a) Original Image. Enhanced image by (b) DehazeNet and (c) Light Scattering Model

Contour Detection

(a) (b) (c) (d)

Fig. 4. (a) Original Image. Edges detected by (b) Canny, (c) SED and (d) HED

Energy Minimization

$$E(\mathbf{u},\mathbf{v}) = \rho_D E_D + \lambda_1 \rho_s E_S + \lambda_2 E_C + \lambda_3 E_{med}$$

$$E_D = \sum_{i,j} (F_1(i,j) - F_2(i+u_{i,j}, j+v_{i,j}))$$

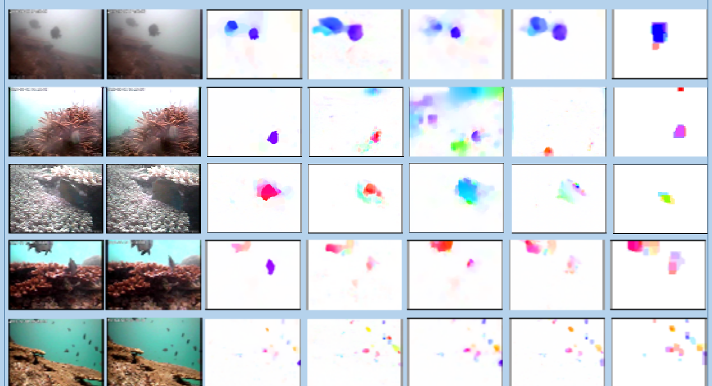
$$E_S = \sum_{i,j} ((u_{i,j} - u_{i+1,j}) + (u_{i,j} - u_{i,j+1}) + (v_{i,j} - v_{i+1,j}) + (v_{i,j} - v_{i,j+1}))$$

$$E_C = (\|\mathbf{u} - \hat{\mathbf{u}}\|^2 + \|\mathbf{v} - \hat{\mathbf{v}}\|^2)$$

$$E_{med} = \sum_{i,j} \sum_{(i',j') \epsilon N_{i,j}} (\|\hat{u}_{i,j} - \hat{u}_{i',j'}\| + \|\hat{v}_{i,j} - \hat{v}_{i',j'}\|)$$

Results

Success Cases:



(a) (b) (c) (d) (e) (f) (g)

Fig. 5. (a) Frame t (b) Frame t+1 (c) Proposed (d) DD Flow (e) EPIC Flow (f) LDOF (g) SIFT Flow

Failure Cases:

(a) (b) (c) (d) (e) (f) (g)

Fig. 6. (a) Frame t (b) Frame t+1 (c) Proposed (d) DD Flow (e) EPIC Flow (f) LDOF (g) SIFT Flow

Conclusion

- Motion information of objects is crucial for such low quality videos.
- We have shown significant improvement for underwater videos and comparative results for complex scenarios
- The proposed flow estimation technique can be further extended to segment and track the objects in hazy, cluttered and dynamic environments.

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