Grenze International Journal of Engineering and Technology, June Issue

MATLAB based Iris Pattern Recognition System

Pallavi U. Dupare[1], Abhijit S. Titarmare[2] and Minakshi M. Wanjari[3]
[1-3]Department of Electronics and Telecommunication Engineering, G H Raisoni College of Engineering Nagpur, India
Email: Pallavi.dupare.com@ghrce.raisoni.net, Abhijit.titarmare@raisoni.net, Minakshi.wanjari@raisoni.net

***Abstract*—With the growing demand for secure identification systems, iris recognition has become a key biometric authentication method. This project focuses on implementing an iris recognition system inspired by the method developed by John Daugman, with some modifications in MATLAB The process begins with image preprocessing, where the iris region is extracted from the Visual Biometric Image. Next, the isolated iris is then adjusted to a standard format, and an Iris Code is created using 1D Gabor filters to capture its unique features. To verify identity, which quantifies the difference between them. The Hamming Distance method is used to compare two iris codes, measuring the differences between them to determine identity verification. The iris recognition algorithm developed by the author has been extensively tested in both laboratory and real-world environments, with millions of comparisons showing no false matches. This method works by analysing the unique phase structure of the iris, which is encoded using multi-scale quadrature wavelets. The system detects identity by checking for statistical independence between different iris patterns. Due to the high complexity and variability of iris features across individuals spanning approximately 249 degrees of freedom— the recognition process achieves exceptionally high accuracy. With the variation in iris patterns contains 3.2 bits of unique information per square millimetre, allowing for highly accurate identification in biometric systems, this system ensures reliable real-time identification. The high confidence level makes it possible to search through large databases in A one-to-many identification system can accurately compare a single input with multiple stored records without errors or mismatches. In contrast, other biometric methods, which lack such precision It can only be used for verifying a single identity at a time or for a small number of comparisons.**

***Index Terms*— Human Recognition, Biometrics, Integer Wavelet Transforms, Iris Image, High Security.**

I. INTRODUCTION

Biometric Authentication has become a widely used and dependable method for verifying a person's identity using physical or behavioural traits. Physiological characteristics include fingerprints, iris patterns, facial features, and hand shapes, which remain consistent over time and are difficult to alter. On the other hand, behavioural characteristics, such as signatures, speech patterns, and typing styles, are influenced by an individual's psychological state and may vary. High confidence personal identification by rapid video analysis of iris texture [1]. In general, physical traits show less variation within the same person compared to behavioural traits, making them more reliable for identification purposes. A Manual Sign is shaped by both deliberate movements and a person's mental state, while speech patterns may vary based on emotions and mood. In contrast, fingerprint patterns remain unaffected by such factors.

Grenze ID: 01.GIJET.11.2.604_22

However, physiological biometrics do not always provide perfect accuracy, as they may still have Unauthorized Access Rate (UAR) or False Non-Match Rate (FNMR). Among all biometric authentication methods, Iris recognition is one of the most reliable biometric identification methods since the likelihood of two individuals having the exact same iris pattern is nearly impossible. This makes eye texture recognition technology a key solution for access control and secure authentication, such as computer systems become more interconnected, secure network access is essential to protect data and prevent unauthorized entry. Relative to fingerprints, the iris is well-shielded from outside elements. factors, as it is located behind the cornea and eyelid. Unlike other biometric features, iris patterns remain stable throughout life, starting from around a year old. This study is organized into major sections: 1 discusses the importance of iris scanning in identity verification.2 provides an overview Eye-Based Identity Verification advancements. The well-known iris recognition system developed by J. Daugman serves as a reference for comparison.

II. Previous Research Analysis

Algorithm of Daugman's represents the iris as two circular boundaries situated between the pupil and the sclera, though they may not be perfectly aligned. Each boundary is defined using three key parameters: (x_0, y_0, r)—where (x_0, y_0) denotes the center coordinates, and r represents the radius of the circle. To determine these parameters, an Integral Differential filter it serves to accurately identify and define the boundaries of the iris. Once the iris image is segmented, it is normalized by converting its Cartesian coordinates into polar coordinates. The 2D Gabor filter then the iris pattern is converted into a 256-byte binary code, which serves as a unique identifier for recognition., an error metric is used to compare difference between two iris templates to measure their similarity. The idea of iris recognition for personal identification dates back to French ophthalmologist Alphonse Bertillon, who was the first to suggest that iris colour and patterns could be used for identity verification. In 1981, after studying various reports highlighting the uniqueness of iris structures, Alternative Iris Recognition Researchers based Dr. A. Safir also proposed using the eye pattern for biometric authentication. In 1987, they collaborated with John Daugman, a Cambridge University computer scientist, to create iris recognition software. His first successful results were published in 1992. Following his work, researchers like Researchers including Wildes, Boles, and Sanchez-Reillo explored different iris recognition techniques, Modifying the way iris features are represented (iris signature) and improving pattern matching techniques can enhance the accuracy and reliability of iris recognition systems.

III. Advanced Approach

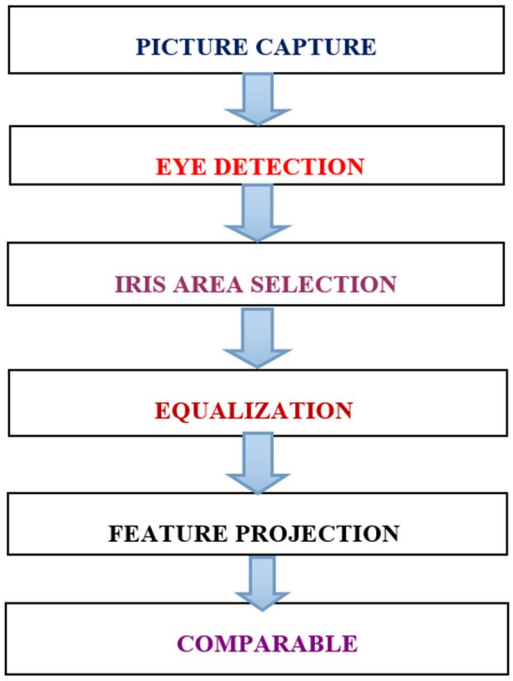

Fig. 1. Overview of an Iris Recognition System Architecture for Result Extraction

Fig.1 Shows Overview of an Iris Recognition System Architecture for Result Extraction Previous research on iris recognition, based on information available in open literature, inspired us to explore potential improvements in the existing methods. To test these new ideas, we implemented them using MATLAB a structured approach: Since the iris appears as part of a larger picture that includes surrounding eye regions, the first step is to isolate the iris.

Before performing iris pattern matching, it is crucial to accurately identify and extract the specific iris region from the captured picture. This ensures that the matching process focuses only on the relevant iris data, improving accuracy and efficiency.

A. Picture Capture

Fig .2, Shows Image of Iris Capturing a clear and high-quality image of the iris without causing discomfort to the individual is a significant challenge in automated iris recognition systems. The human iris typically measures about 11.5 millimetres in diameter and can vary in color, including shades like brown, blue, or green. Since individuals are often protective or cautious about their eyes, it's important to design the system with care. Several factors need to be considered to ensure the process is both effective and comfortable.

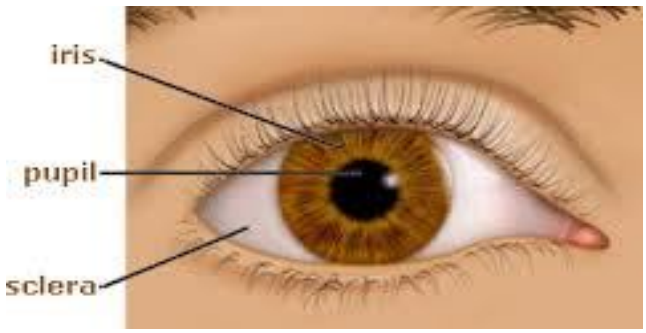

Fig. 2. Image of Iris

B. Eye Detection

Fig.3 Shows Localized Visual When capturing an image of the iris, it's not realistic to expect the image to only contain the iris itself. Instead, the image will include the iris along with other parts of the eye region surrounding it. Before comparing iris patterns for recognition, it's important to first identify and isolate the section of the image that parallels to the eye color.

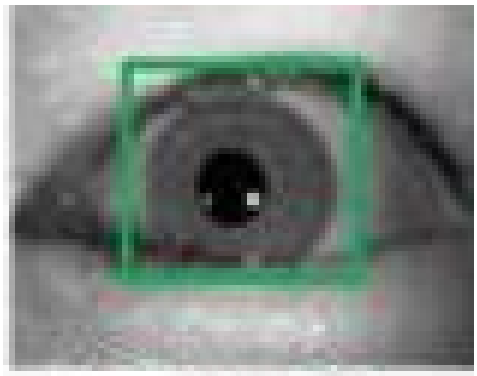

Fig. 3. Localized Visual

C. Iris Area Selection

Fig.4 Shows Iris Area Selected image, Iris Region Extraction it is procedure of dividing a digital picture into different sections, known as pixel groups or super pixels. The main purpose is to make the image easier to interpret and analyse. This technique is used to identify important objects and boundaries, such as lines and curves, within the image.

In simple terms, image segmentation works by assigning a specific label to each pixel, ensuring that pixels with similar properties are grouped together. This method helps in accurately detecting and isolating the iris region, making further processing more efficient.

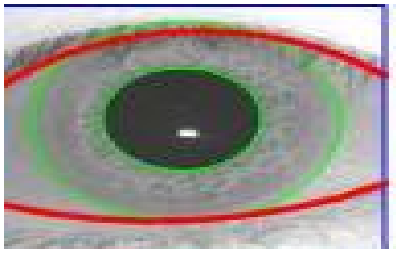

Fig. 4. Iris Area Selected Image

D. Equalization

Fig.5 Shows Normalized Image To extract the best features for iris verification, the iris image is first transformed into polar coordinates and then enhanced using contrast-limited adaptive histogram equalization (CLAHE). This technique improves the image's contrast and details, making the key features clearer for accurate identification. This technique improves image quality by enhancing contrast, making key features more distinguishable. The figure below demonstrates the contrast between the original image and its modified version. highlighting the effectiveness of this enhancement process in improving iris recognition accuracy.

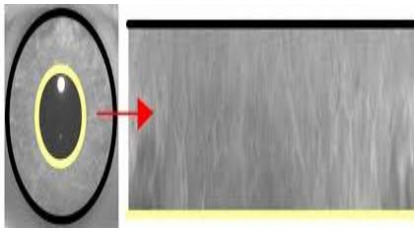

Fig.5. Normalized Image

E. Feature Projection

Fig.6 Shows Image calling interface from database, Feature Projection plays a crucial Function in iris verification, as it helps identify the unique patterns within the iris. The standardized iris image is analysed to extract distinct features, including

- Texture Analysis – Identifies the unique surface patterns of the iris.
- Zero Crossing – Detects significant changes in the iris image
- Overlapping Patches – Divides the iris into small sections for detailed analysis. These features help ensure accurate and reliable iris recognition.

F. Iris Comparable Process

Fig.7 Shows Iris circle detection interface by comparing a pair of iris feature vectors, the Hamming metric is used. This method counts the number of bits that differ between two binary sequences. By analysing the Hamming metric, the system determines if the two iris patterns belong to the same eye or to different eyes. A lower Hamming metric indicates a match, while a higher value suggests they belong to different individuals

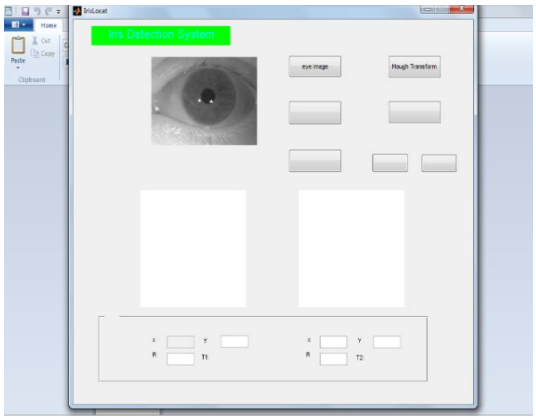

Fig.6. Image calling interface from database

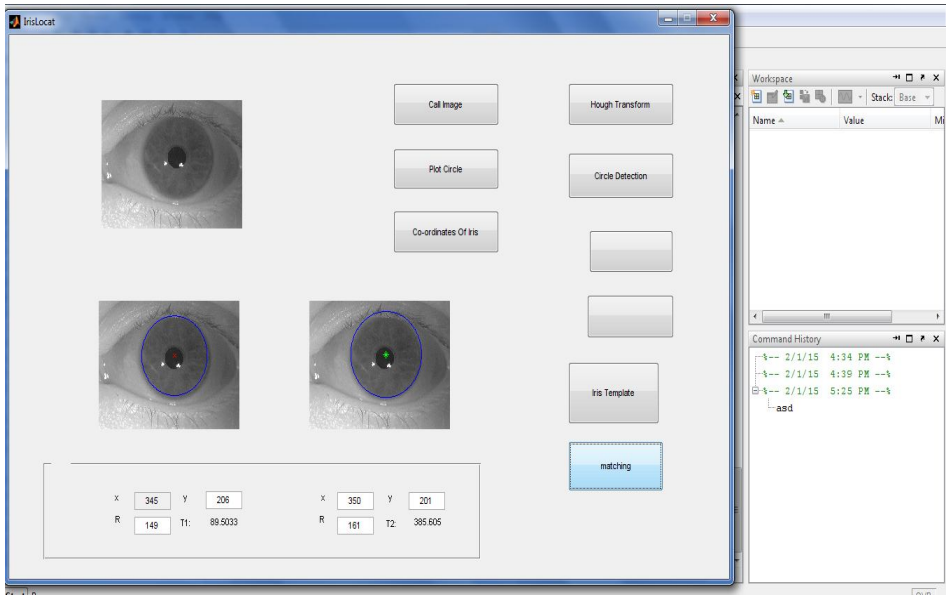

Fig.7. Iris circle detection interface

IV. Experimental Results

Fig.8.Iris matching interface

V. Benefits and Applications of the Proposed Iris Recognition Method

A. Advantages

- Highly Protected – The iris is an internal organ shielded by a transparent and sensitive membrane, making it more secure than fingerprints.
- Stable Shape – The iris has a predictable, flat structure controlled by two complementary muscles that regulate pupil diameter.
- Non-Intrusive Scanning – Iris recognition works like capturing a photograph and can be done from a distance ranging from 10 cm to several meters.
- Efficient Processing – Encoding and matching iris patterns require minimal computational effort, making real-time identification possible.

- Unique to Every Individual – The iris is genetically independent, meaning no two eyes have the same pattern, even in identical twins.

B. Applications of Iris Recognition

Iris recognition is popular in many fields because it offers excellent security and reliability. The potential applications are vast, limited only by innovation. Some key uses include:

- ATM Security – Enhances transaction safety by verifying identity through iris scanning.
- Airport Security – Used for passenger verification and border control.
- Computer Access – Functions as a secure, biometric login system.
- Credit Card Authentication – Prevents unauthorized transactions by linking cards to iris data.
- Financial Transactions – Enhances the security of online banking and e-commerce.
- Biometric Cryptography – Uses iris patterns for encryption and decryption of sensitive data.
- Personal Identification – Applied in driving licenses and national ID verification.
- Entitlement Authentication – Ensures rightful access to government benefits and services.
- Forensic and Law Enforcement – Helps track missing individuals and identify suspects.

Limitations of Iris Recognition

- Lighting Sensitivity – Changes in lighting conditions can impact the accuracy of iris scanners.
- Obstructions – Eyelashes, contact lenses, and reflections can interfere with iris recognition.
- Deformation – The iris can change shape slightly as the pupil expands or contracts, affecting accuracy.
- High Cost – Iris scanners are more expensive compared to other biometric systems.
- Image Quality Issues – Poor-quality images can lead to difficulties in enrolment and recognition failures.
- Privacy Concerns – Some critics worry that iris recognition technology could be used for surveillance and Tracking without consent.

VI. Future Scope and Conclusion

The system can be expanded to work with different databases. Implementation in real-time applications can enhance its usability. Optimization can improve efficiency and reduce processing time. Currently, authentication is limited to a specific region; it can be extended to a broader level. The project can be expanded for national and international use. Remote access through VOIP can be explored for wider accessibility. for future improvements, the developed technique is planned. The optimized code will be loaded onto various hardware devices such as Raspberry Pi, Arduino, 8051, MSP430, VHDL kits, FPGA boards, as well as systems from TI, NI, and other real-time interface platforms. In addition, we will submit research funding proposals to appropriate agencies to support further development.

The iris recognition system has been effectively developed using MATLAB along with mathematical calculations. However, challenges like blurred images and variability in image capture conditions make it difficult to achieve perfect accuracy. To overcome these limitations, capturing images in an ultraviolet environment can enhance recognition performance. Once an image is acquired, the system utilizes the Hough Transform detection technique to differentiate between the pupil and the iris. Various built-in MATLAB functions and mathematical methods are applied to outline the pupillary margin and mark the limbic boundary, ensuring precise feature extraction.

References

[1] Y. Beglamour, J-C. Guézel and T. Mahé, Labiométrie, sésame absolute ..., Industries et Techniques, France, n°817, July 2000.

[2] M.M. Gifford, D.J. McCartney and C.H. Seal, Networked biometrics systems: requirements based on iris recognition, BT Technol. Journal, Vol.17, April 1999.

[3] A. Bertillon, la couleur de iris, Revue scientifique, France, 1885.

[4] J. Daugman, High confidence personal identification by rapid video analysis of iris texture , Proc. Of the IEEE, International Carnahan conf. on security technology, 1992

[5] R.P. Wildes, J.C. Asmuth, G.L. Green and S.C. Hsu, A system for automated iris recognition, IEEE paper, 1994.

[6] W.W. Boles, a security system based on human iris identification using wavelet transform, First international conference on knowledge-based intelligent electronic systems, Adelaide, Australia. Ed, 21-23 may 1997

[7] R. Sanchez-Reillo, C. Sanchez-Avila and J-A .Martin- Pereda, minimal template size for iris recognition, Proc. BMES/EMBS Conf., IEEE Publication, Atlanta, October 1999.

[8] J. Daugman, «High confidence personal identification by rapid video analysis of iris texture », IEEE Conf. Publication, European convention on security and detection, 16-18 May 1995.

[9] N. Sudha, N. Puhan, H. Xia and X. Jiang., “Iris recognition on edge maps”, Proc. IET Computer Vision, Vol. 3, No. I, pp. 1 - 7, 2009.
[10] Ma L., Tan T., Zhang D., Wang Y., “Local intensity variation analysis for iris recognition”, Proc. Pattern Recognition, Vol. 37, No. 6, pp. 1287 – 1298, 2004.
[11] Park C., Lee J., Smith M., Park K., “Iris-based personal authentication using a normalized directional energy feature”, Proc. 4th Int. Conf Audio- and Video-Based Biometric Person Authentication, pp. 224 - 232, 2003.
[12] Boles W.W., Boashash B., “A human identification technique using images of the iris and wavelet transform”, Proc. IEEE Trans. Signal Process., Vol. 46, No. 4, pp. 1185 – 1188, 1998.
[13] Daugman J., “The importance of being random: statistical principles of iris recognition”, Proc. Pattern Recognit., Vol. 36, pp. 279 – 291, 2003.
[14] Dobes M., Machala L., Tichavsky P., Pospisil, “Human eye iris recognition using the mutual information”, Proc. Opt. Opt., Vol. 115, No. 9, pp. 399 – 404, 2004.
[15] Ma L., Tan T., Wang Y., Zhang D., “Personal identification based on iris texture analysis”, Proc. IEEE Trans. Pattern Anal., Vol. 25, Issue 12, pp. 151 – 1533, 2003.
[16] Ma L., Tan T., Wang Y., Zhang D., “Efficient iris recognition by characterizing key local variations”, Proc. IEEE Trans. Image Process., Vol. 13, No. 6, pp. 739 – 750, 2003.
[17] Sanchez-Avila C., Sanchez-Reillo R., “Two different approaches for iris recognition using Gabor filters and multi scale zero-crossing representation”, Proc. Pattern Recogn., Vol. 38, pp. 231 – 240, 2005.
[18] Kong W., Zhang D., “Accurate Iris Segmentation based on Novel Reflection and Eyelash Detection Model”, Proceedings of 2001 International Symposium on Intelligent Multimedia, Video and Speech Processing, Hong Kong, pp. 263–266, 2001.
[19] Romir Mathur, Gopal Sakarkar, Kamlesh Kalbande, Rishi Mathur, Hrugved Kolhe, Harish Rathi, Orthopantomogram (OPG) image analysis using bounding box algorithm. Book Computational Methods and Data Engineering: Proceedings of ICCMDE 2021, Pages 55-65, Springer Nature Singapore
[20] Muhammad Faisal Zafar, Manel, Zaigham Zaheer, Lavaid Khurshid, Daugman, J., “Novel Iris Segmentation and Recognition System for Human Recognition”, IEEE Transactions on Information Technology in Image Processing, Vol. 15, No. 2, Jan 2013.
[21] Basheshankar, Aniket, Aniket Lande, Anuj Nandeshwar, Arnob Sarkar, Ashwin Udapure, and Pankaj H. Chandankhede. "Assistive Cane for Visually Impaired People." In 2022 10th International Conference on Emerging Trends in Engineering and Technology-Signal and Information Processing (ICETET-SIP-22), pp. 1-5. IEEE, 2022.
[22] Sruthi T.K., Jini K.M., “A Literature Review on Iris Segmentation Techniques for Iris Recognition Systems”, Proc. IOSR Journal of Computer Engineering (IOSR-JCE) e-ISSN: 2278-0661, p- ISSN: 2278-8727, Vol. 11, Issue pp. 46 - 50, May - Jun. 2013. 978-1-5090-4890-8/17/$31.00 ©2017 IEEE
[23] Dorge, P., Kamatkar, H., Sakalkar, A., Dani, A., Bhagat, N., Damahe, L., Doifode, V., Titarmare, A. and Nagmote, S., 2024. Design and Implementation of Automatic Solar Panel Cleaning Robot. International Journal of Computing and Digital Systems, 16(1), pp.1-9.
[24] Karlekar, Prachi V., Swapna Choudhary, Atul Deshmukh, and Harish Banote. "Design of an efficient bioinspired model for optimizing robotic arm movements via ensemble learning operations." In 2023 IEEE 8th International Conference for Convergence in Technology (I2CT), pp. 1-6. IEEE, 2023.
[25] Jain, Ekta, Sakshi Badwaik, Sampada Khirwadkar, Shruti Thakare, Mayur Uike, and Pankaj H. Chandankhede. "Design of smart pet food dispenser using embedded system." In 2023 International Conference on Emerging Smart Computing and Informatics (ESCI), pp. 1-5. IEEE, 2023.
[26] Tiple, Rani Chandrabhan, Kalyani Akant, Pankaj Chandankhede, and Santosh Yadav. "IoT based Weather Monitoring System Using OSSA & MA Techniques." In 2023 11th International Conference on Emerging Trends in Engineering & Technology-Signal and Information Processing (ICETET-SIP), pp. 1-5. IEEE, 2023.
[27] Dupare, Shreyash, Yugant Moundekar, and Pankaj Chandankhede. "Implementation of Smartphone Based Activity Recognition." In 2023 International Conference for Advancement in Technology (ICONAT), pp. 1-5. IEEE, 2023.
[28] Dafare, Mayur, Sandesh Waghmare, Abhijeet Bhoyar, Abhijit S. Titarmare, and Pankaj Chandankhede. "LoRa-Enabled Smart RS485 Data Logger and MQTT Gateway for Industrial IoT Applications Using ESP32." In 2023 International Conference on Circuit Power and Computing Technologies (ICCPCT), pp. 1297-1302. IEEE, 2023.
[29] Karlekar, Ms Prachi V., Swapna Choudhary, Atul Deshmukh, and Harish Banote. "Innovations in urban automation: Robotic arm integration in smart city environments." In 2023 International Conference on Sustainable Emerging Innovations in Engineering and Technology (ICSEIET), pp. 314-319. IEEE, 2023.
[30] Kolhe, Pranita, Kamlesh Kalbande, and Atul Deshmukh. "Internet of Thing and Machine Learning Approach for Agricultural Application: A Review." In 2022 10th International Conference on Emerging Trends in Engineering and Technology-Signal and Information Processing (ICETET-SIP-22), pp. 1-6. IEEE, 2022.
[31] Kolhe, Pranita, Aniket Baseshankar, Mansi Murekar, Shubham Sadhankar, Kamlesh Kalbande, and Atul Deshmukh. "Smart communication system for agriculture." In 2022 Third International Conference on Intelligent Computing Instrumentation and Control Technologies (ICICICT), pp. 1122-1126. IEEE, 2022.
[32] Badole, Sanghamitra, Swapna Choudhary, Abhijit Titarmare, and Pranav Khergade. "Review on ground control station design for remotely piloted aircraft system." In 2022 10th International Conference on Emerging Trends in Engineering and Technology-Signal and Information Processing (ICETET-SIP-22), pp. 1-6. IEEE, 2022.