International Journal of Emerging Science and Engineering (IJESE)
ISSN: 2319–6378 (Online), Volume-12 Issue-1, December 2023

Multimodal Biometrics for Human Identification using Artificial Intelligence

Boda Aruna, M Kezia Joseph

***Abstract-** Multimodal biometric systems combine multiple biometric modalities to enhance the accuracy and security of human identification. Instead of relying on a single biometric trait (such as fingerprint or face), these systems use a combination of different biometric characteristics to provide a more robust and reliable identification process. The key idea behind multimodal biometrics is that the fusion of diverse biometric data can overcome the limitations of individual modalities, resulting in higher accuracy and lower error rates [2] [3].*

***Keyword:** Artificial Intelligence, Human Identification*

I. INTRODUCTION

The most common biometric modalities used in multimodal systems include: fingerprint analysis, which involves examining unique patterns on the fingertips, and Face recognition, which identifies individuals based on their facial features. Iris recognition: Scanning and analysing the uniquepatterns in the iris of the eye. Voice recognition: Identifying individuals based on their unique voice characteristics. Palmprint recognition: Analysing the patterns on the palm. Retina recognition: Scanning and analysing the distinctive patterns of the retina. Hand geometry:Measuring the physical characteristics of the hand. Signature recognition: Analysing thedynamic features of a person's signature [1].

II. METHODOLOGY

A. Advantages of Multimodal Biometrics

Increased accuracy: Combining multiple biometric modalities reduces the risk of false positives and false negatives, resulting in higher accuracy rates. Robustness: Even if one biometric modality fails due to factors such as injury or poor image quality, other modalities can still beused for identification. Improved security: Multimodal systems offer stronger authentication, making it more difficult for impostors to bypass the system. User convenience: By using multiple biometric modalities, the system can adapt to different users and situations, making it more user-friendly [7-10].

Manuscript received on 09 August 2023 | Revised Manuscript received on 09 November 2023 | Manuscript Accepted on 15 December 2023 | Manuscript published on 30 December 2023.
*Correspondence Author(s)
Boda Aruna*, Ph.D. Scholar, UCE-Osmania University, Hyderabad (Telangana), India. E-mail: arunaou2018@gmail.com
Dr. M Kezia Joseph, Department of Electronics & Communication Engineering, Stanley Engineering College (A), Hyderabad (Telangana), India. E-mail: sakakezia1981@gmail.com

B. Challenges of Multimodal Biometrics

Data acquisition: Collecting and storing multiple biometric data can be challenging, as differentsensors and technologies may be required for each modality [5] [6]. Computational complexity: The fusion of multiple modalities often requires more processing power and storage resources. Privacy concerns: Collecting and storing various biometric data may raise privacy concerns if not handled properly. Cost: Implementing multimodal biometric systems can be expensive dueto the need for multiple sensors and advanced processing capabilities [11].

III. RESULT

Despite the challenges, multimodal biometric systems have the potential to significantly enhancethe security and reliability of human identification in various applications, including access control, border security, financial transactions, and law enforcement. As technology advances and the adoption of biometrics increases, multimodal systems are likely to play an increasinglyimportant role in ensuring secure and accurate identification [4].

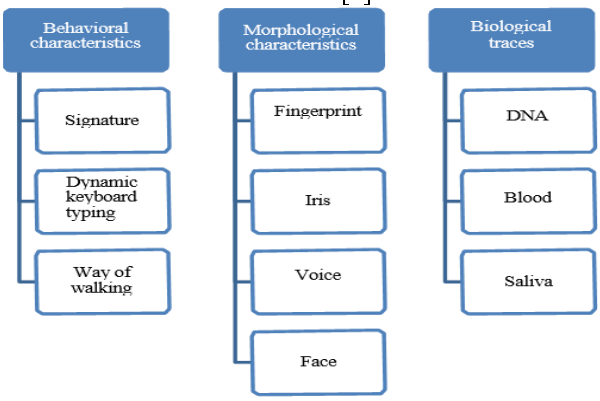

Fig. 1 - Different facets of Biometrics: Behavioural, Morphological and Biological Biometrics with Some Examples

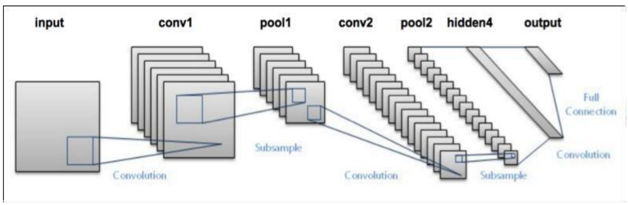

Fig. 2 - Typical Deep Convolutional Neural Network Architecture

Figure 2 illustrates the typical convolutional neural network architecture with a multimodal approach.

IV. CONCLUSION

The idea of multiple biometrics, introduced to address the problems encountered insingle-biometric systems, is another suggested approach. This study validated the feasibility of a multimodal biometric system by concatenating four biometric modalities: fingerprint, finger knuckle, face, and iris. The use of an SVM classifier mainly involves selecting a suitable family of kernel functions and adjusting their parameters. In the preprocessing part, normalisation was performed to ensure that the images had unit variance and zero mean, while also mitigating the effects of varying light conditions. This research work demonstrated that the adopted approach provided excellent results in terms of accuracy and precision, and that it can manage delicate situations, particularly when unimodal systems do not allow for good recognition to be carried out, thus justifying the need to merge several biometric modalities. The methodology presented in the first phase of Chapter Three shows an accuracy of 97.63% with the AdaBoost classifier and 99.13% with the random forest classifier. It has been observed that convolutional neural networks, as feature extractors, are a compelling alternative. Hybrid features are obtained using GLCM, wavelet moments and deep features. For the classification stage, a random forest classifier is used. The important thing is tochoose a specific training dataset well-suited to the data environment with which you later want to test. The proposed approach of the second phase has been tested in the experimental studies carried out. When the three different feature extraction methods are considered, it is seen thatsuccessful results are achieved with an accuracy of 99.33%. The feature selection performed well in the third phase, reaching a maximum accuracy of 99.33% by utilising the FCM and random forest classifier. It has been demonstrated that the proposed multimodal-biometric identification system is more successfulthan single-biometric structures.

DECLARATION STATEMENT

Funding	No, I did not receive.
Conflicts of Interest	No conflicts of interest to the best of our knowledge.
Ethical Approval and Consent to Participate	No, the article does not require ethical approval or consent to participate, as it presents evidence that is not subject to interpretation.
Availability of Data and Materials	Not relevant.
Authors Contributions	All authors have equal participation in this article.

REFERENCES

1. X. Chen, Z. Jing and G. Xiao, ”Nonlinear fusion for face recognition using fuzzy integral”, Communications in Nonlinear Science and Numerical Simulation, vol. 12, no. 5, 2007, pp. 823–831. https://doi.org/10.1016/j.cnsns.2005.07.005
2. M. Liu, X. Jiang and A. C. Kot, ”Efficient fingerprint search based on database clustering”, Pattern Recognition, vol. 40, no.6, 2007, pp. 1793-1803. https://doi.org/10.1016/j.patcog.2006.11.007
3. W. Xiong, K. A. Toh, W. Y. Yau and X. Jiang, ”Model-guided deformable hand shape recognition without positioning aids”, Pattern Recognition, vol. 38, no. 10, 2005, pp. 1651–1664. https://doi.org/10.1016/j.patcog.2004.07.008
4. W. W. Boles, ”A security system based on human iris identification using wavelet transform”, Engineering Applications of Artificial Intelligence, vol. 11, no. 1, 1998, pp. 77–85. https://doi.org/10.1016/S0952-1976(98)80006-7
5. D. A. van Leeuwen, A. F. Martin, M. A. Przybocki and J. S. Bouten, ”NIST and NFI- TNO evaluations of automatic speaker recognition”, Computer Speech & Language, vol. 20, no. 2-3, 2006, pp. 128-158. https://doi.org/10.1016/j.csl.2005.07.001
6. E. Yu and S. Cho, ”Keystroke dynamics identity verification – its problems and practical solutions”, Computers & Security, vol. 23, no. 5, 2004, pp. 428–440. https://doi.org/10.1016/j.cose.2004.02.004
7. L. Nanni, ”An advanced multi-matcher method for online signature verification featuring global features and tokenised random numbers”, Neurocomputing, vol. 69, no. 16–18, 2006, pp. 2402–2406. https://doi.org/10.1016/j.neucom.2006.02.009
8. R. Zhang, C. Vogler and D. Metaxas, ”Human gait recognition at sagittal plane”, Imageand Vision Computing, vol. 25, no. 3, 2007, pp. 321–330. https://doi.org/10.1541/ieejeiss.126.1524
9. S. Ma, T. Zanma and M.Ishida, ”Abstraction and implementation of human skill by hybrid dynamical system theory - application to an automatic driving system -”, IEEJ Transactions on Electronics, Information and Systems, Vol. 126-C, No. 12, 2006, pp. 1524-1530. https://doi.org/10.1002/tee.20077
10. S. Ma, T. Zanma and M. Ishida, ”Automatic Driving System Using Identification of Switched Systems with Unknown Switch Points”, IEEJ Transactions on Electrical andElectronic Engineering, Vol. 1, No. 4, 2006, pp. 426-437.
11. J. Roll, A. Bemporad and L. Ljung, ”Identification of piecewise affine systems via mixed-integer programming”, Automatica, vol. 40, no. 1, 2004.