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Gaussian mixed model-based motion detection and shadow elimination algorithm research

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ABSTRACT

In computer vision field, regarding sequence image's moving target detection is one of its researches important orientations; it has wide research prospects in each field of life. On this basis, the paper goes deeper analysis of complicated scenes moving target detection, provides Gaussian model improvement forms, applies fixed learning rate to learn variance, and sets up lower limit threshold value, targeted at the new type algorithm, according to different confusion scope, it adopts different updating ways, finally by experiment verification, we can get new type algorithm handling quality and speed are obviously faster than traditional algorithm. Combine Gaussian mixed model with HSV color space shadow elimination method, and modifies Gaussian mixed model's parameters, let its shadow elimination efficiency to be greatly promoted, and gets that shadow elimination method purely carrying on in HSV color space will appear great deviation, while adopt Gaussian mixed model learning way to combine with HSV color space shadow elimination ways then it will get closer to practice, so the paper proposed algorithm has good effectiveness and timeliness.

KEYWORDS

Gaussian mixed model; Moving target; Shadow elimination; Mathematical model.

INTRODUCTION

With rapidly development of computer followed by hardware performance constantly promoting, let computer to be able to recognize each thing in life is an important research orientation in the field at present and arouses universal concerns.

Regarding computer detection and shadow elimination aspects research, formers have made many researches and got certain achievements. Such as : Song Yang had ever put forward moving target detection application in human-computer interaction, intellectual interaction environment, educational entertainment, video conferences and model coding, digital library as well as video image aspects marking, the disabled auxiliary system as well as others; Luo Tie-Zhen in the research of motion detection aspect, he had ever proposed a new model, improved its updating efficiency and speed by changing algorithm, and better prevented background disturbance caused error detecting by introducing threshold value detection.

The paper just on the basis of above formers research, targeted at motion detection and shadow elimination algorithm aspect, it makes further analysis and research, improves its detection performance by applying color space and Gaussian model combinative ways, finally uses it to reduce its illumination caused abrupt false detection, the method is convenient and effective, and has wide application values.

GAUSSIAN MIXED MODEL-BASED MOTION DETECTION RESEARCH

In scenes, it takes uninterested and static background as moving target background, effectively extracts scenes relative interested moving targets then can arrive at the purpose of looking for ideal backgrounds, and applied scenes are origins that decide interested targets. Only scenes backgrounds one kind of affiliated interested moving targets gap becomes bigger then can let its interested targets to stand out from moving targets and backgrounds as well as video images, relative typical target detection system is as following Figure 1 shows:

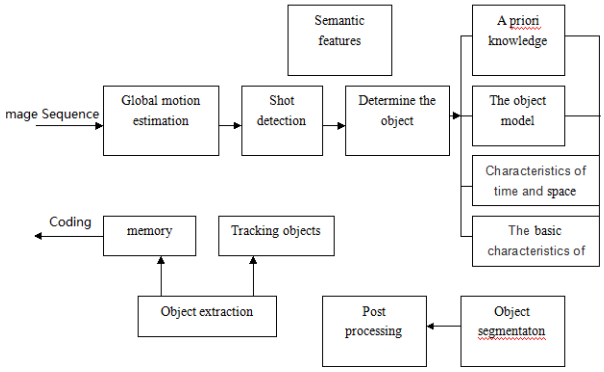

Figure 1 : A typical moving object detection system diagram

Combine above Figure 1 with Gaussian mixed model to implement moving targets detection, to better implement the scene, the paper introduces Gaussian mixed model.

Parameter initialization

Gaussian mixed model implemented initialization refers to solve variance σ_0^2 and gray average μ_0 of a while video sequence images pixels, making initialization on Gaussian mixed model by the two, from which M refers to corresponding distribution parameter, which is also :

$$\mu_0 = \frac{1}{N}\sum_{t=0}^{N-1} I_t \ , \ \sigma_0^2 = \frac{1}{N}\sum_{t=0}^{N-1}\left(I_t - \mu_0\right)^2 \quad (1)$$

Due to memory's storage contents are relative larger in reality, and if requirement on parameter initialization extent are high, pixel color range value is $[0, 255]$, carry on maximum handling with above distribution parameters initialization values, corresponding weights and mean values respectively extract :

$$w_t = 1/M \ , \ \mu_i = 255 \times (i/M), \ i=1, 2\ldots., M \quad (2)$$

In practical phenomenon, we can see that after handling with moving targets complex scenes can speed up scenes background generating speed, from which only very little part exists static backgrounds that is a generating process by learning motion targets.

Parameter updating

Updating of Gaussian mixed model parameters contain parameters updating and weights updating, and according to obtained weights to rank, after that, it can get corresponding images, and match Gaussian mixed model's M pieces of functions to current frame pixel, from which the relationship that needs to meet is :

$$\left|I_t - \mu_{i,t-1}\right| \le D\sigma_{i,t-1} \quad (3)$$

In above formula, at the moment of t-1the i Gaussian function standard deviation is $\sigma_{i,t-1}$, user parameter is D, in general, it takes 2.5, the i function average value is $\mu_{i,t-1}$, then updating formula with the I_i corresponding parameter formula is :

$$w_{i,t} = (1-\alpha)w_{i,t-1} + \alpha \quad (4)$$

$$\mu_{i,t} = (1-\rho)\mu_{i,t-1} + \rho I_t \quad (5)$$

$$\sigma_{i,t}^2 = (1-\rho)\sigma_{i,t-1}^2 + \rho(I_t - \mu_{i,t})^2 \quad (6)$$

Among them, learning rate is defined as α, and $0 < \alpha < 1$, α can decide updating speed, the value gets smaller then corresponding speed will be slower, on the contrary, the value gets larger, then corresponding speed will also be faster, parameter learning efficiency is defined as ρ, and it has $\rho \approx \frac{\alpha}{w_{i,t}}$, when matching hasn't fulfilled, new formed Gaussian formula will replace minimum weight Gaussian function, then the rest Gaussian function will remain original variance and average value, but from which it will weaken, then handle according to following formula :

$$w_{i,t} = (1-\alpha)w_{i,t-1} \quad (7)$$

By above handling, it can get different threshold value, and can appear scenes relative chaotic situations, the way is more fit for Gaussian mixed model.

Background selection

Due to not all Gaussian functions can describe scenes background, make clear which type can describe scenes background is particularly important, describe high frequency pixel by larger weights Gaussian functions is learning system of Gaussian mixed model, and relative smaller weights are Gaussian functions that describe moving targets.

After getting new images, it can update Gaussian mixed model, and do normalization processing with its weights, after that rank them, new formed Gaussian functions replace Gaussian function that ranks in the last, if previous M_i pieces of Gaussian functions are regarded as background distribution, then the rest is regarded as moving target function distribution, now previous M_i pieces of Gaussian functions need to meet the condition as :

$$\sum_{k=i_1}^{iM_1} w_{k,t} \geq \tau \quad (8)$$

In above formula, weight threshold value is expressed by τ, is the description of Gaussian distribution's minimum weight sum, the value gets bigger, then corresponding minimum weight one is regarded as its background distribution, which is easily confusing background factors, the value gets smaller, then only can take one Gaussian function of them as its background, now Gaussian background is too single, and it had better assign its value with a proper threshold value, now it is taking multiple Gaussian functions as its background, which can let background adaptability to be constantly strengthened, and change followed by environment changes.

Motion prospect detection research

Carry out comparison between background model and current input video image is the detection of motion prospect, when background model and input image gap is larger than one threshold value, then contrast ratio will be relative lower, and the contrast ratio is relative larger in the relative larger threshold value regions.

Moving target detection way is if Gaussian function standard deviation is D times smaller than current background Gaussian function and pixel average value difference absolute value, then now I_i is regarded as moving target function, from which D selection is obtained according to experiment. Targeted at the paper research, it assigns $D = 2.5$, background Gaussian function average value and current pixels ratio can be used to judge whether pixel is motion target function, then it needs to meet conditions as :

$$\left|I_t - \mu_{i,t-1}\right| \leq D\sigma_{i,t-1} \quad i=1, \ldots M \quad (9)$$

$$I_t/\mu_{i,t-1} > \alpha_1 \text{ or } I_t/\mu_{i,t-1} < \beta_2 \quad i=1, \ldots M \ \alpha_1, \beta_1 \text{ is threshold value} \quad (10)$$

By adopting "and" ways, and meet above formula in the single channel of RGB, now corresponding pixel will meet above formula, when $I_t/\mu_{i,t-1}$ value variation is relatively unstable, pixel brightness value will be relative lower, now false detection rate will be relative higher, to avoid the phenomenon, it should do target detection according to above formula, when pixel is larger than α_3, and when its pixel brightness is smaller than α_3, do target detection according to above formula.

Gaussian function model improved research

In Gaussian function mixed model, only when M gets bigger, obtained moving targets detection efficiency will be better, now complex scenes handling ability will be stronger. In current researched

Gaussian mixed model algorithm, updating frequency is higher, in order to reduce, now the paper proposes Gaussian model improved schemes, the scheme not only can detect its updating times, but also can increase Gaussian mixed model calculation speed. In order to test its performance, it adopts image sequence moving targets re-detection, carries out normalization handling with current Gaussian function, when its weight is larger than 0.7, Gaussian model will stop updating in 200 frames image, and subsequently shortens its maximum weight by half, after that, it continues parameters learning, corresponding environment is as following TABLE 1 shows :

TABLE 1 : New algorithm processing speed

Method Scene	Single Gaussian	M=3 Gaussian mixed fast algorithm	M=3 Gaussian mixed model	M=5 Gaussian mixed fast algorithm	M=5 Gaussian mixed model
Outdoors	58fps	25fps	22fps	16fps	14fps
Indoors	56fps	27fps	24fps	18fps	17fps

By above TABLE 1, we can see that Gaussian function model improved algorithm has been obviously improved with respect to other algorithms processing speeds, when moving targets activity area only occupies little part of entity, parts in other scenes are static, when in specified monitoring scenes, Gaussian function model improved algorithm obviously has great advantages.

To sum up, the paper targeted at Gaussian mixed model's larger motion variance, poor timeliness and other causes, on this basis, it proposes Gaussian model improved forms, applies fixed learning rate to learn variance, and sets lower limit threshold value, targeted at the new type algorithm, according to different confusion extents, adopts different updating ways, finally through experiment verifying, we can get new type algorithm processing quality and speed is obviously faster than traditional algorithm.

GAUSSIAN MIXED MODEL MOTION SHADOW ELIMINATION ALGORITHM

Regarding motion shadow elimination way, it mainly has two types that are respectively attribute method and model method, attribute method is reflecting shadow area by shadow geometric construction, color, brightness and so on, and model method can be implemented mainly by utilizing irradiant conditions, scenes and other s under specific scenes, the two differences are relative bigger.

Color transformational shadow elimination method generally is converting captured pixel RGB color component through transformation into other color space, and fulfilling shadow elimination in the color space by shadow pixel value, in general we common use HSV, rgb, YUV and others color space forms.

Regarding HSV color space shadow elimination research

HSV color model in general is a king of way that approximates to human color feeling, is different from CMYK and RGB model, the two is reducing original color and adding original color, both of them are defining its colors by original ways, while HSV is a comprehensive form that adds people familiar information by color.

HSVHSV color space cylinder generally expresses mathematical model in case of updating, while it expresses hue grades and differentiable saturability process of reducing with brightness darkens in practice.

Transformation between HSV and RGB is as following show :

max = max(R, G, B)
min = min(R, G, B)
if R = max, H = (G – B) /(max– min)
if G = max, H = 2 + (B – R) /(max– min) **(11)**
if B = max, H = 4 + (R – G) /(max– min)
H = H * 60
if H < 0, H = H + 360
v = max(R, G, B)
S = (max– min) / max

rgb color space shadow elimination

RGB each letter represented colors are respectively blue, green and red, but the color space visual perception cannot be well reflected, and HSV is different, it is composed of brightness, component and hue, but the two can be mutual transformed, its transformation equation is :

$$r = R/(R+B+G) \quad \textbf{(12)}$$

$$g = G/(R+B+G) \quad \textbf{(13)}$$

$$b = B/(R+B+G) \quad \textbf{(14)}$$

$$u = \max(r,g,b),\ V = \min(r,g,b) \quad \textbf{(15)}$$

$$S = [u-v]/u \quad \textbf{(16)}$$

$$h = \begin{cases} 5+b' & if \quad r=u \quad and \quad g=v \\ 1-g' & if \quad r=u \quad and \quad g\neq v \\ 1-r' & if \quad g=u \quad and \quad b=v \\ 3-b' & if \quad g=u \quad and \quad b\neq v \\ 3+g' & if \quad b=u \quad and \quad r=v \\ 5-r' & otherwise \end{cases}$$

$$H = 60*h$$

Among them, $V,S \in [0,1]; H \in [0,360];\ g,b,r \in (0,1),$ adopt cylinder distance measured HSV color space, if there are two points i, j, corresponding colors are $(V_i, H_i, S_i)$and (V_j, H_j, S_j), color distance measurement is:

$$d_{hue}(i,j) = \left|H_i - H_j\right| \quad \textbf{(17)}$$

$$d_{chroma}(i,j) = \sqrt{(S_i)^2 + (S_j)^2 - 2S_iS_j\cos(d_{hue}(i,j))} \quad \textbf{(18)}$$

$$d_{value}(i,j) = \left|V_i - V_j\right| \quad \textbf{(19)}$$

$$d_{hsv}(i,j)=\sqrt{d_{chroma}(i,j)^2+(d_{value}(i,j))^2} \quad \textbf{(20)}$$

When $d_{value}=0$, then it only needs to consider $H\text{and}S$ components, it carries out color space shadow elimination by such way, in the whole area that covered by shadow, background pixel always remains unchanged, according to above process, it can change current pixel value into shadow area, and then eliminate it, corresponding formula is :

$$Th<I_i/I_b<1, r_t=r_b, g_t=g_b \quad \textbf{(21)}$$

By above formula, we can get that rgb color space r, g numeric values present unstable rules, now, now is the time that pixel brightness is relative small, successive covered shadow region r, g will not always remain unchanged. And then it may causes its detection results incorrect, to solve the status, the paper adopts mixed color space form, when pixel presents different brightness, it can eliminate shadow in different color spaces.

$$X=\begin{cases}(r,g,I) & if\ I\geq Itd\\ (R,G,I) & if\ I<Itd\end{cases} \quad \textbf{(22)}$$

By above formula, when threshold value is smaller than monitoring scenes, carry out shadow elimination in the space of (r,g,I), and in case that scenes light ray is relative dark, carry out shadow elimination in the space of (R,G,I).

YUV color space shadow elimination

Under YUV color space, establish shadow model, estimate that shadow will cover pixel in advance, now brightness components will reduce, after that make comparison of U, V two aberration components to see whether they attenuate or not. Assume three colors channel average values are respectively μ_r,μ_u,μ_v, corresponding variances are respectively $\sigma_r,\sigma_u,\sigma_v$, corresponding values after color covering are X_r,X_u,X_v, to judge whether they are shadow areas, then it needs to meet formula as :,

$$a_{\min}<a_r<1 \; and \; a_r=X/\mu_r \quad \textbf{(23)}$$

$$\begin{aligned}(1/\sigma_U)\left|X_U-\alpha_r\mu_r\right|<TH_U\\ (1/\sigma_V)\left|X_V-\alpha_r\mu_V\right|<TH_V\end{aligned} \quad \textbf{(24)}$$

In above formula, $a_{\min}$ is color component maximum attenuation threshold value, when U, V pixel components are relative smaller, then it can prevent black objects existing in shadow. If above formula calculated quantity is relative small, scenes and chroma are not similar, and brightness will separate from real shadow with respect to dark scenes' targets.

Gaussian mixed model and HSV color space shadow elimination

For HSV color space preliminary discriminant shadow, it cannot define one pixel shadow region, then we can combine Gaussian mixed model with HSV color space to detect shadow region, corresponding flow chart is as following Figure 2shows:(from which I_i represents current pixel; I_B represents background pixel)

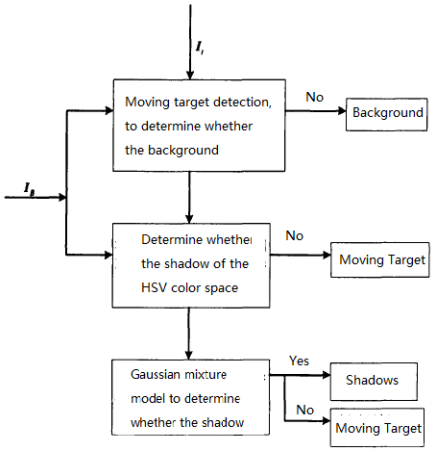

Figure 2 : Shadow detection flowchart

For above process, it can implement its simulation by emulational form, assume that in Gaussian mixed model, variance average value is 30, the first Gaussian function weights is assumed as 1, others are assumed as 0;HSV color space is detected space, respectively take $\alpha = 0.1; \beta = 0.9; \tau_H = 30; \tau_S = 0.9$, in model, variance lower limit is assigned 10, threshold value is assigned 0.7, variance learning rate is 0.002, and average value learning rate is 0.005, then it can get corresponding shadow elimination efficiency figure, when parameters assigned values are the same, in HSV color space, eliminate shadow by shadow color attributes will present many false detection, and after combining Gaussian mixed model with HSV color space, it can reduce its fault efficiency, besides after adjusting parameters values, it can promote its precise.

CONCLUSION

(1) The paper targeted at Gaussian mixed model's larger motion variance, poor timeliness and other causes, on this basis, it proposes Gaussian model improved forms, applies fixed learning rate to learn variance, and sets lower limit threshold value, targeted at the new type algorithm, according to different confusion extents, adopts different updating ways, finally through experiment verifying, we can get new type algorithm processing quality and speed is obviously faster than traditional algorithm.

(2) The paper combines Gaussian mixed model with HSV color space shadow elimination method, and modifies Gaussian mixed model's parameters, let its shadow elimination efficiency to be greatly promoted, and gets that shadow elimination method purely carrying on in HSV color space will appear great deviation, while adopts Gaussian mixed model learning way to combine with HSV color space shadow elimination ways then it will get closer to practice.

REFERENCES

[1] Li Chun-Ming; Moving Body Detection and Face Identification in Video Image:(Doctoral Dissertation), Xian: Xian University, **(2006)**.

[2] Du You-Tian, Chen Feng, Xu Wen-Li; Vision-Based Human Motion Identification Summary, Chinese Journal of Electronics, **35(1)**, 84-97 **(2007)**.

[3] Wang Tao; Video Image-Based Body Detection and Tracking Algorithm Research :(Master's Thesis). Xian: Northwestern Polytechnical University, **(2005)**.

[4] Wang Liang, Hu Wei-Ming, Tan Tie-Niu; Summary of Human Motion Vision Analysis, Chinese Journal of Computers, **25(3)**, 225-238 **(2002)**.

[5] Wang Dian; Mixed Gaussian-Based Background Modeling and Shadow Suppression Algorithm Research :(Master's Thesis), Xian: Northwestern Polytechnical University, **(2006)**.

[6] Yao Min; Digital Image Processing, Beijing: China Machine Press, 226-228 **(2006)**.

[7] Ruan Qiu-Qi; Digital Image Processing Science (Version Two), Beijing: Electronic Industry Press, 98-99 **(2007)**.

[8] Dai Ke-Xue, Li Guo-Hui, Tu Dan; Monitoring Video Moving Targets Detection Subtracting Background Techniques Research Status and Outlook, Journal of Chinese Image Graphics, **11(7)**, 919-928 **(2006)**.