Fuzzy Change Detection in a spatial scene

Nadeem Salamat, El-Hadi Zahzah

Fuzzy Change Detection in a spatial scene

Nadeem SALAMAT
MIA laboratory
University of La Rochelle, Avenue M. Crepeau
La Rochelle 17042, France
nsalam01@univ-lr.fr

El-hadi ZAHZAH
MIA laboratory
University of La Rochelle, Avenue M. Crepeau
La Rochelle 17042, France
ezahzah@univ-lr.fr

***Abstract*—Spatial relations are used in different fields of image understanding, spatial reasoning, linguistics description of scene and new fields like computing with words. These spatial relations can be used to detect changes in a spatial scene, either it is a change in a topological structure or a change in metric information. Three type of spatial relations can be described by fuzzy Allen histograms. As motion cause changes in a spatial scene, this change can be detected with the help of spatio-temporal relations. Different qualitative methods are used to detect changes in scene, for each type of relation a separate model is used.**
In this paper a new methods for detecting the change in a spatial scene is proposed. This methods becomes important for detecting change when the metric relations i.e. when directional and distance informations becomes zero in qualitative methods. A histogram of fuzzy Allen relations are used to detect the change in a spatial scene and fuzzy histograms are compared by a similarity measure to detect the change in spatial scene.

***Keywords*-spatio-temporal relations, Fuzzy histogram of Allen Relations, Quantitative spatial change, Similarity measure**

I. INTRODUCTION

Advent of digital computers has resultant in a rapid expansion is the use of quantitative methods through most of human knowledge. Imprecise knowledge information give rise to fuzzy methods. Changes are concerned with the movement of objects. In daily life observations, objects change their locations, orientations, shapes and sizes over time such as moving objects, mobile devices, cities, lakes or solid objects in movement due to camera positions. A gradual location change of an object may be interpreted as object movement in the embedded space. Object motion takes place in space and time, therefore behavior of moving objects can be discussed in terms of spatio-temporal relations between the objects in scene. Change in object size by expanding or reducing is correspond to the scaling or deformation of the objects. Mostly the reasoning methods depend upon the object location and shape. Detection of this change is important to take different decisions, categorizing spatio temporal relations or starting new processes. These changes can be observed by multiple observation of scene or by comparing the different frames of a video in video analysis.
A spatial scene can be completely described by geometric objects along with their spatial relations such as topological, distance and directional relations. Mostly spatio temporal relations are studied in a separate domains and a variety of researchers such as M. Schneider [5], Nico Van de Weghe et al. [12], [9], [7] etc all emphasis on qualitative methods where they always consider the disjoint objects. They used spatio-temporal changes to model the relations between moving objects on road networks. These spatio temporal changes are essential part of artificial intelligence, formation and disappearance of storms and other natural phenomenon [11] where the some new objects appear and disappear in scene. S. Chaudhary et al. in [13] used fuzzy spatio-temporal relations to describe the video contents. They used histogram of forces which represents limited number of topological relations and movement or expansion of spatial objects can cause to change the topological relations, metric relations or both at the same time. Following are the examples of different moving objects, which shows that moving objects can change the shape, size and locations as a result in the scene the topological relations, metric relations or directional relations between the geometric objects are changed.

- According to the ontological point of view, the cities expand due to increase in inhabitants and their expansion is not uniform. A city or residential area expands over time which can change the spatial relations with respect to the other objects over time. This expansion is irregular and may cause only metric relations changes such as distance or directions. Now consider an example of a city and building outside the city, call museum, first of all it is away from city in east, then city gradually expands and covers the land area around it, in this way the city becomes closer and every corner have a different directional relation with the museum. This scene is explained in figure 1 and (a),(b),(c) and (d) are different views of scene over time.

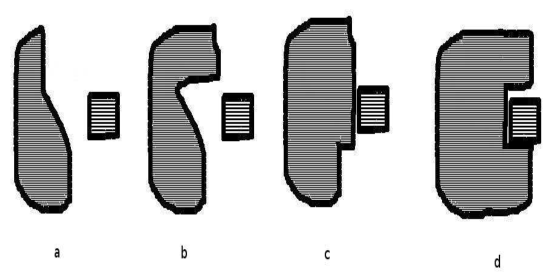


Fig. 1. City changes the size over time and metric relations with museum

- A log close to a lake may go through a variety of topological relationships. When the water surface is too low, that there is a land between the water surface and log. With increase in water level the log will have imediate access to the water surface with continuous increase in water surface log first partially under water then completely under water at edge and finally it may become an island in lake. These relations are explained in figure 2

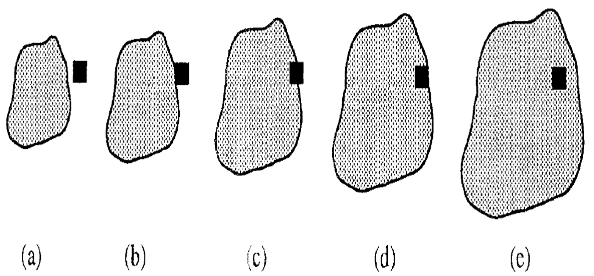


Fig. 2. Changes in topological relationship between lake and log. [2]

- Consider that a cat jumps over the wall, then both the objects don't change their size, only directional relation is changed at each instant of time. A pictorial scene looks like figure 3, where circular object is used to represent the cat position.

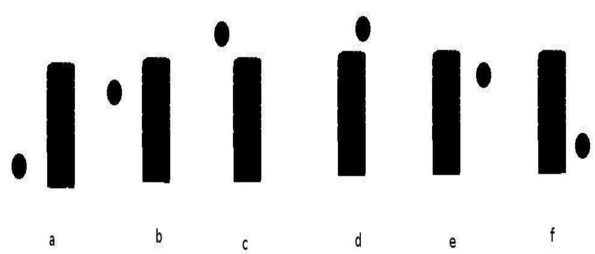


Fig. 3. View of cat jump over the wall

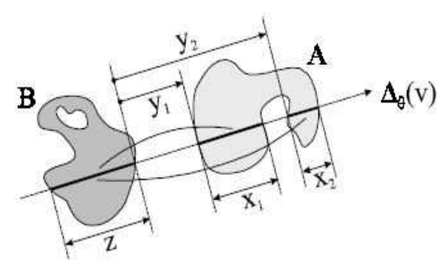
In defining the spatio- temporal relations rigid objects are considered they don't change or split during the movement. Moreover camera motions such as booming, tilting, panning and zooming are not considered. They move continuously and they change their positions to the neighborhood for this purpose concept of gradual changes is introduced. Models for changes of topological relationship are relevant to spatio-temporal reasoning in geographic spaces, as they derive the most like configuration and allow for prediction about significant changes. Such predictions are important methods for reasoning in large scale space and geographic spaces [2] and point set topology is used to determine the topological relations. Where the topological distances are defined between the topological relations to observe that how much change has occurred and same object pair is considered at two different times. A similar approach is adopted by John Z. in [3] where the qualitative directional relations are computed, trajectory of moving objects is represented by 8 directions and distance between these qualitative relations are defined to assess the gradual changes in directional relations. It has been recognized that a qualitative change occur if the deformation of an object effects its topological relations. This method is inspired by Max J. Egenhofer's method [2] of topological distances by considering the directional relations.

Qualitative methods can not detect small changes while the objects are overlapping, contained, contained_by or disjoint. More precisely these methods are qualitative not fuzzy. This paper investigates that how an existing method of combined extraction of topological and directional relations [8], [15] methods can be used to detect the topological or metric changes between the two spatial objects. Motion can be seen as spatio temporal changes, where spatial relation may change with time. This paper is arranged as follows, section 2 describes the histogram of fuzzy Allen relations, in section 3 effect of spatial change on histogram of fuzzy Allen relations and its measure is described, section 4 consists of experiments and section 5 concludes the paper.

II. Histogram of Fuzzy Allen Relations and Terminology Used

A. Oriented lines, segments and longitudinal sections

Let A and B be two spatial objects, $(v, \theta) \in R$, where v is any real number and $\theta \in [-\pi, \pi]$. $\Delta_\theta(v)$ is an oriented line at orientation angle θ. $A \cap \Delta_\theta(v)$ is the intersection of object A and oriented line $\Delta_\theta(v)$. It is denoted by $A_\theta(v)$, called segment of object A and its length is x. Similarly for object B where $B \cap \Delta_\theta(v) = B_\theta(v)$ is segment and z is its length. y is the difference between the maximum value of $B \cap \Delta_\theta(v)$ and minimum of $A \cap \Delta_\theta(v)$(for details see [8]). In case of polygonal object approximations (x, y, z) can be calculated from intersecting points of line and object boundary, oriented lines are considered which passes through one vertex of two polygons. If there exist more than one segment then it is called longitudinal section as in case of $A_\theta(v)$ in figure 4(a)



(a)

Fig. 4. Oriented line $\Delta_\theta(v)$, segment as in case of object B, longitudinal section as in case of object A.(Matsakis [8])

B. 1D Allen relations in space

Allen in [1], introduced the well known 13 jointly exhaustive and pairwise disjoint (JEPD)interval relations based on temporal interval algebra. These relations are arranged as $A = \{<, m, o, s, f, d, eq, d_i, f_i, s_i, o_i, m_i, >\}$. where $\{<, m, o, s, f, d, \}$ ($\{d_i, f_i, s_i, o_i, m_i, >\}$) are the relation *before, meet, overlap, start, finish, during* (resp the inverse relations of the cited ones). The relation eq is the equality spatial relation. All the Allen relations in space are conceptually illustrated in figure 5. These relations have a rich support for the topological and directional relations.

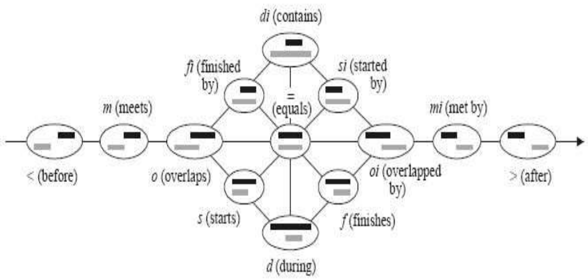


Fig. 5. Black segment represents the reference object and gray segment represents argument object. figure extracted from [8]

C. Fuzzification of Allen relations

In real applications, small errors in crisp values can change the entire result when gradual changes of topological relations occur over time. To cope with these problems fuzzification was introduced, it comprises the process of transforming crisp values into grades of membership for linguistic terms of fuzzy sets. Fuzzification process of Allen relations do not depend upon particular choice of fuzzy membership function, trapezoidal membership function is used due to flexibility in shape change. Let $r(I, J)$ is Allen relation between segments I and J where $I \in A$(argument object) and $J \in B$ (reference object), r' is the distance between $r(I, J)$ and its conceptional neighborhood. We consider a fuzzy membership function $\mu : r' \longrightarrow [0, 1]$. The fuzzy Allen relations defined by Matsakis [8] are

$$f_b(I, J) = \mu_{(-\infty,-\infty,-b-3a/2,-b-a)}(y)$$

$$f_m(I, J) = \mu_{(-b-3a/2,-b-a,-b-a,-b-a/2)}(y)$$

$$f_O(I, J) = \mu_{(-b-a,-b-a/2,-b-a/2,b)}(y)$$

$$f_f(I, J) = min(\mu_{(-(b+a)/2,-a,-a,+\infty)}(y), \mu_{(-3a/2,-a,-a,-a/2)}(y) \mu_{(-\infty,-\infty,z/2,z)}(x))$$

$$f_s(I, J) = min(\mu_{-b-a/2,-b,-b,-b+a/2}(y), \mu_{(-\infty,-\infty,-b,-(b+a)/2)}(y), \mu_{(-\infty,-\infty,z/2,z)}(x))$$

$$f_{si}(I, J) = min(\mu_{(-(b+a)/2,-a,-a,+\infty)}(y), \mu_{(-3a/2,-a,-a,-a/2)}(y) \mu_{(z,2z,+\infty,+\infty)}(x))$$

$$f_{fi}(I, J) = min(\mu_{-b-a/2,-b,-b,-b+a/2}(y), \mu_{(-\infty,-\infty,-b,-(b+a)/2)}(y), \mu_{(z,2z,+\infty,+\infty)}(x))$$

$$f_d(I, J) = min(\mu_{(-b,-b+a/2,-3a/2,-a)}(y), \mu_{(-\infty,-\infty,z/2,z)}(x))$$

$$f_{di}(I, J) = min(\mu_{(-b,-b+a/2,-3a/2,-a)}(y), \mu_{(z,2z,+\infty,+\infty)}(x))$$

$$f_{Oi}(I, J) = \mu_{(-a,-a/2,-a/2,0)}(y)$$

$$f_{mi}(I, J) = \mu_{(-a/2,0,0,a/2)}(y)$$

$$f_a(I, J) = \mu_{(0,a/2,\infty,\infty)}(y)$$

where $a = min(x, z)$, $b = max(x, z)$, x is the length of longitudinal section of argument object A, and z is the length of longitudinal section of reference object B. Most of relations are defined by one membership function and some of them by the minimum value of more than one membership functions like $d(during)$, $d_i(during\_by)$, f $(finish)$, f_i $(finished\_by)$. In fuzzy set theory, sum of all the relations is one, this gives the definition for fuzzy relation $equal$. Fuzzy Allen relations are not Jointly Exhaustive and Pairwise Disjoint (JEPD) because there exist at least two relations between two spatial objects.

D. Treatment of longitudinal sections

During the decomposition process of an object into segments, there can be multiple segments depending on object shape and boundary which is called longitudinal section. Different segments of a longitudinal section are at a certain distance and these distances might effect end results. In polygonal object approximation, instead of applying fuzzification algorithm depicted by Matsakis [8] for fuzzification of segments fuzzy operators are used. In this case each fuzzy Allen relation is a member of fuzzy set, fuzzy $T-norms$and $T-conorms$ are used for fuzzy integration of available information. $\mu_{(OR)}(u) = max(\mu_{(A)}(u), \mu_{(B)}(u))$
When fuzzy operator OR is used, only one fuzzy value contributes for the resultant value which is $maximum$. In this case each Allen relation has a fuzzy grade objective is to accumulate the best available information. Suppose that longitudinal section of object B has two segments such that $z = z_1 + z_2$ where z_1 is the length of first segment and z_2 is the length of second segment and z is length of longitudinal section. Let $\mu_1(y_1)$ defines the value of fuzzy Allen relations with the first segment and $\mu_2(y_2)$ represents value of fuzzy Allen relations with the second segment where y_1 and y_2 are the distances between object A and two segments of B. Now fuzzy OR operator is used to get consequent information obtained from two sets of fuzzy Allen relations.

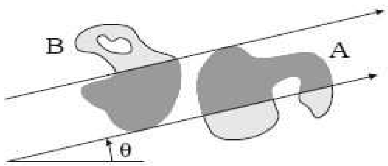


Fig. 6. Histogram of fuzzy Allen relation in direction θ

E. Fuzzy histogram of Allen relations and its normalization

Histogram of fuzzy Allen relations represents the total area of subregions of A and B that are facing each other in given direction θ [8]. Area of subregions of object A and B represented by dark gray color in figure 6 represents a histogram of fuzzy Allen relation in given direction θ. In case of polygonal object approximation which is considered by N. Salamat and Eh. Zahzah [15] to meet the problem of temporal complexity, fuzzy histogram of Allen relations can be written mathematically as:

$$\int_{-\infty}^{+\infty} (\sum_{r \epsilon A} F_r(q, A_q(v), B_q(v)) dv = (x+z) \sum_{k=1}^{n} r(I_k, J_k)$$

where z is the area of reference object and x is area of augmented object in direction θ, n is total number of segments treated and $r(I_k, J_k)$ is an Allen relation for segmentsI_k, J_k. Allen histograms can easily be normalized by dividing all Allen relations by the sum of all the Allen relations for every θ in the given direction. It is represented by $\lceil F_r^{AB}(\theta) \rfloor$ where $r \in A$. $\lceil F_r^{AB}(\theta) \rfloor = \frac{F_r^{AB}(\theta)}{\sum_{\rho \in A} F_\rho^{AB}(\theta)}$.

III. Change detection

This section consist of two parts, first the effect of a change on a fuzzy histogram of Allen relations, second section describes how to measure these changes.

A. Effect of change on fuzzy histogram of Allen relations

To describe the relative position of object pair in an image, there exist three types of relations named as topological, directional and distance relations. These spatial relations are explained in figure 8 and can be arranged as tuple (R, α, D, T). Where R is the topological relation, α is the directional relation and D denotes the distance relation between objects A, B and T denotes the time.
This representation is already used in [4] to represent the spatio-temporal relations between moving objects. When the relations are captured with the help of 1D Allen relations, the distance relations has the importance when the objects are disjoint. For the disjoint relations the distance relations can be estimated from the support of a fuzzy Allen histogram because directional relations are proportional to the visual rang of object [14]. This range is inversely proportional to the distance between the objects.i.e. Closer the distance between objects, larger will be the support for the fuzzy Allen relations

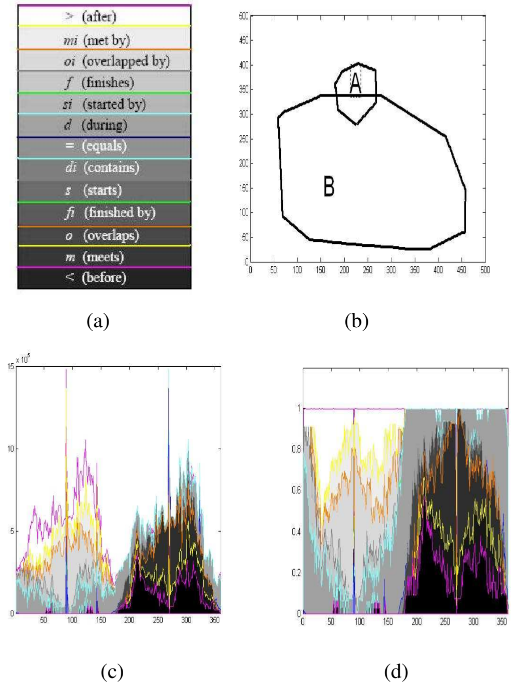


Fig. 7. (a) Histogram representation (b) Overlapping objects (c)Un normalized fuzzy histogram of Allen relations (d) Corresponding normalized fuzzy histogram of Allen relations

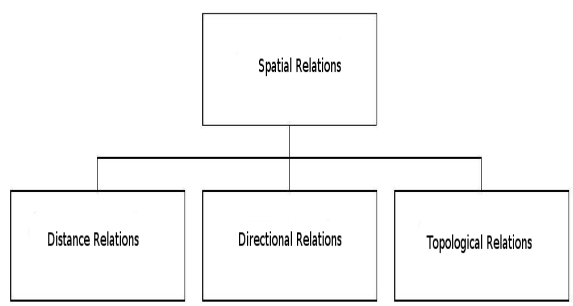


Fig. 8. Spatial Relations for a static image

histograms and vice versa. Thus the above relations can be described as

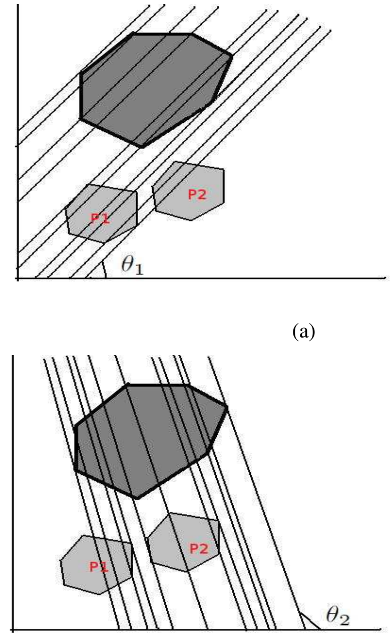
$$(\text{Fuzzy Allen Relations}, \text{Support of histograms}, T)$$

where fuzzy allan relations represents the thirteen fuzzy Allen relations and support of histograms represents the directions where histograms have non zero values and it is an interval between $[0, 2\pi]$ of a period 2π and T is time. To detect the change in a spatial scene topological relations between objects and there histograms can be compared at two different time intervals. When the 13 Allen relations are represented in a histogram, each bin of this histogram consist of a matrix of $13 \times n$ where n represents the total number of segments treated in the process. Suppose these relations are arranged in a following way

$$\begin{pmatrix} < \\ m \\ o \\ s \\ f \\ d \\ = \\ di \\ fi \\ si \\ oi \\ mi \\ > \end{pmatrix} = \begin{pmatrix} a_{1,1} & a_{1,2} & \cdot & \cdot & a_{1,j} & \cdot & \cdot & \cdot & a_{1,n} \\ a_{2,1} & a_{2,2} & \cdot & \cdot & a_{2,j} & \cdot & \cdot & \cdot & a_{2,n} \\ a_{3,1} & a_{3,2} & \cdot & \cdot & a_{3,j} & \cdot & \cdot & \cdot & a_{3,n} \\ a_{4,1} & a_{4,2} & \cdot & \cdot & a_{4,j} & \cdot & \cdot & \cdot & a_{4,n} \\ a_{5,1} & a_{5,2} & \cdot & \cdot & a_{5,j} & \cdot & \cdot & \cdot & a_{5,n} \\ a_{6,1} & a_{6,2} & \cdot & \cdot & a_{6,j} & \cdot & \cdot & \cdot & a_{6,n} \\ a_{7,1} & a_{7,2} & \cdot & \cdot & a_{7,j} & \cdot & \cdot & \cdot & a_{7,n} \\ a_{8,1} & a_{8,2} & \cdot & \cdot & a_{8,j} & \cdot & \cdot & \cdot & a_{8,n} \\ a_{9,1} & a_{9,2} & \cdot & \cdot & a_{9,j} & \cdot & \cdot & \cdot & a_{9,n} \\ a_{10,1} & a_{10,2} & \cdot & \cdot & a_{10,j} & \cdot & \cdot & \cdot & a_{10,n} \\ a_{11,1} & a_{11,2} & \cdot & \cdot & a_{11,j} & \cdot & \cdot & \cdot & a_{11,n} \\ a_{12,1} & a_{12,2} & \cdot & \cdot & a_{12,j} & \cdot & \cdot & \cdot & a_{12,n} \\ a_{13,1} & a_{13,2} & \cdot & \cdot & a_{13,j} & \cdot & \cdot & \cdot & a_{13,n} \end{pmatrix}$$

Each column corresponds to an observer's arguments. These values are summed up in a single value to form a final opinion, different operators are used. Most values in a column of this matrix are zero. Object under relative motion may undergo the topological structure of scene or topological structure remains same but it changes the order relations or metric relations. When the object changes a topological relation, values changes the rows remaining in the same column, when it changes the directional relation, the values changes from one matrix to other. When objects do not change their topological relation, they only change distance information between them, total number of non zero values in matrix or total number of matrix having same values are changed. This phenomenon is represented by the figure 9(a) and figure figure 9(b) where object A is represented by light gray value and object B is represented by dark gray value and P_1 represents the position of object A at time t_1 and P_2 represents the position of object A at time t_2 when the object moves to the new location with respect to object B. Some number of observers in direction θ_1 claims that the object A is before the object B for position P_1 while no observers claims that object A is before object B in the given direction for position P_2. but when the object A moves towards the new position, the number of observers in new direction θ_2 who claim that object A is before B increases and surface area of two objects also changes, by this way histogram translated to the new position.

Normalized fuzzy histograms are considered as fuzzy sets, where core and support of a fuzzy set depends directional and distance contents, if core and support is translated, then object changes only directional relation and if shrinks or expands then object changes the distance relations and change detection can be considered as the inverse of assessing similarity between spatial scene, for detecting change in a spatial scene three types of relations, topological, directional and distance relations are compared. When the spatial relations are computed by the fuzzy histogram of Allen relations, the normalized histograms are considered as a fuzzy set whose support is inversely proportional to the distance and each topological relation is corresponds to a histogram in a direction.



(a)

(b)

Fig. 9. Arguments at different angles where P_1 represents position of object A at time t_1 and P_2 represents position of object A at time t_2

B. Change measure

This change in the spatial scene can exist in three different ways, change in topological, directional and distance relations. These changes can effect the fuzzy Allen histograms in three ways (i) Emerges a new histogram or disappears an existing histogram,(ii) Changes the support of a histogram i.e. histogram support shrinks or expands (iii) Histogram support is translated. When an existing histogram disappears or new histogram appears it means object changes its topological relations. When the histograms expand or shrinks then the object is changing the distance information. To measure these changes different methods of similarity or dissimilarity can be used, as they are the inverse of each other. A similarity measure is used to access the degree of similarity of two images according to spatial relations between objects. Dissimilarity is the negation of similarity so dissimilarity could be defined as

$$\mu_{Dissimilarity} = \overline{\mu_c} = 1 - \mu_c$$

Similarity measures are:

$$\begin{aligned} \mu(A,B) &= \frac{|A \cap B|}{|A \cup B|} \\ &= \frac{\sum_\theta [min(A(\theta), B(\theta))]}{\sum_\theta [max(A(\theta), B(\theta))]} \end{aligned} \quad (1)$$

$$\mu_T(h_1,h_2) = \frac{\sum_\theta (min(h_1(\theta), h_2(\theta)))}{\sum_\theta (max(h_1(\theta), h_2(\theta)))} \quad (2)$$

$$\mu_c(h_1,h_2) = \frac{\sum_\theta (h_1(\theta) h_2(\theta))}{\sqrt{\sum_\theta (h_1^2(\theta)}\sqrt{\sum_\theta h_2^2(\theta))}} \quad (3)$$

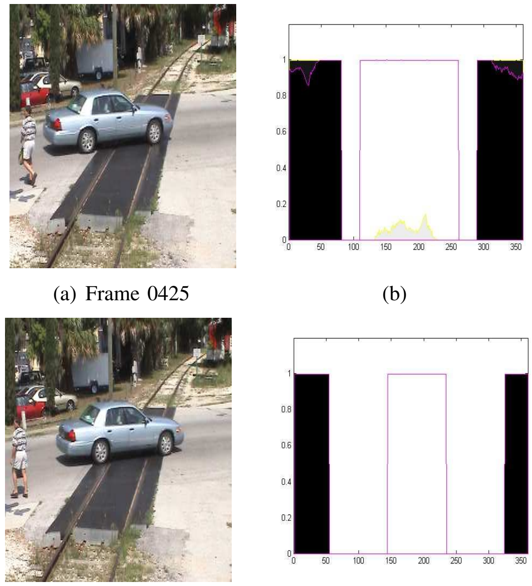
μ is denoted by M_6 in Valerie De Witte1 et al. [10] is histogram comparison method, which is simply an extension of jaccard's coefficient to compare a histogram. μ_T stands for Tversky index and μ_c is normalized cross correlation for similarity measure. Equation 1 can easily be calculated by using $t-norms$ and $t-conorms$. These measures satisfy :
$0 \leq \mu(h_1, h_2) \leq 1$;
$h_1 = h_2 \Rightarrow \mu(h_1, h_2) = 1$;
$\mu(h_1, h_2) = \mu(h_2, h_1)$;
$\mu(qh_1, qh_2) = \mu(h_1, h_2)$ Histogram measure represented in equation 3 also has the property: $\mu(q_1 h_1, q_2 h_2) = \mu(h_1, h_2)$. Where normalized cross correlation is invariant to the camera zooming so due to this reason it is preferred to use this similarity measure. As most of the fuzzy Allen relations are reorientation of each other [16] and for any θ, this reorientation reflects through the following equations. $F_b^{AB}(\theta) = F_a^{AB}(\theta+\pi)$,$F_{mi}^{AB}(\theta) = F_m^{AB}(\theta+\pi)$, $F_{oi}^{AB}(\theta) = F_o^{AB}(\theta+\pi)$,$F_{si}^{AB}(\theta) = F_{fi}^{AB}(\theta+\pi)$,$F_d^{AB}(\theta) = F_d^{AB}(\theta+\pi)$,$F_{=}^{AB}(\theta) = F_{=}^{AB}(\theta+\pi)$, In other words, only eight Allen histograms are independent and $F_d^A B(\theta)$, $F_{di}^A B(\theta)$, $F_{=}^A B(\theta)$ are periodic of period π. In this way we have to compare 8 dissimilarity measures corresponds to 8 2D topological relations. A vector or a similarity row or column matrix could be defined. If each element of this matrix is zero then there is no spatial change in the spatial scene.

IV. Experiments

for the experiment purposes, All the 13 fuzzy Allen histograms are calculated from angle measure $[0, 360]$ with the increment of one degree and similarity between them. In practice 8 fuzzy Allen histograms can be computed from [0,180] using the above cited relations. In the first example (figure 10(a) to 10(d)), we consider two frames of a well known image sequence of Y. Sheikh and M. Shah [6] where both objects are moving in opposite directions where the speed of the car is h_1 and speed of man is considered as h_2. If the one object say reference object B (car) is considered at rest and the object A is under motion, then net speed of object A will be $h_1 + h_2$. Here manual segmentation is taken, because here the problem is to detect the change in the scene not the segmentation. As at each frame the distance between the object increases, at the first analysis frame the fuzzy meet relation exists i.e. in terms of Allen relations fuzzy meet and meet_by relations exists along with certain directions. When the distance between the objects increase, the histogram for the relations meet and meet_by. Then the similarity between the two histograms are calculated.
All those histograms which don't exist, the similarity or dissimilarity between them is considered to be zero. Dissimilarity matrix will be

$$(0.25, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0.25)$$

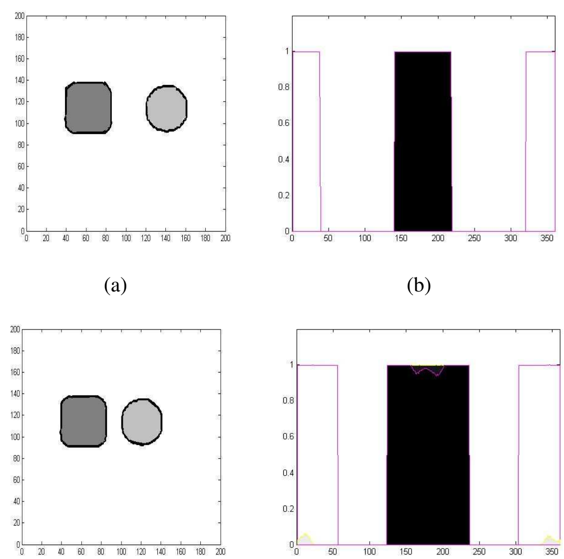
In second example (For reference figure 11(a) to 11(d)) In this example two trail objects are considered for experimental purposes, rectangular object B represented by dark gray color, and circular object A is represented by the light gray color. In fact, the example represents the inverse phenomenon to the example 1. At initial stage the objects are at a certain distance, they have only disjoint topological relation, when the distance between them decreases to a certain extent, emerges a new histogram for the fuzzy meet relation. Although the objects don't meet but fuzzification is object size dependant. As a result, whole topological structure is changed and a new fuzzy topological relations exists in certain directions.



(a) Frame 0425 (b)

(c) Frame 0430 (d)

Fig. 10. Two frames of an image sequence of Y. Sheikh and M. Shah [6] and their spatial relations



(a) (b)

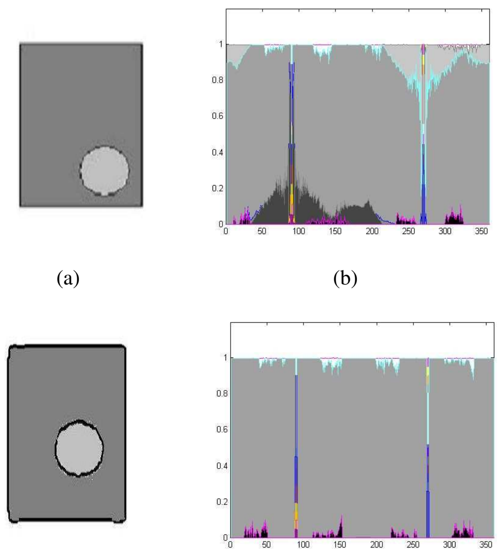
(c) (d)

Fig. 11. (a) and (c) are images where in (c) object A moves towards object B (b) and (d) are their histogram representations.

Dissimilarity matrix will be

$$(0.17, 1, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0.17)$$

In third example (figure 12(a) to 12(d)) when the object A (light gray object)is inside the object B(dark gray object), fuzzy Allen histograms are calculated there exist number of histograms due to fuzzification. In the second case object A slightly changes its position while remaining inside the object B, for experimental purpose object A is translated by (-10,20), this results change in the fuzzy histograms. In this example qualitative directional and distance relations don't exist, and there is no qualitative change in spatial scene. But in fact there is a change in spatial scene, that object A has changed its location.



(a) (b) (c) (d)

Fig. 12. (a) and (c) are images where in (c) object A moves towards the center of object B (b) and (d) are their histogram representations.

Dissimilarity matrix will be

$$(0.40, 0.01, 0.01, 0.93, 0, 0, 0.02, 0.02, 0, 0.93, 0.01, 0.01, 0.40)$$

V. Conclusion

Most of the existing methods for scene similarity are qualitative, as similarity depends upon topological, directional and distance relations. In these methods, small changes in the spatial relations cannot be detected. A fuzzy method for detecting small changes in scene is introduced and a fuzzy similarity function is used to detect the change in spatial scene structure. This method works when the qualitative methods fail to detect the small changes, particularly when the directional and distance informations become uneffective.i.e. object is inside an object. In dynamic scene analysis or in video analysis these changes have a fundamental importance and can be used to describe the spatial relations between moving objects or for defining different types of spatio temporal relations. These changes may be in topological, directional or distance relations.

References

[1] Allen JF, *Maintaining Knowledge about Temporal Intervals* , Communications of the ACM **26(11)** (1983), 832–843.

[2] Max J. Egenhofer and Khaled K. Al-Taha, *Reasoning about Gradual Changes of Topological Relationships*, Proceedings of the International Conference On GIS - From Space to Territory (London, UK), Springer-Verlag, 1992, pp. 196–219.

[3] John Z. Li, M. Tamer, Duane Szafron, and Sw Gbt Ddi, *Modeling of Moving Objects in a Video Database*, Proceedings of IEEE International Conference on Multimedia Computing and Systems, 1997, pp. 336–343.

[4] C. Shim and J. Chang, *Content-based retrieval using trajectories of moving objects in video databases*, Database Systems for Advanced Applications, International Conference on **0** (2001), 0168.

[5] Ralf H. Güting and Markus Schneider, *Moving objects databases*, Morgan Kaufmann Publishers, 2005.

[6] Yaser Sheikh and Mubarak Shah, *Bayesian modeling of dynamic scenes for object detection*, IEEE Transactions on Pattern Analysis and Machine Intelligence **27** (2005), no. 11, 1778–1792.

[7] Nico Van de Weghea Anthony G. Cohnb Philippe De Maeyera, Frank Witlox, *Representing Moving Objects in Computer-based Expert Systems: The Overtake Event Example* , Expert Systems with Applications **29** (November 2005), no. 4, 977–983.

[8] P.Matsakis and Dennis Nikitenko, *Combined Extraction of Directional and Topological Relationship Information from 2D Concave Objects, in fuzzy modeling with spatial informations for geographic problems*, Springer-Verlag Publications, pp. 15-40, New York, 2005.

[9] Nico Van de Weghe, Anthony G. Cohn, Guy De Tre, and Philippe De Maeyer, *A qualitative trajectory calculus as a basis for representing moving objects in geographical information systems*, Control and Cybernetics **35** (2006), no. 1, 97–119.

[10] Valerie De Witte1 Tom Mlange1 M.Nachtegael, S.Schulte and Etienne E. Kerre1, *Image Similarity From Fuzzy Sets to Color Image Applications, Series Lecture Notes in Computer Science*, vol. 4781/2007, pp. 26–37, Springer Berlin.

[11] Colin Robertson, Trisalyn Nelson, Barry Boots, and Michael A. Wulder, *Stamp: spatial-temporal analysis of moving polygons*, Journal of Geographical Systems **9** (2007), no. 3, 207–227.

[12] Matthias Delafontaine, Nico Van de Weghe, Peter Bogaert, and Philippe De Maeyer, *Qualitative Relations Between Moving Objects in a Network Changing its Topological Relations*, Inf. Sci. **178** (2008), no. 8, 1997–2006.

[13] Archana M. Rajurkar, R.C. Joshi, and Santanu Chaudhary, *Video content description using fuzzy spatio-temporal relations*, Hawaii International Conference on System Sciences **0** (2008), 139.

[14] Min Deng.Zalim li, *A Statistical Model for Directional Relations Between Spatial Objects* , GeoInformatica **12(2)** (2008), 193–217.

[15] Nadeem Salamat and El hadi Zahzah, *Spatial relations analysis by using fuzzy operators.*, ICCS (2), Lecture Notes in Computer Science, vol. 5545, Springer, 2009, pp. 395–404.

[16] Wawrzyniak-L. Matsakis, P. and J. Ni, *Relative positions in words: a system that builds descriptions around Allen relations*, International Journal of Geographical Information Science,Taylor Francis (2009).