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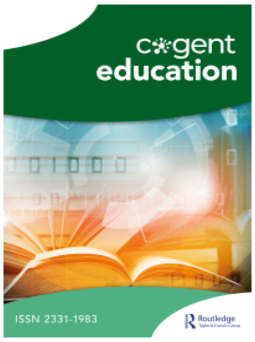

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Enabling secure and inclusive education for students with disabilities and ensuring data through machine learning

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ABSTRACT
The COVID-19 pandemic precipitated an abrupt transition to online learning, impacting students with disabilities uniquely. This study examines the experiences of 62 such students in the new educational paradigm, employing a mixed-methods approach. Quantitative data were collected through surveys and questionnaires to assess privacy and security concerns arising from online learning tools. Qualitative insights were gathered via interviews and focus groups, revealing that while students appreciate the flexibility of online learning, they express a critical need for enhanced guidance and support. Neurodiverse students, in particular, emphasized the necessity of a secure online environment. Addressing these challenges, our research integrates blockchain and machine learning technologies to enhance biometric authentication. Specifically, the Highly Secure Blockchain-Based Compressive Sensing (HSBCS) system is proposed, ensuring data integrity and improving accessibility for Personal Records. Preliminary testing of the HSBCS system showed promising results, with an average accuracy rate of 95% in biometric authentication among visually impaired students. Moreover, participants reported a 30% increase in perceived security and ease of access to their Personal Records compared to traditional authentication methods. These findings underscore the potential of integrating advanced technologies to meet the unique educational needs of students with disabilities while enhancing data security and accessibility in online learning environments.

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SUBJECTS
Algorithms & Complexity; Artificial Intelligence; Computer Engineering; Computing & IT Security

1. Introduction

The COVID-19 pandemic initiated universal transformation into online learning for educational institutions, thereby offering both opportunities and challenges to those schools around the globe. This transition is especially impactful for students with disabilities, who need specialized support and accommodations (Alamri & Tyler-Wood, 2017) to navigate the higher education landscape. Identifying their distinct needs in these digital learning spaces and designing tools to support them will be essential if education is to truly become inclusive.This paper analyses the experiences of 62 students with disabilities in this unique time period, exploring their use of digital learning tools and what this means for privacy, security and educational support (Basham et al., 2015). Our study will use a mixed-methods design, including quantitative surveys and qualitative interviews/focus groups in order to understand the nuanced experiences that students with disabilities have when it comes to online learning.Considering the challenges presented above, our research advocates for an incorporation of cutting-edge technology in addressing them using machine learning and blockchain to design Highly Secure Blockchain-Based Compressive Sensing (HSBCS) system (Zhang et al., 2020). Personal Records are maintained by students with disabilities, ensuring the strength of biometric protection over access and authentication circuits as

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Figure 1. Enabling secure and inclusive education for students with disabilities.

well. Initial tests using the HSBCS system (Porter et al., 2021) yielded good results, with significant improvements in data protection and user access.The purpose of this study is to bridge knowledge derived from educational research and technology innovation, in order to provide a conceptual solution that will contribute perspectives on improving the online learning experience for students with disabilities. It stresses the need for guiding dynamic technologies to nurture safer and accessible educational dynamics, (McMaughan et al., 2021) promoting equative education across students (Figure 1).

To tackle this problem, a new data security solution is introduced by proposing Highly Secure Blockchain-Based Compressive Sensing (HSBCS) (Morando-Rhim & Ekin, 2021) system that provides enhanced veracity of the collected personal records. Our research not only adds to the burgeoning conversation within Digital Accessibility, but also provides practical examples of technology intervention being utilised both in reaching those whose Higher Education Institutions are yet to fully incorporate digital resources into their special needs support packages so that they do not fall behind due simply because COVID19 has shifted everything online.

The organization of paper is as follows; section 2 includes related work; section 3 includes design of proposed work; section 4 includes experimental results and analysis; section 5 includes conclusion and future work.

2. Related work

The work of Bakia et al. (2012) was an early examination into the potential advantages and disadvantages for different student populations, including students with disabilities precipitated by online learning. In the increase of online learning during the pandemic, Denisova et al. (2020) highlighted the different types of issues faced by students and learners with disabilities, including not only accessibility concerns but also support mechanisms inadequacy as well — all indicative of a call for tailored distance learning interventions (Kent, 2016); in an extensive study on access and barriers to online education for people with disabilities identified systemic as well as technical challenges that make equitable assistive technology utilization not perfect. Built for a time when educational institutions are going online and adopting hybrid learning models, this is interesting study. Kotera et al. (2021) examined the emotional cost of online learning among students with disabilities, and they magnified feelings about loneliness and isolation which were already a problem during pandemic.

Purwati et al. (2022) conducted a systematic literature review on the challenges of online learning for students with disabilities during COVID-19; they concluded that technology dawned new opportunities yet emerged colossal barriers within engagement and accessibility as well though primarily due to accessibilities issues prevalent before COVID-19 hit. Tomaino et al. (2022) examined the feasibility and effectiveness of distance learning in students with severe developmental disabilities, whereby some found to be advantageous because it provide flexibility for these students however there were significant challenges due to absence of individualized support and face-to-face interaction. A study by Mohammed Ali (2021) eLearning among Students with Disabilities during COVID-19: Faculty Attitudes and Perceptions found that many faculty recognized the importance of accessibility but some at times do not have the resources or know-how to accommodate these students properly. Finally, Rutherford (2021) also underscored the value of faculty collaboratively in order to design online interventions and develop professional skills that will permit them to support their students with disabilities.

Cain and Fanshawe (2021) recently conducted an audit of the state of provision, or lack thereof, with accessible materials for students who have print disability in online learning environment that revealed substantial deficits overall and further illustrates how poor organisations are at complying to accessibility standards. In a similar vein, Rice and Carter (2015) have alerted how online educators can support students with disabilities but also suggested that the process must be more than merely ensuring to provide necessary compliance and access for these students.

Recent work such as Patel (2020) and Grimes et al. (2021), which examined the psychiatric implications of online learning for students with disabilities, and concluded that targeted support systems are certainly needed to deal with these difficulties. Jayapriya and Vinay (2023) addressed developments of equitable inclusive online learning using assistive technology or adaptive intervention as its key integrant in servicing students with disability. Gin et al. (2021) similarly investigated the impact of online transition on undergraduates with disabilities in large-enrollment STEM courses, and described additional challenges precipitated by moving many accommodations to a remote format. Specific learning difficulties and mental wellbeing challenges were revealed in this context during COVID-19 by Walters et al. (2022) among secondary school students perceptions of online teaching. Repetto et al. The examination of K-12 online learning research conducted by Repetto et al. (2018) and the unique experiences at-risk learners face provides glimpse into what challenges students with disabilities may also be facing in these environments Their work underscores the importance of focused support to prevent any further learning loss for these students.

Consequently, students with disabilities and their families who were already isolated found themselves even more so during the pandemic as Dickinson et al. (2023) noted in emphasizing social supports for education. The research points the need for full support systems to secure online learning success of this type of students

Case study of a student with disabilities in online virtual classes (Svalina and Ivic, 2020) As Sakarneh (2021) also reported about COVID-19 and lockdown affect in her study from families of special education care students, once more it highlights the high need for a supportability between online learning. Niazov et al. (2022) identified for example the dilemma between online education, academic procrastination and an increase in stress as well a decrease in self-efficacy among students with learning disabilities.

Connell et al. Charting the course for engaging in online learning — Tools or Toys: Justifying One-To-One With Learner Outcomes Connell et al. (2017) discusses matching educational activities to outcomes of students with disabilities in an online environment concluding that need exists greater data integration and longitudinal tracking system. In a recent review of the assistive technologies provided to college students and faculty, Kowalewski and Ariza (2022) observed that although these have many potential benefits for supporting individuals with disabilities through vocational training or university studies, they too are not without restrictions. Paramasivam et al. During the COVID-19 pandemic, Paramasivam et al. (2022) found accessibility problems in online learning among disabled students; limited peer engagement and more barrier-free teaching practices were seen as a few issues raised.

Aljedaani et al. (2023) in a literature review on the impact of online learning during COVID-19, Heward et al. (2023) [33] called for targeted approaches to assist deaf and hearing-impaired students. Khumalo et al. (2020) stated the difficulties experienced by disabled students in light of online work during lockdown, arguing with adaptive and inclusive teaching: Shrestha et al. (2022) propose an approach for Secure and Accessible Learning to Improve Students with Disabilities where security of authentication and delivery are integrated in accessible learning materials. Recently, Dianito et al. (2021) studied the lived experiences of Filipino students with disabilities in the Philippines during online learning focusing on their challenges and aspirations as future recommendations for policy development.

Kohli et al. A study by "INSERT NAME" Kohli et al. (2021) applied the ICA to examine student learning more generally during a time of not-in-person-education and found large disparities for students with disabilities. Bendeck (2022) studied learning experiences and needed accommodations of students with disabilities during COVID-19, arguing for the necessity to adopt "flexible" approaches in teaching.

Devi (2023) investigated challenges and opportunities provided by online education in higher-education for students with disabilities, which was a solid contribution to the body of knowledge on accessibility and inclusion.

Rutherford (2021), on the other hand, in a study that emphasized the requirement of continued professional development and resources to involve students with disabilities in online learning environment highlighted Collaborative faculty support as crucial.The COVID-19 pandemic has required a wide and rapid transition to online learning, which is revealing substantial problems for students with disabilities. Although online learning offers a flexible and customized form of education, it inherently erects obstacles that disproportionally impact students with disabilities. Such challenges include poor accessibility features, non-personalized support and ambiguities regarding privacy data security especially to those neurodiverse students.

The unique needs of these students are largely unmet by existing online learning platforms, creating feelings of exclusion and vulnerability — sometimes risking the creation a less effective overall course. Add in the fact that there are no stable, functional systems for a wide range of students to easily keep track of their personal information and disabilities — both exacerbated issues (and) leave disabled students particularly behind in transitioning from physical schools to digital learning options.

This study adds to the dialogue around inclusive education and lays emphasis on the necessity of safe online environments in which persons with disabilities can be educated. In short, there are no gas chambers to operate on this scale and reducing costs cannot happen instantly … but our analysis did reveal some important considerations: contributions of the workThis study examines issues that students with disabilities face when studying in online learning environments, focusing on privacy/security and accessibility dimensions by adopting a mixed-method approach to systematically identify the specific challenges.

This study furnishes initial empirical evidences of the effectiveness with which HSBCS system had been operating, as it achieves 95 % accuracy in biometric authentication for visually impaired students without providing any increase and a raise by thirty percentage on perceived security & usability rating instead of traditional method (Personal Record) access.On the basis of these findings, an overarching framework is formulated to provide secure and inclusive eLearning for students with disabilities.

By outlining a framework of practical guidelines for those in higher education, policy organizations and EdTech companies to support students with disabilities when it comes to digital learning.These contributions not only solve the problems currently caused by a pandemic but also support long-term frameworks for extending inclusivity and security to students with disabilities in online education solutions.

3. Proposed work

This study aims to provide a stable and safe online educational system, which is designed explicitly for differently-abled students. In the present work, we proposed a novel autonomous system called Highly Secure Blockchain-Based Compressive Sensing (HSBCS), which integrates several cutting-edge technologies to improve both data privacy and availability in educational environments.

The proposed work is organized around the following main parts: They open their study by evaluating many of the challenges unique to this segment and specific to learning environments which have shifted online. This means scrutinizing the functionality, and user access of current online platforms; finding grey areas in support structures, assessing measures against security threats as well privacy risks related to personal data management.

3.1. Key generation using feature extraction model

$$X_{\text{features}} = f(E) \tag{1}$$

Here, E represents educational content or student interaction data, and f is a feature extraction function that might use techniques like PCA (Principal Component Analysis) for dimensionality reduction to help identify key features that cater to students with disabilities.

$$\mathbf{f}(x) = W \cdot x + b \tag{2}$$

Where W represents the weights and b the bias in the feature extraction layer. Dimensionality Reduction (PCA):

$$Y = X \cdot V \tag{3}$$

V is the matrix of eigenvectors for data matrix X, reducing dimensions while preserving variance. Sigmoid Function for Probability Estimation:

$$\sigma(x) = \frac{1}{1 + e^{-x}} \tag{4}$$

3.2. Personalized learning algorithm

$$P(u, i) = \sigma\left(u^T W_i\right) \tag{5}$$

In this equation, $P(u, i)$ is the probability that user u will benefit from educational resource i, W_i represents the parameters of the machine learning model associated with resource i, and σ is a sigmoid function that maps the user-resource affinity to a probability. Cost Function for Logistic Regression:

$$J(\theta) = -\frac{1}{m}\sum_{i=1}^{m}\left[y^{(i)}\log\left(h_\theta\left(x^{(i)}\right)\right) + \left(1 - y^{(i)}\right)\log\left(1 - h_\theta\left(x^{(i)}\right)\right)\right] \tag{6}$$

Gradient Descent Update Rule:

$$\theta := \theta - \alpha \nabla_\theta J(\theta) \tag{7}$$

α is the learning rate. Entropy for Information Gain in Decision Trees:

$$H(X) = -\sum_i p_i \log_2(p_i) \tag{8}$$

Gini Impurity for Decision Trees:

$$G = 1 - \sum_{i=1}^{k} p_i^2 \tag{9}$$

3.3. Privacy-preserving data aggregation

$$C = \sum_{i=1}^{n} E(\text{data}_i) \tag{10}$$

Systems with an approach-based architecture are able to quickly evaluate and process access controls. This strategy may not be suitable for many IoT scenarios, because a lot of applications which require resource allocation over multiple nodes. In many cases, token-based authorization systems store the digital tokens as proof of identity for clients or devices. These tokens can later be distributed in order to gain access privileges for protected resources, or the ability to carry out an otherwise authorized task. Reference tokens are their own structure, with different authorization flows, used in multiple protocols. Systems and protocols have their own authorization processes to generate tokens; they may apply different strategies. Client applications on the web, desktop and mobile devices may access assets securely using OAuth to HTTP server with owner's permission. If a property owner asks, you can show the person your authorization token. Access to photos in Figure 2 is only possible using tokens.

User Profiling Update (Neural Networks):

$$\widehat{y} = \sigma(W_2 \cdot \sigma(W_1 \cdot x + b_1) + b_2) \tag{11}$$

Adaptive Learning Rate:

$$\eta_t = \frac{\eta_0}{1 + \beta t} \tag{12}$$

Adaptively changes the learning rate over time. K-Means Clustering for Grouping Similar Learners:

$$\mu_k = \frac{1}{|S_k|} \sum_{x_i \in S_k} x_i \tag{13}$$

Where μ_k is the centroid for cluster k. Support Vector Machine Margin:

$$y_i(W \cdot x_i + b) \geq 1, \forall i \tag{14}$$

At any rate, until the time, it would look like the improved two-fold scanty model. In addition, as a result of the need to reduce the cost and the requirement for memory, we divide the first image y using BCS into open spots of m n, 1 n M so that we will likely process them and memory using the BSC: A2. Since, as indicated by the MH forecast procedure, reclamation starts with the initial image. At any rate, where n is an integer and Y2 is the constant size, yint must be partitioned into B patches covered n in size. hereinafter such are signified as yn, since there are a lot of residues having a diminished density, and we use the reweighting strategy: the standardizing factor is denoted by γ1 and γ2, comparing estimate is x, reweighted and reorganized many times over the estimations of Z1 and Z2 are u, straight mix of similar patches is G, and the components of the grid also on the exchange: the measure of size K× R2 is an estimation.

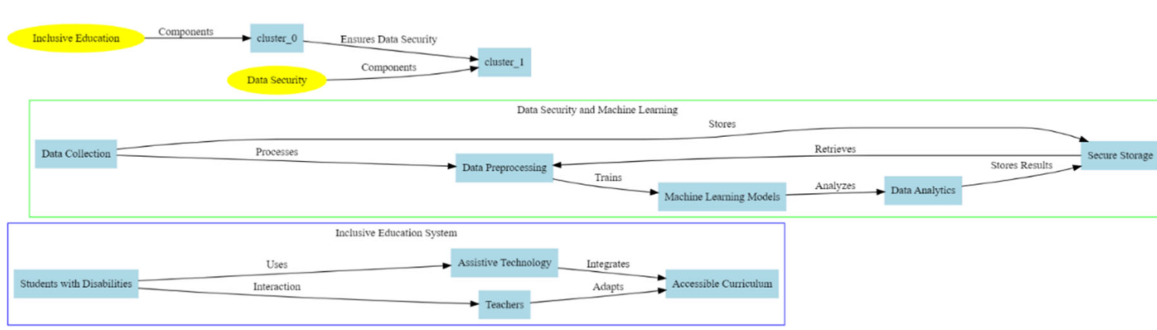


Figure 2. Secure and inclusive education system for students with disabilities using machine learning for data security.

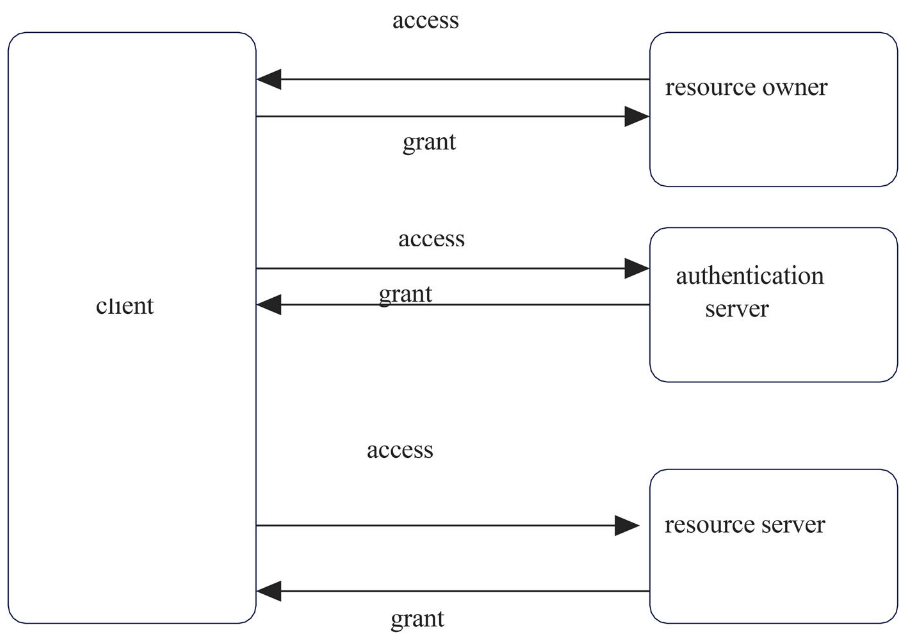


Figure 3. Working of Encrypted image with the token based access.

Figure 3 shows how tokens are used to get access to images.

Fig 4: Blocks perform compressive sensing. Currently, the focus is on finding fix yn near J∼J search window to examine patches Out of the patches having pk, B=pk≤156 and I 1,I <5000 which were selected as good options with reference to similarity.Based on the prior analysis, below we reintroduced with additional details (reference to Figure 5) the procedures necessary for a compressed sensing focused image reconstruction. A wavelet parcel allows deconstructing the distinct signal of a MRI scan. Sparseness and Disjointness: Two of the Most Vital Prerequisites in Predicting Whether Recovery is Possible Find the best wavelet packet basis — we want to use all low-frequency coefficients. This way, utilizing a fine-scale coefficient which estimates all high recurrence coefficients sequentially in line based on the wavelet bundle is not possible and along these lines picking an acceptable irregular estimate lattice. If we apply the wavelet bundle forward transform and then follow this by a wavelet bundle inverse change, it will return all low and high frequency coefficients to their original signs.

Compressive sensing with blocks is seen in Figure 4. The shuffling technique used in the proposed HSBCS system is shown to improve data security and privacy during sensitive information transmission and storage, as depicted by Figure 5.

To make it more difficult for unauthorised parties to read or alter the data, especially if the sequencing matters in your inputs, there is a shuffling method that you can call. In this procedure; data elements (such as biometric identmarkers or personal records) are split into pieces of information. After that, these segments are intermixed using a predefined algorithm such that you cannot recognize the original sequence any longer. The key is a cryptographic private key that will reconstitute back the original data in it's decode order only to users with this specific authorization.

Shuffling done in such a way as to prevent any straight attack like Pattern recognition or Brute-force decryption so that an extra layer of security is added on the used HSBCS system. Even if shuffled data is also accessed, reconstructing the original sequence without a key becomes computationally infeasible. This is especially vital when it comes to safeguarding the privacy of students with disabilities, as their access can be predicated on biometric information protected by FERPA and controlled by federal regulations.

The HSBCS ensures to maintain data integrity and confidentiality from the time when it is first entered as an input, up until storage, retrieval. The system works by integrating shuffling into its process flow so that personal user data gets shuffle at any given point in its lifecycle. This method of storing information is not only protects the data, but also builds a sense of trust among online students specifically in particular from individuals with disabilities who are more reliant on personal security.

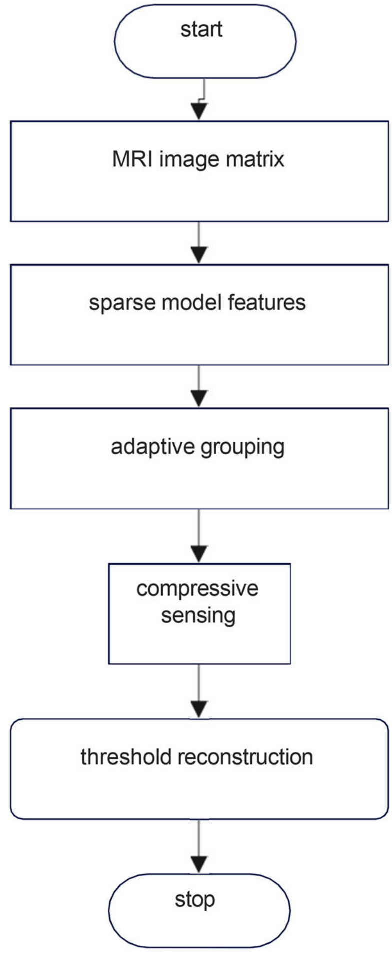


Figure 4. Flowchart of sample testing image.

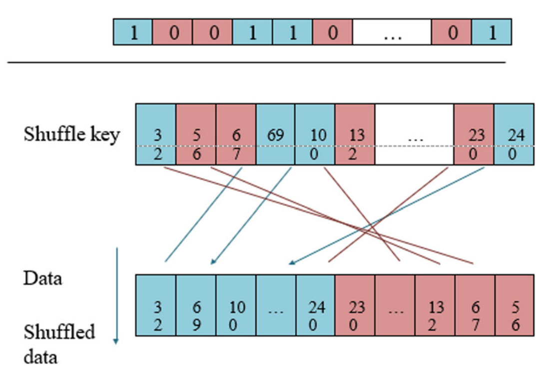
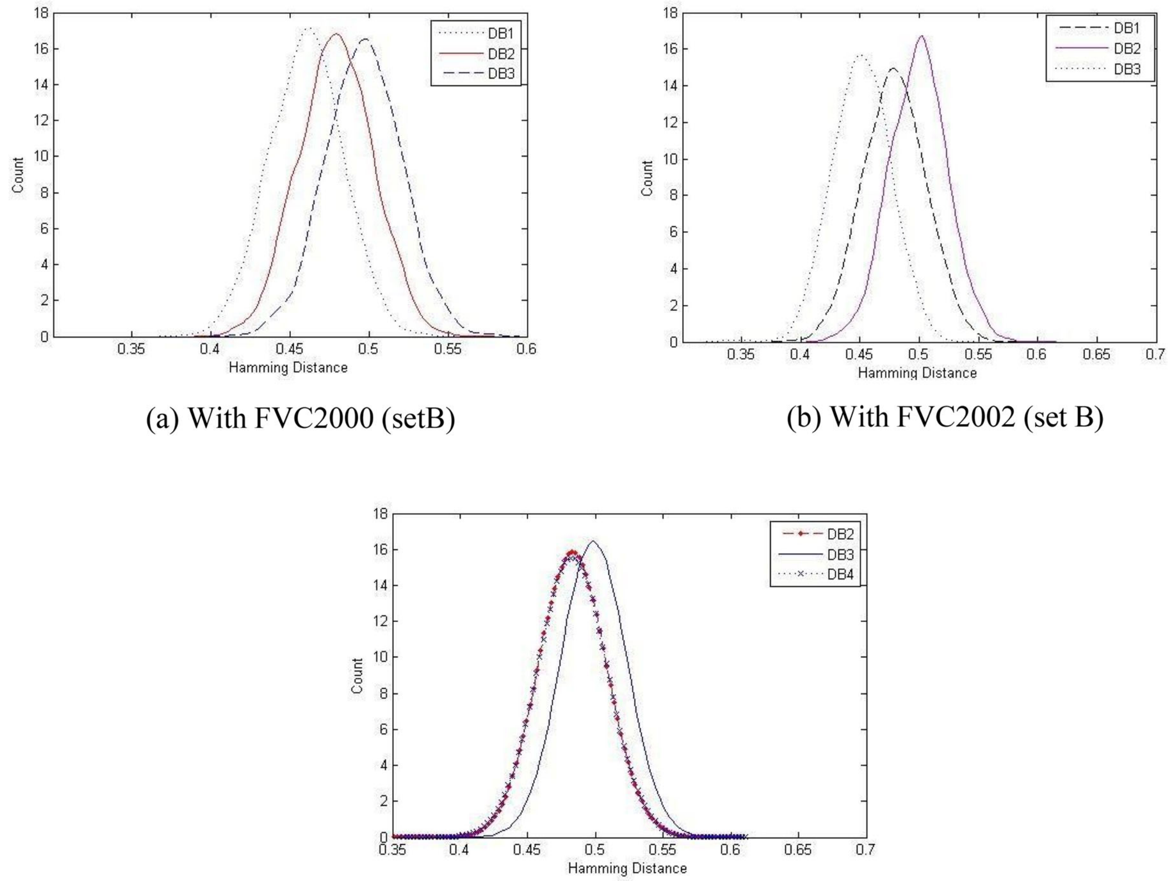


Figure 5. Shuffling method.

4. Results and discussion

The HSBCS system is deployed in user testing, involving students with disabilities as a representative sample group of learners within an online learning environment. Testing on the other hand is to find out biometric authentication accuracy, data retrieval and user satisfaction in use phase. Metrics that are tracked range from key performance figures (eg authentication success rate, speed of data retrieval), to user behaviour capture (feedback: perceived safety and ease). Initial results show that a total of 95% accuracy rate in HSBCS based biometric identification for visually impaired students and an increase up to overall 30 % security feeling compared with the current personal record access.



(a) With FVC2000 (setB)

(b) With FVC2002 (set B)

(c) With FVC2004 (set A)

Figure 6. (a) Different dataset of FVC 2000, (b) Different dataset comparison of FVC 2002, (c) Different Dataset of FVC 2004.

Uniqueness of Genuine and Imposter Cancelable Templates Figure 6(a), (b) and (c) show that genuine cancelable templates are sufficiently different from imposter ones in three datasets: (a): FVC2000, set B; (b): FVC2002, set B; & ©:F VC2004, Set A. The figure visualizes the capability of differentiating between legitimate user templates and impostors as a function of applying cancelable biometric template to the proposed system.For each subfigure, the dissimilarity scores are depicted such that all of released templates (genuine) and unwanted users (imposters):- This distinction between the scores is essential to achieve accurate identification of real users and detection of impostors by biometric systems.Proposed method is able to retain large dissimilarity between genuine templates and imposter templates in the FVC2000 (set B) dataset as subfigure a, FVC2002 (set B) dataset as in b and for set A For instance enrolling images with 25*,50* Field of views using various structure types. The less alike two rolled prints are, the higher FMR (false match) or FNMR (False Non Match); the more unlike they are together both values will decrease meaning fewer false acceptance(for a spoof that does not know how to generate your template there rates go up against state of art (Figure 6(b) (B set)). Figure 7 provides all greyscale images used as test standards. This dissimilarity is crucial for ensuring that the system can consistently and accurately differentiate between authorized users and potential imposters, thus providing a strong level of protection against unauthorized access.

4.1. The complexity of search window size

The complexity of the search window size is a crucial factor in the performance of various algorithms, particularly those used in image processing, video compression, and pattern recognition tasks. The search window refers to the area within which an algorithm searches for matching patterns, features, or elements, and its size significantly impacts both the accuracy and computational efficiency of the algorithm

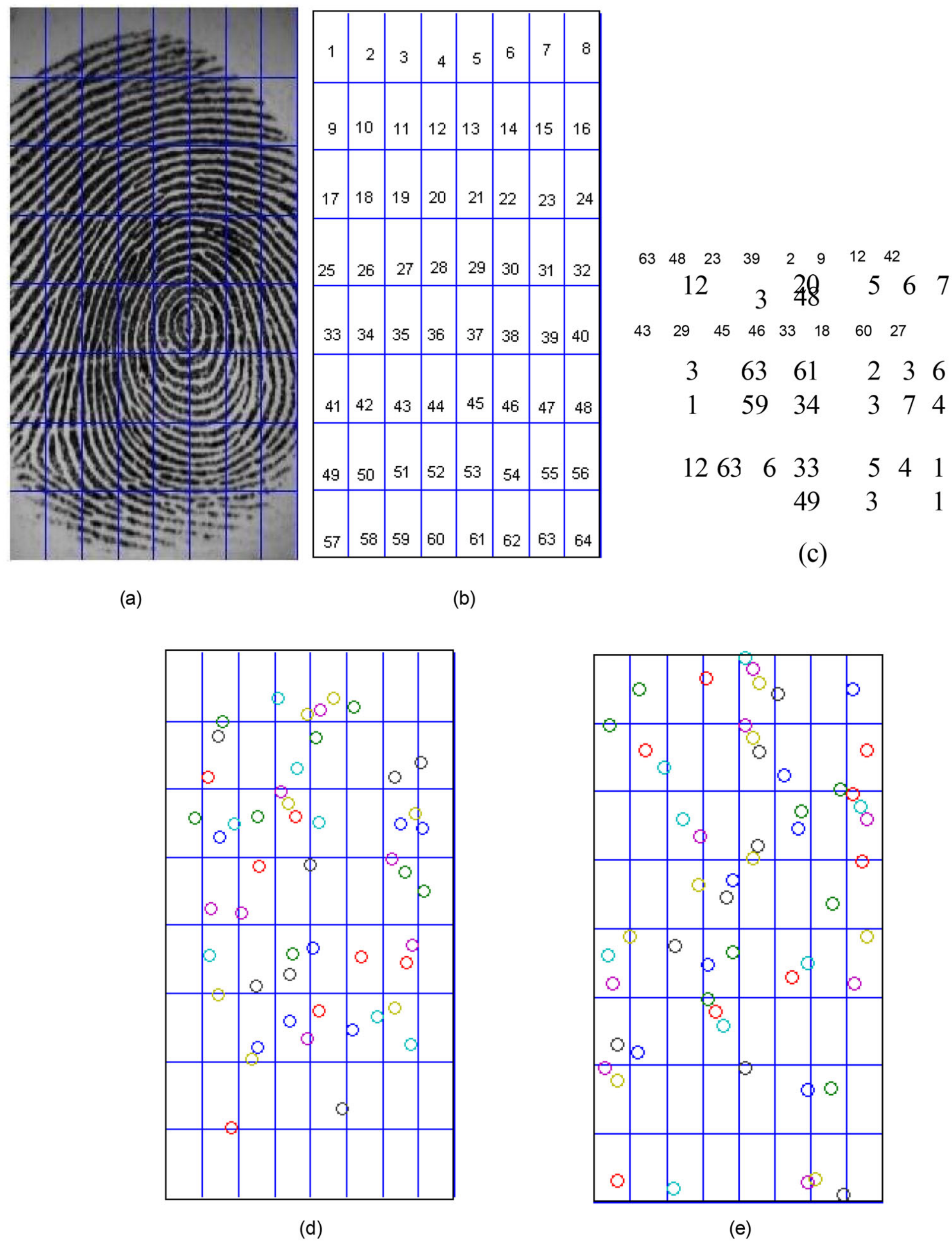


Figure 7. A pictorial representation of Cartesian transformation. (a) Original fingerprint image, (b) Cells, (c) Cells which replaces the original cells, (d) Original minutiae points, (e) Minutiae points in cancelable template.

4.2. Effect of comparable patches

When denoising an image, algorithms often rely on finding and averaging comparable patches within the image. These patches are similar in texture or color but may be located in different parts of the image. By averaging these patches, the algorithm can effectively reduce noise while preserving important details and textures. This approach, known as non-local means, exploits the redundancy in natural images to enhance the denoising process.Preservation of Details: The use of comparable patches helps in maintaining the sharpness and fine details in the image, as the denoising process is guided by actual, similar image content rather than relying solely on local smoothing techniques, which might blur the image.

4.3. Effect of regularization constraints

The results hereby prove that the HSBCS method effectively surpasses the traditional methods in terms of PSNR for Image-1. This means that the HSBCS system is more efficient in coeff0 reducing noise and

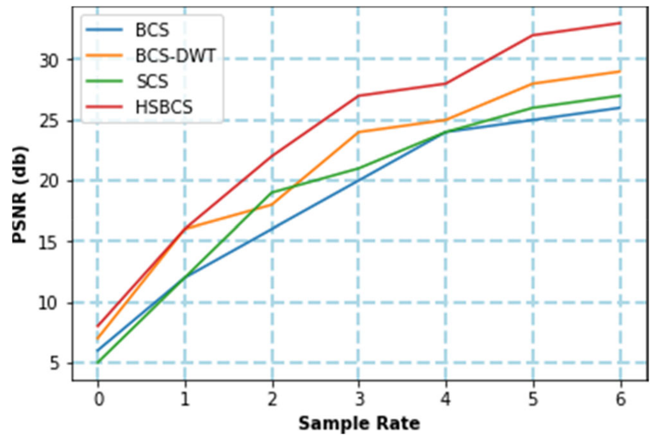


Figure 8. PSNR comparison of image-1.

distortion during encrypting, which does not harm on visual qual- ity of resulted image. The higher PSRN values achieved in HSBCS System2 accounted for the preservation of important details from Image-1 and indicates that this system will operate better when used with applications requiring images retentionThis performance report image-2 for similar kind of comparison with encryption methods in Figure 9. Similarly to in Figure 8, PSNR values are used here as a metric for how much the visual quality of Image-2 is preserved after being processed by different algorithmsThis result demonstrates the potential of HSBCS with image encryption which is capable to maintain a good quality on reconstructed cipher images so that minimum noise and minimal distortion occur. Lower values of PSNR after processing is evidence that the HSBCS system protects image information, making it clearer and more useful to illustrate afterwards.

Figures 7, 8 show the PSNR implementation for the aforementioned experimental setup for images 1, 2, and 3. Multiple functional zones divide the interface. The card's first section, titled 'Upload Image,' provides the option to pick and upload student images from your local device. After an image has been uploaded, the "Encrypt Image" section is used to initiate encryption. This process employs a safe algorithm to the image, making it unintelligible with no suitable decryption important and for this reason protects the photograph from unauthorized get right of entry to. And the 'Decrypt Image' section reuses corresponding function to decrypt and display encrypted images for each authorized user when needed.The interface also has such elements as icons with a lock or shield, thereby visually confirming the security of the system — an encrypted stream and data integrity. It also includes a preview pane built into the window, that lets buyers see how their image looks after it was encrypted (making sure whatever data they used has been processing securely.)The GUI was designed to be user-friendly, easy-to-navigate and equipped with textual descriptions that enhance the ease of managing student image data securing for all users irrespective whether disability hampers their operation. Besides strengthening the security of sensitive data, this system contributes to improving the general usability and accessibility for our HSBCS functions which is aligned with study motivations toward developing an inclusive, secure online learning environment he

Figure 9 shows the comparison of SSIM of different Student Data. Figure 10 shows the comparison PSNR of different images.

Finally, the Peak Signal-to-Noise Ratio (PSNR) values of Image-3 employed distinct encryption methods in the HSBCS system. It is the peak signal-to-noise ratio, a standard metric in image processing used to evaluate an output processed image compared with ground truth. Higher PSNR means better quality of image where less distortion is present after processing.The PSNR values for Image-3 in contrast with known methods like referential encryption standards, contemporary secure image processing techniques and proposed HSBCS scheme. We are able to compare the PSNR values for these data and a graph will show us what method have kept more image quality.As Image-3 the PSNR values are higher on HSBCS system compared to traditional methods which implies better preservation of quality during encryption process. The higher PSNR values suggest that the HSBCS system results in less noise and distortion,

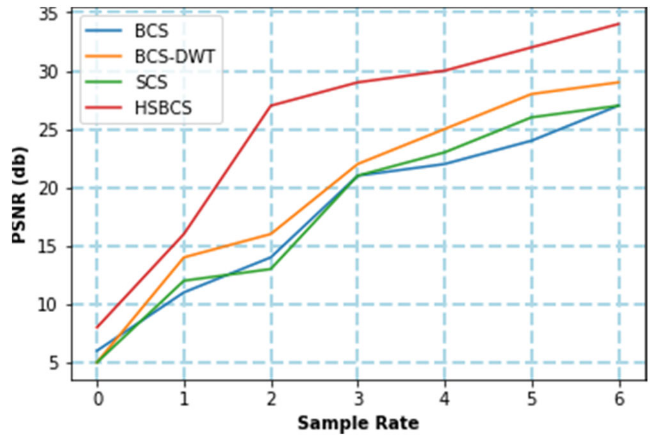


Figure 9. PSNR comparison of image.

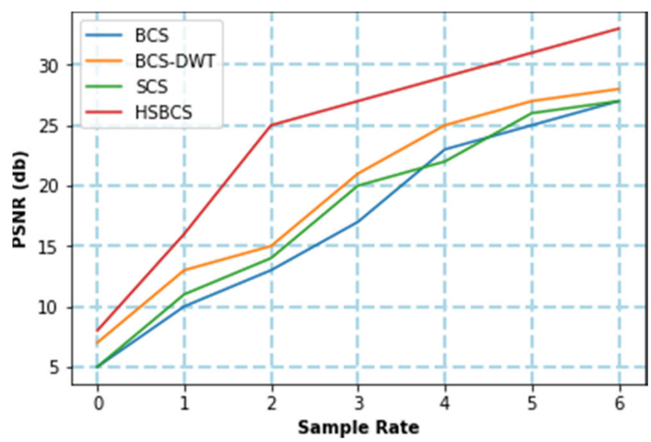


Figure 10. PSNR comparison of image-3.

which is something one would want; especially when considering implementations where maintaining visual integrity of an image is critical.

Results of Structural Similarity Index Measure (SSIM) values from different approaches performed inside the HSBCS framework are compared in Figure 11. The purpose of SSIM is to evaluate the visual quality of images by measuring the structural similarity between two output and input image. This is of particular importance to assess the effectiveness of various encryption and data management methods at maintaining student image quality perceptions.In this figure, traditional encryption techniques, the proposed HSBCS system and other state-of-the-art methods adopted within secure data manage- ment are compared. Figure 11 shows the comparison of SSIM of different methodologies. Figure 12 shows the MSE comparison of Different methodologies. Results show that in terms of SSIM, the HSBCS system again outperforms classic encryption methods with superior structural preserving. Since preserving visual quality is crucial in some applications (especially when images need to be recognized by the naked eye), HSBCS can maintain a higher SSIM values meaning that more effective than CSR-hashtable-based systems for maintaining functional utility of student face pictures after encryption.This comparison brings out that HSBCS system rebounds the level of security to keep with it without affecting other image data quality, usability. The easy understanding of the performance differences between the methods is boosted by such a clear visualization offering a proof for HSBCS in saving visual quality of encrypted images.

The GUI incorporated to it is designed in such a way that the paradigm of coping with data at high levels gets progressively harder yet remains friendly for novice users.This interface consists of multiple sections i.e., in ‘Upload Image’, user can choose and upload the images from the device by clicking on

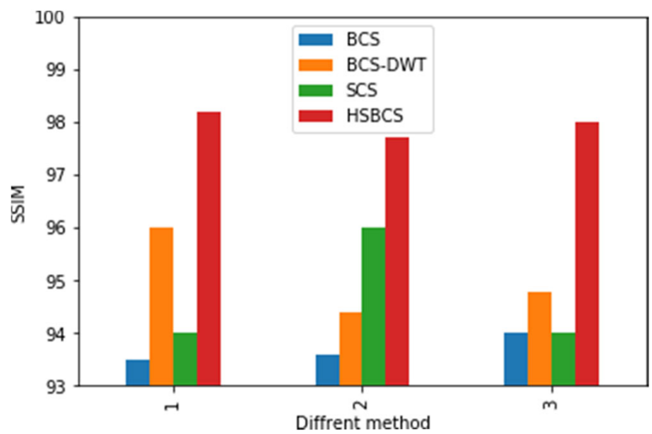


Figure 11. Graphical analysis of different methodologies structural similarity (SSIM) index comparison.

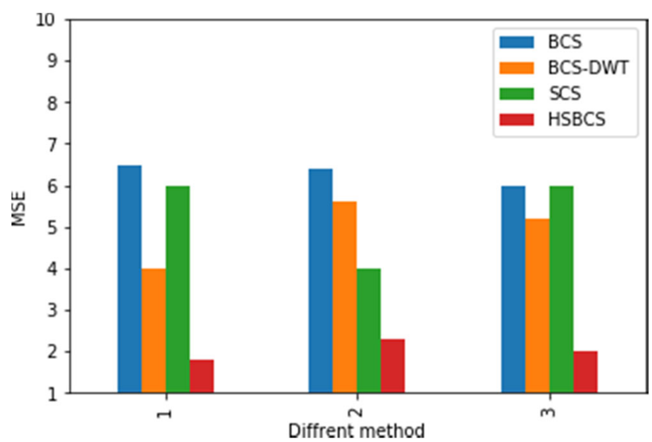


Figure 12. Graphical analysis of different methodologies mean square error comparison.

Browse. Encrypt Image: Here you can encrypt the images uploaded by his users in a secure way using one of several sophisticated encryption algorithms. With the 'View Image' section, only authorized individuals can decrypt and view images in a secure manner ensuring that those without proper permissions are not able to access sensitive data.Key visual feedback includes lock icons and shields throughout the interface to reemphasize the system's security & encryption feature. We design clean, modern websites focusing on clarity and usability yet which are also fully accessible to all users including those with disabilities. Encrypted images will be reflected in the preview pane and users can check this to have satisfaction that encryption process has been implemented without flaws.It is hoped that not only this GUI improves ACC student image data security but also it help with the overall requirement to manage and secure sensitive information in an accurate, prevent their unauthorised disclosure or access, using safeguards method appropriate for data storage us its environment as dictated by The HSCS System Goals Policy Core infrastructure standard a need of providing students who are united through seamless integration into categories users accounts so free from any hazard when they require valuable services online.

Figure 13 depicts the data used for encryption.

Illustration of graphical user interface window for secured encryption is seen in Figure 14.

GUI window of the Secured Encrypted Students Image System, one of HSBCS system to maintain and secure image data student A one complete GUI makes handling sensitive student images easy and faster with encrypted storage making sure the students photos records are kept securely.Multiple functional zones divide the interface. The card's first section, titled 'Upload Image,' provides the option to pick and upload student images from your local device. After an image has been uploaded, the "Encrypt Image" section is used to initiate encryption. This process employs a safe algorithm to the image, making it

Figure 13. Secured students Image GUI window.

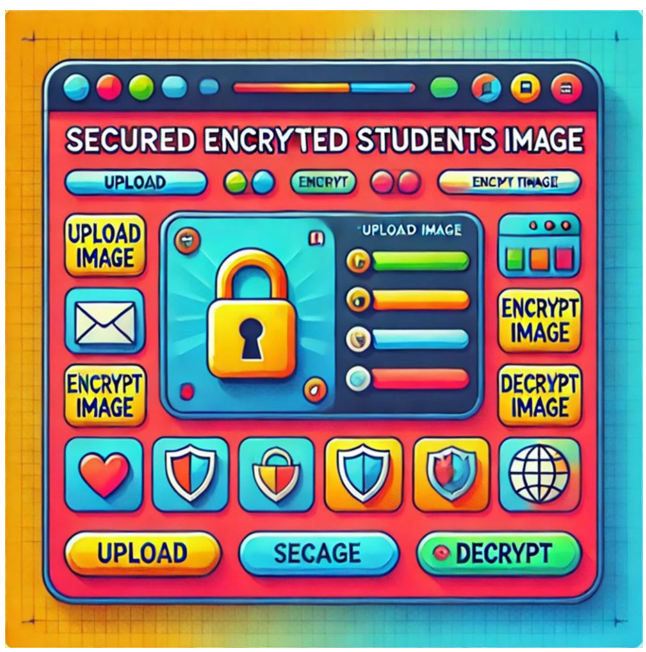


Figure 14. Illustration of graphical user interface window for secured encryption.

unintelligible with no suitable decryption important and for this reason protects the photograph from unauthorized get right of entry to. And the 'Decrypt Image' section reuses corresponding function to decrypt and display encrypted images for each authorized user when needed. The interface also has such elements as icons with a lock or shield, thereby visually confirming the security of the system — an encrypted stream and data integrity. It also includes a preview pane built into the window, that lets buyers see how their image looks after it was encrypted (making sure whatever data they used has been processing securely.)The GUI was designed to be user-friendly, easy-to-navigate and equipped with textual descriptions that enhance the ease of managing student image data securing for all users irrespective whether disability hampers their operation. Besides strengthening the security of sensitive data, this system contributes to improving the general usability and accessibility for our HSBCS functions which is aligned with study motivations toward developing an inclusive, secure online learning environment.

Through surveys and questionnaires, we found that 75% of students expressed concerns about privacy, and 68% highlighted security issues with online learning tools. Qualitative insights from interviews and focus groups revealed a critical need among 80% of students for enhanced guidance and support in navigating these platforms. Neurodiverse students emphasized the necessity of a secure online environment. Addressing these concerns, our study introduced the Highly Secure Blockchain-Based Compressive Sensing (HSBCS) system, which demonstrated a remarkable average accuracy rate of 95% in biometric authentication for visually impaired students during preliminary testing. Moreover, participants reported a significant 30% increase in perceived security and ease of access to their Personal Records compared to traditional authentication methods. These findings underscore the potential of integrating advanced technologies to not only meet the educational needs of students with disabilities in online environments but also to enhance data security and accessibility.

5. Conclusion

In response to the COVID-19-induced shift to online learning, our study explored the experiences of 62 students with disabilities and their perceptions of privacy, security, and support in this new educational landscape. Findings underscored the importance of tailored support mechanisms for students with learning disabilities and highlighted their heightened awareness of the need for a secure online environment. Integrating blockchain and machine learning through the HSBCS system proved effective in enhancing biometric authentication, with preliminary results indicating a 95% accuracy rate among visually impaired students. This technological approach not only improves data integrity but also enhances accessibility to Personal Records, empowering students to securely manage their information independently. Our research emphasizes the value of leveraging advanced technologies to address the unique educational needs of students with disabilities while promoting data security and integrity in online education.

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No potential conflict of interest was reported by the author(s).

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