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A study on the reference image selection for the removal of moving objects from frontal in-vehicle camera videos

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Abstract In recent years, the demand for a street-view image database combining street-view images and their location information is increasing. When using such a street-view image database for various applications, privacy violation is one of the biggest problems because street-view images may contain moving objects, such as pedestrian and vehicle. To solve this problem, this paper proposes a method for moving objects removal from a street-view image by integration of frontal in-vehicle camera videos captured along the same route. Although image registration plays an important role to integrate such videos, it is difficult to align images correctly if reference image contains moving objects. Therefore, alignment of moving object regions needs to be done by combining it with the image registration of it surrounding regions. However, if the moving object region is large, appropriate alignment is difficult. To overcome this problem, we propose a method of reference image selection using the accuracy of the registration and the extraction of scenery candidate regions. Experimental results showed the proposed method could reduce deterioration of visual image quality in comparison with conventional methods.

Key words In-vehicle camera, removal of moving objects, reference image selection

1. まえがき

Google … [1] … [2] … [3] …

… 1 … 1 … 1 … "Bertalmio … [4] …

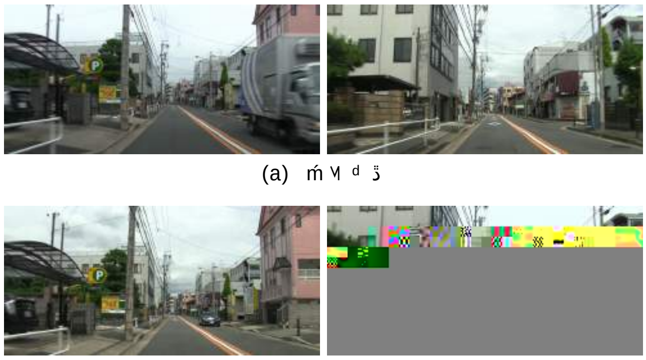
… "Flores … [5] …

… "Kawai … [6] … 1 …

… [7] …

… [8] …

… 1 …



(a) …

(b) …

(c) … (a) … (b) …

1 …

… [9] …

… "2. … "3. … 4. … 5. …

2. 移動物体除去手法

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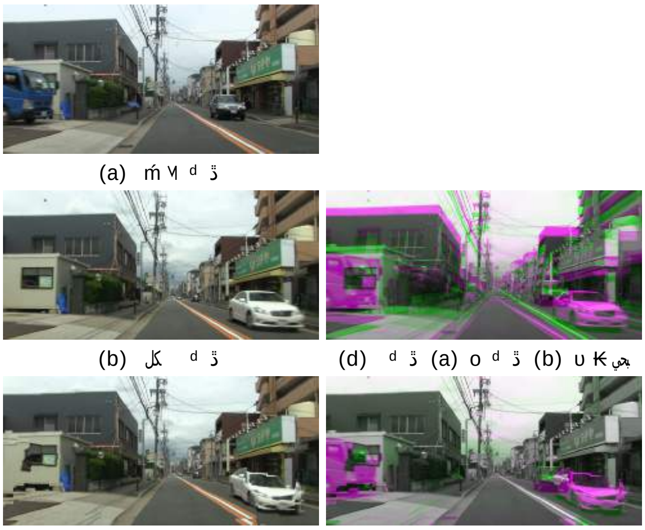
1 http://www.google.co.jp/help/maps/streetview/



(a) ḿ ܓ ᵈ ȝ

(b) ぷ ᵈ ȝ　(d) ᵈ ȝ (a) o ᵈ ȝ (b) υ Ꝁ

(c) ˥ ᵈ ȝ　(e) ᵈ ȝ (a) o ᵈ ȝ (c) υ Ꝁ

ˇ 4 SIFT flow ς Ͽ ɯ ȝ ٹ ‴ ɘ β Ώ ᴬ υ ʻ ᵈ ȝ (a) Ɣ ḿ ܓ ς ᵈ ȝ (b) Ɣ ȝ ٹ ‴ ɘ β ή ζ Ϛ υ Σ ᵈ ȝ (c) ʻ ϖ ζ " ᵈ ȝ (a) o (b) " ᵈ ȝ (a ᑊ o (c) δ Ч ε Ч υ Ꝁ Ɣ ɂ ς ή ζ Ϛ υ Σ δ Ч ε Ч ᵈ ȝ (d) " ᵈ ȝ (e) ξ Θ ɯ

ς φ " ƙ ᵈ ȝ ő ɉ υ ᵈ ȝ ς Π Κ ν ḿ ܓ ő o ぷ ő υ ᵈ ȝ ɉ Ρ Ӡ ϳ ΠШ ˎ ж Ɣ δ Ч ε Ч ╬ ˥ ű ɯ ʻ Ï υ o Τ " ╔ ȝ ٹ Σ ũ Κ Ύ π " ᵈ ȝ ɉ ĭ ʼ ϳ ΠШ ˎ ж ḥ ā Σ ؠ Τ Φ ρ ɯ " o Κ Μ ƕ ה Σ Θ ɯ ʻ Ï Ч Ɣ ή ν " ᵈ ȝ ɉ ĭ ʼ ϳ ΠШ ˎ ж ḥ ā Ɣ Ɒ ɉ o ή " DP Щ Ў Ḱ o ʍ ς Ͽ κ ν ő ḥ ξ υ ᵈ ȝ o υ ɉ ᴀ Ψ Ɣ , Μ ʻ

2.3.2 ᵈ ȝ Ή ξ υ ᵈ ȝ υ ȝ ٹ ‴ ɘ β

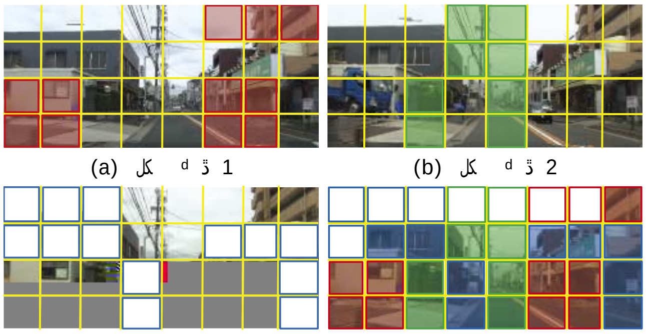
2.3.1 ς Ͽ ɯ ɉ ᴀ Ψ Ӡ Ч ζ ᵈ ȝ Ή φ " ╔ ȝ ٹ υ ρ Γ Κ ς Ͽ ɯ Ą Ξ Σ Ў ρ ɯ ʻ Ï Ч Ɣ Ƹ ű ɯ ζ ϙ ς " SIFT flow [11] Ɣ Κ ζ ᵈ ȝ υ ȝ ٹ ‴ ɘ β Ɣ , Μ ʻ SIFT flow φ " ƙ ᵈ ς ɉ ή ν SIFT ぷ ĺ Ɣ ╬ ˥ ή " ɣ Ɣ Κ ν ᵈ υ ɉ ᴀ Ψ Ɣ , Μ ʻ Ŗ Ş δ υ Ϛ υ ξ φ ρ Φ SIFT ぷ ĺ Ɣ Κ ɯ ζ ϙ " SIFT o ς ᵓ ž " Є ρ ˎ ж ⊐ ς ɉ ή ν ξ Θ ɯ " ϖ ζ Ϥ ⊐ ς ǃ ȁ ξ Θ ɯ ζ ϙ " υ Optical flow Ͽ ɯ Ϛ Ƹ ɣ ς ȝ ٹ ‴ ɘ β Ɣ , Μ Ï o Σ ᵶ ξ Θ ɯ Ï o Σ Ş Ӡ Ч ν Κ ɯ ʻ ˇ 4 ς ȝ ٹ ‴ ɘ β Ώ ᴬ υ Ɣ ű ʻ ᵈ ȝ (d) o ᵈ ȝ (e) Ɣ ɖ ű ɯ Ï o ς Ͽ ɯ " SIFT flow ς Ͽ ɯ Ꞑ ρ ȝ ٹ ‴ ɘ β Σ ᵶ ξ Θ ɯ Ï o Σ ɘ Ρ ɯ ʻ

2.3.3 ᵈ ȝ Ή ς Π Ψ ɯ ḿ ܓ ᵈ ȝ ٺ

ᵈ ȝ Ή ς ḭ ϖ Ч ɯ υ ᵈ ȝ Ɣ ḿ ܓ o ή ν 2.3.2 υ ⋆ ⌂ Ɣ , Μ ʻ δ υ Δ " 2.2 ξ ϳ ή ζ ܓ Ɣ , Μ Ï o ς Ͽ ɯ " ƙ ᵈ ȝ Ή ς Π Ψ ɯ ḿ ܓ ᵈ ȝ Ɣ ٺ ű ɯ ʻ

2.3.4 ᵈ ȝ Ή υ ‴

2.3.2 " 2.3.3 ς Ͽ κ ν ᵈ ȝ ξ ȝ ٹ ‴ ɘ β ά Ч ζ ᵈ ȝ Ή Ɣ Κ ν " Ў υ ܓ İ Ɣ , Μ ʻ 2.3 υ ⊐ ς Ͽ ɯ " ж ڲ ʼ ж ʄ ς ɉ ᴀ ű ɯ Φ Μ Γ ж Ή ς ɉ ή ν " ڲ ŵ υ ῄ ς Ͽ ɯ Ў υ ܓ İ Σ ᵶ ξ Θ ɯ ʻ ᾰ ŏ ɂ ς φ " ϖ α ƙ ᵈ ȝ Ɣ W ῷ υ Μ Ў Ḱ ς ᵍ ή " δ Ч ε Ч Μ Ў Ḱ υ ᵈ Ş Ɣ ϑ ζ Φ Μ Γ ж ς Ç ű ɯ ʻ ν ς " ӝ υ υ ɂ ḫ $F(n)$ Ɣ ℗ ⊐ ű ɯ Μ Ў Ḱ Ɣ ٺ ű ɯ ʻ



(a) ぷ ᵈ ȝ 1　(b) ぷ ᵈ ȝ 2

(c) ぷ ᵈ ȝ 3　(d) ˥ ᵈ ȝ

ˇ 5 ὸ ʄ υ ٺ o ‴ Ƃ ʻ ᵈ ȝ (a) " ᵈ ȝ (b) " ᵈ ȝ (c) Ɣ ぷ o ή ν " ᵈ ȝ (d) Ɣ ˥ ű ɯ

$$F(n) = \sum_{w=1}^{W} [(1-\lambda) f_w(n_w) + \lambda g_w(n_w)] \qquad (2)$$

Ï Ï ξ " n_w φ w υ Μ Ў Ḱ ξ Θ ɯ ʻ ϖ ζ " f_w φ Ў ɉ Ӡ ή ά ς ȟ ű ɯ Χ Ε ж Б ↑ ξ Θ ɯ " δ υ ὐ ╬ ς φ Φ Μ Γ ж Ь Β ↑ ϭ o Ρ ↑ ж Њ [12] Ɣ Κ ɯ ʻ Φ Μ Γ ж Ь Β ↑ ϭ o Ρ ↑ ж Њ φ " ぷ o ű ɯ Φ Μ Γ ж υ Μ θ ɉ " o ρ ɯ Φ Μ Γ ж Ɣ ˥ ű ɯ Ρ ↑ ж Њ ξ Θ ɯ ʻ Ï Ï ξ " ɉ " Φ Μ Γ ж φ ڲ υ Φ Μ Γ ж o υ ȁ υ Σ ℗ ܓ ς ρ ɯ Φ Μ Γ ж o ή ν Ṯ ά Ч ɯ ʻ δ Ï ξ " f_w φ ɉ " Φ Μ Γ ж o ڲ υ Φ Μ Γ ж o υ ȁ υ Σ ˥ ά Ч ɯ ʻ ⊐ Ͽ ɯ " Ў ρ ɯ Ƣ ς ж ڲ ʼ Ɣ ᵓ ╔ ή ζ ʌ ‴ " Θ ɯ ܓ ʄ ς λ Κ ν Ą ɯ o ὸ υ ɳ Σ ɯ ɣ Σ Κ ζ ϙ " Φ Μ Γ ж Ь Β ↑ ϭ o Ρ ↑ ж Њ ς Ͽ ɯ ˥ ά Ч ɯ ɉ " Φ Μ Γ ж φ " Μ Ў Ḱ υ ڲ ῷ Ώ ᴬ ς ɉ ᴀ ű ɯ ʻ ϖ ζ " Φ Μ Γ ж Ь Β ↑ ϭ o Ρ ↑ ж Њ υ ぷ ς φ 2.2 υ ܓ ξ Ӡ Ч ζ Ƹ ή Φ ȝ ٹ ‴ ɘ β ξ Τ ν Κ ɯ ᵈ Ɣ ɉ ĭ o ή ζ Μ Ў Ḱ υ ɳ o ű ɯ Ï o ξ " Ў ɉ ܓ İ ᵈ ȝ υ ᵈ ה ⊐ Ɣ ϑ ű ɯ ʻ ή Ρ ή " Φ Μ Γ ж Ь Β ↑ ϭ o Ρ ↑ ж Њ ς Ͽ ɯ ƙ Μ Ў Ḱ υ ٺ φ ς , ɘ Ч ɯ ζ ϙ " ῦ Μ Ў Ḱ υ ɉ ς ȟ ű ɯ Χ Ε ж Б ↑ g_w Ɣ ぷ ű ɯ Ï o ξ " ʌ ʌ Ώ Ɣ Ƽ ű ɯ ʻ ʌ ή Φ φ ᾰ [7] Ɣ ╢ ʌ ά Ч ζ Κ ʻ ϖ ζ " λ φ f_w o g_w ς ɉ ű ɯ ɳ ξ Θ ɯ " ӝ υ υ Ͻ ή ξ φ $\lambda = 0.6$ o ή ζ ʻ ˇ 5 ς ƙ ぷ ᵈ ȝ Ρ Ӡ $F(n)$ υ ᑊ ς Ͽ ɯ ˥ ς ▬ ɘ Ч ɯ Μ Ў Ḱ Ɣ ٺ ή ν ‴ ű ɯ ▸ Ɣ ű ʻ ρ Π " Ͻ Δ φ ƙ Μ Ў Ḱ φ Κ Σ ű ɯ Ͽ Μ ς ٹ ή " α С з o В ↑ o ʍ Ɣ Κ ν ‴ ű ɯ Ï o ξ " Ў ɉ Ɣ ܓ İ ή ζ ᵈ ȝ Ɣ ‴ Ƃ ű ɯ ʻ

3. 実 験

ὲ ə υ " ƕ Ɣ ɣ ɦ ű ɯ ζ ϙ ς " Ͻ ή Ɣ , κ ζ ʻ ϖ α 3.1 ξ ḿ ܓ ᵈ ȝ υ ٺ Ꞑ ɯ w Ͻ ή ς λ Κ ν ˥ ϑ " ν ς 3.2 ξ Ў ɉ ܓ İ υ Ꞑ w Ͻ ή ς λ Κ ν ˥ ϑ ɯ ʻ

ぷ o ή ν ж Ό Ɣ Ў ρ ɯ Ƣ ς ȝ , ή ν ╔ ή ζ ȝ ∂ э Ь Д ᵈ ȝ ő 5 Ɣ Κ ζ ʻ ᵒ ȝ φ 720 ˎ 340 pixels o ή ζ ʻ Ρ з ˎ Ы з ˎ Γ φ 23.98fps ξ Θ ɯ " 40 ḥ ╔ ή ζ ʻ ϖ ζ " ╔ Ό φ ٺ ʔ ʌ ξ " Ў ɉ Σ ɵ Ӡ ς ɯ б ڲ ξ Θ κ ζ ʻ ƙ ᵈ ȝ ő ς ḭ ϖ Ч ɯ ᵈ ȝ φ δ Ч ε Ч 1,000 ξ Θ ɯ " δ υ Μ θ 25 ς ٺ ɤ η 40 Ɣ Ꞑ w υ ɉ ʌ o ή ζ ʻ ɖ 1 φ ḿ ܓ ᵈ ȝ υ ٺ Ɣ , ɘ ρ Κ ξ Θ ɯ ʻ λ ϖ ɯ " ᵈ ȝ ő υ ᵈ ȝ o υ ɉ ᴀ Ψ Ɣ ή ζ Δ υ ḿ ܓ ᵈ ȝ ő υ ƙ ᵈ