Optimized Algorithm for Face Detection Integrating Different Illuminating Conditions

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ABSTRACT

Face detection is a significant research topic to contrive identity for many automated systems. We present a novel face detection algorithm to detect a single face in an image sequence in the real-time environment by finding structural features. The proposed method allows the user to detect the face in case the lighting conditions, pose, and viewpoint vary.

The proposed algorithm combines two segmentation approaches. The first approach is a Pixel-based approach by using the components Y, C_b, and C_r in YC_bC_r color model as threshold conditions to segment the image into luminance and chrominance components. Based on the components of YC_bC_r color model, the pixel can be classified to have skin tone if it's value is between two specific thresholds. The second approach is an Edge-based approach by using Roberts cross operator. It approximates the magnitude of the gradient of the test image. It also separates the integrated regions into the face and highlights these regions of high spatial gradients which correspond to the edges of the face. The new algorithm achieves high detection rate and low false positive rate.

INTRODUCTION

❖ Segmentation

✓ Color based method

The conversion of RGB color space into full-range YC_bC_r color space is done by the following formula:

$Y = 0.299R + 0.587G + 0.114B$
$C_b = -0.1687R - 0.3313G + 0.500B + 128$
$C_r = 0.500R - 0.4187G - 0.0813B + 128$

Where R, G, B ∈ [0,255], and Y, C_b, C_r ∈ [0,255]. This linear conversion is simple and effective.

✓ Edge-based method

$$\underset{G_x}{\begin{bmatrix} +1 & 0 \\ 0 & -1 \end{bmatrix}} \; and \; \underset{G_y}{\begin{bmatrix} 0 & +1 \\ -1 & 0 \end{bmatrix}}$$

Figure1. Roberts cross operator masks

- The gradient magnitude can be defined as:

$$\nabla I(x,y) = \sqrt{G_x^{\,2} + G_y^{\,2}}$$

- Let θ (*x*, *y*) represents the direction angle of *I* at *(x, y)*, then the direction of the gradient is expressed as:

$$\theta(x,y) = \arctan\left(\frac{G_y(x,y)}{G_x(x,y)}\right)$$

PROPOSED METHOD

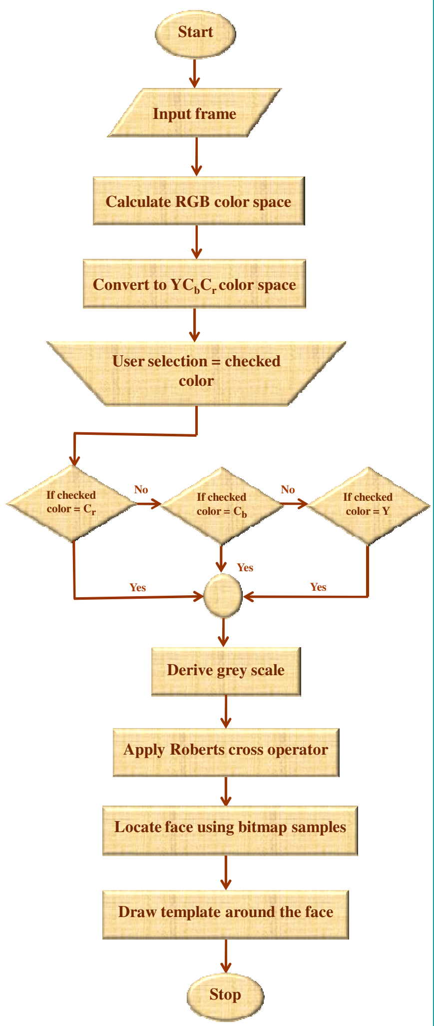

Figure2. Face detection flow chart

EXPERIMENTAL RESULTS

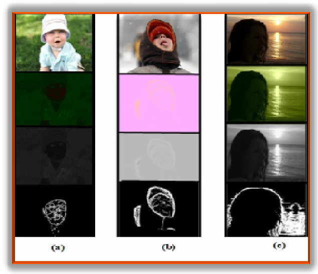

Figure3. Decomposition based on (a) C_r components (b) C_b components (c) Y components

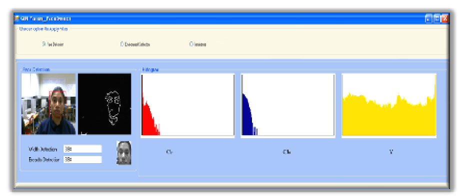

Figure 4. Output of the face detection method

Computer Vision \ Human Vision	Positive	Negative	Total
Presence	512	38	550
Absence	54	496	550
Total	566	534	1100

Table1. Computer vision versus human vision

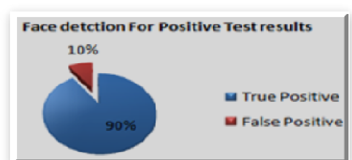

Figure 5. False positive rate verses true positive rate

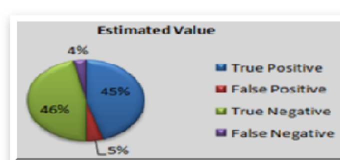

Figure 6. Accuracy of the proposed method

CONCLUSION

The proposed algorithm achieves 90% detection rate and 10% false positive rate. This project will be extended by implementing the proposed approach using IMB400 wireless multimedia sensor network boards. Since the sensors are low computational resources, extracting features such as skin color and edges which need fewer computation will be effective to detect faces.