

ExamGuard: Smart contracts for secure online test

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ABSTRACT

The education sector is currently experiencing profound changes, primarily driven by the widespread adoption of online platforms for conducting examinations. This paper delves into the utilization of smart contracts as a means to revolutionize the monitoring and execution of online examinations, thereby guaranteeing the traceability of evaluation data and examinee activities. In this context, the integration of advanced technologies such as the PoseNet algorithm, derived from the TensorFlow Model, emerges as a pivotal component. By leveraging PoseNet, the system adeptly identifies both single and multiple faces of examinees, thereby ensuring the authenticity and integrity of examination sessions. Moreover, the incorporation of the COCO dataset facilitates the recognition of objects within examination environments, further bolstering the system's capabilities in monitoring examinee activities. Of paramount importance is the secure storage of evidence collected during examinations, a task efficiently accomplished through the implementation of the blockchain technology. This platform not only ensures the immutability of data but also safeguards against potential instances of tampering, thereby upholding the credibility of examination results. Through the utilization of smart contracts, the proposed framework not only streamlines the examination process but also instills transparency and integrity, thereby addressing inherent challenges encountered in traditional examination methods. One of the key advantages of this technological integration lies in its ability to modernize examination procedures while concurrently reinforcing trust and accountability within the educational assessment ecosystem. By harnessing the power of smart contracts, educational institutions can mitigate concerns pertaining to data manipulation and malpractice, thereby fostering a more secure and reliable examination environment. Furthermore, the transparency afforded by blockchain technology ensures that examination outcomes are verifiable and auditable, instilling confidence among stakeholders and enhancing the overall credibility of the assessment process. In conclusion, the adoption of smart contracts represents a paradigm shift in the realm of educational assessment, offering a comprehensive solution to the challenges posed by traditional examination methods. By embracing advanced technologies such as PoseNet and blockchain, educational institutions can not only streamline examination procedures but also uphold the highest standards of integrity and accountability. As such, the integration of smart contracts holds immense potential in shaping the future of online examinations, paving the way for a more efficient, transparent, and trustworthy assessment ecosystem.

1. Introduction

The education industry has undergone a monumental transformation in recent years, leading to a gradual shift away from traditional examination methods reliant on paper and pen. While these methods have served their purpose for decades, they are now deemed somewhat limited in the face of technological advancements. The emergence of online examination systems has offered a more accessible and convenient alternative, facilitating assessments through web portals or desktop software. Moreover, in some instances, Artificial Intelligence

(AI) is deployed to enhance examination security and integrity.

Despite the ease and convenience afforded by online examination platforms, several unresolved issues persist, posing challenges to the robustness and security of the assessment process. Among these concerns are:

1. **Unchecked Running Applications:** One significant issue plaguing online examinations is the ability of examinees to run additional applications or software during the assessment, potentially enabling cheating or unauthorized assistance.

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2. Unchecked Audio: Another challenge arises from the lack of monitoring mechanisms for audio during examinations. This oversight leaves room for verbal communication or external interference, compromising the integrity of the assessment process.
3. Sole Reliance on Camera Features: In some instances, online examinations rely solely on camera features to verify the presence of examinees. While this serves as a basic form of authentication, it may not sufficiently deter cheating or ensure the authenticity of examinee identities.

These unresolved issues underscore the need for a more robust and secure examination conduction system capable of addressing these challenges effectively. To address these shortcomings, this paper conducts a comprehensive literature survey on the current landscape of online examination systems. By reviewing existing methodologies, technologies, and challenges, it seeks to identify opportunities for improvement and innovation in the field of online assessment. Subsequently, the paper presents a proposed system aimed at mitigating the aforementioned issues and enhancing the security and integrity of online examinations. Central to this system is the integration of advanced technologies, including smart contracts and AI algorithms, to monitor and regulate examination procedures.

The proposed system leverages smart contracts, which are self-executing contracts with the terms of the agreement directly written into code. By utilizing blockchain technology, smart contracts provide a transparent and immutable framework for enforcing examination protocols and ensuring the integrity of evaluation data. Additionally, the system incorporates AI algorithms, such as PoseNet from the TensorFlow Model, to accurately identify and track examinee activities during examinations. By analyzing visual data captured through cameras, these algorithms can detect and flag suspicious behaviors, such as the use of unauthorized applications or collaboration with external parties.

Moreover, the integration of the COCO dataset enables the system to recognize objects within examination environments, providing further insights into examinee conduct and surroundings. This enhanced monitoring capability serves to deter cheating and malpractice while promoting fairness and integrity in the examination process. Preliminary testing of the proposed system demonstrates promising results in improving the security and integrity of online examinations. By leveraging smart contracts and advanced AI algorithms, the system effectively identifies and mitigates potential threats to the examination environment, ensuring a level playing field for all examinees.

Furthermore, the integration of blockchain technology provides a transparent and auditable record of examination activities, enhancing accountability and trust in the assessment process. Through real-time monitoring and analysis, administrators can proactively address any irregularities or suspicious behaviors, thereby upholding the integrity of the examination system.

In conclusion, the adoption of advanced technologies holds immense potential in revolutionizing the online examination landscape, offering a more secure, transparent, and equitable assessment experience. By addressing the unresolved issues inherent in traditional examination methods, such as unchecked running applications and unmonitored audio, the proposed system represents a significant step forward in enhancing the integrity and security of online examinations.

Moving forward, further research and development efforts are warranted to refine and optimize the proposed system for widespread adoption. By collaborating with stakeholders across the education sector, including educators, administrators, and technology providers, we can collectively work towards creating a more robust and resilient examination conduction system capable of meeting the evolving needs of the digital age.

2. Literature survey

Online examination systems represent a paradigm shift in the

assessment process, transitioning from traditional, human-based methods to technology-driven platforms. These systems leverage various technological tools, including Artificial Intelligence (AI), to monitor and regulate examination procedures. The integration of AI-based protectors ensures continuous surveillance of examinee activities, thereby enhancing the security and integrity of the assessment process. These protectors employ sophisticated algorithms to detect and prevent instances of cheating or malpractice in real-time. Moreover, examination records are securely stored for a designated period, ensuring transparency and accountability in the evaluation process. This fusion of technology and human oversight not only streamlines examination procedures but also safeguards the authenticity and reliability of assessment outcomes. Thus, online examination systems represent a comprehensive approach to modernizing the examination process while maintaining the highest standards of integrity and fairness.

Aishwarya et al. [1] introduced an innovative system that enhances face detection accuracy in online examinations. Their approach involves converting detected images into grayscale, a technique aimed at improving the detection process's robustness. By first converting images to grayscale, the system reduces complexity and enhances efficiency, making it easier to identify facial features. This initial step simplifies subsequent processing, enabling more accurate detection of faces within the image.

After converting the image to grayscale, the system proceeds to detect faces using specialized algorithms. This step involves analyzing the grayscale image to identify regions corresponding to facial features. Once faces are detected, the system then determines their positions within the original colored image, ensuring accurate localization.

The paper delves into the system architecture, detailing the various components and algorithms employed. It provides insights into the methodology used for face detection, highlighting the significance of grayscale conversion in enhancing detection accuracy. Additionally, the paper discusses the integration of this system into online examination platforms, emphasizing its potential to improve security and integrity.

Overall, Aishwarya S et al.'s [1] proposed system represents a significant advancement in face detection technology for online examinations. By leveraging grayscale conversion and advanced algorithms, the system offers enhanced accuracy and reliability, contributing to the overall efficiency and effectiveness of online examination systems.

In their 2021 proposal, Ningyuan Chen and David Siu-Yeung Cho [2] introduced a decentralized architecture for online examination systems, leveraging blockchain technology to ensure robust data security. This innovative approach utilizes decentralized Online Social Networks (OSNs) to enhance the security and control of the examination environment.

By employing blockchain technology, the proposed system decentralizes data storage and management, eliminating single points of failure and reducing the risk of data breaches or tampering. Decentralized OSNs offer a more secure and controllable social network environment, providing users with greater autonomy over their data and interactions.

The use of decentralized architecture in online examination systems holds immense potential for enhancing security and trust. By distributing data across a network of nodes, the system reduces vulnerabilities and strengthens resilience against cyber threats. Moreover, decentralized OSNs empower users with greater control over their personal information, promoting transparency and accountability in the examination process.

Overall, Ningyuan Chen and David Siu-Yeung Cho's proposal represents a significant advancement in online examination system architecture, offering enhanced data security and user control through decentralized blockchain technology. This decentralized approach has the potential to revolutionize the examination environment, providing a safer and more controllable platform for conducting assessments.

Mayuri D Kulkarni and Khalid Alfatmi [3] presented an innovative system in 2021 designed to ensure the security of examination data

while also providing comprehensive monitoring of examinees. Central to their proposal is the utilization of smart contracts, which serve as the cornerstone for various aspects of the examination process, including credential verification, monitoring, and posture detection.

One key feature of their system is its emphasis on keeping examination data secure. By leveraging blockchain technology, the system ensures the integrity and immutability of examination records, safeguarding against unauthorized access or tampering. Through the use of decentralized storage and cryptographic techniques, examination data is stored securely, reducing the risk of data breaches or manipulation.

Moreover, the proposed system integrates smart contracts for monitoring examinees throughout the examination process. Smart contracts are programmable agreements that automatically execute predefined actions when certain conditions are met. In this context, smart contracts are utilized to track examinee behavior and ensure compliance with examination rules and regulations.

One notable application of smart contracts in the proposed system is for posture detection. By writing a smart contract specifically designed for posture detection, the system can continuously monitor the posture of examinees during the examination. This feature helps prevent cheating or unauthorized behavior by ensuring that examinees remain in a predefined posture throughout the examination duration.

Additionally, smart contracts are employed for credential checking and verification. Examinees' credentials, such as login information or identification details, are verified using predefined rules encoded in smart contracts. This automated verification process helps streamline the examination administration process while enhancing security and reliability.

To facilitate posture detection [4], the system utilizes the dlib toolkit, a widely-used library for machine learning and computer vision tasks. The dlib toolkit offers robust algorithms for facial detection and tracking, making it well-suited for monitoring examinee posture during examinations. By continuously analyzing video feeds or images captured during the examination, the system can detect and flag any instances of unauthorized behavior or non-compliance with examination guidelines.

In summary, Mayuri D Kulkarni and Khalid Alfatmi's proposed system offers a comprehensive solution for ensuring the security and integrity of online examinations. By leveraging blockchain technology and smart contracts, the system provides secure storage of examination data while also enabling comprehensive monitoring of examinee behavior. The integration of posture detection capabilities further enhances the system's effectiveness in preventing cheating or unauthorized behavior during examinations. Overall, their proposal represents a significant advancement in the field of online examination systems, offering enhanced security, reliability, and integrity.

Mr. Apoorv Jain, Dr. Arun Kumar Tripathi, Naresh Chandra, and P. Chinnasamy [5] introduced a novel system in 2021 that utilizes smart contracts to enhance security in online examination platforms. Central to their proposal is the integration of server runtime environment NodeJS and MongoDB database system, combined with blockchain technology, to create a highly secure examination environment. Their system represents a departure from traditional cloud-based systems, offering improved security and reliability.

Smart contracts, a key component of their system, are self-executing contracts with the terms of the agreement directly written into code. These contracts are stored on a blockchain network, ensuring transparency, immutability, and security. By leveraging smart contracts, the proposed system automates various aspects of the examination process, including authentication, verification, and monitoring.

The use of NodeJS as the server runtime environment offers several advantages, including scalability, performance, and ease of development. NodeJS is known for its event-driven architecture and non-blocking I/O model, making it well-suited for building real-time, data-intensive applications such as online examination platforms. Additionally, NodeJS integrates seamlessly with MongoDB, a NoSQL database system, providing flexibility and efficiency in data storage and retrieval.

One of the primary benefits of the proposed system is its enhanced security compared to traditional cloud-based systems. By leveraging blockchain technology, the system decentralizes data storage and management, reducing the risk of data breaches and unauthorized access. Blockchain ensures the integrity and immutability of examination records, mitigating the threat of tampering or manipulation.

Moreover, smart contracts play a crucial role in ensuring security and reliability throughout the examination process. These contracts enforce predefined rules and conditions, automating authentication, verification, and monitoring tasks. By eliminating the need for human intervention, smart contracts reduce the risk of errors and biases, enhancing the overall integrity of the examination system.

The proposed system offers several advantages over traditional cloud-based systems. Firstly, blockchain technology provides a decentralized and distributed ledger, ensuring transparency and accountability. All examination data and transactions are recorded on the blockchain network, providing an auditable and tamper-proof record of events.

Secondly, NodeJS and MongoDB offer scalability and performance benefits, enabling the system to handle large volumes of data and concurrent users efficiently. NodeJS's event-driven architecture allows for asynchronous processing, optimizing resource utilization and improving responsiveness.

Furthermore, the use of smart contracts automates and streamlines various aspects of the examination process, reducing administrative overhead and ensuring consistency and fairness. Smart contracts enforce predefined rules and conditions, eliminating the need for manual intervention and reducing the risk of errors or biases.

In conclusion, Mr. Apoorv Jain, Dr. Arun Kumar Tripathi, Naresh Chandra, and P. Chinnasamy's proposed system represents a significant advancement in online examination platforms. By leveraging smart contracts, NodeJS, and MongoDB, combined with blockchain technology, the system offers enhanced security, reliability, and scalability compared to traditional cloud-based systems. This innovative approach has the potential to revolutionize the examination process, ensuring fairness, transparency, and integrity for all stakeholders involved.

Li, Qiuyan, and Chengyong Yang [6] introduced a comprehensive system in 2022 that serves as an administrator interface for online examination platforms. This system offers various modules designed to streamline and manage different aspects of the examination process. One notable feature of their proposal is its utilization of the open-source Hadoop framework on a cloud computing platform, providing scalability, flexibility, and efficiency.

The administrator interface encompasses several key modules, each tailored to address specific administrative tasks related to online examinations. These modules include:

1. Administrator Operation Interface: This module serves as the central dashboard for administrators, providing access to essential functions and controls. Administrators can oversee various aspects of the examination process, including candidate management, course management, examination planning, and monitoring.
2. Candidate File Management: This module facilitates the management of candidate files, including registration details, identification documents, and examination results. Administrators can upload, organize, and access candidate files efficiently, ensuring data integrity and security.
3. Course File Management: This module allows administrators to manage course materials, including syllabi, lecture notes, and reference materials. Administrators can upload, update, and organize course files, making them accessible to candidates and instructors as needed.
4. Examination Plan Management: This module enables administrators to create, schedule, and manage examination plans. Administrators can define examination parameters, such as duration, format, and

- grading criteria, and assign examinations to specific courses or candidates.
5. Examination Process Management: This module facilitates the monitoring and management of the examination process in real-time. Administrators can track candidate progress, monitor examination sessions, and intervene in case of any issues or anomalies.

The use of the open-source Hadoop framework on a cloud computing platform offers several advantages for the proposed system. Hadoop is a distributed computing framework that provides scalable, reliable, and cost-effective storage and processing capabilities. By leveraging Hadoop, the system can efficiently handle large volumes of data generated during the examination process, ensuring optimal performance and reliability.

Furthermore, deploying the system on a cloud computing platform enhances flexibility and accessibility. Cloud platforms offer on-demand access to computing resources, allowing the system to scale dynamically based on demand. Additionally, cloud-based deployment enables administrators to access the system from anywhere, anytime, using a standard web browser, enhancing convenience and flexibility.

Overall, Li, Qiuyan, and Chengyong Yang's proposed system offers a comprehensive and scalable solution for managing online examinations. By providing an intuitive administrator interface with modular functionality, the system streamlines administrative tasks and enhances efficiency. Moreover, the integration of the open-source Hadoop framework on a cloud computing platform ensures scalability, reliability, and cost-effectiveness, making it a robust solution for online examination management.

In reviewing the papers listed above, we conducted a survey to analyze the tools and technologies utilized in existing systems for blockchain-based smart examination approaches. The research revealed a diverse range of tools and technologies employed to enhance security, reliability, and efficiency in online examination platforms.

One common thread among these papers is the prominent role of smart contracts in facilitating various aspects of the examination process. Smart contracts serve as programmable agreements that automatically execute predefined actions when specific conditions are met. In the context of online examinations, smart contracts are primarily utilized for verification purposes, ensuring the authenticity and integrity of examination-related transactions and data.

The papers underscore the importance of leveraging blockchain technology to enhance the security and transparency of online examination platforms. By utilizing blockchain, these systems decentralize data storage and management, mitigating the risk of data tampering or unauthorized access. Additionally, blockchain enables the creation of a transparent and immutable ledger of examination records, providing stakeholders with greater confidence in the integrity of the examination process.

Overall, the papers highlight the growing interest and investment in blockchain-based solutions for online examinations. By leveraging innovative technologies such as smart contracts and blockchain, these systems aim to revolutionize the examination process, offering enhanced security, reliability, and transparency for all stakeholders involved.

3. Face verification

Face verification is a biometric authentication method that involves recognizing and matching faces to verify individuals' identities. It is a crucial component of many modern security systems, aiming to enhance human comfort and security while ensuring personal privacy. Biometric recognition systems, including face identification, offer several advantages such as accuracy, cost-effectiveness, and suitability as a backup mechanism.

Biometric authentication methods have gained significant traction in recent years due to their effectiveness in enhancing security and

convenience. Among various biometric modalities, face recognition stands out as one of the most widely adopted and accepted methods. It relies on unique facial features to verify individuals' identities, making it suitable for a wide range of applications, from smartphone unlocking to airport security checks.

One of the key advantages of face verification is its accuracy. Modern face recognition algorithms can achieve high levels of accuracy, often surpassing other biometric modalities. This accuracy ensures reliable identification of individuals, reducing the likelihood of false positives or false negatives. As a result, face verification systems provide a robust security solution for various applications, including access control, financial transactions, and identity verification.

Another advantage of face verification is its cost-effectiveness. Unlike other biometric modalities such as fingerprint or iris recognition, face verification does not require specialized hardware or equipment. In many cases, existing cameras or imaging devices can capture facial images for verification purposes, reducing the cost of implementation. This cost-effectiveness makes face verification an attractive option for organizations seeking to enhance security without significant investment in hardware or infrastructure.

Additionally, face verification is suitable for use as a backup mechanism in multi-factor authentication systems. Multi-factor authentication combines two or more independent factors to verify individuals' identities, enhancing security compared to single-factor authentication methods. Face verification can complement other authentication factors such as passwords or security tokens, providing an additional layer of security. In the event of a compromised password or token, face verification can serve as a reliable backup mechanism, ensuring secure access to sensitive systems or data.

Furthermore, face verification offers advantages in terms of user convenience and acceptance. Unlike traditional authentication methods such as passwords or PINs, face verification does not require users to memorize or input complex credentials. Instead, users can simply present their faces for verification, making the authentication process quick and effortless. This convenience encourages user adoption and acceptance, leading to higher compliance with security policies and procedures.

Despite its advantages, face verification also poses certain challenges and considerations. One concern is the potential for privacy invasion or misuse of facial data. As face verification systems capture and store individuals' facial images, there is a risk of unauthorized access or misuse of this sensitive data. To address these concerns, organizations must implement robust security measures to protect facial data and ensure compliance with privacy regulations [7].

Another challenge is the susceptibility of face verification systems to spoofing or manipulation. Advances in technology have made it possible to create realistic facial masks or digitally alter facial images, posing a threat to the integrity of face verification systems. To mitigate this risk, organizations must implement robust anti-spoofing measures and regularly update their face recognition algorithms to detect and prevent fraudulent attempts.

In conclusion, face verification is a valuable biometric authentication method that offers several advantages, including accuracy, cost-effectiveness, and suitability as a backup mechanism. It provides a secure and convenient way to verify individuals' identities, enhancing security while ensuring user comfort and privacy. However, organizations must address privacy concerns and implement anti-spoofing measures to maximize the effectiveness of face verification systems. With proper safeguards in place, face verification can serve as a reliable and efficient authentication solution for various applications in today's digital age.

4. ID verification

ID verification is a fundamental process in various industries and applications, involving the authentication of individuals based on

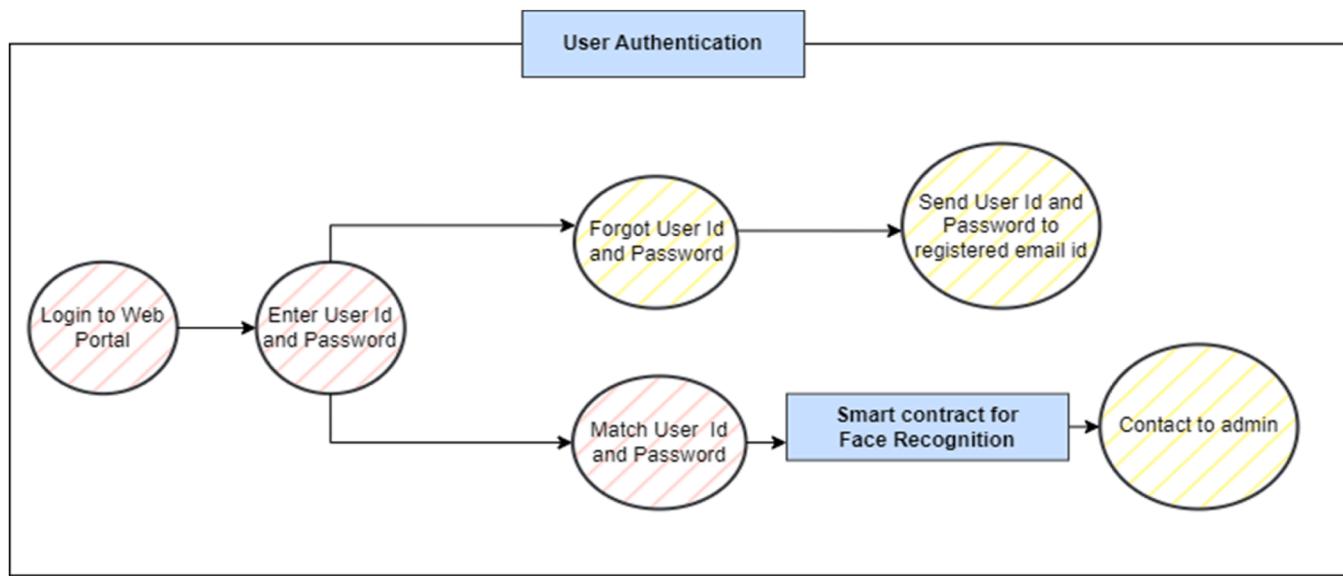


Fig. 1. Smart contract for user authentication.

government-issued identification documents. These documents typically include essential personal information such as name, date of birth (DOB), and address, serving as proof of identity. The primary purpose of ID verification is to ensure the accuracy and validity of the information provided by individuals during registration or authentication processes.

Government-issued identification cards, such as driver's licenses, passports, or national identity cards, are commonly used for ID verification purposes. These documents contain unique identifiers, security features, and biometric data (in some cases), making them reliable tools for verifying individuals' identities.

One of the key advantages of ID verification systems is their compliance with regulations and standards. Many industries, including finance, healthcare, and telecommunications, are subject to strict regulatory requirements regarding customer identification and authentication. ID verification systems help organizations comply with these regulations by ensuring that individuals are who they claim to be. By verifying the authenticity of government-issued identification documents, organizations can mitigate the risk of fraud, money laundering, and identity theft, thereby enhancing regulatory compliance and reducing legal liabilities.

Moreover, ID verification systems contribute to a growing sense of security among users and organizations. In an increasingly digital and interconnected world, the risk of identity fraud and cybercrime is ever-present. By implementing robust ID verification processes, organizations can establish trust and confidence with their customers, partners, and stakeholders. Individuals feel reassured knowing that their identities are protected, while organizations safeguard against unauthorized access and fraudulent activities.

Credential verification is another essential aspect of identity authentication, involving the verification of individuals' credentials, such as login IDs, passwords, or one-time passwords (OTP). Credential verification systems authenticate users based on the credentials provided during the login or authentication process, ensuring that only authorized individuals gain access to protected systems or services. One common method of credential verification is the use of login IDs and passwords. Users are required to enter their unique login IDs and corresponding passwords to access secure systems or platforms. Additionally, organizations may implement multi-factor authentication (MFA) mechanisms, requiring users to provide additional verification factors such as OTPs sent to registered mobile numbers or email addresses.

The advantages of credential verification systems include ease of use and enhanced security. Unlike traditional authentication methods that

rely solely on passwords, MFA mechanisms provide an additional layer of security by requiring multiple factors for authentication. This reduces the risk of unauthorized access resulting from compromised passwords or stolen credentials. Furthermore, credential verification systems are user-friendly, allowing individuals to access protected systems or services quickly and securely.

Overall, ID verification and credential verification systems play crucial roles in ensuring the security and integrity of digital interactions. By verifying individuals' identities and credentials, organizations can prevent unauthorized access, protect sensitive information, and maintain compliance with regulatory requirements. As technology continues to evolve, ID verification and credential verification systems will remain essential components of effective identity authentication strategies, contributing to a safer and more secure digital environment for individuals and organizations alike.

Pose estimation is a critical aspect of computer vision and facial recognition systems, enabling the identification and tracking of facial features and expressions. Researchers have employed various machine learning and deep learning approaches to tackle pose estimation challenges, including single face detection, multiple face detection, and voice recognition. These approaches utilize a combination of algorithms and techniques to achieve accurate and efficient pose estimation.

One common approach used [8] in pose estimation is the Boosted Adaptive Particle Filter (APF), which is employed for single face detection and face tracking purposes. The APF model enhances the face detection process by focusing on attention regions in image frames, speeding up the detection process and improving accuracy. Additionally, algorithms like AdaBoost are utilized for detecting multiple faces in videos, leveraging boosting techniques to enhance the performance of face detection algorithms.

Researchers [9] have also explored the use of deep learning models such as Densenet-1221 and Dual Shot Face Detector for face detection tasks. Densenet-1221, trained on datasets like WIDER FACE, is capable of classifying faces into different categories based on their difficulty levels, providing insights into the complexity of facial recognition tasks. Similarly, the Dual Shot Face Detector employs a Densenet Backbone for face detection, enhancing the accuracy and robustness of face detection algorithms.

Another approach involves using Deep Pyramid Single Shot Face Detector, which utilizes deep convolutional neural networks (CNNs) for detecting faces in tiny images. By optimizing the initial layers of the CNN with a low stride and utilizing techniques like Jaccard overlap, this

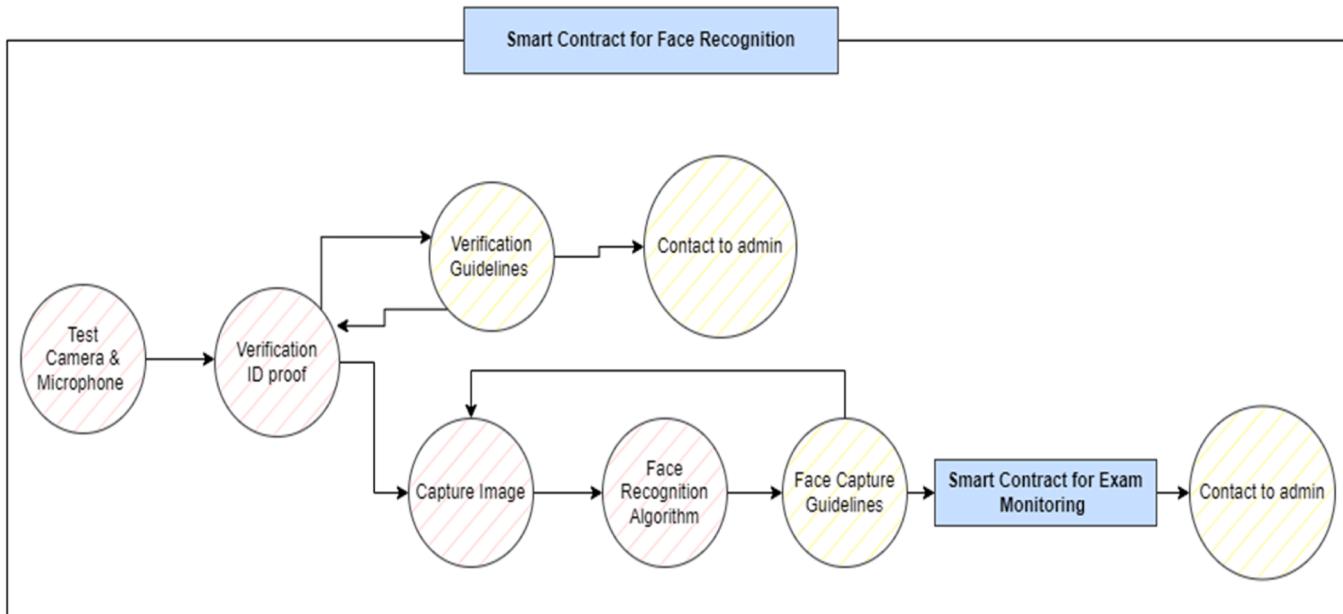


Fig. 2. Smart contract for face recognition.

model achieves superior performance in detecting faces, even in challenging scenarios.

Skin color-based face detection techniques [10] have also been explored, where skin color is used as a primary feature for detecting faces. Algorithms such as AdaBoost are employed, with skin color matching against a threshold value to identify potential face regions. Segmentation mechanisms like Y-Cg-Cr are used to check skin color, further enhancing the accuracy of face detection algorithms.

In addition to pose estimation, researchers have proposed various face verification modules aimed at verifying frontal faces based on different features. These modules include: a. Face skin classification using k-nearest neighbours (k-NN) clustering algorithm into four categories, utilizing multivariate normal distribution for accurate classification. b. Face symmetry verification, where the face area is divided into

left and right blocks, and histogram analysis is performed to match corresponding blocks using Symmetric Similarity Coefficient threshold matching. c. Template matching for eyes verification, employing ensemble classifiers like artificial neural networks (ANN) to verify frontal faces based on eye features.

These face verification modules leverage advanced machine learning techniques to enhance the accuracy and reliability of facial recognition systems. By combining pose estimation and face verification approaches, researchers aim to develop robust and efficient systems capable of accurately identifying and verifying individuals in various scenarios, from security surveillance to biometric authentication (Figs. 1 and 2).

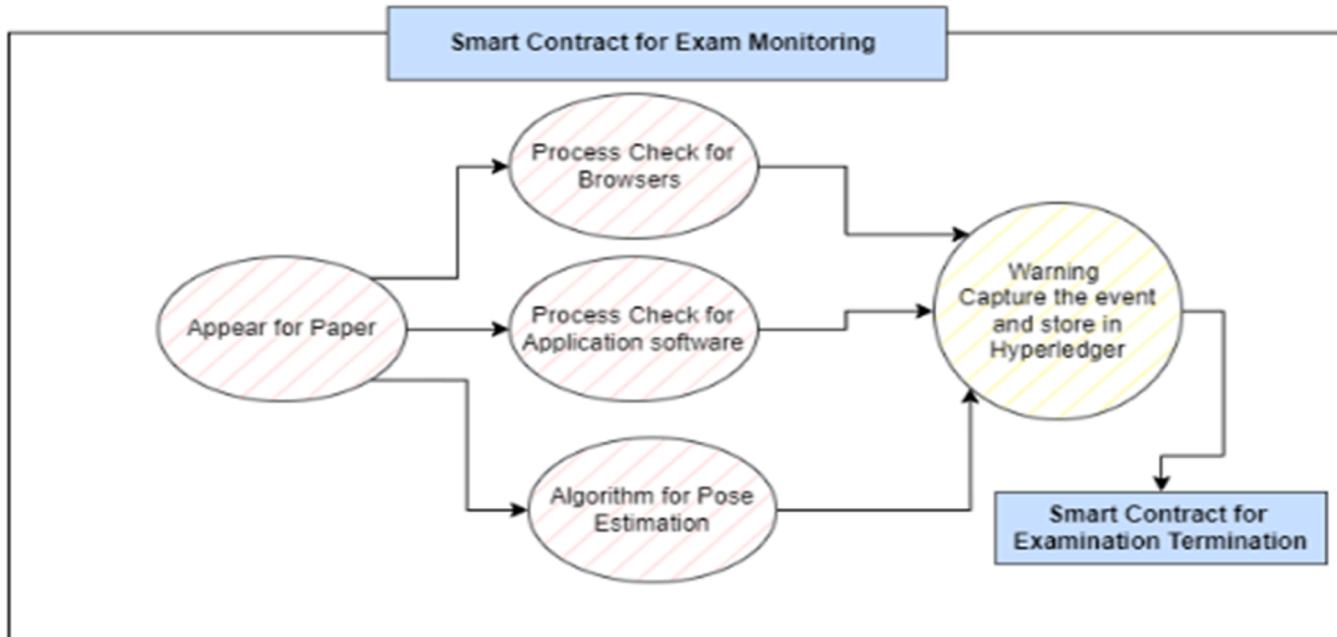


Fig. 3. Samrt contract for examination monitoring.

5. Proposed methodology

The proposed system for online examination aims to enhance security, authentication, and monitoring through the utilization of smart contracts and advanced technologies such as face recognition and pose estimation. This system provides a comprehensive approach to ensure the integrity and fairness of online examinations. Let's delve into the details of each component and its functionalities:

5.1. Initial authentication smart contract

- Upon logging into the online examination portal, the examinee encounters the initial authentication smart contract. This contract executes various authentication steps to verify the examinee's identity.
- The authentication process involves both password authentication and face recognition authentication. The examinee must provide their credentials (username and password) and undergo face recognition verification.
- Upon successful execution of this contract, the examinee gains access to the examination portal.

5.2. Smart contract for face recognition

- The face recognition smart contract verifies the examinee's face from the database. This process ensures that the individual attempting the examination is the authorized user.
- Advanced facial recognition algorithms are employed to accurately match the examinee's facial features with the stored data.

The contract returns a positive result if the examinee's face is successfully authenticated, allowing them to proceed with the examination

5.3. Smart contract for examination monitoring

- The examination monitoring smart contract plays a crucial role in ensuring the integrity and security of the examination process.
- The prime focus of this contract is on the algorithm for pose estimation, which serves as a proctor during the examination.
- Pose estimation techniques are utilized to monitor the examinee's gestures, detect multiple faces in the vicinity, and check for the presence of unauthorized individuals.

Additionally, the contract monitors for voice presence near the examinee, further enhancing examination security (Fig. 3).

6. Technologies used

- The proposed system leverages React.js for front-end development, providing a user-friendly interface for examinees to interact with the examination portal.
- For the blockchain platform, Hyperledger Fabric is utilized, offering a secure and scalable framework for implementing smart contracts and managing transactional data.

PoseNet, a state-of-the-art pose estimation model, is employed for examinee detection and monitoring during the examination. This technology enables real-time tracking of human poses, facilitating proactive intervention in case of suspicious behaviour.

By integrating these components into the online examination system, the proposed solution enhances security, authentication, and monitoring capabilities. Examinees undergo rigorous authentication procedures, including password verification and facial recognition, to ensure their identities are accurately verified before accessing the examination portal. Throughout the examination, the monitoring smart contract utilizes advanced pose estimation algorithms to detect and prevent unauthorized activities, thereby upholding the integrity and

fairness of the examination process.

Furthermore, the use of blockchain technology ensures the immutability and transparency of examination records, providing a reliable audit trail for administrators and stakeholders. Hyperledger Fabric offers a secure and efficient platform for deploying smart contracts and managing transactional data, ensuring the integrity and confidentiality of examination-related information.

Overall, the proposed system represents a comprehensive approach to online examination security, incorporating advanced technologies and robust authentication mechanisms to safeguard against fraud and misconduct. By leveraging smart contracts, face recognition, and pose estimation, the system aims to enhance the reliability and trustworthiness of online examinations, ultimately benefiting both examinees and educational institutions.

7. Results and discussion

The proposed method for online examination incorporates the use of PoseNet to continuously monitor examinees in real-time, detecting any irregularities or malpractices during the examination process. Additionally, PoseNet enables the detection of multiple human presences, further enhancing the system's monitoring capabilities.

PoseNet, a state-of-the-art pose estimation model, plays a crucial role in monitoring examinees during online examinations. By analyzing the pose of examinees in real-time, PoseNet can detect any deviations from expected behavior, alerting administrators to potential instances of cheating or misconduct. This real-time monitoring capability is essential for ensuring the integrity and fairness of online examinations, particularly in the absence of a proctor.

The proposed methodology utilizes TensorFlow library's PoseNet function for pose estimation. Pose estimation is performed for various body parts, including the eyes, ears, and forehead, allowing for comprehensive monitoring of examinee posture and movements. This single pose estimation algorithm takes as input image elements and various parameters, such as scale factor, flip horizontal, and stride, to provide output in the form of pose confidence and an array of keypoints.

Furthermore, the proposed method utilizes the TensorFlow COCO-SSD model to identify multiple objects present in single images or videos. With the ability to detect 90 different classes in the COCO dataset, including common objects and items, COCO-SSD enhances the system's monitoring capabilities by identifying any additional individuals or objects in the examination environment.

The integration of PoseNet and COCO-SSD into the online examination system yields several significant results and benefits. Firstly, the continuous monitoring provided by PoseNet ensures that examinees are under constant observation, deterring potential instances of cheating or academic dishonesty. This proactive approach to monitoring helps maintain the integrity of online examinations and preserves the credibility of academic assessments.

Moreover, the detection of multiple human presences using PoseNet and COCO-SSD adds an extra layer of security to the examination process. By identifying any unauthorized individuals or additional examinees in the examination environment, the system can prevent collusion or unauthorized access, further safeguarding the fairness and reliability of the examination process.

Additionally, the real-time alerts generated by PoseNet enable administrators to take immediate action in response to any detected irregularities or suspicious behavior. Whether it's detecting unusual poses or identifying unauthorized individuals, the system provides administrators with timely notifications, allowing them to intervene and address the situation promptly.

The details for the proposed work is at github for Front End <https://github.com/Harshbhavsar2004/web-examination> and Back End <https://github.com/Harshbhavsar2004/Examination-center>.

Overall, the results obtained from the implementation of PoseNet and COCO-SSD in the proposed online examination system demonstrate

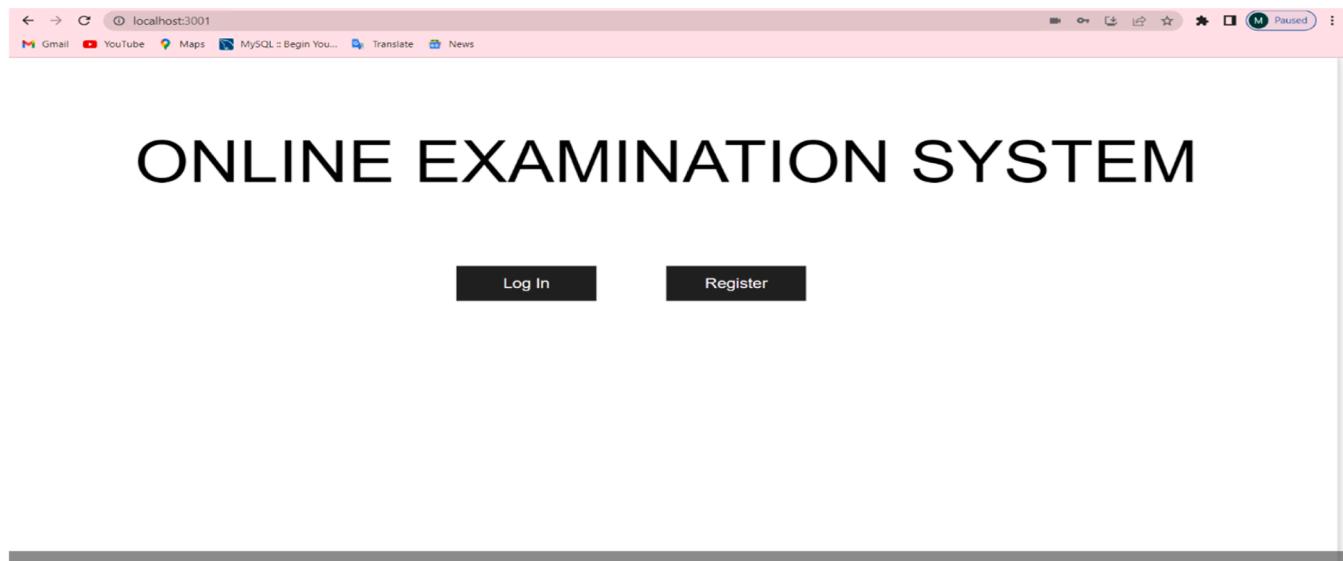


Fig. 4. Login page to online examination portal.

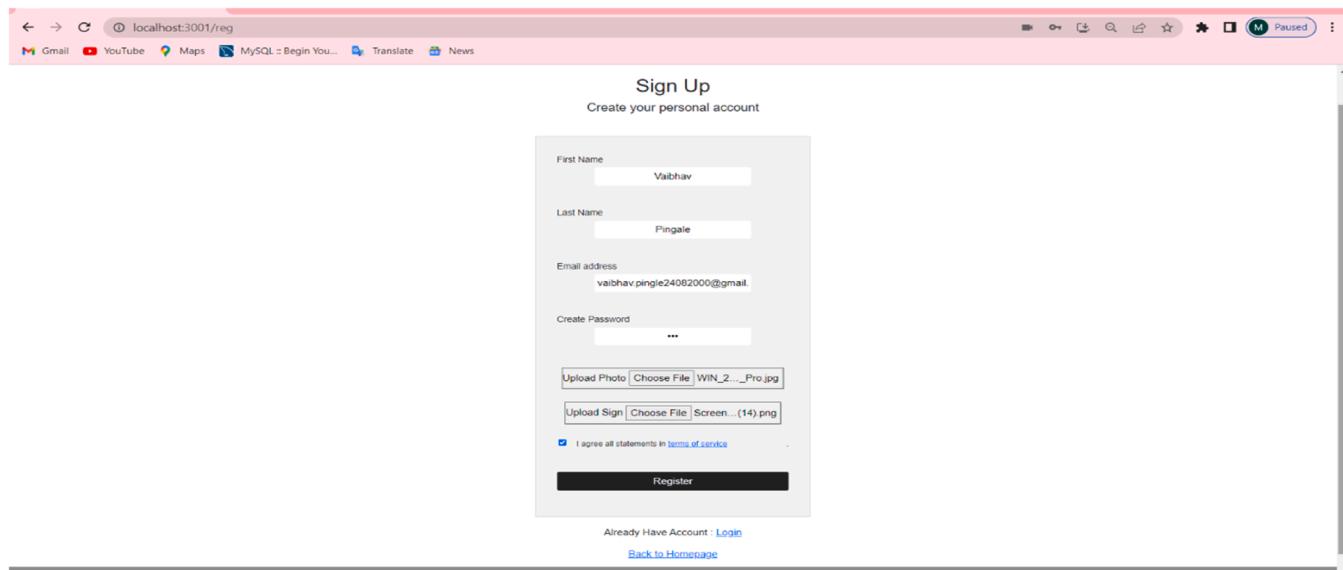


Fig. 5. Login page.

significant improvements in monitoring and security capabilities. By leveraging advanced pose estimation and object detection technologies, the system effectively detects and prevents cheating or misconduct, ensuring the integrity and fairness of online examinations. Additionally, the real-time monitoring and alerts provided by the system empower administrators to maintain control over the examination process and uphold academic standards effectively.

In addition to pose estimation and human presence detection, the proposed online examination system incorporates object detection functionality to identify and warn against the presence of mobile phones during examinations. Mobile phones pose a significant risk in terms of cheating and academic dishonesty, as they can be used to access unauthorized materials or communicate with others during the examination. Therefore, detecting and preventing their presence is essential for maintaining the integrity of the examination process.

The object detection module in the system utilizes the TensorFlow COCO-SSD model, which is capable of identifying various objects, including mobile phones, in images or videos. By analyzing the

examination environment in real-time, the system can detect the presence of mobile phones and issue warnings to both examinees and administrators (Figs. 4–9).

When a mobile phone is detected in the examination environment, the system generates a warning message, alerting the examinee to the violation of examination rules and reminding them to refrain from using mobile devices during the test. Simultaneously, the system logs details of the violation, including the timestamp, location, and identity of the examinee, into the blockchain-based smart contract.

The smart contract serves as a secure and immutable ledger, recording all instances of detected violations and associated details. By storing this information on the blockchain, the system ensures transparency and accountability in the examination process, as administrators can access a comprehensive record of past violations and take appropriate action as needed. Furthermore, the smart contract can automatically trigger additional measures in response to repeated violations or egregious misconduct. For example, if an examinee persists in using a mobile phone despite warnings, the smart contract may escalate

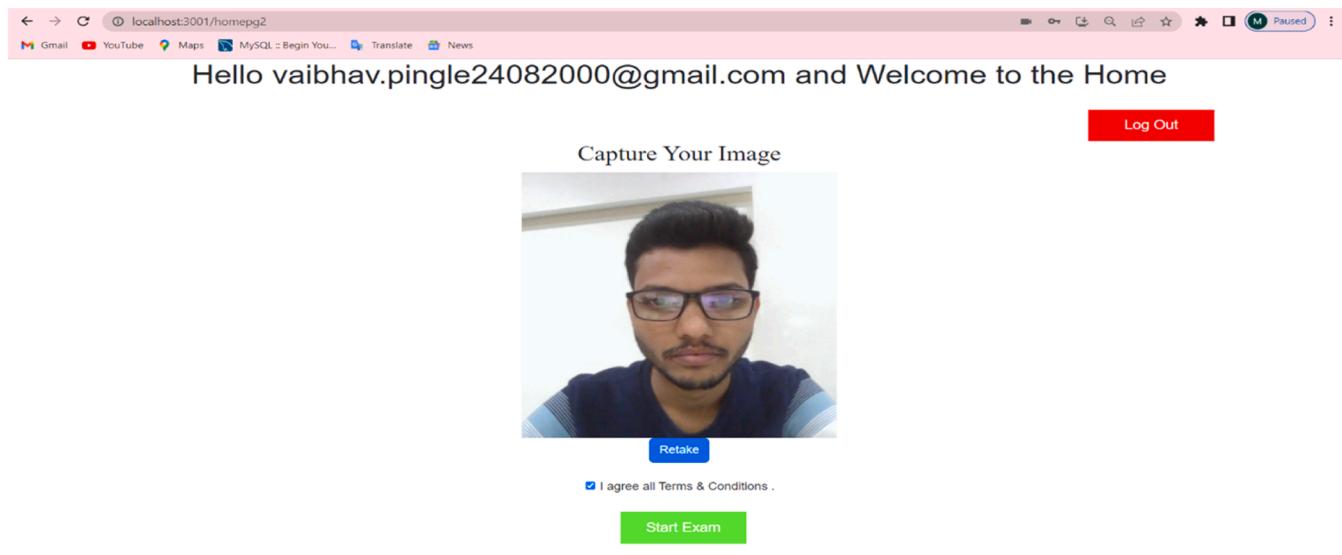


Fig. 6. Identity verification through face recognition.

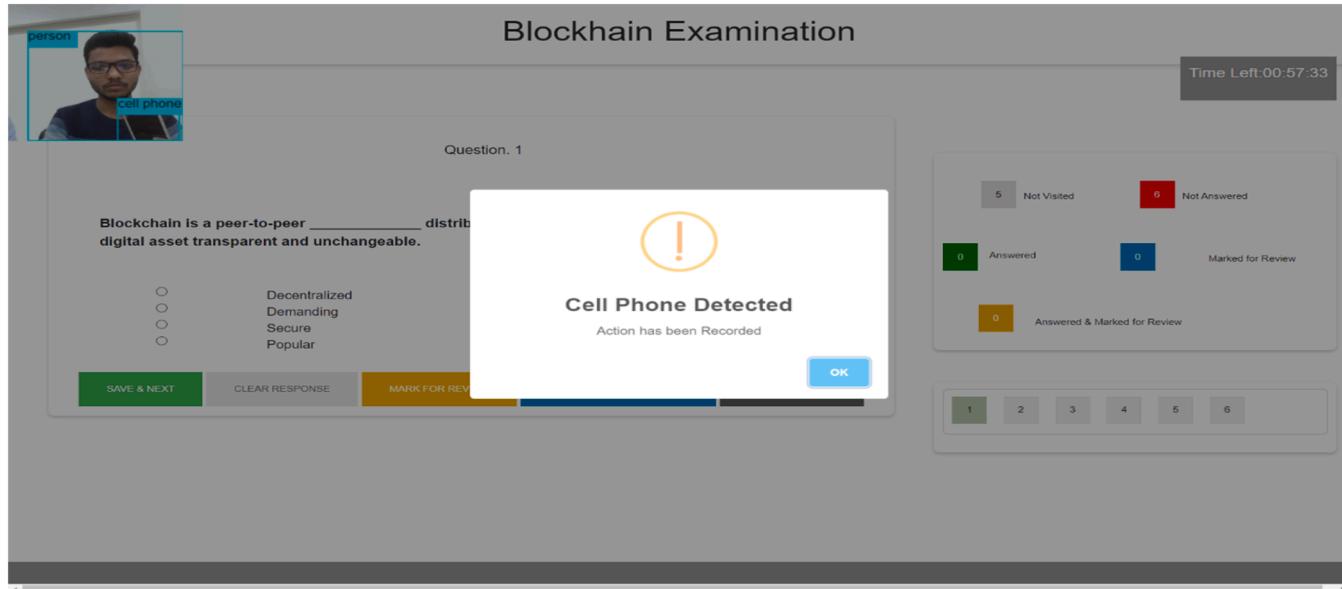


Fig. 7. Object Detection(Mobile Phone) and warning with details which will be stored in smart contract.

the severity of penalties, such as disqualification from the examination or suspension from future assessments.

Additionally, the object detection module can be configured to issue warnings to administrators in real-time, allowing them to monitor the examination environment closely and intervene as necessary.

Voice detection is an essential component of the proposed online examination system, serving as a mechanism to identify and address unauthorized communication during examinations. By incorporating voice detection technology, the system can effectively monitor audio activity in the examination environment and issue warnings in response to detected violations. When an examinee attempts to communicate verbally during the examination, the voice detection module analyzes the audio input in real-time to determine whether it constitutes a violation of examination rules. This analysis may involve detecting speech patterns, identifying keywords related to examination content, or recognizing the presence of multiple voices indicating collusion.

Upon detecting unauthorized voice activity, the system generates a

warning message, alerting the examinee to the violation of examination rules and reminding them to maintain silence during the test. Simultaneously, the system logs details of the violation, including the timestamp, location, and identity of the examinee, into the blockchain-based smart contract. The smart contract serves as a secure and immutable ledger, recording all instances of detected voice violations and associated details. By storing this information on the blockchain, the system ensures transparency and accountability in the examination process, as administrators can access a comprehensive record of past violations and take appropriate action as needed.

Furthermore, the smart contract can automatically trigger additional measures in response to repeated violations or egregious misconduct. For example, if an examinee persists in communicating verbally despite warnings, the smart contract may escalate the severity of penalties, such as disqualification from the examination or suspension from future assessments.

Additionally, the voice detection module can be configured to issue

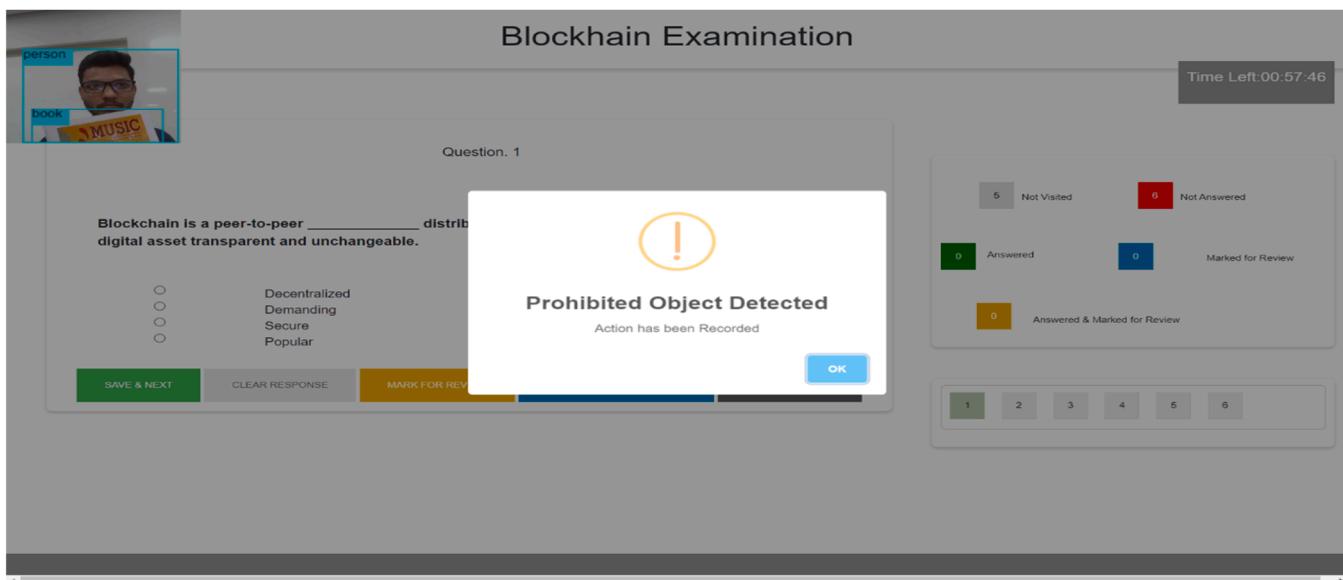


Fig. 8. Object Detection(Book) and warning with details which will be stored in smart contract.

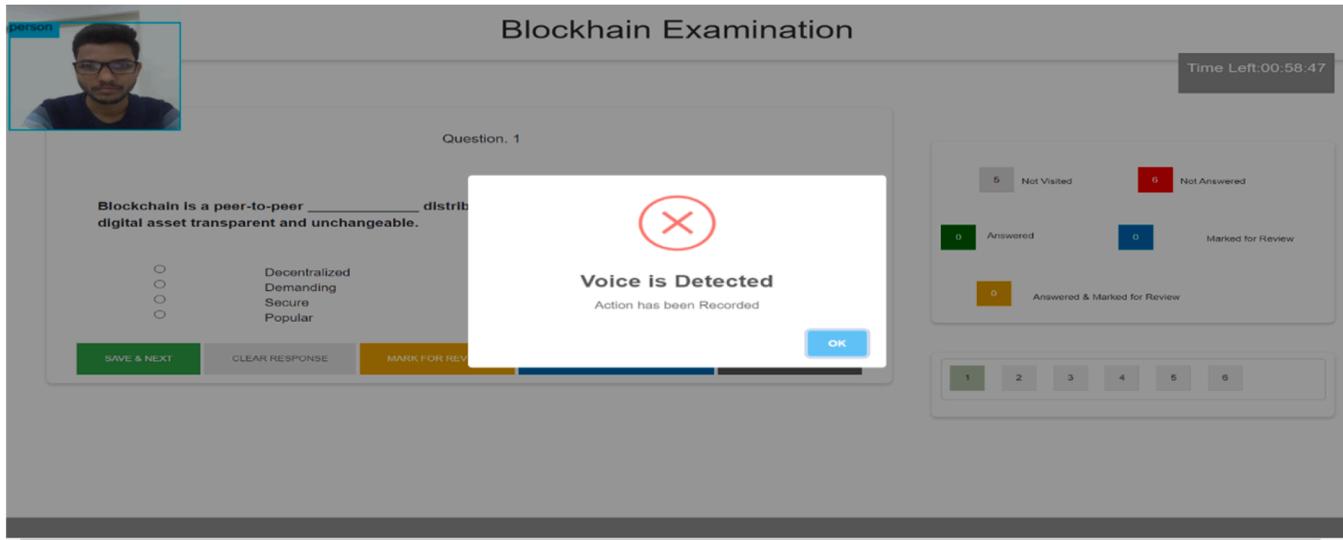


Fig. 9. Voice detection and warning will be stored in smart contract.

warnings to administrators in real-time, allowing them to monitor the examination environment closely and intervene as necessary. Administrators can receive notifications through various channels, such as email or SMS, enabling swift response to detected violations and ensuring the integrity of the examination process.

The integration of voice detection functionality into the proposed online examination system enhances its monitoring and security capabilities, particularly concerning the detection of unauthorized communication. By leveraging advanced technologies for audio analysis and blockchain-based smart contracts for data storage, the system can effectively detect and deter cheating behavior, safeguarding the fairness and integrity of online examinations.

Overall, voice detection and warning mechanisms play a crucial role in maintaining the integrity of online examinations by identifying and addressing unauthorized communication. Through the storage of violation details in a blockchain-based smart contract, the system ensures transparency, accountability, and effective enforcement of examination rules, ultimately contributing to a trustworthy examination

environment (Figs. 10–13).

8. Conclusion

The proposed online examination system represents a significant step forward in the realm of digital assessments, offering a comprehensive solution to the challenges faced in monitoring examinee activities, maintaining integrity, and ensuring security during online examinations. By leveraging advanced technologies such as PoseNet algorithm for examinee detection, the COCO dataset for object identification, and the blockchain technology for secure record-keeping, the system provides a robust framework for conducting fair, reliable, and tamper-proof examinations in the digital age.

Reducing Proctor Burden and Enhancing Monitoring is One of the primary objectives of the proposed system. Traditionally, proctors are tasked with observing examinee activities, maintaining logs, and making decisions based on their observations. However, this manual approach is time-consuming, resource-intensive, and prone to errors. By

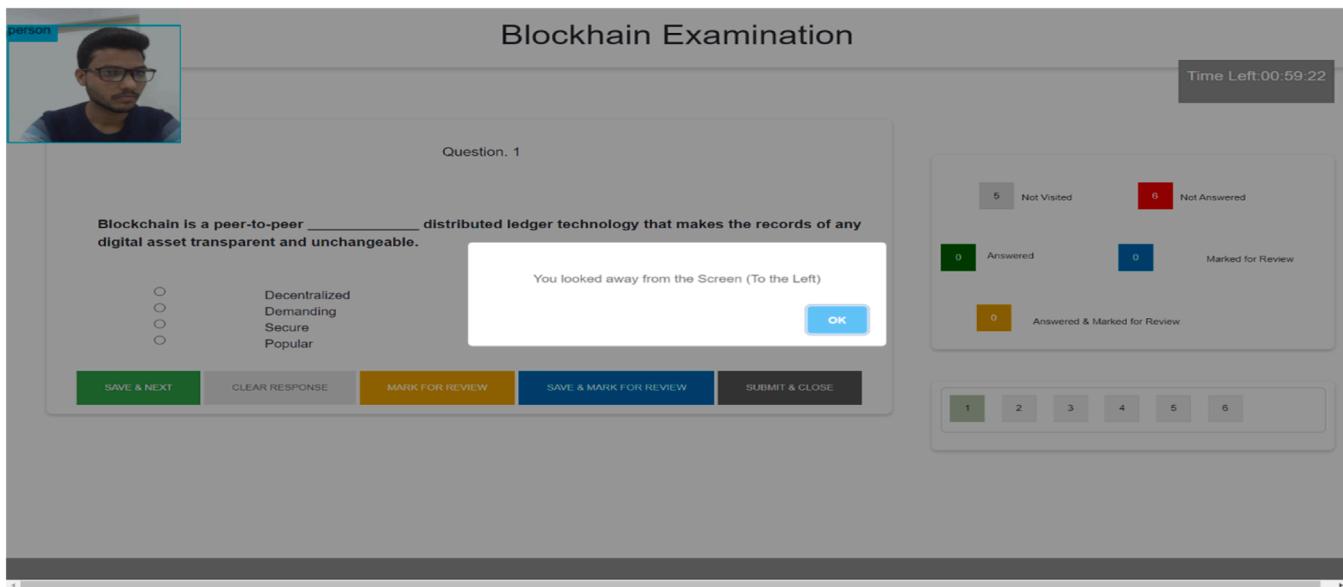


Fig. 10. Warning for Malpractice during examination.

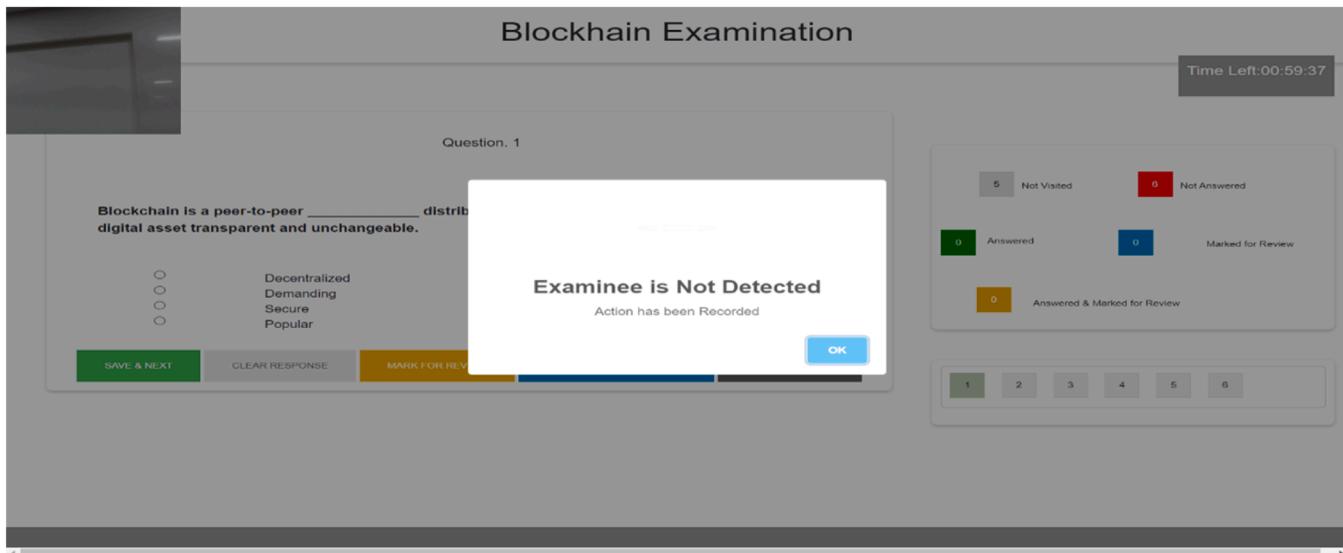


Fig. 11. Absence of Examinee.

incorporating the PoseNet algorithm, the proposed system automates the monitoring process, accurately detecting examinee presence and posture based on 17 key points on the human body. This real-time monitoring capability significantly reduces the workload on proctors, allowing them to focus on other important tasks while ensuring continuous surveillance of examinee activities.

Secure and Immutable Record-Keeping with blockchain technology is one of the key features of the proposed system. This utilization of the blockchain technology for secure and tamper-proof record-keeping. A permissioned blockchain framework specifically designed for enterprise applications, offering features such as confidentiality, scalability, and immutability. By storing each piece of evidence during the examination in a blockchain-based smart contract, the system creates a transparent and immutable record of examinee activities. This record includes timestamps, PoseNet detections, object identifications, and any other relevant information, providing administrators with a comprehensive overview of the examination process. Moreover, the tamper-proof nature of the blockchain ensures that examination data cannot be altered

or manipulated, enhancing the integrity and reliability of the assessment process.

In addition to examinee detection Object Identification Using COCO Dataset to identify objects present in the examination environment. The COCO dataset contains a diverse range of images labeled with object categories, making it an ideal resource for training object detection models. By leveraging this dataset, the system can accurately identify objects such as mobile phones, notes, or other prohibited items that may compromise the integrity of the examination. This capability enhances the system's monitoring capabilities, enabling administrators to detect and address potential instances of cheating or misconduct proactively.

Enhancing Security and Fairness offers several key advantages over traditional methods of examination supervision. By automating the monitoring process, leveraging advanced technologies for examinee detection and object identification, and employing blockchain-based record-keeping, the system enhances security, reduces the burden on proctors, and ensures fairness and transparency in the examination process. With its ability to store each piece of evidence securely in a

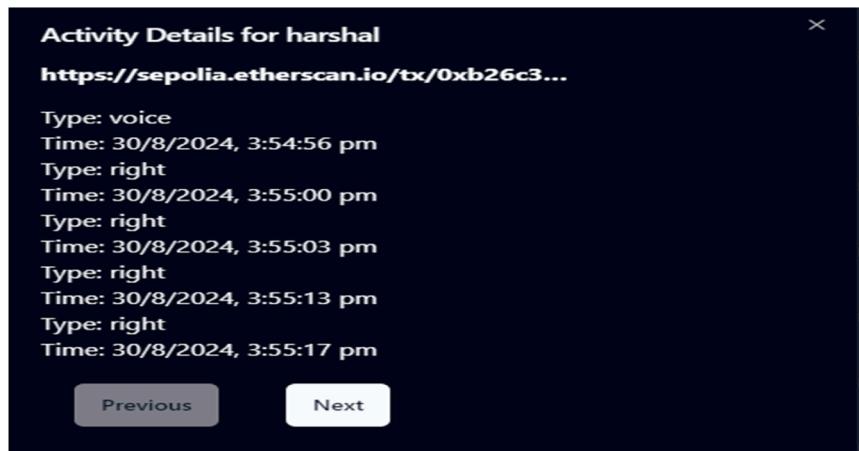


Fig. 12. Activity track at Admin Portal.

sepolia.etherscan.io/tx/0x26021c4d7b4bfac612f05c81d2f9fa295bc24991507476858654fd7ea1f1dcdf

Sepolia Testnet Search by Address / Txn Hash / Block / Token

Etherscan Home Blockchain Tokens NFTs More

Transaction Details

Overview State

[This is a Sepolia Testnet transaction only]

Transaction Hash: 0x26021c4d7b4bfac612f05c81d2f9fa295bc24991507476858654fd7ea1f1dcdf

Status: Success

Block: 6480259 325759 Block Confirmations

Timestamp: 52 days ago (Aug-11-2024 03:10:36 PM UTC)

Transaction Action: Call 0x891f5593 Method by 0xDC1a3e8d..4E0A31F98 on 0x4A043791..E5162363e

From: 0xDC1a3e8d61727857c8B2F826B0BC1b74E0A31F98

To: 0x4A043791091486559Bf085FD35e5Ab9E5162363e

Value: 0 ETH (\$0.00)

Transaction Fee: 0.0002767806992412 ETH \$0.00

Gas Price: 12.1426998 Gwei (0.0000000121426998 ETH)

Fig. 13. Activity track stored at Blockchain Platform.

tamper-proof ledger, accurately detect examinee presence and posture, and identify objects in the examination environment, the proposed system provides a robust and reliable framework for conducting online examinations.

In conclusion, the proposed online examination system represents a significant advancement in the field of digital assessments. By leveraging cutting-edge technologies such as PoseNet algorithm, the COCO dataset, and the blockchain platform, the system offers a comprehensive solution to the challenges faced in monitoring examinee activities, maintaining integrity, and ensuring security during online examinations. By automating the monitoring process, reducing the burden on proctors, and providing a secure and transparent record of examination data, the proposed system addresses key shortcomings of traditional examination methods and offers a reliable framework for conducting fair and reliable assessments in the digital age. With its potential to revolutionize the way examinations are conducted, the

proposed system holds promise for enhancing the quality, efficiency, and integrity of online assessments, ultimately benefiting students, educators, and institutions alike.

Compliance with ethical standards

No human and animal involved in study.

CRediT authorship contribution statement

Mayuri Diwakar Kulkarni: Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Ashish Awate:** Validation, Software, Data curation, Conceptualization. **Makarand Shahade:** Validation, Resources, Formal analysis. **Bhushan Nandwalkar:** Visualization, Data curation.

Declaration of competing interest

No Competing Interests.

Data availability

Front End Code <https://github.com/Harshbhavsar2004/web-examination> Back End Code <https://github.com/Harshbhavsar2004/Examination-center>.

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