ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

Data Association of Motion Components for Human Tracking in Thermal Images

Rupali C. Dagade[1], Prof. PankajA.Salunkhe [2], Sanjay V. Sonar[3]

Dept. of EXTC., SES GOI FOE, Mumbai University, India[1]

Assistant Professor, Dept of EXTC, YTIET, Mumbai University, India[2]

Dept. of EXTC., SES GOI FOE, Mumbai University, India[3]

ABSTRACT: Motion Tracking has been applied in many recent applications like surveillance, ADAS etc. Current research in this field includes making system robust and reliable in human tracking. We propose a novel approach for motion tracking using Thermal Imaging. This algorithm is not using the features of object to be tracked which is very much analogous to tracking with natural eyes in thermal imaging. We exploited the various types of data association like spatial data association, temporal data association, in the proposed approach in order to reduce the false decision. In addition to these, Wigner distribution was applied to the difference image for reducing the fluctuation in threshold image in terms of the false objects detection. Thus results obtained with this algorithm proves the efficient and error less performance of person tracking in thermal images.

KEYWORDS: Motion tracking; Human tracking; Video Surveillance; Thermal Video; Wigner Distribution

I. Introduction

Recent advances in digital storage and video hardware has led to new applications like surveillance, advance driver assistance system, non-cooperative biometrics, virtual reality etc. The cheaper cost and easy availability of imaging modality has attracted researcher’s attention in motion tracking system to be applied in a number of applications.
The purpose of our research work is to research the approaches for motion tracking of human beings using thermal imaging only. Emphasis is placed on using only thermal imaging using infrared cameras. Recently, there have been some attempts to include the thermal imaging in applications like face recognition and motion tracking in addition to the visible cameras.

However, if only one of the modalities is used and reliable results are obtained with it, cost saving and higher processing speed would be the benefits for the system. In applications like outdoor surveillance, thermal imaging can play vital role in identifying persons and tracking each of them. This fact has primly motivated us to use only thermal imaging for motion tracking of human beings. Another advantage regarding thermal imaging lies in the fact that it cannot sense shadow or light illumination, which is normally the bottleneck in most of the motion tracking based on visible camera. Thus, making it more suitable for motion tracking in out-door environment in day time as well as night time, where shadows and variable illuminations are dominating factors making tracking more difficult.

On the contrary, clutters like cool body, variation in temperature across same subjects, blowing winds with different temperature gradients and person overlap while crossing each other, put challenges in thermal imaging and will have to be handled intelligently in order to obtain the efficient performance from motion tracking system using only single imaging modality like thermal imaging.

II. Related work

In applications like outdoor surveillance, where the background temperature is largely different from human beings, thermal imaging can become crucial in identifying the moving person and in tracking them. This fact has primarily motivated us to use only thermal imaging for motion tracking of human beings. Another advantage of thermal imaging

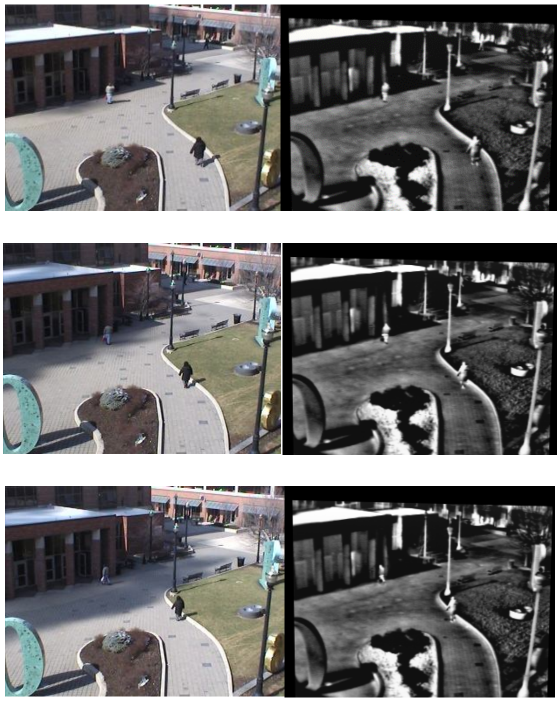
ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

is that it cannot sense the shadow or light illumination, which is normally a bottleneck in most of the motion tracking systems based on visible wavelength. Thus, thermal imaging become more suitable for motion tracking in outdoor environments in day time as well as night time, where shadows (see figure 1), non-uniform illumination and low light (night time) are dominating elements, making tracking more complex. On the other side, clutters like cool body, variation in temperature across same subject, blowing winds with different temperature gradients, person overlap while crossing each other, put challenges in thermal imaging and will have to be handled intelligently in order to achieve efficient and reliable performance from motion tracking system using thermal imaging only [1,2].



a) b)

Figure 1: Shadow effects frame 12, 160 and 248 (from top to bottom) taken simultaneously from a) Visible camera b) Thermal Camera.

The definition of motion tracking is to determine the position of object across the frames from image sequences/video. Based on the position of imaging instrument, two types of motion tracking are a possible:

- Static Camera Tracking
- Active Motion Tracking

Based on motion objects types, it is also classified in two categories:

- With Markers (used in 2D and 3D animations)
- Marker-less (of our interest)

Depending on the methodology by which motion tracking can be initiated, there are, typically, two classes of motion tracking algorithms:

- Recognition based tracking
- Motion based tracking

Depending on the type of motion to be tracked in human motion tracking, motion tracking applications can be placed in two categories:

- Articulated Motion
- Moving Motion

Multiple object tracking is required in most of the application including surveillance.

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

The advanced algorithm like particle filter is heavily relies on good feature selection to update the weights of each particle filter and hence posterior state distribution [17]. The recursive nature of this algorithm adds further importance to weight updatation based on good features. The standardization of this evaluation process can enable one to have performance of different features even before its application in tracking algorithm. Multiple object tracking is required in most of the applications including surveillance. In literature, various motion tracking technologies are described, such as Kalman filter (KF), extended KF, particle filter, unscented KF, hidden Markov model, affine transform and Gabor transform.

Motion tracking using motion estimation involves the matching of a moving object in the surrounding of its location on the next frame. There are the following approaches for finding the best matching unit [3,4,5]: pixel based (computationally complex), block based, region based and mesh based (triangle, hexagonal, content based). The process of best matching unit to estimate the motion vector includes search based in similarity criterion across the pixels in close vicinity in next frame. This search window is typically 15x15 pixels hence it needs high computational power. In order to reduce this computational complexity there are various optimization techniques in the literature: 2-D logarithm search [6], TSS [7], NTSS [8], FSS [9], two step multiple local winners based [10] and conjugate direction search [11]. Kalman filter [12] and particle filter [13] are the two popular technologies in the field of motion tracking. These methods are widely used in the visible camera based motion tracking.

III. METHODOLOGY

The typical motion tracking system is shown in figure 2, which is normally composed of imaging system, image processing algorithm to give location of objects and display device to show path of object and /or signal generation logic to detect the event.

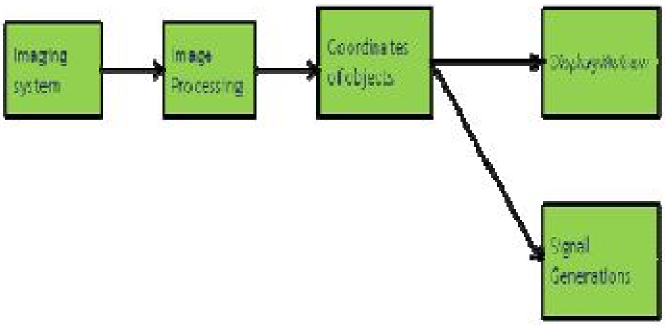


Figure 2: The typical motion tracking system

Our work is more towards the development of motion tracking algorithm to be applied on the images captured from thermal camera. The basic algorithmic approach is depicted in figure 3.

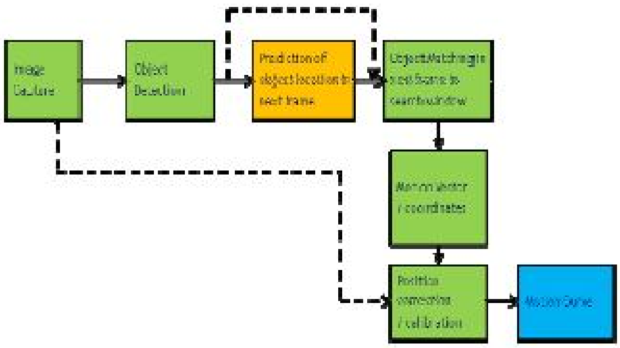


Figure 3: Generalized Motion Tracking Algorithm

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

Object Detection can be archived with the following approaches. Ref [2]. Figure 4 show the difference image.

- Image subtraction between successive frames is relatively easy approach
- If required morphological, operators can be used.
- Segmentation may be required

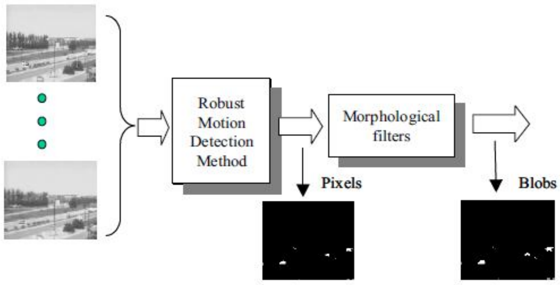


Figure 4 : Object detection

This work has been inspired from tracking done by natural eyes in thermal imaging. In the absence of features, eye can do tracking in images captured by thermal camera. For this purpose, we exploited the various types of data associations. There are two types of data association we exploited in this novel approach.

- Spatial Data association
- Temporal Data Association

First, we calculate the difference image between current frame and previous frame. The Wigner distribution is applied to the difference image. It is been observed , experimentally , that motion tracking over the difference image was more unstable(fluctuating) than that over the Wigner distribution of the difference image. Then Wigner image is threshold to get binary image. The foreground object map is created by giving different label to each object using 8-neibourhood connectivity. However, because of aforementioned clutters available in thermal images, false negative objects are huge in threshold image. Each object is threshold for size of the object in pixel. This step outputs the objects which are moving and sufficiently larger size Due to non-uniform temperature within in the same object, same person may exist in more than one blobs. To connect these blobs, we use vertical andhorizontal threshold of distance s between two nearby blobs. Due to vertical shape of person moving, vertical threshold was kept larger than horizontal one. This also helps in separating two persons close by moving in same direction. This step outputs the same label to close by blobs indicating close blobs are of same person.

We used temporal buffer to apply the temporal data association on the object yielded by previous step. Each object is evaluated for its centroid. This centroid is tested with existing objects in previous frames for their closeness. Nearest object from previous frame with distance less than threshold if found, its label is allotted to object from current frameindicating that object from previous frame is now at new position given by its centroid. The object width and height from previous frame are also allocated to object in current frame (in future objects history about width and height will be averaged or rule will be created to allot the height and width to object in current frame). The temporal buffer is updated with new object location.

DOI: 10.15680/ijircce.2015. 0308109

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

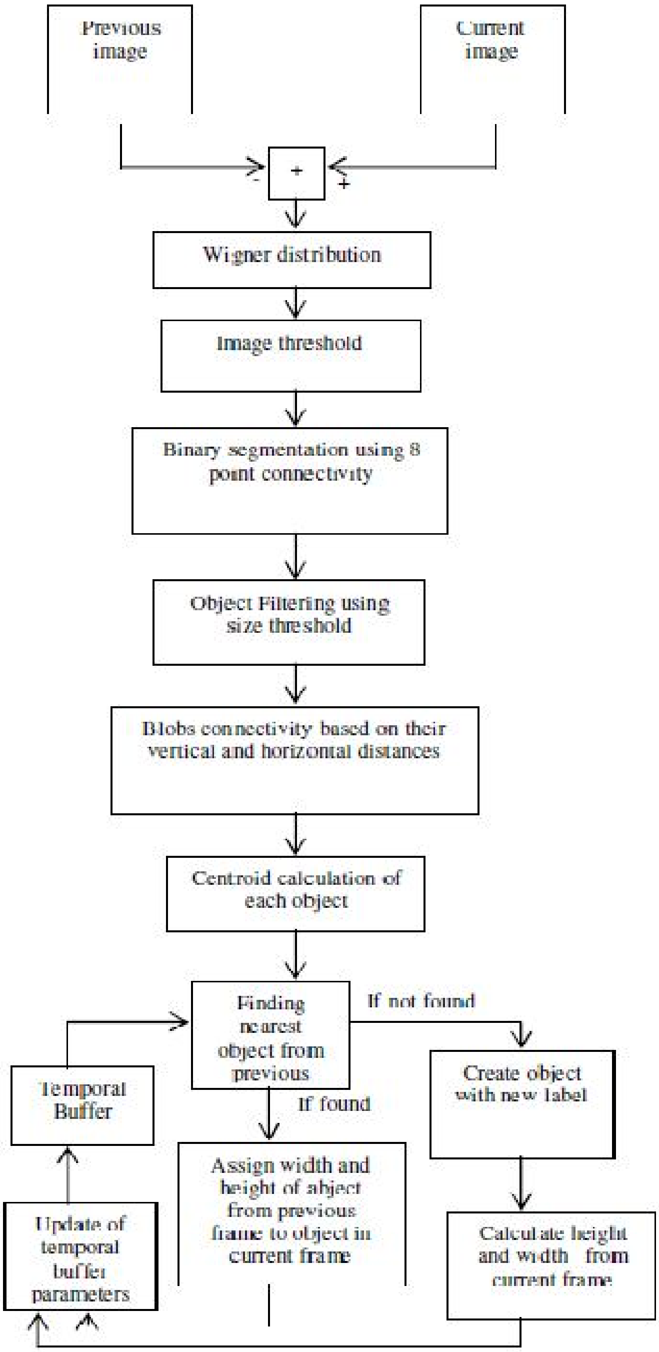


Figure 5: Flow chart for our algorithm

IV. Experimental Results and Discussion

The algorithm was developed in MATLAB and applied on the database available on OTCBVS website, ref [18]. We used third database, namely, OSU Color and Thermal Database. This database includes six image sequences each is of around 2500 frames, varies sequence to sequence. First three sequences are from one location with pedestrians. Second

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

sequence was taken from different location. Wigner image was threshold with threshold value 0.30. The threshold of size for filtering out false objects was 15 pixels. Depth of temporal buffer was four. Vertical and horizontal distance thresholds were 20 and 10 respectively. Minimum distance for object to be present in next frame as same object was 5 pixels in any direction. All these threshold parameters are kept constant for all the sequences. Color resolution of all the frames is 8-bit gray scale. The following discussion will be on the experimental results obtained in different sequences. It can easily observed that our algorithm has detected object even in the situation where it is not visible with human eye easily.

We applied this approach on the all the six sequences available in dataset. The figure 6 (a) show the results obtained on first frame sequence. In this frame (frame 1.59), two persons are moving and third person is stopped, which is very clear from results obtained with our algorithm. In frame 1.255, all three persons are moving, which has been captured by our algorithm in figure 6 (b). Similar situation with many people can be verified in figure 6(c) (frame 2.13). In figure 6 (d) (frame 3.259), it can be observed that our algorithm is capable of identifying the movement of multiple objects located at far distance from camera. Next figure 6(e) (frame 4.25) shows the strength of this approach by identifying the movement even behind tree which is not visible with human easily. Figure 6 (f) (frame 5.11) shows the changing temperature in field of view of the camera due to blowing wind. In this situation also, our algorithm is capable of avoiding the false negative recognition. Critical situation in figure 6(g) (frame5.17) shows, the changing temperature environment, and our approach was able to recognize the true positive object movement. In figure 6 (h) (frame 6.11), though person and vehicle, parked there, has same intensity, our algorithm has detected the moving person.

Thus results obtained with this algorithm proves the efficient and error less performance of person tracking in thermal images. Our future work, involves the obtaining the threshold automatically and / or making thresholds adaptive o the location of objects by considering the perspective parameters of camera.

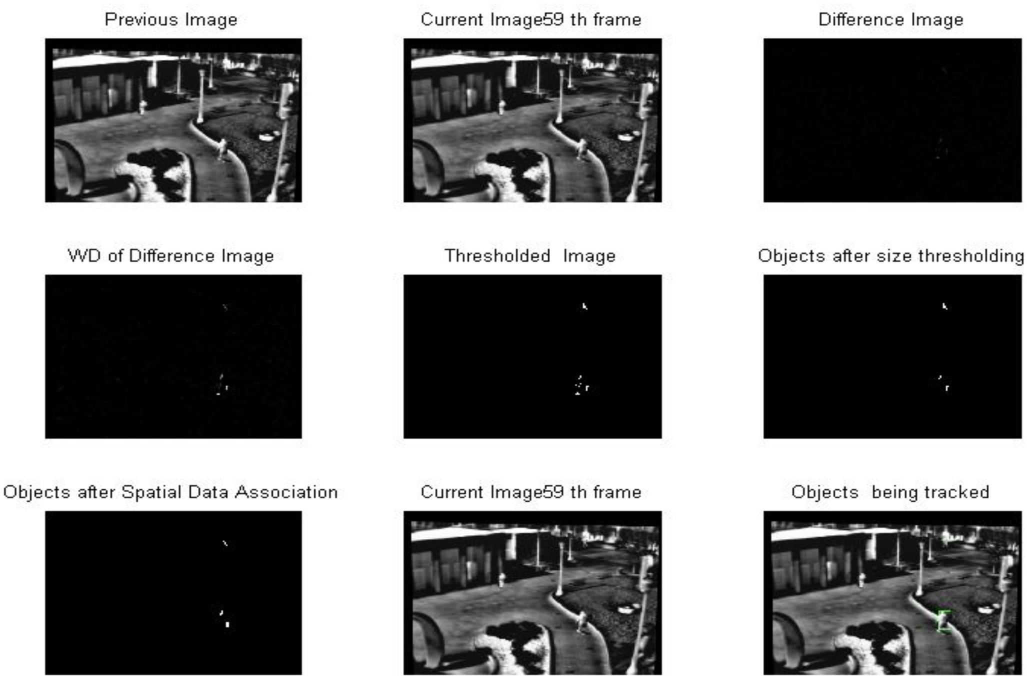


Figure 6 (a)

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

Figure 6(b)

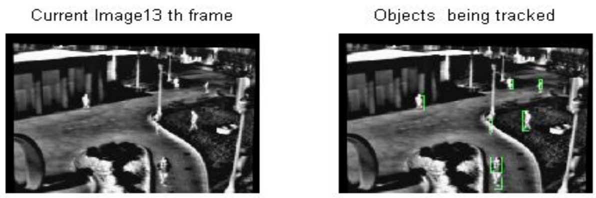


Figure 6 (c)

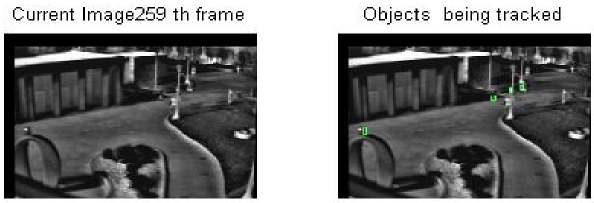


Figure 6 (d)

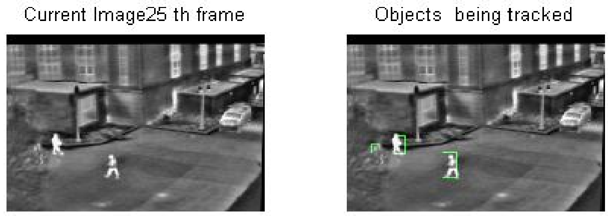


Figure 6(e)

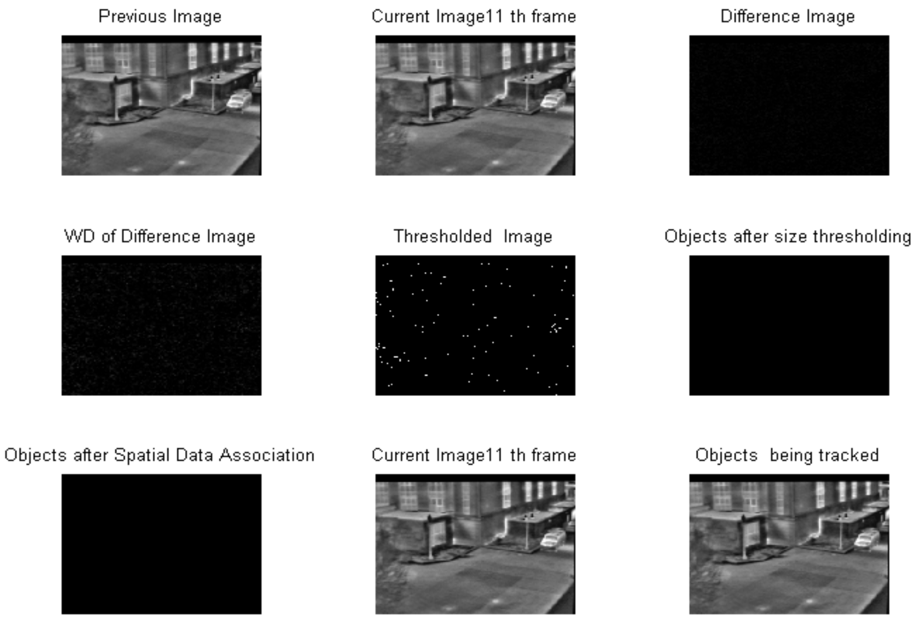


Figure 6 (f)

Figure 6 (h)

ISSN(Online): 2320-9801
ISSN (Print): 2320-9798

International Journal of Innovative Research in Computer and Communication Engineering

(An ISO 3297: 2007 Certified Organization)

Vol. 3, Issue 8, August 2015

V. CONCLUSION

We developed a novel approach for motion tracking using Thermal Imaging. This algorithm is not using the features of object to be tracked which is very much analogous to tracking with natural eyes in thermal imaging. We exploited the various types of data association like spatial data association, temporal data association, in the proposed approach in order to reduce the false decision. In addition to these, Wigner distribution was applied to the difference image for reducing the fluctuation in threshold image in terms of the false objects detection. Thus results obtained with this algorithm proves the efficient and error less performance of person tracking in thermal images. The computational complexity is very less in this algorithm.

Future work includes the adaptation of the threshold parameters. Also some more image sequences will be tested. More robust data association rules would be searched in order to have better performance from motion tracking system using thermal images.

REFERENCES

1. Lawrence B. Wol_, Diego A. Socolinsky, and Christopher K. Eveland, Chapter 6, \Face Recognition in the Thermal Infrared", Computer Vision Beyond the Visible Spectrum, Advances in Pattern Recognition, Springer, 2005
2. E. Herrero, C. Orrite, A. Alcolea, A. Roy, J.J. Guerrero, C. Sages, \Video-Sensor for Detection and Tracking of Moving Objects" IbPRIA, Pattern Recognition and Image Analysis, LNCS 2652, pages 346-353, 2003.
3. Van Beek, P.J.L.; Tekalp, A.M.; Puri, A.; \2-D mesh geometry and motion compression for e_cient object-based video representation", Int. Conf. on Image Processing, 1997. Volume: 3, 1997 , Page(s): 440 - 443 vol.3
4. Altunbasak, Y.; Murat Tekalp, A.; Bozdagi, G.; \Two-dimensional object-based coding using a content-based mesh and a_ne motion parameterization" Int. Conf. on Image Processing, 1995. Proceedings, Volume: 2 ,1995 , Page(s): 394 - 397 vol.2
5. Badawy, W.; Bayoumi, M.; \A mesh based motion tracking architecture", The 2001 IEEE Int. Symposium on Circuits and Systems, 2001. ISCAS 2001. Volume: 4, 2001 , Page(s): 262 - 265
6. Jain, J.; Jain, A.; \Displacement Measurement and Its Application in Interframe Image Coding", IEEE Trans. on Communications, Volume: 29 , Issue: 12, 1981, Page(s), 1799 - 1808
7. http :/www:ece:cmu:edu= ee899=project=deepakmid:htm
8. Reoxiang Li; Bing Zeng; Liou, M.L.; \A new three-step search algorithm for block motion estimation" IEEE Trans. on Circuits and Systems for Video Technology, Volume: 4 , Issue: 4 1994, Page(s): 438 - 442
9. Lai-Man Po; Wing-Chung Ma; \A novel four-step search algorithm for fast block motion estimation" IEEE Trans. on Circuits and Systems for Video Technology, Volume: 6 , Issue: 3 , 1996, Page(s): 313 - 317
10. Hsien-Hsi Hsieh; Yong-Kang Lai; \A novel fast motion estimation algorithm using _xed subsampling pattern and multiple local winners search" The 2001 IEEE Int. Symposium on Circuits and Systems, 2001. ISCAS 2001. Volume: 2 Page(s): 241 -244 vol. 2
11. Srinivasan, R.; Rao, K.; \Predictive Coding Based on E_cient Motion Estimation" IEEE Trans. on Communications, Volume: 33 , Issue: 8 ,1985 , Page(s): 888 -231
12. C. Stau_er and W. E. L. Grimson," Learning patterns of activity using real-time tracking", IEEE Trans. on Pattern Analysis and Machine Intelligence, 22(8):747-757, 2000.
13. M. Isard and A. Blake,"CONDENSATION-Conditional Density Propagation for Visual Tracking", Int. Journal of Computer Vision 29(1), 5-28 (1998)
14. K. Nummiaroa, E. Koller-Meierb and L.V. Gool,"An adaptive color-based particle _lter ", Image and Vision Computing Volume 21, Issue 1, 10 January 2003, Pages 99-11
15. C. S.Won, D. K. Park and S.J. Park,"E_cient Use of MPEG-7 Edge Histogram Descriptor ", ETRI Journal, Volume 24, Number 1, February 2002
16. Davis, J., Sharma, V.: \Background-subtraction using contour-based fusion of thermal and visible imagery". Computer Vision and Image Understanding 3(2-3) (2007) 162-182
17. S. Arulampalam, S. Maskell, N.J. Gordon, T. Clapp," A tutorial on particle filters for on-line non-linear/non-Gaussian bayesian tracking", IEEE Transactions of Signal Processing 50 (2) (2002) 174-188

BIOGRAPHY

RUPALI CHARUDATTA DAGADE was the lecturer in the Electronic & telecommunication Department, Yadavrao Tasgaonkar Polytechnic ,MSBTE Mumbai University. She received Bachelor of Electronic & Telecommunication degree in 2011 from KGCE, Karjat , Mumbai University,Maharshtra, India. Her research interests are Image Processing, Digital Processing,,Laser Communication,Mobile Communication etc .