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Classification of Motions Types by Rough Set Theory in Video Tracking Applications

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Abstract: Rough Set Theory (RST) is a moderately new mathematical model to imperfect knowledge. RST concepts are utilized to analysis and classification of uncertain, imprecise, or incomplete knowledge and information. The purpose of this research is to classify group of kinds of persons' motions numerate overlapping situations with each other similar to (bending, jacking, jumping, pjumping, running, siding, skipping, walking, waving) and the difficulty of distinguishing among these movements so we found and analyzed a set of attributes such as displacement, velocity, different in length and slope and because of the overlapping which resulted between these qualities so that we have been used RST which is used in distinguishing forms of overlapping movements types in classification process.

Key words: Rough set theory, video tracking, motion, classification, information system, decision system

INTRODUCTION

We face many various challenges in classification form of objects movements in video tracking field according to overlap and similarity among the objects movements in the common attributes and difficult in distinguishing these movements. The RST submits a modern mathematical path to imperfect or to vagueness knowledge. Imperfect or vagueness is represented by a boundary region of a set. It is utilized in many applications and different domains, such as engineering, decision support, banking, environment, medicine and others.

We have proposed in this research the use of RST in the classification process of persons movementbecauseit is suitable with imperfect vagueness or information knowledge.RST consists of set, information system, rule, decision rule, decision table, discernibility matrix, indiscernibility, set approximation, reducts, dependency of attributes and decisional attribute (Result).

Rough set philosophy is established on the hypothesis that with each object of the universe some information (data, knowledge) is associated. It is based on data analysis which starts from a data table called a decision table, columns of which are labeled by attributes, rows by objects of interest and entries in the table are attributes values. Attributes of the decision table are splitting into two sets (condition and decision attributes) (Pawlak, 1982, 2010).

Some research associated with our research like this Yhun *et al.* (2006); proposed motion-base, fulfillment by analyzing luminance information and motion information of video which is extracted and analyzed. Therefore, RST is used to classify the shots into two kinds, global and local motions (Yhun *et al.*, 2006).

Set: A set is a collection of things which are related to each other (Pawlak, 2003). Set represent motion types. We use nine movement forms (bending, jacking, jumping, pjumping, running, siding, skipping, walking and waving) and use Weizmann Database, we canrepresent by universal group as:

$$\text{Universal (U)} = (e1, e2, e3, e4, e5, e6, e7, e8, e9)$$

where, e1: Experiment 1, ..., e9: Experiment 9.

Information system: The information system is a finite data table, columns of which are features or attributes, rows are objects (Sanchez, 2014). An Information System IS or S is a pair (U and A), it is a finite data table and represent in equation 1 as:

$$S = (U, A) \quad (1)$$

Where:

U = Universe and it is finite, non-emptyset and represents many varied of experiments object
A = Attribute {Displacement, Velocity, Height Different and Slope} values to the domain of a are symbol V_a. and information function is f_a

$$f_a = Uv_a \quad (2)$$

Particular domains of attributes are: Particular domains and range of attributes are represented as below:

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Table 1: Information system is relation between experiments and attributes

	Attributes			
Exp.	Displacement	Velocity	High diff.	Slope
e1	1	1	3	1
e2	1	2	3	2
e3	2	2	2	1
e4	1	2	2	3
e5	2	3	1	1
e6	2	2	1	1
e7	2	2	3	1
e8	2	1	3	1
e9	1	1	1	1

- $V_{Displacement} = \{1, 2\}$. Short = 1, Long = 2
- $V_{Velocity} = \{1, 2, 3\}$. Slow = 1, Medium = 2, Fast = 3
- $V_{Height\ diff.} = \{1, 2, 3\}$. Little = 1, Medium = 2, High = 3
- $V_{slope} = \{1, 2\}$. Little change = 1, High change = 2

Rows of a table are called objects, examples, or entities. We can represent information system in Table 1.

Rules: Rules are consisting of a set of conditions which mean a decision. Rules are divided into two types.

Exact: One set of conditions attends one result.

Approximate: One set conditions attends >1 result:

$$C_1, C_2, C_3 \text{ and } C_4 \rightarrow D \quad (3)$$

Where:
C_1 = Displacement
C_2 = Velocity
C_3 = Height diff
C_4 = Slope
D = Decision set

- Rule 1: if C_1 = 1 and C2 = 1 and C3 = 3 and C4 = 1then D = 1 (Bend)
- Rule 2: if C_1 = 1 and C2 = 2 and C3 = 3 and C4 = 2 then D = 2 (Jack)
- Rule 3: if C_1 = 2 and C2 = 2 and C3 = 2 and C4 = 1 then D = 3 (Jump)
- Rule 4: if C_1 = 1 and C2 = 2 and C3 = 2 and C4 = 3 then D = 4 (Pjump)
- Rule 5: if C_1 = 2 and C2 = 3 and C3 = 1 and C4 = 1 then D = 5 (Run)
- Rule 6: if C_1 = 2 and C2 = 2 and C3 = 1 and C4 = 1 then D = 6 (Side)
- Rule 7: if C_1 = 2 and C2 = 2 and C3 = 3 and C4 = 1 then D = 7 (Skip)
- Rule 8: if C_1 = 2 and C2 = 1 and C3 = 3 and C4 = 1 then D = 8 (Walk)
- Rule 9: if C_1 = 1 and C2 = 1 and C3 = 1 and C4 = 1 then D = 9 (Wave)

Table 2: It shows decision system

Decision	Attributes					
Motion type	D.	Slop.	Hgh.	Veloc.	Disp.	Exp.
Bending	1	1	3	1	1	e1
Jacking	2	2	3	2	1	e2
Jumping	3	1	2	2	2	e3
Pjumping	4	3	2	2	1	e4
Running	5	1	1	3	2	e5
Siding	6	1	1	2	2	e6
Skipping	7	1	3	2	2	e7
Walking	8	1	3	1	2	e8
Waving	9	1	1	1	1	e9

Decision system: A decision system is a set of rules and conditions according to suitable application; it is a triple and denoted by DS or T. Decision System's Symbolsare represented by Eq. 4-6:

$$DS = (U, C, D) \quad (4)$$

Union of conditions and decisions is represented all attributes and show in Eq. 5:

$$A = C \cup D \quad (5)$$

Intersection between set of conditions and decision must equal Φ as follow in Eq. 6:

$$C \cap D = \Phi \quad (6)$$

Conditional attributes are represented (displacement, velocity, height diff. and slope) and decisional conditional is assigned to (Motion types), there are explaining in Table 2. Jacking (rise hand with leg in same location), Pjumping (jump in same location), Skiping (jump by one leg) and Waving (rise right hand in same Location).

Indiscernibility relation: It is a chief concept in RST and is assigned as a relation among two objects or more, where every value is identical with respect to a subset of attributes considered.

Objects are differences and similarities based on the philosophies of discernibility and indiscernibility in RST. Indiscernibility relation is examined to object similarities while discernibility relations to difference object (Zhao *et al*., 2007). Indiscernibility is referring by IND. We find the indiscernibility depend on Table 2:

IND({C1}) = {{e1,e2,e4,e9},{e3,e5,e6,e7,e8}}
IND({C2}) = {{e1,e8,e9},{ e2,e3,e4,e6,e7},{e5}}
IND({C3}) = {{e1,e2,,e7,e8 },{e3,e4 },{e5,e6,e9}}
IND({C4}) = {{e1,e3,e5,e6,e7,e8,e9},{e2},{e4}}
IND({C1,C2}) =
{{e1,e9},{e2,e4},{e3,e6,e7},{e5},{e8}}

IND({C1,C3}) =
{{e1,e2},{e3},{e4},{e5,e6},{e7,e8},{e9}}
IND({C1,C4}) =
{{e1,e9},{e2},{e3,e5,e6,e7,e8},{e4}}
IND({C2,C3}) =
{{e1,e8},{e2,e7},{e3,e4},{e5},{e6},{e9}}
IND({C2,C4}) =
{{e1,e8,e9},{e2},{e3,e6,e7},{e4},{e5}}
IND({C3,C4}) =
{{e1,e7,e8},{e2},{e3},{e4},{e5,e6,e9}}
IND({C1,C2,C3}) =
{{e1},{e2},{e3},{e4},{e5},{e6},{e7},{e8},{e9}}
IND({C1,C2,C4}) =
{{e1,e9},{e2},{e3,e6,e7},{e4},{e5},{e8}}
IND({C1,C3,C4}) =
{{e1},{e2},{e3},{e4},{e5,e6},{e7,e8},{e9}}
IND({C2,C3,C4}) =
{{e1,e8},{e2},{e3},{e4},{e5},{e6},{e7},{e9}}
IND({C1,C2,C3,C4}) =
{{e1},{e2},{e3},{e4},{e5},{e6},{e7},{e8},{e9}}

Approximations space: It is represented by entities in inconsistent information table which have condition attribute values are the similar and lead to various or different concepts.Approximation spaceis represented by Eq. 7:

$$S = (U, R) \tag{7}$$

Where:

U = A finite set of objects
$R \subseteq U \times U$ = An equivalence relation on U (Munakata, 2008)

It is an important concept in RST and divided into some types (Kusiak, ????):

Lower approximation: It is assigned to the collection of observations that can all be categorized into this concept. Depend on equation 1, we find:

$$\underline{B}X = \{x \mid [x]_B \subseteq X \tag{8}$$

Upper approximation: it is assigned to the collection of observations that can be possibly categorized into this concept:

$$\bar{B}X = \{x \mid [x]_B \cap X \neq \varnothing \tag{9}$$

Boundary Region (BR): It is related between lower and upper approximation and represented imprecision or vagueness of imperfect knowledge in RST:

$$BN_B(X) = \bar{B}X - \underline{B}X \tag{10}$$

Positive region: certainly and surely member of X:

$$POS_B(X) = \underline{B}X \tag{11}$$

Negative region: certainly and surely non-member of X:

$$NEG_B(X) = U - \bar{B}X \tag{12}$$

Accuracy of Approximation: It is represented the percentage or ratio Lower to upper approximation as shown in Eq. 13 (Tripathy and Acharjya, 2012):

$$\text{Obviously } 0 \leq \alpha_B(X) \leq 1 \tag{13}$$

- If $\alpha_B(X) = 1 \rightarrow$ Crisp (Upper and Lower Approximation is identical and not appear any rough set events).
- If $\alpha_B(X) < 1 \rightarrow$ Rough set event

Comparison between rough and fuzzy set: The RST and FST (fuzzy set theory) are expanding in field of old-style set theory in the following there is a comparison between them.

- RST is chiefly interest in crisp information and its important concept is indiscernibility. FST is considered as mathematical resources for reproducing the fuzziness information that the human cannot distinguish their mechanism
- RST leads to rough non-overlapping style, while the FST shows the fuzziness among overlapping sets
- FST is regarded as a part of vague boundaries, whereas RST deals with a crisp set
- RST deals with the approximation of sets, while FST deals with fuzzy concept of membership function (Jian *et al*., 2010)
- It is essential that FST treats with a membership function which values are universal set interval [0, 1]. Thus it is not necessary that RST deals with membership function instead deals with indiscernible elements (Yao, 1998)
- FST is style of vagueness. RSTis style of ambiguity due to loss of information

MATERIALS AND METHODS

Suggested method: Suggested method consists of four major modules (Fig. 1):

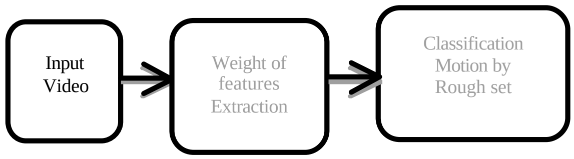

Fig. 1: Block diagram design of suggested method

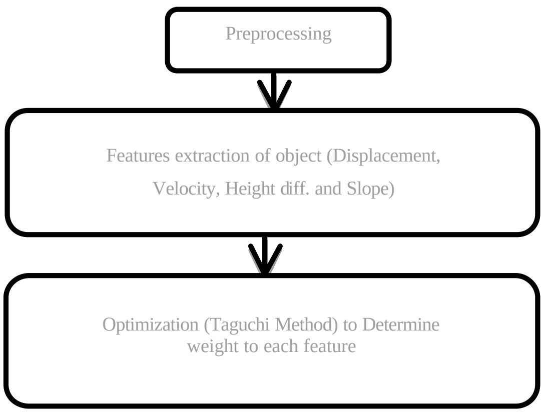

Fig. 2: Block diagram offeatures extraction weight

- Input video
- Weight Features extraction
- Classification motion (Rough set)

Input video: Modify video signal to series of frames classified to characteristics as shown in the following Table 3:

Weight features extraction: Weight feature extraction shown in Fig. 2.

Preprocessing: It is consists of series process:

- Transform to sequence of frames
- Convert to gray frames
- By subtraction algorithm to set B/W frames
- Segmentation by region growing algorithm
- Determine trajectory of object

Features extraction: Features extraction can be classified into three main groups namely:

- Low-level, (e.g., color, gradient, motion)
- Mid-level, (e.g., edges, corners, regions)
- High-level (objects) (Maggi, 2011)

In this study, researchers are tacked mixed between low and high Level features (motion and object). Features Extraction of Object (Displacement, Velocity, Height and Slope) used to classify motion form of object.

Table 3: The Movie Characteristics.

Database name	Weizmann
Frame No.	Variation
Frame Dimension (Width×Height)	180×144
Frame rate (No. Fr/sec)	25
Type of Files	avi

Optimization (taguchi method): The Taguchi method includes reducing the variant in an operation through powerful design of experiments. It is prepared to improve the fitness of tracking systems and operations where the performance based on many parameters (Roy, 1990). They are statistical methods developed by Genichi Taguchi to improve the quality of manufactured goods and more recently also applied to engineering (Rosa *et al*., 2008).

We are utilized Taguchi method to determine the best feature from features mentioned in paragraph B above and most influential parameter ranging. After determining the weight of each feature, we start applying the priority best weight to the feature for the purpose of separating and identifying forms of movement of object.

RESULTS AND DISCUSSION

Classification" To classify persons movement and form (walking, running, waving, etc.), we depend on the information described in Paragraph 1, we are applying rough set method and its properties for this purpose and we are utilized a number of attributes of the features extraction from Weizmann DB as described in Fig. 3 and Table 4.

Rules used to classify motion kinds depend on attributes: We can classify motions types (bending, jacking, jumping, pjumping, running, siding, skipping, walking, waving), rough set is classify attributes nearest to binary classificationas show in Fig. 4 if apply steps below.

Step 1: By Attribute (displacement). It is classified into two groups according to motion condition (No. of pixel traveled by object in film).

Group 1 (slow motion): Bending, jacking, pjumping and waving.

Group 2 (fast motion): Jumping, running, siding, skipping and walking.

Step 2: By Attribute (velocity). It is classify each group to sub group according to some conditions below (No. Pixel/ Time) (Table 5).

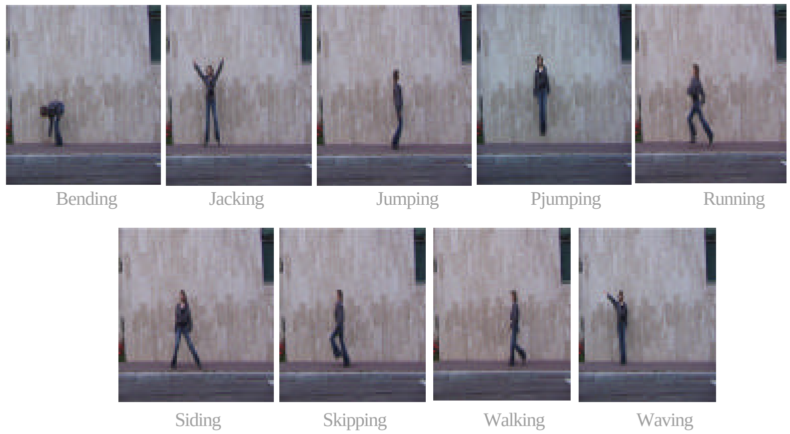

Fig. 3: Imagesrefer to motion types

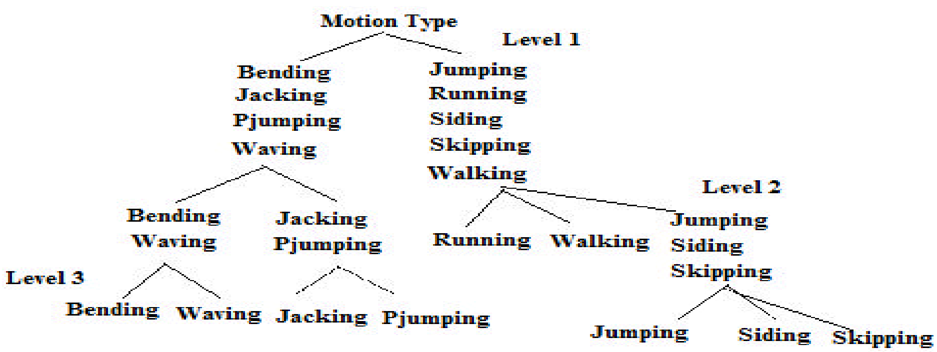

Fig. 4: The classification attributes are represented in tree graph

Table 4: Information System for attributes values of practical experiments

Motion form	No. Frame	Motion kind	Attributes Displacement No. Pixel/ Fr.	Velocity Pixel/sec	Height Diff. Pixels	Slope, Theta, Average	Slope, Theta Reference Po.
1	83	1	1.414	0.426	26	0.061, 2.734	0.100, 5.711
Bending	63		2.000	0.794	25	0.000, 0.000	0.061, 2.780
	62		1.000	0.403	30	0.037, 2.121	0.062, 2.812
2	75	1	7.000	2.303	14	0.086, 3.701	1.000, 45.00
Jacking	95		6.325	1.664	22	0.279, 9.410	0.375, 20.556
	55		3.000	1.364	25	0.309, 9.792	0.080, 4.574
3	66	2	140.100	53.052	13	0.536, 24.862	0.013, 0.764
Jumping	44		92.195	50.106	14	0.896, 33.114	0.096, 5.469
	39		85.288	54.672	13	0.779, 31.582	0.000, 0.000
4	61	1	11.045	4.527	55	3.467, 18.313	0.302, 16.821
Pjumping	48		5.831	3.037	16	0.392, 12.072	0.219, 12.339
5	41	2	159.615	97.326	19	0.674, 15.679	0.044, 2.534
Running	27		128.062	118.576	9	0.215, 11.751	0.022, 1.273
	35		114.000	81.429	21	0.566, 22.831	0.043, 2.463
6	52	2	148.165	71.233	11	0.659, 24.669	0.083, 4.724
Siding	59		146.086	61.901	12	0.461, 22.596	0.000, 0.000
	42		106.471	63.375	12	0.549, 25.423	0.145, 8.236
7	56	2	137.131	61.219	19	0.637, 27.617	0.153, 8.711
Skipping	55		148.000	67.273	25	0.616, 26.000	0.093, 5.315
	36		85.053	59.065	19	0.608, 23.048	0.086, 4.917
8	83	2	154.263	46.465	14	0.511, 20.092	0.227, 12.804
Walking	72		128.141	44.493	22	7.132, 43.462	0.000, 0.000
	49		98.127	50.065	3	0.397, 19.738	0.028, 1.577
9	81	1	0.000	0	4	0.015, 0.614	0.125, 7.125
Waving	52		1.000	0.481	4	0.022, 0.949	0.125, 7.125
	53		0.000	0	4	0.018, 0.816	0.125, 7.125

Table 5: Velocity attributes conditions

Groups	1		2		
Conditions: Velocity (No. Pixel/Time)	V<Val1: Very slow	V>=Val1: Slow	V≥Val1: Fast	V≤Val2: Slow	Val1>V>Val2: Med
Sub Groups	Gr1_1	Gr1_2	Gr2_1	Gr2_2	Gr2_3
Motion Type	Bending Waving	Pjumping Jucking	Running	Walking	Jumping Siding Skipping

Table 6: It represents difference in height of attributes condition

Groups	Gr1_1			Gr2_3		
Conditions: Diff Height (No.Pix/Time)	DH>Val1	DH<Val2	Val2≤DH<Val1	DH<Val1	Val1≤DH <Val2	DH>Val2
Sub Groups	Gr1_1_1	Gr1_1_2	Gr1_2	Gr2_3_1	Gr2_3_2	Gr2_3_3
Motion Type	Bending	Waving	Pjumping Jacking	Siding	Skipping	Jumping

Table 7: It indicates approximation relation

	Motion decision			Attributes		
Speed	Type	Form	Slope	Hgh. Diff.	Velo.	Exp.
Slow	No	Bending	1	3	1	e1
Slow	No	Jacking	2	3	2	e2
Medium	Yes	Jumping	1	2	2	e3
Slow	No	Pjumping	3	2	2	e4
High	Yes	Running	1	1	3	e5
Medium	Yes	Siding	1	1	2	e6
Medium	Yes	Skipping	1	3	2	e7
Medium	Yes	Walking	1	3	1	e8
Slow	No	Waving	1	1	1	e9

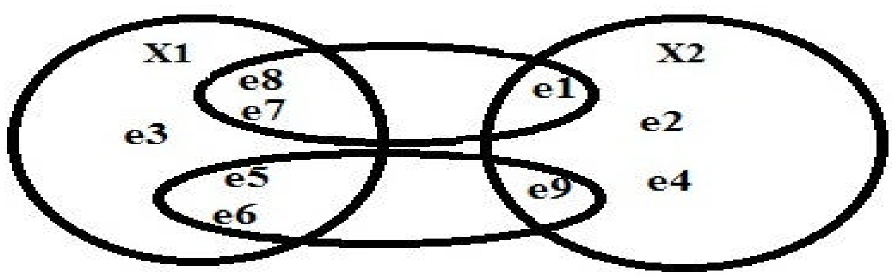

Fig. 5: Upper and lower approximation between Height and slope attributes

Step 3: By attribute (diff. height). Classification of sub-groups to other sub-groups (Table 6).

Step 4: By attribute (slope). In last step, we Classify group (Gr1_2) according to slope condition value or theta (Table 7).
If(Theta≥Val1) Pjump
Else Jack

Approximation relation: Depend on Table 7, we are finding. We are making into two sets X1, X2 as below:

$$X_1 = \{E \mid \text{Motion } (E) = \text{Yes}\} = \{e3, e5, e6, e7, e8\}$$
$$X_2 = \{E \mid \text{Motion } (E) = \text{No}\} = \{e1, e2, e4, e9\}$$

To find lower and upper approximation relation for relations below (Fig. 5-10).

Difference height and slope relation:

$$R = \{\text{Height Diff., Slope}\}$$
$$U / R = \{\{e1,e7,e8\},\{e2\},\{e3\},\{e4\},\{e5,e6,e9\}\}$$
$$\underline{R}X_1=\{e3\}$$
$$\bar{R}X_1=\{e3,e1,e5,e6,e7,e8,e9\}$$
$$\underline{R}X_2=\{e2, e4\}$$
$$\bar{R}X_2=\{e1, e2, e4, e5, e6, e7, e8, e9\}$$

Boundary region:

$$BN_E(X_1)=\bar{B}X_1-\underline{B}X_1=\{e3,e1,e5,e6,e7,e8,e9\}-\{e3\}=\{e1,e5,e6,e7,e8,e9\}$$
$$BN_E(X_2)=\bar{B}X_2-\underline{B}X_2=\{e1,e2,e4,e5,e6,e7,e8,e9\}-\{e2,e4\}=\{e1,e5,e6,e7,e8,e9\}$$

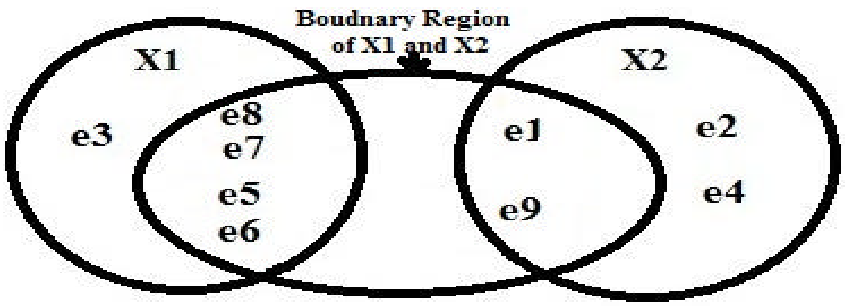

Fig. 6: Boundary region of two groups (X1 and X2)

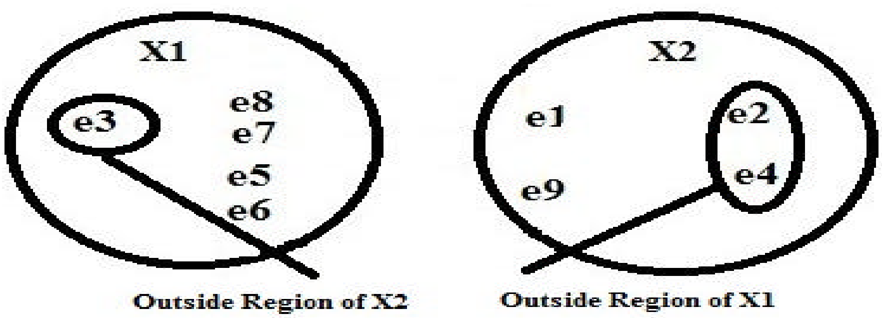

Fig. 7: Outside region of two groups (X1 and X2)

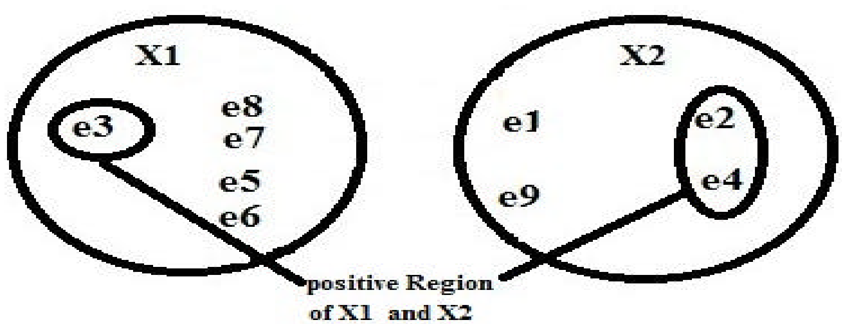

Fig. 8: Positive region of two groups (X1 and X2)

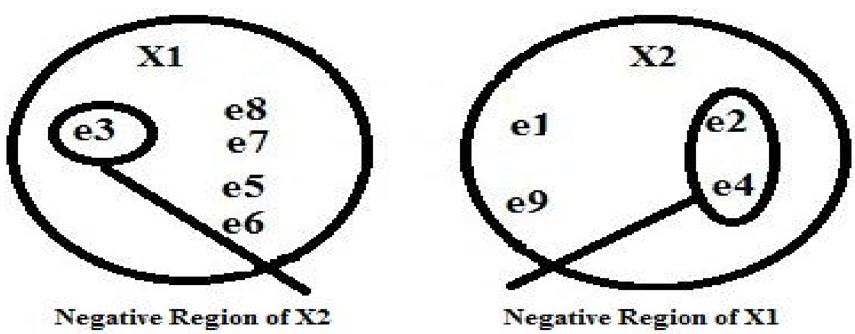

Fig. 9: Negative region of two groups (X1 and X2)

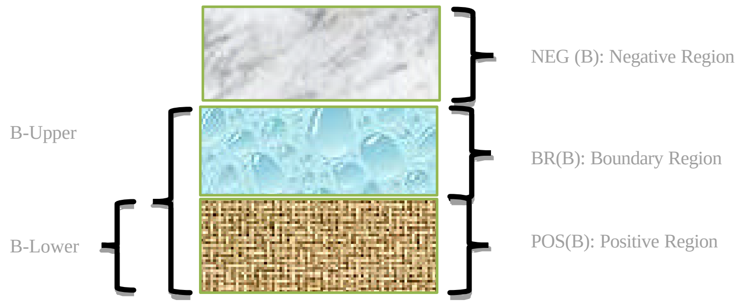

Fig. 10: It represents negative, positive and boundary regions

Outside region

$$OUTSIDE_E(X_1) = U\text{-}\bar{B}X_1 = \{\{e1,e7,e8\},\{e2\},\{e3\},\{e4\},\{e5,e6,e9\}\}\text{-}\{e3,e1,e5,e6,e7,e8,e9\} = \{e2,e4\}$$

$$OUTSIDE_E(X_1) = U\text{-}\bar{B}X_1 = \{\{e1,e7,e8\},\{e2\},\{e3\},\{e4\},\{e5,e6,e9\}\}\text{-}\{e1,e2,e4,e5,e6,e7,e8,e9\} = \{e3\}$$

Positive region

$$POS_E(X_1)=\{e3\};\ POS_E(X_2)=\{e2,e4\}$$

Negative region

$$NEG_E(X_1)=U\text{-}\bar{B}X_1\{\{e1,e7,e8\},\{e2\},\{e3\},\{e4\},\{e5,e6,e9\}\}\text{-}\{e3,e1,e5,e6,e7,e8,e9\} = \{e2,e4\}$$

$$NEG_E(X_2)=U\text{-}\bar{B}X_2\{\{e1,e7,e8\},\{e2\},\{e3\},\{e4\},\{e5,e6,e9\}\}\text{-}\{e1,e2,e4,e5,e6,e7,e8,e9\}= \{e3\}$$

Accuracy of approximation: Positive, negative and boundary regions are present in Fig. 10.

CONCLUSION

We are selecting some features extraction from each video tracking application and implement information system (table) and set number of rules to make decision system. It more efficient tool and algorithm for finding and manipulating hidden patterns in information system data without need to member function such as in fuzzy set. RST provide as ability to analyze people's different motion, treatment and classify motions although overlapping and convolution among these motions. It is assisting to find minimum sets of data after applied some concept in RST similar to set approximation, indiscernibility, reduct and others concepts.

REFERENCES

Jian, L., S. Liu and Y. Lin, 2010. Hybrid Rough Sets and Applications in Uncertain Decision-Making. CRC Press, USA., Pages: 261.

Munakata, T., 2008. Fundamentals of the New Artificial Intelligence: Neural, Evolutionary, Fuzzy and More. 2nd Edn., Springer Verlag, USA., ISBN-13: 978-1846288388.

Pawlak, Z., 1982. Rough sets. Int. J. Comput. Inform. Sci., 11: 341-356.

Pawlak, Z., 2010. Rough set theory and its applications to data analysis. Cybernet. Syst., 29: 661-688.

Rosa, J.L., A. Robin, M.B. Silva, C.A. Baldan and M.P. Peres, 2009. Electro deposition of copper on titanium wires: Taguchi experimental design approach. J. Mater. Process. Technol., 209: 1181-1188.

Roy, K.R., 1990. A Primer on the Taguchi Method. Van Nostrand Reinholds, New York.

Tripathy, B.K. and D.P. Acharjya, 2012. Approximation of classification and measures of uncertainty in RS on two Universal sets. VIT University. Int. J. Adv. Sci. Technol., 40: 77-90.

Yao, Y.Y., 1998. A comparative study of fuzzy sets and rough sets. Inf. Sci., 109: 227-242.

Yuan, Z., Y. Wu, G. Wang and J. Li, 2006. Motion-Information-Based Video Retrieval System Using Rough Pre-Classification. In: Transactions on Rough Sets V. F.P. James and A. Skowron (Eds.). Springer, Berlin, Germany, ISBN: 978-3-540-39382-5, pp: 306-333.

Zhao, Y., Y. Yao and F. Luo, 2007. Data analysis based on discernibility and indiscernibility. Inf. Sci., 177: 4959-4976.