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Fuzzy Inference System Aided Personal Detection: Ear Biometrics

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***Abstract*— Ear biometric is receiving increased momentum in recent years because of various proven advantages, ear biometric system are based on the biological features of the ear, these features being extracted from the images will surely be approximate interns of their dimensions and the extent, it is exactly here the fuzzy inference system(FIS) for personal detection, for building this system around 840 right ear images were collected, processed and the shape based biometric features were elicited, the system so developed has shows excellent performance in terms of sensitivity, specificity and accuracy which are 94.11%, 100%, and 95% respectively.**

***Index Terms*— Biometrics, Ear Images, Fuzzy inference system, fuzzy rules, Person identification system.**

I. INTRODUCTION

Fuzzy logic [1] is widely used for human-related sciences, and successfully solves these problems. Biometrics is one of these attractive applications, which requires feature extraction and matching tasks. Especially, fuzzy logic has been successfully applied to many biometric matching systems, such as face recognition, fingerprint recognition and so on [2], [3], [4], [5] in which fuzzy logic achieved higher robustness, adaptively and precision. Chen et al. [6] have developed fingerprint identification by fuzzy similarity measures. Fuzzy inference is the actual process of mapping from a given input to an output using fuzzy logic. The process involves basic elements namely, membership functions, fuzzy logic operators, and if-then rules. Fuzzy inference systems have been successfully applied in various engineering domains fields such as automatic control, data classification, decision analysis, expert systems, and computer vision. Because of its multi-disciplinary nature, the fuzzy inference system is known by a number of names, such as fuzzy-rule-based system, fuzzy expert system, fuzzy model, fuzzy associative memory, fuzzy logic controller, and simply fuzzy system. Figure 1: depicts general fuzzy inference system architecture.

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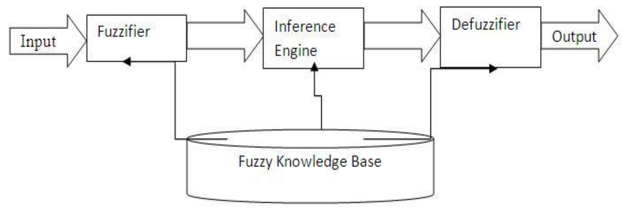

Figure 1: Fuzzy inference system Architecture.

Fuzzy Inference Systems: The steps of fuzzy reasoning (inference operations upon fuzzy IF–THEN rules) performed by FISs are:
i. Compare the input variables with the membership functions on the antecedent part to obtain the membership values of each linguistic label. (This step is often called fuzzification.)
ii. Combine (usually multiplication or min) the membership values on the premise part to get firing strength (degree of fulfillment) of each rule.
iii. Generate the qualified consequents (either fuzzy or crisp) or each rule depending on the firing strength.
iv. Aggregate the qualified consequents to produce a crisp output. (This step is called defuzzification.)
Fuzzy Knowledge Base: The rule base and the database are jointly referred to as the knowledge base.

- A rule base containing a number of fuzzy IF–THEN rules;
- A database which defines the membership functions of the fuzzy sets used in the fuzzy rules.

The schematic view of an fuzzy inference system is presented in the figure 2.

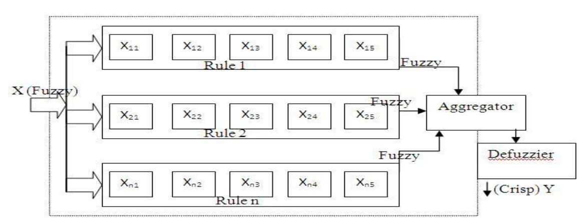

Figure 2: Fuzzy inference Engine

Fuzzification :-The linguistic variables of the fuzzy rules are expressed in the form of fuzzy sets where these variables are defined in terms of degree of their associated membership functions. This method of calculating the degree of belongingness of the crisp input in the fuzzy set is called the fuzzification. The membership functions may be triangular, trapezoidal, gaussian or bell shaped. As the information about the degree of the membership is used for further processing, considerable amount of information may be lost during the course of fuzzification. This is because the procedure can be seen as a nonlinear transformation of the inputs. For example in the case of triangular or trapezoidal membership functions information is lost in the regions of membership functions where the slope is zero, as at these points the membership functions are not differentiable. Therefore fuzzy systems having triangular or trapezoidal membership function can encounter problems of learning from data. Nonlinear membership functions like gaussian or bell function may be used to overcome this difficulty.

Aggregation:-After the degree of each linguistic statement is evaluated, they are combined by logical operators such as AND and OR. The conjunction of these linguistic statements is carried out by logical t-norm and the t-conorm operator to a large number of linguistic statements. Max and Min operators are used for classification task. For the purpose of approximation and identification the product and algebraic product operators are better suited due to their smoothness and differentiability. Similarly, the bounded sum and difference operators offer several advantages to some neuro-fuzzy learning schemes.

Activation:-Here the degree of rule fulfillment is used to calculate the output activations of the rules.

Accumulation:-In this step the output activations of all the rules are joined together to give rise to the fuzzy output of the system.

Defuzzifier: Converts the fuzzy output of the inference engine to crisp using membership functions analogous to the ones used by the fuzzifier.

Five commonly used defuzzifying methods are: – Centroid of area (COA) – Bisector of area (BOA) – Mean of maximum (MOM) – Smallest of maximum (SOM) – Largest of maximum (LOM).

The six steps of fuzzy inference system are:

i. Determining a set of fuzzy rules

ii. Fuzzifying the inputs using the input membership functions

iii. Combining the fuzzified inputs according to the fuzzy rules to establish rule strength (Fuzzy Operations)

iv. Finding the consequence of the rule by combining the rule strength and the output membership function (implication)

v. Combining the consequences to get an output distribution (aggregation)

vi. Defuzzifying the output distribution (this step is only if a crisp output (class) is needed).

This paper elaborates a development of fuzzy inference system which can facilitate person detection using Ear biometric features.

II. RELEATED RESEARCH

In an application the biometric features like face, iris and finger print as the most promising biometric authentication that can precisely identify and analysis of a person as their unique textures can be quickly extracted during the identification process[8]. The biometric detection and authentication often deals with non-ideal scenarios such as blurred images, off-angles, reflections, expression changes. These precincts imposed by uni modal biometrics can be pound by incorporating multimodal biometrics. For the idea purpose, the authors present a new Effective fake detection method that can be used in multiple biometric systems to detect different types of fake access attempts. The important feature and objective proposed system is to enhance the image quality and very low degree of complexity for security of biometric recognition frameworks. For the preprocessing they have used score level approach Median filter with canny edge detection and Hough transform with Anisotropic Gaussian Filter. For the Feature Extraction we have used Gabor filter. The classification is done by ANFIS which is an efficient classification. The performance of the proposed approach is validated and is efficient.

Fuzzy inference system is choosing an alternative machine for integrated process planning and scheduling of a job shop manufacturing system, as a substitute of choosing alternative machines randomly, machines are being selected based on the machines reliability. The MTTF values are input in a fuzzy inference mechanism, which outputs the machine reliability. The machine is then being penalized based on the fuzzy output. The authors [9] have made the most reliable machine will have the higher priority to be chosen. In order to overcome the problem of un-utilization machines, sometimes faced by unreliable machine, the genetic algorithms have been used to balance the load for all the machines.

System traffic light settings that currently present in Indonesia are many who use the timer (timer) resulting in the accumulation of vehicles on any or all channels. The authors [10] have made a use of fuzzy logic-based system that can manage the traffic lights in accordance with the density that occurs. So it is no longer in the accumulation of vehicles, especially at intersections adjacent. This system is a traffic light settings at adjacent intersections using fuzzy logic The workings of this system based on the rule (rule) that have been made. If the state of the roads at the time when the green light more or equal to the number of vehicles waiting for the red light, then the system will continue the green light on the road. Then if a state road when the green light less than the number of vehicles waiting roads or when the red light, then the roads will be green, and so on. It is expected to be applied to the actual conditions that the accumulation of vehicles on adjacent intersections can be resolved. Crisp logic is a logic system that has only two true or false membership values' concept is much application primarily for control systems, one of which at traffic light 'system traffic light settings with the concept of fuzzy logic is able to work according to road conditions being regulated' inference system is then evaluated by using the knowledge base rules fuzzy which eventually produced a solution fuzzy region.

Fuzzy inference system has been developed for the appraisal system and to evaluate the effectiveness and efficiency of their employees [11]. In evaluating staff performance, performance appraisal normally involved in awarding the numerical values or linguistic labels to employee's performance. These values and labels are used to represent each staff achievement by reasoning incorporated in the arithmetical or statistical methods. Although, the staff performance appraisal may involve judgments which are based on imprecise data especially when a person (the superior) tries to interpret another person's (his/her subordinate) performance. Thus, the scores awarded by the appraiser are only approximations. The fuzzy logic perspective, the performance of the appraise involves the measurement of his/her ability, in competence and skills, which are actually fuzzy concepts that can be captured in fuzzy terms. Accordingly, fuzzy approach can be used to handle these imprecision and uncertainty information. Therefore, the performance appraisal system can be examined using Fuzzy Logic Approach, which is carried out in the study. The study utilized a Cascaded fuzzy inference system to generate the performance qualities of some University non-teaching staff that are based on specific performance appraisal criteria.

III. DATA FOR THE MODEL

Ear images for this classification work were acquired [12] from the pupils of Siddaganga group of institutes. The subjects involved were mostly students and faculty numbering 605. In each acquisition session, the subject sat approximately one meter away with the side of the face in front of the camera in outside environment without flash. Ear is divided into 6 segments as seen in Figure 3.

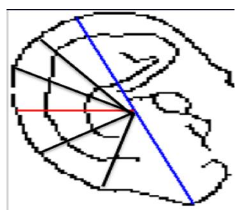

Figure 3: Outer edge of ear with major and minor axis.

To isolate important and relevant information from the image, canny edge detection is used with threshold of 0.3. Major and minor axes were identified. Major axis is the one which has the longest distance between two points on the edges of the ear. The minor axis is drawn in such a way that it passes through tragus and is orthogonal to the major axis. The figure 4 represents the flow of the process involved, starting from image acquisition, followed by capturing the region of interest image followed by the step involved in getting the clear edge later, inverting the obtained edge image to get the clear boundary of the image, then the important step follows for calculating the features of the each ear and store separately in the database in the format of excel sheet finally, for matching and verification in between the processes.

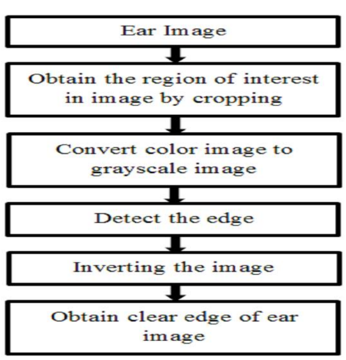

Figure 4: Steps involved in ear edge detection

IV. METHODOLOGY

The methodology involved in this work includes following steps:

i. Identification of the optimum number of classes with minimum overlapping using K-means for grouping the ear database; further it would help in defining the rules for the fuzzy inference system.
ii. Defining the input member function for all the linguistic features.
iii. Defining the fuzzy rules using if-then conditions.
iv. Grouping of the ear through output member function.

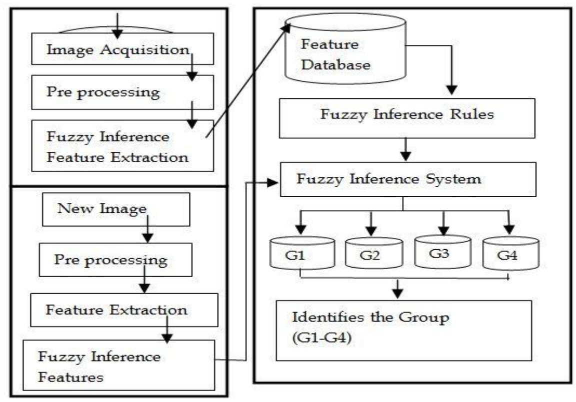

Figure 5: The Flow diagram.

Firstly images are acquired and preprocessing is done to remove noise, features are extracted to get ratio of the upper area by lower area, radius of gyration with respect to both the axis, major axis and minor axis. The extracted are accommodated features fuzzy linguistic values are stored in the database. The entire sequence of the work is shown in Figure 5.

A. K-means algorithm

K-means clustering is an iterative, data-partitioning algorithm that assigns *n* observations to exactly one of *k* clusters defined by centroids, where *k* is chosen before the algorithm starts. The purpose of applying the k-means clustering algorithm is to find a set of clustered centers and a partition of training data into subclasses. Normally, the center of each cluster is initialized to a randomly chosen input datum. Then each training datum is assigned to the cluster that is nearest to itself. After training data have been assigned to a new cluster unit, the new center of a cluster *represents* the average of the training data associated with that cluster unit. After all the new clusters have been calculated, the process is repeated until it converges [13]. Series of computational experiments were conducted in order to find optimum number of classes with minimum overlapping. The experiments started with five, four and *three* classes. In all the cases the percentage of overlapping among the classes were verified. It was found that three groups were ideal because of minimum overlapping.

B. Defining the input member function for all the linguistic features.

Triangular membership functions are used for both the input and output, Table 1 through Table 5 shows the parametric values of the inputs and Table 6 shows the output which is to capture the grouping, All the table present extremities and prototypic values of parameters corresponding to respective triangular membership functions.

Table 1:Ratio of upper area verse lower area range (Triangular Member function)

Sl.no	Name	Left	Mid	Right
1.	Low	1.27	3	4.74
2.	Medium	4.72	7.12	9.49
3.	High	9.5	11.8	14.24
4.	Very High	14.25	17.23	20.22

Table 2:Radius of Gyration with respect to X-axis range (Triangular Member function)

Sl.no	Name	Left	Mid	Right
1.	Low	8.9	29.1	50.25
2.	Medium	50.26	71.3	92.5
3.	High	92.5	114	134.77
4.	Very High	134.78	156	177

Table 3:Radius of Gyration with respect to Y-axis range (Triangular Member function)

Sl.no	Name	Left	Mid	Right
1.	Low	8.9	29.1	50.25
2.	Medium	50.26	71.3	92.5
3.	High	92.5	114	134.77
4.	Very High	134.78	156	177

Table 4:Major Axis range (Triangular Member function)

Sl.no	Name	Left	Mid	Right
1.	Low	75	80.1	85.25
2.	Medium	85.26	90.3	95.5
3.	High	95.52	100.5	105.5
4.	Very High	105.6	111	119

Table 5:Minor Axis range (Triangular Member function)

Sl.no	Name	Left	Mid	Right
1.	Low	45	48	52.25
2.	Medium	52.26	56	59.51
3.	High	59.92	63	66.77
4.	Very High	66.78	70	75

Table 6:Output Member function range (Triangular Member function)

Sl.no	Name	Left	Mid	Right
1.	Low	0.5	1	2
2.	Medium	1.5	2	3
3.	High	2	3	3.5
4.	Very High	3	4	4.5

A fuzzy association mapping of the input rules is shown in the Table 7.

Table 7: Fuzzy Association Map

Rule Number	Ratio of UA/LA	RGx	RGy	Major	Minor	Group
1.	2	1	1	4	3	1
2.	1	2	1	4	3	1
3.	1	2	1	4	3	1
4.	1	2	2	4	3	1
5.	2	2	2	4	2	2
6.	1	2	1	3	2	2
7.	1	3	1	3	3	2
8.	1	3	2	2	1	2
9.	1	2	2	4	3	3
10.	1	2	2	4	3	3
11.	1	3	3	4	4	3
12.	1	2	2	4	3	3
13.	1	2	1	4	3	4
14.	1	3	1	4	3	4
15.	1	3	1	4	3	4
16.	1	3	1	4	3	4

V. Results

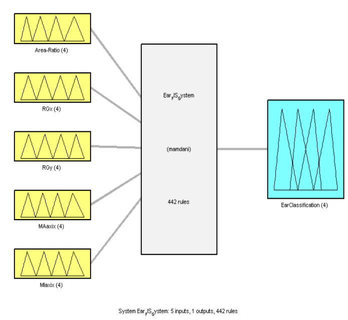

Figure 6: Fuzzy three layer model.

The figure 6 shows the basic model of the system, which consists of the five features as the input, the rule base output involving four group involving 442 fuzzy rules.

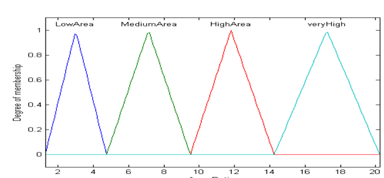

Figure 7: Input t Member ship function area ratio.

The snap shot of the triangular input member functions are show from the figure 7 to figure 11. Figure 12 show snap shot of the fuzzy inference scheme. The output member functions showing the distribution of four groups is depicted in figure 13.

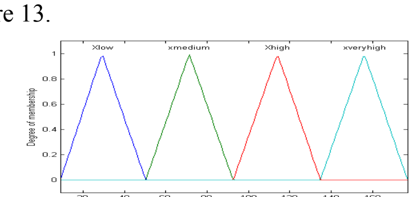

Figure 8: Input triangular Member function for RGx.

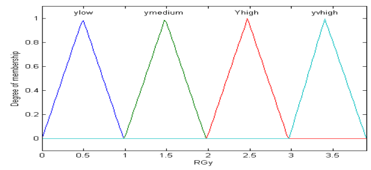

Figure 9: Input Member ship function for RGy.

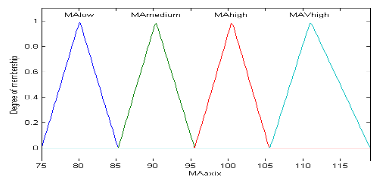

Figure 10: Input Member ship function for Major Axis.

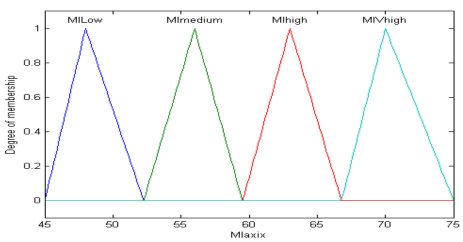

Figure 11: Input Member ship function for Minor Axis.

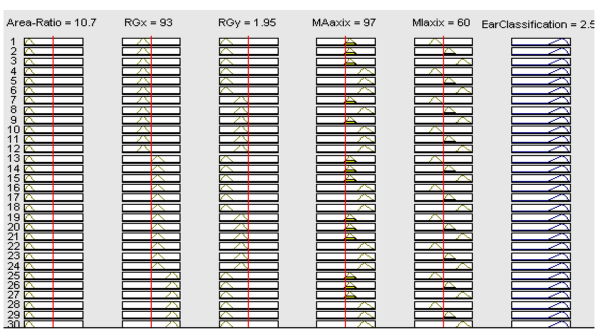

Figure 12: Fuzzy Inference system Rules

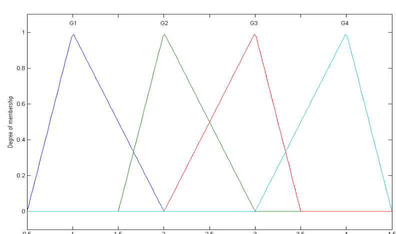

Figure 13: Output Member ship function for grouping.

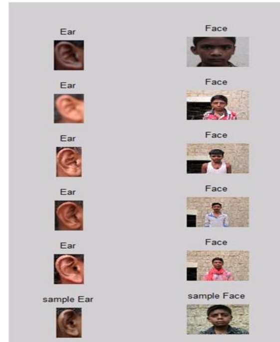

Figure 14 (a): Group 1

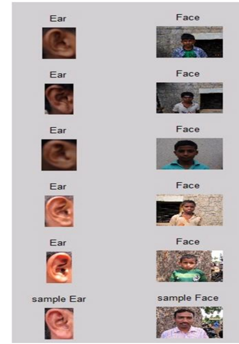

Figure 14 (b): Group 2

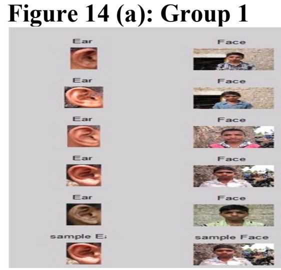

Figure 14 (c): Group 3

Figure 14 (d): Group 4

Figure 14: Grouping of Ear Biometrics

Figure 14, shows the grouping of the ear based on the fuzzy inference system.

A. Evaluation of the system:

The evaluation of the system helps us to make the system more realistic, efficient and in a efficient way, for this purpose twenty ear images are considered which were not used during the development of the fuzzy inference system. To evaluate the system percentage of correct detected images, specificity, sensitivity and accuracy were estimated. The sensitivity is defined as percentage of correctly identified instances and specificity is defined as percentage of incorrect identified instances. Accuracy is the overall success rate of the classifier [14]. These metrics are computed by using the following equations. The computed values are shown in Table 8.

$$\text{Sensitivity} = \frac{TP}{TP+FN} \quad \text{---- (1)}$$

$$\text{Specificity} = \frac{TP}{TP+FP} \quad \text{--- (2)}$$

$$\text{Accuracy} = \frac{TP+TN}{TP+\ FP\ +FN+TN} \quad \text{--- (3)}$$

Where TP=True Positive, TN=True Negative, FN=False Negative, and FP= False Positive.

Table 8: Evaluation of the system

Sl.no	No. of test Images	TP	TN	FP	FN
1.	20	16	3	0	01
Percentage					
Sensitivity		Specificity		Accuracy	
94.11		100		95	

VI. CONCLUSION

This paper presented the development of personal identification system which founded on fuzzy logic, the system was developed using 840 images. The evaluation of the system yielded satisfying results confirming applicability of the fuzzy inference system in such identification processes.

REFERENCES

[1] Z. Lotfi Fuzzy sets Inform. Contr., 8 (1965), pp. 338–353

[2] L. Simon, S. Mark "A practical guide to biometric security technology", Int. J. IT Professional, 3 (1) (2001), pp. 27–32

[3] A.K. Jain, et al. "An introduction to biometric recognition", Int. J. CSV Tec., 14 (1) (2004), pp. 420

[4] J. Anil, P. Sharath Biometrics systems: anatomy of performance, IEICE Trans. Fundamentals, E84-D (7) (2001), pp. 788–799

[5] Z. David, Z. Wangmeng, "Computational intelligence-based biometric technologies", Int. J. CIM., 2 (2) (2007), pp. 26–36

[6] C. Xinjian, et al., " A new algorithm for distorted fingerprints matching based on normalized fuzzy similarity measure", Int. J. Image Processing, 15 (3) (2006), pp. 767–776

[7] C. Vassilios, et al., "Multimodal decision-level fusion for person authentication", Int. J. of SMC, Part A: Systems and Humans, 29 (6) (1999), pp. 674–680.

[8] S. Wilson and A. Lenin Fred, "An Efficient Biometric Multimodal Face, Iris and Finger Fake Detection using an Adaptive Neuro Fuzzy Inference System (ANFIS)", Middle-East Journal of Scientific Research 22 (6): 937-947, 2014 ISSN 1990-9233 © IDOSI Publications, 2014.

[9] Genetic Algorithms in Integrated Process Planning and Scheduling", International Journal of The Computer, The Internet and Management, Vol. 10, No2, 2002, p 81 – 96.

[10] Sumiati,Haris Triono Sigit, Andri Kapuji, "Mamdani Fuzzy inference system Application Setting For Traffic Lights", International Journal of Application or Innovation in Engineering & Management (IJAIEM), Web Site: www.ijaiem.org Email: editor@ijaiem.org, Volume 3, Issue 10, October 2014 ISSN 2319 – 4847.

[11] Amartya Neogi, Abhoy Chand Mondal and Soumitra Kumar Mandal, "A Cascaded Fuzzy Inference System for University Non-Teaching Staff Performance Appraisal", Journal of Information Processing Systems, Vol.7, No.4, December 2011.

[12] M.A.Jayaram, Prashanth G.K., Sachin C Patil, "Inertia-Based Ear Biometrics: A Novel Approach", Journal of intelligent systems, De_Gruiter publications, advanced online publication, June 2015.

[13] H. Hikawa, Implementation of Simplified Multilayer Neural Network with On-chip Learning, Proc. of the IEEE International Conference on Neural Networks (Part 4), Vol. 4, 1999, pp 1633-1637.

[14] M.A.Jayaram, Prashanth G.K., Shabreen Taj, " Classification of ear biometric data using support vector machine", British Journal of Applied science and technology, 11(1), PP 1-10, 2015.

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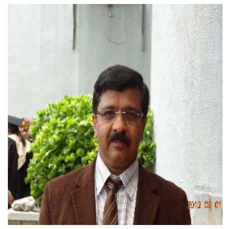

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