Convolution Neural Network Based Deep Feature Fusion for Palmprint and Handvein

Shreyas Rangappa, Naveena C, H K Chethan, K S Ragunnandan, Sunil C

Abstract*: A distinctive Deep Convolution Neural Network (CNN) outline architecture model is presented in this work which proficiently signify complex image features. With two convolution layers implementation of feature extraction is carried out successfully and provides a well-built biometric verification system by using physiological traits Palm print and Hand vein for development of our system. The formation of CNN hyper parameters carried out in numerous experiments such as filters and its size in each layer, number of convolution layers needed, batch size, iterations, learning rate is a paramount and epochs defining these factors are truly dependent on the nature of data and its size. The new method presented in our model has been part with and it gives 99% of GAR in biometric verification of unimodal system and extremely the experimentation has condensed results when combined with deep feature extraction and classification outcomes.

Keywords: Handvein, Palmprint, Convolution Neural Network.

I. INTRODUCTION

Nowadays a Biometric has become a unique identification system for humans and it becomes very important study the in depth knowledge of subject technology interface. Biometric model is totally based on pattern recognition scheme which obtains biometric data from an individual and from these obtained data it extracts the set of features and relates this feature set with the template set present in the datasets. Biometric systems exist in two modes such as verification mode or identification mode depending on the context of the application. In the phase of verification mode the person's identity is validate from the acquired biometric data and is equated with the template that is present in the database and in the stage of identification mode the templates of all the users present in the database is recognized by an individual to be same [1].

To understand the modalities of the biometrics that are involved in organizing the whole biometric systems possess a challenging task over a long period of years. In general to know the an exact traits which best fits for an application and interpretation of algorithms for extraction features that contains noise and combination of fusion between the traits etc., all these depends to develop an better multimodal biometric systems. Hence, investigating such an aspects from the root level creates a great demand. In present day and the future of the technology is completely depended on Artificial intelligence (AI), Machine learning (ML) and deep learning techniques. In 1956 the theoretical concept of Artificial intelligence was evolved and further machine learning was introduced as the subcategory of AI and deep learning is subcategory of MI. Artificial intelligence is a smart software which reproduces in the manner which a human brain behaves in its thinking, learning and ability to resolve the problem. Machine learning is a technique which acquires from its proficiency without being tough programmed and eventually predicts. Deep learning is based neural networks and it imitates the human brain whereas dendrites deliver input to neuron, nucleus executes the function and the output is guided to another neuron from axon output terminal [2].

In essence, researchers have comprehensively explored the problem on fusion of palmprint and hand vein recognition in biometrics from past few decades. Texture-based coding, feature extraction and subspace feature acquisition are some of the methods used to evaluate palmprint and hand vein in biometrics from years and even so, their results are inadequate and it shows there is still a need to improve. To enhance such issues we have adopted, deep convolutional neural networks (DCNN) can learn higher-level features from enormous training samples through this deep architecture. Hence, we propose a deep learning based method for fusion of palmprint hand vein recognition in biometrics [3].

The rest of the matters of the paper is as follows section II describes the related work on fusion palm print and hand vein used to develop an multimodal biometric system and section III gives detail explanation of proposed methodology of fusion of palm print and hand vein based on deep neural network and section IV demonstrates experimentation and results and section V concludes the proposed work and predicts future scope of the work.

II. RELATED WORK

Sen Lin et. al., [4] proposed a new method for multimodal biometrics recognition by combining palm print and palm vein. This model presents two new process known as neighbor based pattern (NBP) and multi-block mean neighbor based binary pattern (MMNBP). For analyzing the gray mean value the images are correspondingly allocated into blocks and this creates multi-block mean image and further NBP method and MMNBP method will be combined to enhance this model of fusion process and achieves good results.

Revised Manuscript Received on October 05, 2019.

* **Shreyas Rangappa**, Dept. of Computer Science, SJBIT, Bangalore, India.
Naveen C, Dept. of Computer Science, SJBIT, Bangalore, India.
Chethan H K, Dept. of Computer Science, University of Mysore, Mysore,
Raghunandan K S, Dept. of Computer Science, University of Mysore, Mysore, India.
Sunil C, Dept. of Computer Science, University of Mysore, Mysore, India.

Lin Zhang et. al., [5] proposed a novel method constructed on Deep Convolutional Neural Networks (DCCN) in palmprint and palm vein recognition. Deeper features is extracted and for identification Support Vector Machine (SVM) classifier is used and for verification the Euclidean distance is adopted for matching. In additional to this model preparation they also developed a contactless palm vein device that is capable of capturing high quality palm vein images.

Ma Xin et. al., [6] proposed a unique routine for recognition of palm vein by employing fusion of local Gabor histograms (FLGH). With help of local maximum difference operator encrypts the Gabor magnitude by introducing a descriptor known as local Gabor principal differences patterns and also encrypts Gabor phase patterns with local Gabor exclusive OR patterns. Finally, to condense the dimensionality of the feature depiction Fisher's linear discriminant procedure is used and accuracy is found to be good. Y T Luo et. al., [7] proposed a novel method for recognition of palmprint by introducing a similar descriptor that resembles local binary patterns and this descriptor is knows as local line directional patterns. For extraction of palmprint features the Gabor filters and modified finite random transform are used. They also compared the performance between local binary patterns and local line directional patterns and implemented on four databases for evaluation purpose. M I Ahmad et, al., [8] proposed a novel method for recognition of multimodal biometric system by fusion of face and palmprint based on non-stationary features. First the basic features will be extracted from face and palmprint and this is fused with non-stationary feature that creates a new set of feature vectors. To express the nonlinear data from the fusion of features gaussian mixture model is used. This model is compared with several other existing methods and gives better results. Li Peidan et. al., [9] proposed a new process for person recognition with the fusion of two behaviors such as, palmprint and palm vein. A new feature descriptor is implemented based on Non-Halo Complex Matched Filtering and this performed by making use of Exynos5410 system and it shows that there increasing results in accuracy and verification process. L Mirmohamadsadeghi et. al., [10] proposed a different technique for recognition of palm vein constructed on local texture features like local binary patterns and local derivative patterns and also fused together for investigations. When compared with individual methods and as well as fusion methods it proves to be local derivative pattern method accomplishes better than other two methods. Lin Zhang et. al., [11] proposed a novel image acquisition scheme for palmprint images which is capable of capturing high quality images and it should be user-friendly in nature. Further they have developed a CR_CompCode for recognition of contactless palmprint and proves to be highly accurate and also computation speed has been improved. Gen Li et. al., [12] proposed a novel technique for recognition of palmprint based on exceptional local descriptor known as local micro structure tera pattern. Line-shaped filter is made used in this implementation to remove the unwanted features and local region histograms will be released from local micro structure tera pattern and it is interrelated to form a particular feature vector. At last, to this feature vector a kernel linear discriminant technique is employed for reducing the dimension and this method is compared with other existing methods and proves to give effective results. L Fei et. al., [13] proposed a novel method for extracting features and recognition of palmprint with the implementation of double half-orientation process. While, extracting half orientation features from the palmprint they will describe the half Gabor filters and instead of single dominant orientation they have used double half orientation for effective extraction of global orientation of feature from the palmprint and experimentation is carried out on three different standard datasets and gives good results for identification and verification of palmprint. Gopal et. al., [14] proposed a novel method for fusion of dorsal hand vein, palmprint and palm-phalanges print for personal identification model. To develop this model they have generated their distinct datasets termed as NIST palmprint database and score level fusion is implemented between all the traits by making use of t-norm, Yager's weighted averaging and conventional fusion operators. Finally for matching scores they have used support vector machine, k-nearest neighbor and random forest techniques and proposed work gives better results when compared to unique model. Lunke Fei et. al., [15] proposed novel method for palmprint recognition based on double orientation code for extracting the orientation features and for testing the resemblance between double orientation code the nonlinear equivalent score has been implemented. Discrete filters have been used for feature extraction of palmprint and proves to better when compared to conventional methods. A M Al-juboori et. al., [16] proposed a novel method for segmentation and verification in biometric system by using palm vein. Enrichment of palm vein images are done by making use of Gaussian second derivative method and for extraction of feature Gabor filters and fisher discriminant analysis is united to form a single technique known as Gabor Fisher Vein feature. For verification of palm vein cosine distance process is used and achieves good results. M Aykut and M Ekinci., [17] proposed a novel method for recognition of palmprint and creating high quality contactless palmprint image database for an effective authentication system. For perfect segmentation of palms they make use an Active Appearance Model (AAM) technique and for extracting the palm image a new Region of Interest based palm model that make use of nonlinear regression has been proposed and methods proves to achieve high recognition rate. A Rao et. al., [18] stated that biometric system based on palmprint and hand vein on both forms like unimodal and multimodal. By making use of non-standard masks method they extracted features from palmprint and hand vein that supports all conditions such as multialgorithmic, multimodal and unimodal systems. Kernel direct discriminant analysis method is applied for effective classification and method achieves good results.

III. PROPSED METHDOLOGY

Identification and verification of a person based on palmprint and hand vein have been drawn more attention towards computer vision methods from latest years. According to an observation from the latest literature Convolution Neural

Networks have been outperformed when compared to conventional methods because of its capability of performing self-learning ability on different types of composite and huge data. Hence this has been motivated us to implement Convolution Neural Network based on deep features to improve a Multimodal Biometrics for identification of a person [19].

To obtain the information of the given kernel size from the patches of the images and it will be gained by CNN. Therefore the role of CNN becomes very important for designing kernel size of each layer and the information received from the kernel size is directly proportional. Typically, for capturing the minute information the local information will be extracted from the small size kernel from the given patches of the images.

In this existing model, to obtain to obtain the minute spatial information from the convolutional layers, we fix the size of the kernel to 3x3 that is minimum for all the layers. The 2 layer CNN architecture designed to training model and for training certain images it will be scaled to size of 60x60 and the same size will be used for mapping the input features as well as for verification. According to the availability of the datasets during the whole phase of training, we utilize and design the set of hyper parameters with training images of the size 60x60, so that it plays a very important role in simplifying the process of learning in effective and competent manner. For investigation purpose we have described roughly the hyper parameters such as, size of the kernel (preferably small), momentum, learning rate, padding, stride, maxpool, activation function Rectified Linear Unit (ReLU), small batch of images for learning, Batch Normalization (BN) factor and number of output from each layer. Convolution of the input images by fixing the kernel size to 3x3 and the size of the padding is fixed to 1x1 and we define it as $(k-1)/2$, hence 'k' stands for the size of the kernel and local path of the information will be captured during the phase of extracting the weights. To moderate the internal covariance between the set of all the images we make use of mini batch BN layer. Especially, with small stride it is accepted to be negligible amount of information loss and for this purpose we have fixed the striding ids to 1 in our methodology. We consider ReLU the non-linearity method in addition to the output of the convolution layer, as it maintains the size of the input images thus the stronghold and impact of ReLU can diminish the varnishing gradient issue and it turns into an element gradient function in the network and it is given by Eq. 1

$$f(x) = \begin{cases} x, & x \geq 0 \\ 0, & x < 0 \end{cases} \quad (1)$$

During the classification stage, the dimension of the feature map will be reduced and the size of the window is 2x2 in the max-pooling layer and once the ReLU process is completed the size of stride and padding will be fixed to 1. Learning rate is fixed to 10^{-1} and during the process of training CNN, Stochastic Gradient Decent Momentum (SGDM) method is applied. After 20 epochs the model will not be stable due to overfitting problem as it carries huge number of data at the point of experimentation and hence learning rate will be reduced to 10^{-1}. At last the convergence rate will be attained at 10^{-5} at 50 epochs. As a final point, softmax layer is used for fruitful classification of the input sliding window image.

IV. EXPERIMENTATION AND RESULTS

A novel deep CNN architecture in modeling a robust and reliable biometric verification system adopting the two hand modalities such as Handvein from Cluj University database and Palmprint from PolyU Palmprint database has been proposed. From the modality of Handvein we have evaluated 100 users so that each user consists of Handvein images of 5 samples, in that 3 samples for training and 2 for testing. From the database of Palmprint 100 users have been evaluated, 10 samples for each users and from these 10 samples we have preferred 6 samples for training and 4 samples for testing. In view of the standard benchmark threshold values for FAR 0.01%, 0.1%, 1%, we have executed extensive experimentation in investigating the ideal curve fitting for the data.

Table-I illustrate the palm print and hand vein unimodal biometric system verification results. Significant results have been achieved from all the standard benchmark threshold values, and it is completely reliant on the proposed system for compacted security systems. Table-II illustrate the authentication results of multimodal biometric systems instigated using feature level fusion scheme. We have acquired 99.7% GAR on 1% FAR, the results illustrates the assurance of the novel proposed deep CNN architecture and the fine tuning of its hyper parameters in attaining significant result.

Table-I: Results of Unimodal Biometric Verification System

FAR %	Palmprint (GAR%)	Handvein (GAR%)
0.01	97	97.4
0.1	98.6	99
1	98.9	99

Table-II: Results of Multimodal Biometric Verification System

FAR %	Multimodal feature level fusion of face and iris (GAR%
0.01	98.5
0.1	99
1	99.7

V. CONCLUSION AND FUTURE WORK

In our novel proposed model of unimodal biometric verification system archives great performance and also provides unyielding security essentials, 99.7% accuracy has been achieved from the feature level fusion of multimodal biometric system. Henceforth as we have achieved prominent results from unimodal biometric verification system itself and now it is completely dependent on system developers to rely on multimodal biometric

system deployment. From the recent research works we can observe that, in specifying the selection of features, reduction, classification and feature extraction methods was a difficult task with absence of deep CNN architectures. Therefore, when we compare the conventional methods of feature extraction and classification with the deep CNN techniques, present research proves to be most significant and promising with deep CNN models. In future the machine learning and non-deterministic approaches will be used efficiently. The process of choosing an optimal output filters, learning rate, number of epochs and batch size for the behavioral and physiological biometric modalities are the future scope of our proposed model.

REFERENCES

1. S K Jichkar and K P Kamble., "A Survey on Palm Vein Recognition", International Journal for Advance Research in Electrical Electronics and Instrumentation Engineering, IJREEIE, Vol. 5 , Issue. 10, 2016.
2. J A Unar, W C Seng and A Abbasi., "A Review of Biometric Technology along with trends and prospects", Pattern Recognition, Elsevier, Vol. 47, Issue. 8, pp. 2673-2688, 2014.
3. P A patil and P E Ajmire., "Survey: Human Identification Using Palm Vein Images", International Journal for Emerging technologies in Engineering Research (IJETER), Vol. 6, Issue. 3, 2018.
4. Sen Lin, Y Wang, Tianyang Xu and Y Tang., "Palmprint and Palm Vein Multimodal Fusion Biometrics based on MMNBP", Chinese Conference on Biometric Recognition (CCBR), pp. 326-336, 2016.
5. Lin Zhang, Z Cheng, Ying Shen and D Wang., "Palmprint and Palm Vein Recognition based on DCCN and A New large Scale Contactless Palm vein Datasets", Symmetry 2018, Vol. 10, Issue 4, 2018.
6. Ma Xin and Jing Xiaojun., "Palm Vein Recognition Method based on Fusion of Local Gabor Histograms", The Journal of China Universities of Posts and Telecommunications, Elsevier, Vol. 24, Issue. 6, 2017.
7. Y T Luo, L Y Zhao, B Zhang, Wei Jia, Feng Xue, J T Lu, Y H Zhu and B Q Xu., "Local Line Directional Pattern for Palmprint Recognition", Patter Recognition, Elsevier, Vol. 50, pp.26-44, 2016.
8. M I Ahmad, W L Woo and S Dlay., "Non-Stationary Feature Fusion of Face and Palmprint Multimodal Biometrics", Neurocomputing, Elsevier, Vol. 177, pp. 49-61, 2016.
9. Li Peidan, Z Miao and Z Wang., "Fusion of Palmprint and Palm vein images for Person Recognition", 2014 12th International Conference on Signal Processing (ICSP), Hangzhuo, pp. 2407-2410,2014.
10. L Mirmohamadsadeghi and A Drygajlo., "Palm Vein Recognition with Local texture Patterns", in IET Biometrics, Vol. 3,no. 4, pp. 198-206, 2014.
11. Lin Zhang, Lida Li, A Yang, Y Shen and M Yang., "Towards Contactless Palmprint Recognition: A Novel Device, A New Benchmark, and a Collaborative representation based Identification Approach", Pattern Recognition, Elsevier, Vol. 69,pp. 199-212, 2017.
12. Gen Li and Jaihie Kim., "Palmprint recognition with Local Micro structure Tetra Pattern", Pattern Recognition, Elsevier, Vol. 61, pp. 29-46, 2017.
13. Lunke Fei, Yong Xu and David Zhang., " Half-Orientation Extraction of Palmprint Features", Patter Recognition Letters, Elsevier, Vol. 69, pp. 35-41, 2016.
14. Gopal, S Srivastava, S Bhardwaj and S Bhargava., "Fusion of Palm-Phalanges print with Palmprint and Dorsal hand Vein", Applied Soft Computing, Elsevier, Vol. 47, pp. 12-20, 2016.
15. Lunke Fei, Yong Xu, W Tang and David Zhang., "Double-Orientation Code and Nonlinear Matching scheme for Palmprint Recognition", Pattern Recognition, Elsevier, Vol. 49, pp. 89-10, 2016.
16. A M AI-Juboori, X Wu and Q Zhao., "Biometric Authentication System based on Palm Vein ",2013 International Conference on Computer Science and Applications, Wuhan, pp. 52-58, 2013.
17. M Aykut and M Ekinci., "Developing a Contactless Palmprint Authentication System by Introducing a Novel ROI Extraction Method", Image and Vision Computing, Elsevier, Vol. 40, pp. 65-74, 2015.
18. A Rao, M Imaran, R Ragvendra and H G Kumar., "Multibiometrics: Analysis and Robustness of Hand Vein and Palmprint Combination used for Person Verification", International Journal of Emerging Trends in Engineering and Technology (IJETET), 2011.
19. K S Raghunandan, B M Chethankumara, G H Kumar and C Sunil., "Convolutional Neural Network Based Deep Features for Text Recognition in Multi Type Images", 2018th International Conference on Advances in Computing, Communication and Informatics, ICACCI, pp. 502-507, 2018.

AUTHORS PROFILE

Shreyas R received degree in Bachelor of Electronics and Communications Engineering from Visvesvaraya Technological University, Belgaum, Karnataka and MASc. in Electronics and Communications Engineering Dept. from Dalhousie University, Halifax, N.S., Canada. Currently he is pursuing Ph.D. at SJBIT Bangalore, Karnataka. His research interest includes image processing, pattern recognition, video understanding and Bio-medical Image Processing. He has published many papers in International conferences and Journals.

Naveen C received Bachelor's, Master's and Doctorate degree from VTU, Belgaum, Karnataka, India. His research interest includes image processing, pattern recognition and video understanding. Currently working as Professor IN THE Department of Computer Science & Engineering, SJBIT Bangalore. He has guided fourPh.d Students and several masters' students for their projects. He has published many papers in International conferences and Journals. He has delivered many research talks and presented symposium across the globe.

Chethan H K received Bachelor's, Master's and Doctorate degree from University of Mysore, Karnataka, India. Currently working as Professor at Maharaja Institute of Technology, Thandavapura, Karnataka India. Guiding eight Ph.d Students in several domains. Have guided several projects for bachelors and masters' student. He has published many papers in International conferences and Journals.

Raghunandan K S received masters from University of Mysore in the Year of 2013. Currently, he is pursuing Ph.D. at University of Mysore, Karnataka, India. His research interest includes image processing, pattern recognition and video understanding. He has published many papers in International conferences and Journals.

Sunil C received degree in Bachelor of Electrical and Electronics Engineering and M.Tech in Bio-medical Signal processing and Instrumentation from Visvesvaraya Technological University, Belgaum, Karnataka. Currently he is pursuing Ph.D. at University of Mysore, Karnataka. His research interest includes image processing, pattern recognition, video understanding and Bio-medical Image Processing. He has published many papers in International conferences and Journals.