

Hand Gesture Object Recognition Based on the combination of Fuzzy Reasoning Method, Back propagation Algorithm and Mamdani Classification Approach

Samta Jain Goyal, Arvind Kumar Upadhyay, Rakesh Singh Jadon

Abstract: In present scenario, the importance of Hand Gesture Object Recognition is widely used in many real time applications. HGOR System is basically a combination of The Fuzzy Reasoning System (FRS), Artificial Neural Network (ANN) with the Fuzzy Measure classifiers. The purpose of this work is to investigate and develop more effective and more accurate system than the earlier developed System. The purpose of this system is to speed up the recognition process because these systems take more training and testing time. This work presents a method for HGOR for the Static hand position to get the meaning for machine interaction. Also, this work is used for facial expression recognition based on hand gesture position surrounding the face to get better position for communication through machine in HCI.

Index Terms: Artificial Neural Network (ANN), Fuzzy Reasoning System (FRS), Fuzzy Measure classifier, Hand Gesture Object Recognition (HGOR), Human-Computer Interaction (HCI), Mamdani Classification.

I. INTRODUCTION

Non-verbal communication includes various body gestures such as facial parts, hand, leg movements, body movements and so on. Earlier the way of communication generally facial expressions was used widely. But in HCI, proper interaction with a system, facial and hand gesture plays a major role. This kind of development helps in many real time applications such as sign language recognition, interactive games, vision-based augmented reality, telling passengers about the safety features by the airhostess, for the physically challenged people etc. So many algorithms, approaches, techniques are used by many researchers for the same purpose [1]. Hand gesture object can be classified in two types i.e. Static and Dynamic gestures. Static gesture is type of posture which refers only a single image corresponding to a single command. These types of gestures require less computational power due to its simplicity. Whereas in the dynamic gestures, which is basically a sequence of postures,

intended to change over a period of time which is quite complex to calculate accurate result through the machine to reach on proper output. The proposed technique presents an image for recognizing hand gesture object by passing it through five stages- image acquisition, preprocessing, Segmentation, feature extraction, and classification. This work uses the combination of Fuzzy Reasoning Method, Backpropagation Algorithm & Mamdani ‘classification approach.

Fuzzy Reasoning through the Soft Computing deals with the flexible Recognition system. A Fuzzy Reasoning System (FRS) which help to encompasses the implementation of a nonlinear functionality. A Fuzzy Reasoning System (FRS), depicted in Figure-1, contains the fuzzification which is generally used for computes the membership degrees of the input values to the fuzzy sets. This FRS consist Rule Base System, this rule-based system is designed through the Inference rules which are associating linguistic input variables to linguistic output values. There is an Information Manager which is used to search adequate rules to apply for selection of the input. This system contains an Inference Machine to give the membership degrees from the output values will be in the output sets based on selected rules [2-5].

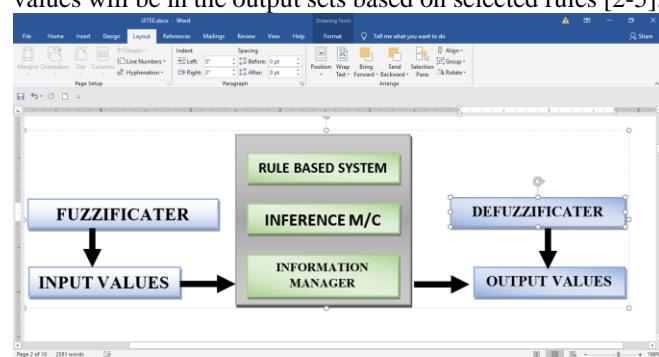


Figure-1: Components of Fuzzy Reasoning System (FRS)

And at last, the defuzzification component basically determines a single output value as a function and their membership degrees to the output sets. There are many effective Fuzzy Reasoning based approaches which we are using to get better quality of output results. These are fuzzy logic, fuzzy sets, neural networks, hybrid neuro-fuzzy methods, fuzzy rule and finite state machine, hidden Markov based models etc.

Manuscript published on 30 March 2019.

*Correspondence Author(s)

Samta Jain Goyal, CSE Department, Amity University, Madhya Pradesh, India

Dr.A.K. Upadhyay, CSE Department, Amity University, Madhya Pradesh, India

Dr.R.S. Jadon, MCA Department, MITS, Gwalior, Madhya Pradesh, India

© The Authors. Published by Blue Eyes Intelligence Engineering and Sciences Publication (BEIESP). This is an open access article under the CC-BY-NC-ND license <http://creativecommons.org/licenses/by-nc-nd/4.0/>

Hand Gesture Object Recognition Based on the combination of Fuzzy Reasoning Method, Back propagation Algorithm and Mamdani Classification Approach

Actually, Fuzzy Reasoning System (FRS) is a good combination of fuzzy logic and neural network. FRS is a system which is used to experiments and analysis the problems. In this work it is used to recognize Hand gestures as an object so that it can merge for further research if required. It behaves like a module which can use at the particular time and on particular requirements. this approach is implemented through the function which divides the input image into particular groups. These groups use a Fuzzy measure. These measures are used to find the shape of the hand and picturize the required inputs to be acted upon in order to get the required interpretation of the hand gestures an object.

II.OVERALL APPROACH

Gesture is all about communication through body language, majorly focused around face or hand. Gesture recognition would be an ideal approach to improve the human-machine interaction. Thus, considering it as an object, it can be done with the help of Fuzzy Reasoning System (FRS). This system also comprises the concepts of ANN. In ANN, (Figure-2) it works on the methods of feedforward and feedback. In feedforward, after performing its function, neuron passes its output to all of the neurons that are in the layer below it while in feedback two-way communication is used by introducing loops. These lines of communication have two types of connection mechanism, one is summing mechanism and another one is subtracting mechanism. In general, multiple inputs received from the neuron will produce a resultant output to be processed further. These artificial neurons have dual modes of operations, mainly- Training Mode and Using Mode [6]. For a particular input patterns in Training mode, neurons are trained to fire (or not), while in using mode, taught patterns are detected at the input and associated output replaces the current output. Moreover, in case of input patterns are not from taught list, firing rules are used.

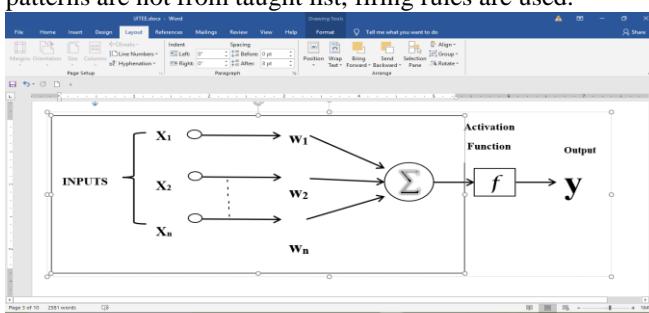


Figure-2: Method of feedforward and feedback.

Now, it is well known that in ANN, the main components are neurons which clustered together to form an interconnected network called neural network. These connections are done through synapses which are also termed as connecting links and work like a glue for the system. It also has associated weight to provide a variable strength to an input [7-10]. In this manner the entire system has been divided into Input, Output and Hidden Layers as shown in Figure-3.

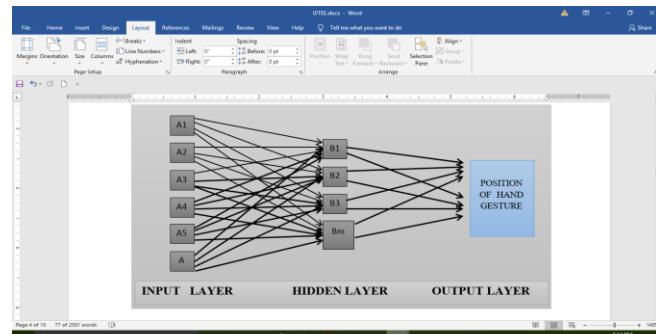


Figure-3:System divided into Input, Output and Hidden Layers

Our proposed work on Hand Gesture Object Recognition is based on the concept of FRS and ANN with Mamdani Inference System. In the proposed model, at first, input image of the object is acquired which is common in all object recognition processes. Then after, input image will be sent for preprocessing through many step functions including segmentation, noise reduction, edge detection and so on. Primarily in segmentation, skin region is separated from the rest of the image so that the entire input object image can be divided into two layers i.e., foreground and background. Now for image partitioning, thresholding is used for separating hand region and the region with different colors. In the next sub phase, Noise Reduction will be carried out for removing unwanted visual distortion from the input image. Noise level is reduced from the acquired input by using mean filters method in which center pixel is replaced by average of the pixels in its neighborhood. Feature extraction is all about transforming visual information into vector space by retrieving important data from the raw input image. It helps to recognize unique patterns in images which can be used for mathematical processing. In HGOR, there are greater possibilities to recognize hand posture by identifying and extracting geometric features. Mathematically, a feature is a multidimensional vector obtained from the acquired input image using certain analysis. The widely used visual cues for determining these vectors are texture, color and shape of the hand. These are better to be used for good feature extraction as, it is the crucial part of gesture recognition.

II. FUZZY REASONING METHOD FOR PROPOSED HGOR SYSTEM USING THE BACK-PROPAGATION ALGORITHM AND MAMDANI 'CLASSIFICATION APPROACH

Our study says that Hand Gesture Object Recognition is classified into two main categories. In the First category, static hand gesture object recognition where it relies only on the information about the flexure angles where as in dynamic hand gesture object recognition, it relies flex angles as well as hand trajectories and orientations.

In Hand gesture object recognition, it basically consists of hand postures, angles of fingers, palms, positions and all. General acquired sample images for hand gesture object recognition are based on spatio-temporal patterns.



There are many ways to recognize hand gesture object to get its position, meaning of the position, its representation and so on. In my work we are using the combination of Fuzzy Reasoning Method and Mamdani Classification which gives our result better than the existing. HGOR System dividing the hand gesture object into many groups which follows a pattern of hand gesture object such as the shape, position of hand movement, Gripped Fingers, Upward Fingers and so on. These extracted features are used as the inputs for this newly designed HGOR system based on FRS. In the recognition process of HGOR System, use Fuzzy Measure classifiers to classify an image to get pattern of hand gesture object. The Fuzzy Measure algorithm has been used extensively where we divided the hand gesture object into different pattern groups using the FRS. We chose this method to reduce the computation time. The goal of this process is to find the shortest distance between the features of an image. Fuzzy Measure obtains classes on the basis of the total mean of the classes which are close to the K spot. The shortest matrix distance is measured using the Euclidean distance [10].

The Fuzzy Reasoning System (FRS) provides a Neuro-Fuzzy system with a highly structured platform which uses IF-THEN fuzzy rules to provide Learning Ability. There we used couple of input and output data to establish learning procedures which optimized the learning parameters. This system uses the Mamdani model for the fuzzy elaboration. We used X and Y as the inputs of the proposed Fuzzy Reasoning System and Z as an output value. The model of the Fuzzy Reasoning System using Mamdani model is described using the following Equations:

Rule1: If x is P_1 and y is Q_1 , then

$$F_2 = A_1x + B_1y + c_1 \quad (1)$$

Rule2: If x is P_2 and y is Q_2 , then

$$F_2 = A_2x + B_2y + c_2 \quad (2)$$

x and y are the fuzzy inputs. P_1 and P_2 are membership functions, while f_1 and f_2 are the outputs withand $A_1, A_2, B_1, B_2, C_1, C_2$ as the parameters of consequence.

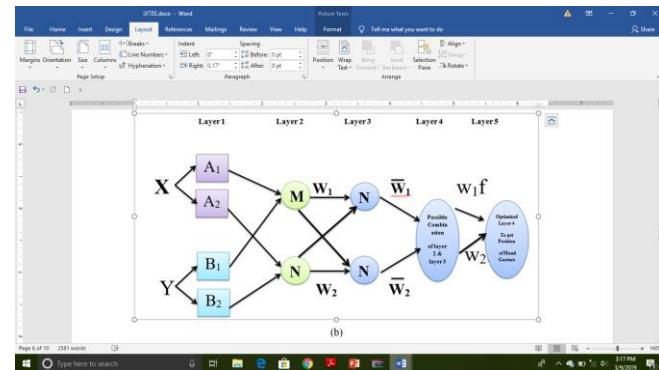
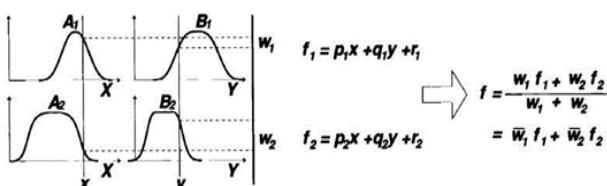


Figure-4: Mamdani Model: (a) Type-3 Fuzzy Reasoning; (b) Type-3 FRS (Equivalent FRS)

Here is our overall approach depicted in following Figure-5:

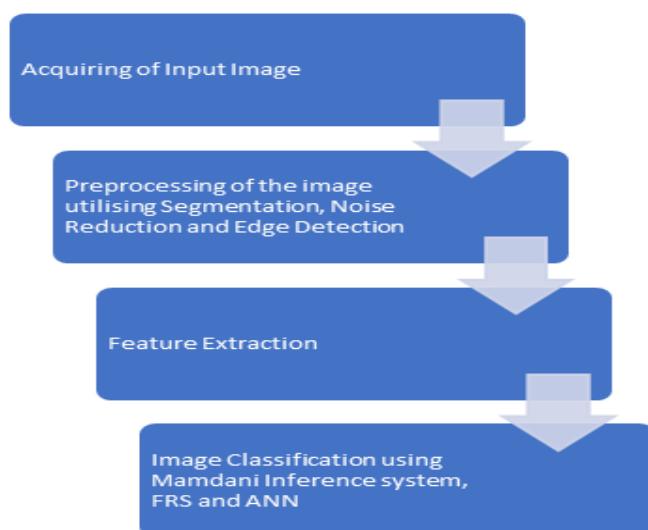


Figure-5: Overall Approach for HGOR System

III. OUR SYSTEM FOR HAND GESTURE OBJECT

Recognition has five stage for finding out actual hand gesture from the input image. These all phases have sub phases to get better results. Because all major phases have many sub phases to give better results for further processing phase. These are known as Image acquisition, Image preprocessing, Image segmentation, features extraction and last based on extracted features classify the actual output of the concern classes of gesture. These all phases use the dataset in every phase during the processing. The input image is first capturing through the suitable input device [11]. Then remove noise, detect edges to get comparatively better output for further processing in preprocessing stage. After then Segment image based on edge detection of the desired output. Segmented image then goes for the feature extraction phase for detecting actual features of the object so that based in that we can get actual features of the object. These features are then used to classify the state of a class where is it pointing, or thinking, waving, showing some standard patterns during the communications.

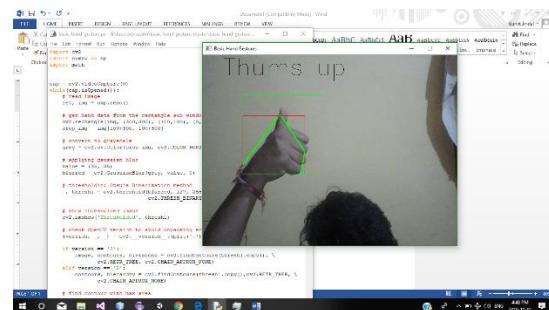
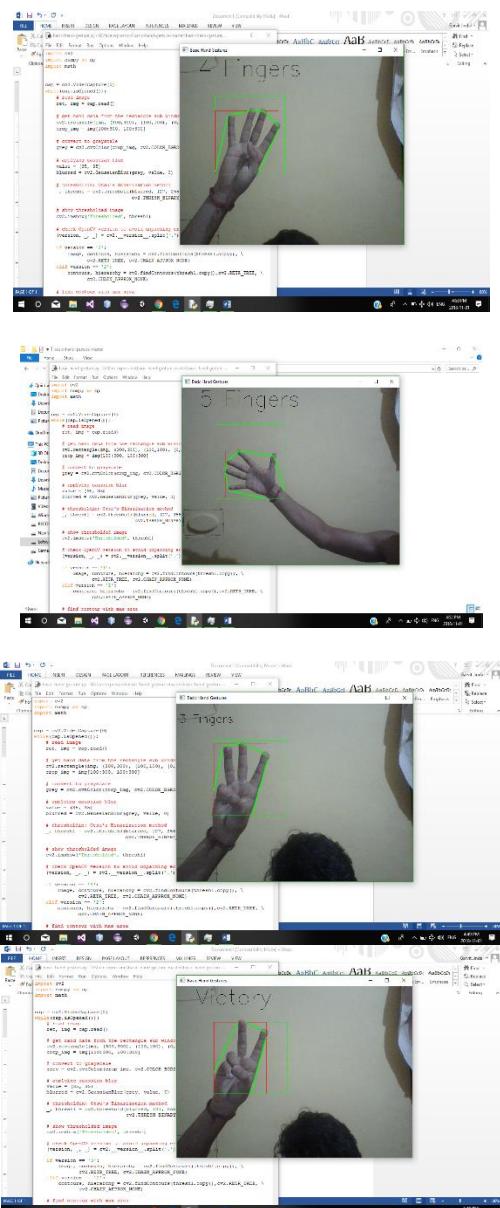


Hand Gesture Object Recognition Based on the combination of Fuzzy Reasoning Method, Back propagation Algorithm and Mamdani Classification Approach

The proposed system has been tested using OpenCV & Python. These all done through Training and testing stage to get advanced results based on the newly added parameters of an input image so that we can classify the image based on different gesture of the hand.

IV. RESULTS AND DISCUSSION

As explained the above system which has been tested using OpenCV with the database in two stages. One is Training and other is Testing part. In the Training Phase, each image, feature vectors for each image is extracted using OpenCV tools. And in the Testing step, taking care of each hand gesture.



Process	Time Elapsed (sec)
Grayscale Conversion	0.16815
Ridge Detection	0.4617
Wrist Detection	0.372419
Gesture Segmentation	0.21475
Gesture Recognition	0.19412

Figure-6: Results and Table of Experiment

The experimental results showed that the correct recognition rates were 97.4% and 95.1% for the training set and testing set, respectively [Figure 6]. We then used the rules extracted from the first database to test the second database. The correct recognition rate was 96.2%.

V. CONCLUSION

We presented a Hand Gesture Object Recognition System based on Fuzzy Reasoning System (FRS) based. The purpose of this study is to propose a new approach for Hand Gesture Object Recognition which involves creating groups on the basis of the hand patterns using the FRS. The Hand Gesture Object Recognition System is carried out with the groups using Fuzzy Measure classifications. The overall approach will be extended to include new types of features and gestures of hands to decrease of noise, complexity, and time need for recognition. We got better results than the existing approaches as shown in above figures. In future we will add this work to get facial emotions during communication based on its hand gesture.

REFERENCES

1. Jayesh s. sonkusare, Nilkanth B. chopade, Ravindra sor and Sunil L. tade, "A review on Hand Gesture Recognition System", in International Conference on Computing Communication Control and Automation, 2015.
2. Mokhtar M. Hasan, and Pramod K. Mishra, 2012. Hand Gesture Modeling and Recognition using Geometric Features: A Review, Canadian Journal on Image Processing and Computer Vision Vol. 3, No.1.
3. Shiguo Lian Wei Hu, kai Wang "Automatic User State Recognition for Hand Gesture Based Low-Cost Television Control System" IEEE Transaction paper,2014.
4. Sukhdip Singh, Yogita Bhardwaj, "Hand Gesture Recognition Techniques: A Review", in National conference on Innovative Trends in Computer Science Engineering (ITCSE), ISSN:2349-7688, April 2015.



5. Mokhtar M. Hasan, Noor A. Ibraheem and Rafiqul Z.Khan, "Comparative study of Skin Color based Segmentation Techniques", International Journal of Applied Information Systems (IJAIS), Volume 5, No. 10, August 2013.
6. Anupam Agrawal, Siddharth S. Rautaray," Vision based hand gesture recognition for human computer interaction: a survey", Springer/Science Business Media Dordrecht, 2012.
7. Gashree R N ,Stafford Michahial , Aishwarya G N ,Beebi Hajira Azeez ,Jayalakshmi M R ,and R Krupa Rani, "Hand Gesture Recognition using Support Vector Machine", in International Journal Of Engineering And Science (IIES), Volume 4, Issue 6, Pages PP.42-46, June – 2015, ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805.
8. E. Ohn-Bar and M. M. Trivedi, "Hand gesture recognition in real time for automotive interfaces: A multimodal vision-based approach and evaluations," IEEE Trans.Intelligent Transportation Systems, vol. 15, no. 6, pp.2368–2377, Dec 2014.
9. W. Heng, A. Kl'ser, C. Schmid, and C.-L. Liu, "Dense trajectories and motion boundary descriptors for action recognition," Intl. Journal of Computer Vision, vol. 103, no. 1, pp. 60-79, May. 2013.
10. Afef Salhi and Ameni Yengui Jammoussi, "Object tracking system using Camshift, Meanshift and Kalman filter," World Academy of Science, Engineering and Technology International Journal of Electrical, Computer, Energetic, Electronic and Communication Engineering Vol:6, No:4, 2012, pp. 421-426.
11. Xianggong Hong, Xiying Zheng, Huimei Xiao, Zhiyi Xue, "An Improved Camshift Algorithm Based on Grabcut with a LBP Model of Correction Tracking Centroid," Chemical Engineering Transactions, VOL. 46, 2015, DOI: 10.3303/CET1546063, pp. 373-378.

AUTHORS PROFILE



Samta Jain Goyal is working as an Assistant Professor in Computer Science and Engineering department at Amity University, Gwalior. She received M. Tech degree in Computer Science and Technology from JNU, Jodhpur in 2012 and pursuing Ph.D. from Amity School of Engineering and Technology, Amity University Madhya Pradesh, Gwalior.



Dr. Arvind Kumar Upadhyay is working as Professor in Computer Science & Engineering department (ASET), Amity University, Madhya Pradesh, Gwalior. He has done his Ph.D. (Computer Science & Engineering) from MNNIT, Allahabad, Year 2015. Thesis title: "Regression Testing: A new approach using Clustering and Association rule in test suit Prioritization and Reduction"



Dr.R.S. Jadon is Professor & Head in Department of Computer Applications, Madhav Institute of Technology and Science, Gwalior (M.P.). He has done his Ph.D. in 2002 from IIT Delhi Computer Science & Engg. On "A Fuzzy Theoretic Approach for Characterizing Video Sequences".