International Journal of Technology and Emerging Sciences (IJTES)

www.mapscipub.com

Volume 02 || Issue 03 || July 2022 || pp. 52-55 E-ISSN: 2583-1925

Identification of Biometric Facial Geometry using RGB-D Image based Fuzzy Model

Atharva Wagare[1], Dr. Shubhangi Rathkanthiwar[2], Dr. Hemant Pendharkar[3]

[1]*Student, Dept. of Computer Technology, Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra, India*
[2]*Professor, Dept. of Electronics Engineering, Yeshwantrao Chavan College of Engineering, Nagpur, Maharashtra, India*
[3]*Professor, Department of Mathematics & Statistics, University of South Florida, USA*

Abstract - *Automatic facial recognition is important, difficult as well as complex task. Therefore, there is the need for the development of algorithms which are capable of handling different facial recognition problems. This paper is presenting a review on Identification of biometric facial geometry using an RGB-D image based fuzzy model. Combination of RGB image and its depth image forms a RGB-D image in which RGB color is used to detect the skin using membership functions for space color red, space color green and space color green and Kinect device is used to obtain images with 3-D information.*

***Key Words*:** Facial geometry, Kinect, facial recognition, RGB-D image, fuzzy membership function, fuzzy logic.

1. INTRODUCTION

Facial geometry is detected by important cephalometric points. These are directly related to underlaying skeletal cranial points. Using the data structure called point cloud model, the human face is detected from RGB-D image. A fuzzy membership function is used to differentiate between human skin color and non-skin color.

The approach of recognizing 3D face with the help of isogeodesic stripes takes geometric details of 3D face. These details then get encoded into a compact representation of graph. This graphical representation of 3D face allows to match face recognition efficiently. This approach is also best suitable in identifying face in of very large datasets with appropriate index structures [2]. In the process of face recognition with fuzzy rough set theory (FRST), the support vector machine (SVM) collects the features from images of human face by combining two techniques namely 2-D wavelet decomposition technique and the greyscale integral projection technique. Here reduction algorithm is capable of eliminating the redundant features of dataset which leads to reduction in the space dimension of sample data [4]. Among various face recognition algorithms, LDA is one of the famous algorithm but the result produced is weak. To improve the result a membership degree matrix of training samples is calculated first by fuzzy k-nearest neighbor (FKNN) [5]. Emotions has vital role in human interaction this leads to the generation of the need to recognize them. A method comprises detection of eye and mouth among different ages by formation of the different color spaces combinations with the help of parameters which includes eye and mouth opening, mouth width, and eye opening/width ratio. These are selected for the fuzzy analysis [7].

In the context of facial recognition there is a common assumption that the face images have similar poses, and they are well aligned [1]. The common approach is to make discrete poses and learn to detect them individually. Some methods require total facial characteristics completely visible in each pose. In general, 2D images based facial recognition methods are sensitive towards difference in illumination and shortage of features. Fuzzy neural network-based system combine the histogram which have information of color and depth. AN algorithm detects face by classifying and identifying face images. This is achieved by combining membership functions and Independent Component Analysis. [6]

In the assumption of uniqueness of every face, there are some constant landmarks on the face that help in the definition of geometry of human face. Human face can be described by the points that correspond to underlaying skeletal craniometrical points and called as cephalometric points. In addition to allowing us to create the geometry of face, these points helps to develop the indices that are essential in revealing various relationships. In this approach information is described in form of fuzzy patterns. A cloud of point is formed by the output RGB-D image from a Kinect Device. A rule-based fuzzy membership function is used for description of relation of each point with its neighbor with the color information and depth. This all process if followed by creation of concentric squares using facial information of symmetric properties of face. Finally with the help of point cloud configuration, contours to obtain facial areas can be described.

2. GEOMETRY OF FACE

The cephalometric points on face are partitioned as lateral points (go, zy), cranial points (at, eu, sg, g, v), orbital points (en, ec, or, im, il), labial points (stm, li, ch, sls, ls), nasal points (sn, na, n, al, prn), auricular points (sa, sba, para, pa, tr), mental points (lm, pog, gn) [1]. This leads us to the point that area of face is contoured namely mental, frontal, nasal, labial, orbital, buccomandibular, zygomaxillary, and auricular along with requirement of a solid geometry for true mathematical treatment of such surface. The most essential facial planes includes transglabellar plane (TPG), midfacial plane (MFP), midsagittal plane (MSG) and transverse nasal plane (TNP).

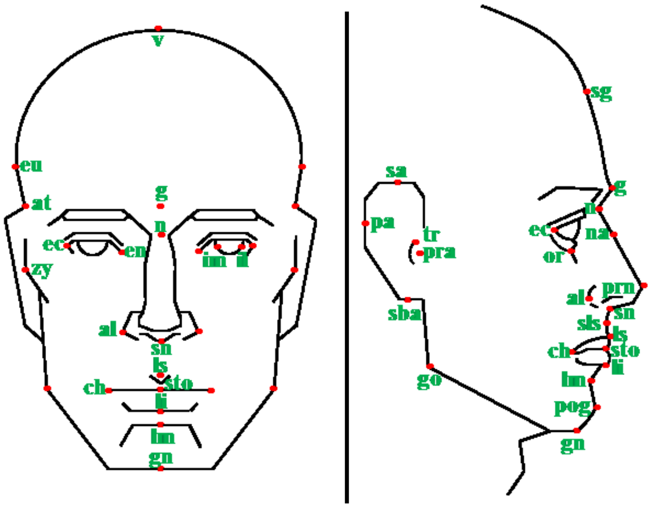

Figure-1: Cephalometric points underlying the skeletal craniometric points

3. POINT CLOUD PARADIGM

Data structure used for recognition of human face from RGB-D image consists a set P = {p_1, p_2, p_3, … , p_n}, where every point has a relation with three integers (x, y, z) which are later translated to coordinates on a plane. Given RGB color space pc = {r_p, g_p, b_p} where r_p, g_p, b_p ∈ [0…225]. For the color of set points that corresponds to the skin Pc = {p_{1c}, p_{2c}, …, p_{nc}}, the histogram of P_c, H (P_c), denotes the distribution of probability for every pic, for i = 1, 2, …, n. H (P_c) is normalized by P, then H (P_c) takes a color space Pc belonging to [0, 1]; the description of fuzzy set can be given as a pair (P_c, H), H: $P_c \rightarrow [0, 1]$, which is normalized histogram. For every p_c ∈ Pc, H (P_c) is the membership grade of pc such that

$$p_c \in (P_c, H) \leftrightarrow p_c \in P_c \text{ and } H(p_c) \neq 0$$

Therefore, whether the skin or not-skin, every class membership function is related with primary space color i.e. red, green and blue.

$$\mu_{SKIN_i}(P_c) = \beta_i e^{-\frac{(p_c-\alpha_i)^2}{2\sigma_i^2}}$$

Where {p_{cr}, p_{cg}, p_{cb}} ∈ [0, …, 255]; i = {R, G, B}; β_i = max (H (P_{ci})), α = argmax H(P_{ci}) and σi2 is the variance of each and every fuzzy set p_{ci}

The value of the point to that of the object is calculated by incorporating Z-function and also S-function to every color point.

$$\mu^{Z}_{NON-SKIN_i}(p_{c_i}) = \begin{cases} 0 & for\ p_{c_i} \leq a_{si} \\ 2\left(\frac{p_{c_i}-a_{si}}{\gamma_{si}-a_{si}}\right)^2 & for\ a_{si} \leq p_{c_i} \leq b_{si} \\ 1-2\left(\frac{p_{c_i}-\gamma_{si}}{\gamma_{si}-a_{si}}\right)^2 & for\ a_{si} \leq p_{c_i} \leq b_{si} \\ 1 & for\ \gamma_{si} \leq p_{c_i} \end{cases}$$

$$\mu^{Z}_{NON-SKIN_i}(p_{c_i}) = \begin{cases} 1 & for\ p_{c_i} \leq a_{zi} \\ 1-2\left(\frac{p_{c_i}-a_{zi}}{\gamma_{zi}-a_{zi}}\right)^2 & for\ a_{zi} \leq p_{c_i} \leq b_{zi} \\ 2\left(\frac{p_{c_i}-\gamma_{zi}}{\gamma_{zi}-a_{zi}}\right)^2 & for\ a_{zi} \leq p_{c_i} \leq b_{zi} \\ 0 & for\ \gamma_{zi} \leq p_{c_i} \end{cases}$$

For I = {R, G, B}; b_{si} and b_{zi} represents the crossover points of fuzzy sets which are described by $\mu^{Z}_{NON-SKINi}$ (p_{ci}), $\mu^{Z}_{NON-SKINi}$ (p_{ci}) respectively. The membership value of p_{ci} = b_{si} or b_{zi} which equals to 0.5; a_{si} = y_{zi} argmax H(p_{ci}); a_{zi} = 0.5*y_{zi}; and y_{zi} = 1.5*a_{si} r_p, g_p, b_p ∊ [0, …, 255].

Results for the fuzzy model, whether it is skin or non-skin are shown in Fig. 3, 4 and 5. For every color fuzzy set, we have three classes

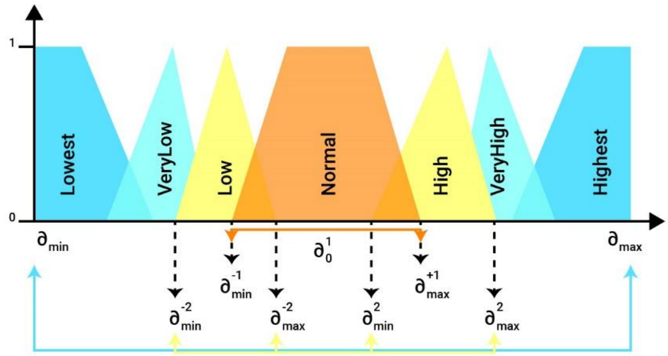

Figure-2: Depth Difference Fuzzy Membership Function

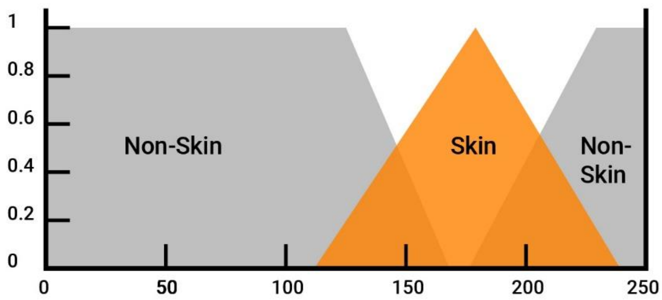

Figure-3: Space Color Red Membership Function

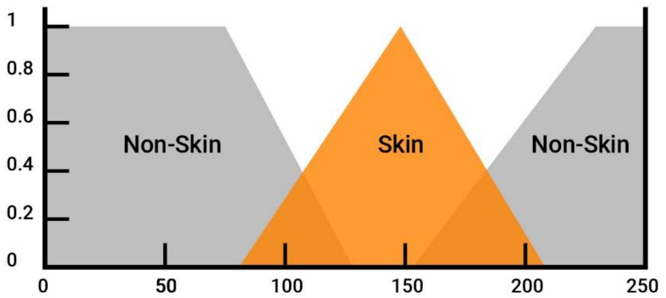

Figure-4: Space Color Green Membership Function

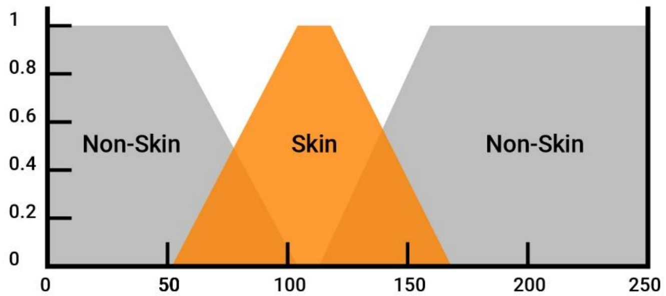

Figure-5: Space Color Blue Membership Function

4. REFERENCES

[1] MC. Victor Fernandez, Dr. Andres Mendez, Dr. Marco Antonio Ramos, Psic. Monika Gudino, "Fuzzy model based on RGBD images to identify biometrical facial geometry" IEEE International Conference on Fuzzy Systems (FUZZ-IEEE) 2013

[2] S. Berretti, Alberto Del Bimbo, "3D Face Recognition Using Isogeodesic Stripes" IEEE Transactions on Pattern Analysis and Machine Intelligence, Vol 32, No 12 2010

[3] J. Naruniec, M. Kowalski, M. Daniluk, "3D face data acquisition and modelling based on an RGBD camera matrix" IEEE International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications 2015

[4] Shi-yi Wang, Liang, Tao, "Face recognition using fuzzy rough set and support vector machine", IEEE International Conference on Intelligent Computing and Intelligent Systems 2010

[5] YUAN Wei, "Face Recognition Method Based on Improved LDA", 9th International Conference on Intelligent Human-Machine Systems and Cybernetics

[6] Xiqin He, Liangdong Guo, Cunrui Wang, Xiangdong Liu, "Face recognition based on fuzzy Independent Component Analysis", International Conference on Computer Science and Service System 2011

[7] F. Farahani, M. Sheikhan, Ali Farrokhi, "A fuzzy approach for facial emotion recognition", 13th Iranian Conference on Fuzzy Systems (IFSC) 2013

AUTHOR PROFILE

Atharva Wagare is an Undergraduate Student of Computer Technology Department at Yeshwantrao Chavan College of Engineering. He is also pursuing Bachelor of Science Degree in Data Science and Applications from Indian Institute of Technology, Madras, Chennai. His areas of interest include programming with Python, C, C++, Data Science.

Shubhangi Rathkanthiwar Being an author of more than 107 papers which are published in International journals and Conferences, she has written 6 books and 5 book chapters. Holding 3 patent granted by Government of India, she has 8 filed patent applications and 2 copyrights contributing towards her credit. She has specialization in Artificial Neural Networks, IoT Modules in Telemedicine, Signal Processing in Wireless Communications, Embedded Systems, etc. She was reviewer for IEEE Access and Elsevier Journal on Applied Soft Computing, IEEE Transactions on Vehicular Technology and IEEE Transactions on Industrial Electronics, IEEE Communications Survey and Tutorials. Also, she was not only TPC member but also reviewer for multiple diverse IEEE conferences. Dr. Rathkanthiwar has received 'Global Excellence award-2021', 'Best research paper award' (2011). For her significant contribution in academics and students centric teaching/learning activities she has received National Academy conferred 'Shikshak-Ratna Award' in New Delhi in 2011-12She has been invited as 'Lead Guest Editor' to publish Special Technical Issue of refereed international journals. She was also invited as 'Woman Scientist' to present her views in panel discussions in several international conferences, especially 'Women in Engineering' WiE wing. She is visitor of 11 countries including USA, China, Singapore, Scotland, England, etc. for presentations of various research and academic collaborations. She always serves the scholastic needs of the Department, Institute as well as the University. She is currently serving the Department of Electronics Engineering at YCCE, Nagpur as a Professor.

Dr Hemant Pendharkar is a Professor of Mathematics at the University of South Florida. Previously, he has served as a Professor of Computer Science and Mathematics at Worcester State University. His Ph.D. in Mathematics is in the area of Operator Algebras. Dr Pendharkar has published research articles in Mathematics, Computer Science, Theoretical Physics and pedagogy. Between 2016 – 18, he has served as the Office of Naval Research Faculty Fellow and Senior Research Fellow at the SPAWAR Atlantic center. He spent spring and summer of 2009 at the AT&T Research Labs (Formerly, The BELL Labs). Additionally, his has executed funded projects for Office Of Naval Research, NASA Glenn Research Center, National Science Foundation, Department of Defense - Army Research Office (Infrastructure) and NH State Department of Education (Graduate student participant.) Dr Pendharkar has taught in Mathematics, Computer Science, Master of Science for Teachers Program and MS in Management program. He has been a visiting faculty in Israel during the summers of 2009-2011. He has directed award winning student projects. Additionally, has trained corporates in areas of computer science. . Dr Pendharkar has also served in administration as the Vice President for Academic Affairs (2007-09), Associate Vice President for Student Affairs Fellow (2006-07), University-wide Chair of university core-curriculum (2011-13), and currently he holds a position as Campus Associate Chair at USF Mathematics and Statistics.