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Hybrydowa metoda detekcji twarzy

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Streszczenie

Pierwszym elementem systemu identyfikacji użytkownika jest zagadnienie detekcji twarzy. Rezultat identyfikacji zależy od skuteczności procedury detekcji i lokalizacji twarzy. Istnieje wiele popularnych metod detekcji twarzy, które można podzielić na dwie grupy: (i) bazujące na detekcji koloru skóry, (ii) wykorzystujące dopasowanie wzorca. Do detekcji koloru skóry wykorzystuje się jeden z modeli barw, np. RGB, HSV, YCbCr, a następnie weryfikuje się czy wybrany obszar jest twarzą. W systemach dopasowania wzorca należy przeszukać cały obraz porównując fragmenty do wzorca. Te metody są czasochłonne i wymagające dużej mocy obliczeniowej. Większość z tych metod nie jest użytecznych w systemach typu on-line lub czasu rzeczywistego ze względu na czas obliczeń. Zaproponowana hybrydowa metoda jest użyteczna w tego typu systemach i daje możliwość budowy i rozwoju praktycznych systemów identyfikacji osób. Wykorzystuje ona elementy wspomnianych metod w taki sposób, aby skrócić czas obliczeń. Po wstępnej selekcji potencjalnych obszarów mogących zawierać twarz, weryfikacja następuje przy wykorzystaniu wzorca oczu, co znacznie skraca czas obliczeń.

Słowa kluczowe: detekcja twarzy, lokalizacja twarzy, biometryka, identyfikacja osób, rozpoznawanie twarzy.

The hybrid method of face detection

Abstract

The face detection problem is the first part of user identification systems. The success of identification depends of effectiveness of face detection and localization. The are many popular methods of face detection, but not all of them are useful in real-time or on-line face recognition. The propose hybrid method is useful for this kind of systems and create possibility to build and develop practical system of people identification. This method uses skin detection algorithm with HSV colourspace and for verification potential area with face template matching with eyes image pattern.

Keywords: face detection, face localization, biometrics, face recognition, user identification

1. Introduction

The face detection problem is very important in complex user identification systems. This is the first part of processing path. The success of identification (recognition) depends of effectiveness of face detection and localization. If there is no face – there is no recognition.

There are many methods of face detection. The most popular group of methods are methods based on skin colour detection. They use some colour space as RGB, HSV, YCbCr or others [1,2,3,7]. Disadvantages of these techniques are following: many false positive errors, sensitive on change of lighting condition and type of light (bulb, fluorescent, sun).

Second group of face detection methods consists of methods using the template matching. The idea of these techniques is to make a comparison of an input image with the pattern including the face [8]. They have good recognition rate, but they are computationally expensive, because they need to analysis of whole image.

The methods using features form the third group of techniques of face detection. They may use Eigenface (PCA/KLT), Hidden Markov Models, Support Vector Machines or statistics. They are very effectiveness but also are complicate and computationally expensive.

2. Skin colour detection

The face localization over colour image use technique named skin colour detection. This is made with quantization of colourspaces, segmentation of image and next separate the regions of skin. We need to verification each region that it is face or not, obviously.

The most popular use colorspace are: RGB, HSV, YCbCr.

2.1. RGB

RGB is a colorspace originated from display devices, it describe colour as a combination of three coloured rays: Red, Green and Blue. It is one of the most widely used colour spaces for processing and storing of digital image data [7]. We can use simply segmentation on RGB colorspace (1) [4]. The result of application of this technique shown on Fig.1.

$$\frac{R}{G}-\frac{B}{G} > Threshold \qquad (1)$$
$$R,G,B = 0..255$$

This procedure give us weak results and have problem with variable light conditions. The better way is use the normalized RGB (2) [5,7] which is resistant to different kind of light. The result of application of this technique shown on Fig.2.

$$\begin{aligned} r &= \frac{R}{R+G+B} \\ g &= \frac{G}{R+G+B} \\ b &= \frac{B}{R+G+B} \\ r+g+b &= 1 \\ R,G,B &= 0..255 \end{aligned} \qquad (2)$$

2.2. HSV

Hue-saturation based colour spaces were introduced when there was a need for the user to specify colour properties numerically. They describe colour with intuitive values, based on the artist's idea of tint, saturation and tone. *Hue* defines the dominant colour (such as red, green, purple and yellow) of an area, *saturation* measures the colourfulness of an area in proportion to its brightness. The "value" is related to the colour luminance [7]. It may be use for skin detection (3) [3]. The result of application of this technique shown on Fig.3.

Convert RGB to HSV :

$$M = \max(R, G, B)$$
$$m = \min(R, G, B)$$
$$r = \frac{M - R}{M - m}$$
$$g = \frac{M - G}{M - m}$$
$$b = \frac{M - B}{M - m}$$
$$V = \max(R, G, B)$$
$$\text{if } M = 0 \text{ then } S = 0 \text{ and } H = 180°$$
$$\text{if } M <> 0 \text{ then } S = (M - m) / M$$
$$\text{if } R = M \text{ then } H = 60(bg)$$
$$\text{if } G = M \text{ then } H = 60(2 + rb)$$
$$\text{if } B = M \text{ then } H = 60(4 + gr)$$
$$\text{if } H >= 360 \text{ then } H = H - 360$$
$$H < 0 \text{ then } H = H + 360$$

Skin detection : (3)

$$H < 0.15 \text{ or } H > 0.95$$
$$S < 0.68$$
$$V > 0.3$$
$$H,S,V = [0,1]$$
$$R,G,B = [0,1]$$

Values H, S, V for skin detection selected experimentally.

2.3 YCbCr

YCrCb is an encoded non-linear RGB signal, commonly used by European television. Colour is represented by Y, which is luminance, computed from non-linear RGB, constructed as a weighted sum of the RGB values, and two colour difference values of chrominance *Cr* and *Cb* that are formed from components of RGB [3,7]. The result of application of this technique (4) shown on Fig.4.

$$\begin{aligned} Y &= 0.299R + 0.587G + 0.114B \\ Cb &= 128 - 0.168736R - 0.331264G + 0.5B \\ Cr &= 128 + 0.5R - 0.418688G - 0.081312B \\ Y &> 80 \\ 85 < Cb &< 135 \\ 135 < Cr &< 180 \\ Y, Cb, Cr &= 0..255 \end{aligned} \quad (4)$$

Fig. 1. RGB mask (1) for skin detection.

Fig. 2. Normalized RGB mask (2) for skin detection.

Fig. 3. HSV mask (3) for skin detection.

Fig. 4. YCbCr mask (4) for skin detection.

3. Template matching

The template matching technique is use for classify object, which compare part of image to another and may be use to recognize similar object. The template matching method for face detection use the pattern of face [3,6,8]. Pattern of face is comparison whit whole input image from top to bottom, and from left to right. It is very computationally expensive. Additional this type of face detection methods are characterized by frequent non-face errors.

4. Propose method of face detection

Presented above face detection methods have some advantages and disadvantages. Therefore is presented own detection methods. This method use skin detection technique for selection potential areas containing a face. HSV colour space is use in this step. Next, template matching technique is apply to verification each region that it is the face or not. Difference this method from others is that it use as pattern image of eyes (Fig. 6) and not whole face as most methods.

Algorithm:

1. *Start*
2. *Take a frame(image) from video stream.*
3. *Make a quantization to HSV colour space.*
4. *Analyse image with equations (3).*
5. *Make a mask.*
6. *Select areas of skin.*
7. *For i=1 to numbers_of_skin_areas*
   - *7.1 Take size of area.*
   - *7.2 Scale pattern of eyes adequately to size of skin area.*
   - *7.3 Compare pattern with area: if distance<threshold than save coordinates of face.*
8. *If number_of_ frame= end than STOP, else go to 2.*

Fig. 5 Samples of eyes pattern

5. Practical application

Propose above method of face localization may be use in practical real-time or on-line face identification system. Scheme of that system shown on Fig.6. Hybrid method of face localization use skin detection and template matching is applying as first part of system. When face is localized than face is normalized. Next, wavelet transform is use for features extraction. Hidden Markov models are use for training and testing procedure. Decision is made on the base maximum likelihood [9].

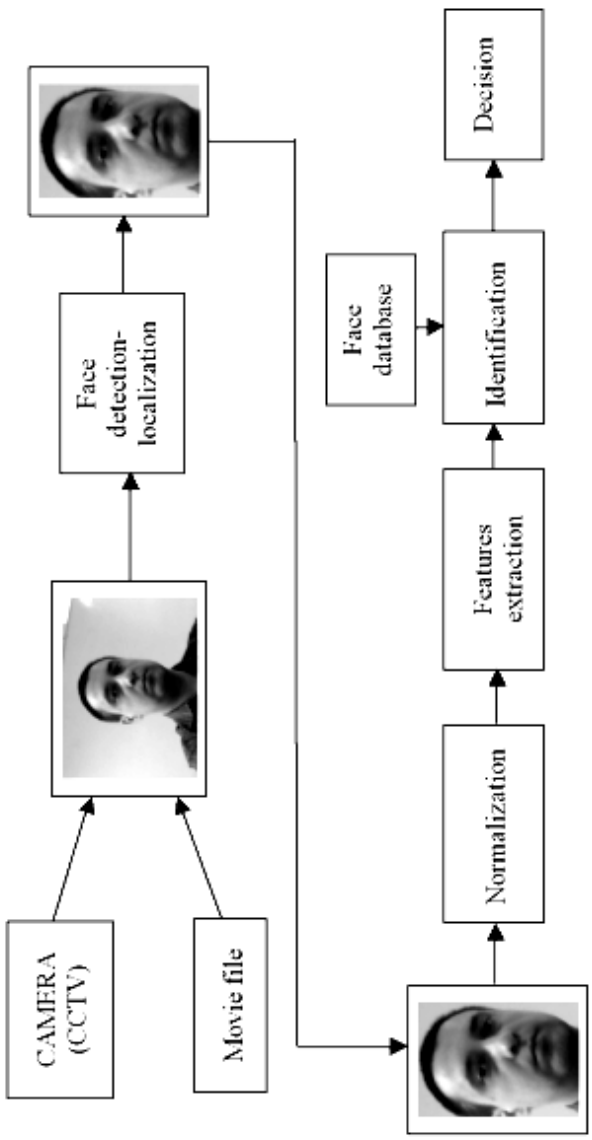

Fig.6. Scheme of real-time face recognition system

Conclusion

In this paper shown popular methods of face detection, but not all of them are useful in real-time or on-line face recognition. The propose hybrid method is useful for this kind of systems. This create possibility to build and develop practical system of people identification.

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