

A Hybrid Quantum-Adversarial AI Framework for Defence Vision Security and Content Integrity

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Abstract— Modern defense and high-security environments require surveillance systems that provide real-time monitoring, high detection accuracy, and strong data integrity. Traditional surveillance approaches rely heavily on manual observation and basic motion detection techniques, which are often inefficient and vulnerable to operational errors and security threats. This paper presents a Hybrid Quantum-Adversarial AI Framework for Defense Vision Security and Content Integrity, designed to provide an intelligent, secure, and integrated surveillance solution. The proposed framework utilizes advanced deep learning techniques, specifically a YOLO-based object detection model, to perform real-time classification of individuals as Defence Personnel and Non-Defence persons. To improve reliability and robustness, the system incorporates adversarial validation mechanisms including Structural Similarity Index (SSIM) and pixel-level processing for detecting manipulated inputs such as replay attacks and frame freezing. To ensure secure data handling, alert information is protected using AES-based encryption and SHA3 hashing techniques, while a quantum-inspired key generation approach enhances overall security strength. The framework also integrates real-time alert delivery through Telegram and Web Push notifications along with a centralized monitoring dashboard for managing alerts, logs, and system status. The modular architecture enables seamless communication between detection, validation, storage, and notification components and supports deployment on cloud platforms such as AWS EC2. Experimental evaluation demonstrates that the proposed framework provides an efficient, scalable, and secure surveillance solution by combining real-time AI detection, adversarial robustness, and protected data management into a unified system.

Keywords— Defense Surveillance, Artificial Intelligence, YOLO, Adversarial Detection, Structural Similarity Index (SSIM), AES Encryption, SHA3 Hashing, Computer Vision, Cloud Deployment, Real-Time Monitoring

I. INTRODUCTION

Modern defense and surveillance environments have become increasingly dependent on intelligent monitoring systems due to growing security concerns, the need for rapid response, and the protection of sensitive infrastructure. Traditional surveillance approaches primarily rely on manual observation and basic motion detection techniques, which are often inefficient, difficult to scale, and vulnerable to operational errors. Human monitoring of multiple surveillance feeds for extended periods frequently results in delayed threat response and reduced situational awareness, particularly in large-scale defense environments and restricted zones [1].

Recent advancements in Artificial Intelligence (AI), Computer Vision, and Deep Learning have significantly transformed

surveillance technologies by enabling automated analysis and real-time decision-making. Object detection models such as YOLO (You Only Look Once) provide high-speed identification and classification capabilities that improve surveillance efficiency and reduce dependency on manual intervention. These technologies enable security systems to process continuous video streams and detect suspicious activities with improved speed and accuracy [2].

Although AI-based surveillance systems provide strong detection capabilities, they often remain vulnerable to adversarial attacks and data security threats. Techniques such as replay attacks, frame freezing, and manipulated video inputs can deceive detection models and compromise system reliability. Existing solutions generally focus on object detection alone and do not incorporate mechanisms for validating input authenticity or protecting sensitive surveillance records. As a result, there remains a significant need for surveillance frameworks that combine intelligent monitoring with adversarial robustness and secure data management [3].

This paper presents a Hybrid Quantum-Adversarial AI Framework for Defense Vision Security and Content Integrity, designed to address the limitations of conventional surveillance approaches. The proposed framework integrates a real-time YOLO-based detection pipeline with adversarial validation techniques including Structural Similarity Index (SSIM) and pixel-level processing to identify manipulated or replayed inputs. In addition, the system incorporates secure data handling mechanisms through AES-based encryption and SHA3 hashing, while a quantum-inspired key generation approach enhances protection against emerging security threats [4].

The proposed system operates through a browser-based surveillance interface that captures live video streams and transmits them to the backend for parallel processing. Detection and adversarial validation modules operate simultaneously to maintain low latency and improve system reliability. When suspicious activity or unauthorized access is detected, the framework automatically generates alerts, securely stores evidence, and delivers notifications through Telegram and Web Push services. The architecture also includes an interactive dashboard for monitoring alerts, logs, and overall system status [5].

The framework is designed using a modular and scalable architecture to support efficient integration between detection, validation, storage, and notification components. Cloud deployment capability through platforms such as AWS EC2 enables remote accessibility, centralized monitoring, and improved scalability for real-world deployment scenarios. By combining intelligent surveillance with advanced security mechanisms, the proposed framework provides a comprehensive solution for modern defense and critical infrastructure applications [6].

The remainder of this paper is organized as follows: Section II presents the review of existing surveillance approaches and related research contributions. Section III describes the proposed system architecture. Section IV explains the methodology and implementation process. Section V discusses experimental results and system evaluation. Section VI presents future enhancement opportunities, and Section VII concludes the paper with final observations and future research directions.

II. EXISTING APPROACHES

The rapid growth of intelligent surveillance technologies has significantly improved monitoring capabilities across defense, public safety, and high-security environments. Recent research has focused on integrating Artificial Intelligence (AI), Computer Vision, adversarial defense mechanisms, cryptographic security, and scalable deployment architectures to develop more reliable surveillance systems. Traditional surveillance solutions primarily depend on manual monitoring and basic motion detection techniques, which are often insufficient for handling modern security challenges in real-time environments [7].

Object detection has emerged as one of the most important areas of intelligent surveillance research. Deep learning models such as YOLO (You Only Look Once) have demonstrated high-speed and accurate object recognition capabilities through single-stage neural network processing. These models are widely adopted in defense monitoring, restricted area surveillance, and automated security applications due to their low latency and efficient real-time performance [8]. However, conventional object detection frameworks mainly focus on recognition accuracy and generally do not provide protection against adversarial manipulation or secure evidence management.

To address detection reliability issues, researchers introduced adversarial validation techniques designed to identify manipulated or fraudulent inputs. Adversarial attacks such as replay attacks, frame freezing, and pixel-level perturbations can mislead AI detection systems without being easily noticeable by human observers. Techniques including Structural Similarity Index (SSIM) and frame consistency analysis have shown effectiveness in identifying abnormal input behavior and improving surveillance robustness [9]. However, these approaches are often implemented independently and lack seamless integration with detection pipelines.

Data protection has also become an important research area in surveillance systems. Encryption algorithms such as Advanced Encryption Standard (AES) and integrity verification techniques such as SHA3 hashing are commonly used to secure surveillance records and prevent unauthorized access or tampering. Recent developments have explored quantum-inspired security mechanisms and advanced key generation approaches to strengthen protection against future computational threats [10]. Despite strong security capabilities, these systems generally focus only on storage protection and do not support intelligent surveillance functionalities.

Cloud-based surveillance architectures have further improved scalability, remote accessibility, and centralized monitoring. Platforms such as AWS EC2 enable efficient deployment and support large-scale video processing and real-time alert delivery [11]. However, many cloud-based systems remain vulnerable when encryption, adversarial defense, and intelligent detection mechanisms are not integrated properly.

The analysis of existing approaches reveals several limitations in current surveillance systems:

- Limited integration between AI detection and security mechanisms
- Lack of adversarial validation for replay and manipulation attacks
- Weak secure storage and evidence protection methods
- Limited support for cloud scalability and remote monitoring
- Dependence on isolated modules without centralized management
- Delays in real-time alert generation and incident response

These limitations highlight the need for a unified surveillance framework that integrates intelligent detection, adversarial robustness, secure encrypted storage, cloud deployment, and automated alert mechanisms into a single scalable architecture.

Table-I: Comparison of Existing Systems and Proposed Framework

Feature	Existing Systems	Proposed Framework
Object Detection	Detection Only	YOLO-Based Real-Time Detection
Adversarial Protection	Limited	SSIM-Based Validation
Data Encryption	Partial	AES + SHA3 Security
Secure Storage	Basic	Encrypted Evidence Storage
Notification System	Limited	Telegram + Web Push
Cloud Deployment	Partial	AWS EC2 Support
Dashboard Monitoring	Basic	Integrated Dashboard
System Integration	Fragmented	Unified Architecture

III. PROPOSED SYSTEM ARCHITECTURE

The proposed system is designed as a centralized and intelligent surveillance framework integrating Artificial Intelligence (AI), adversarial validation, secure data protection, and real-time notification services into a unified architecture. The framework improves surveillance accuracy, strengthens content integrity, and supports scalable deployment for defense environments.

The proposed architecture follows a layered design approach where individual modules operate independently while maintaining seamless communication across the complete surveillance workflow. The system captures live video streams, performs object detection and adversarial validation simultaneously, secures generated evidence through encryption mechanisms, and delivers alerts through integrated notification services.

The architecture consists of the following major components:

- Client Layer
- Application Layer
- Processing Layer
- Security Layer
- Storage Layer
- Notification Layer
- Dashboard Layer

The client layer captures live camera input and transfers video frames into the backend processing environment. The application layer handles request processing and authentication services. The processing layer performs YOLO-based detection and adversarial validation in parallel to ensure efficient and reliable surveillance operation.

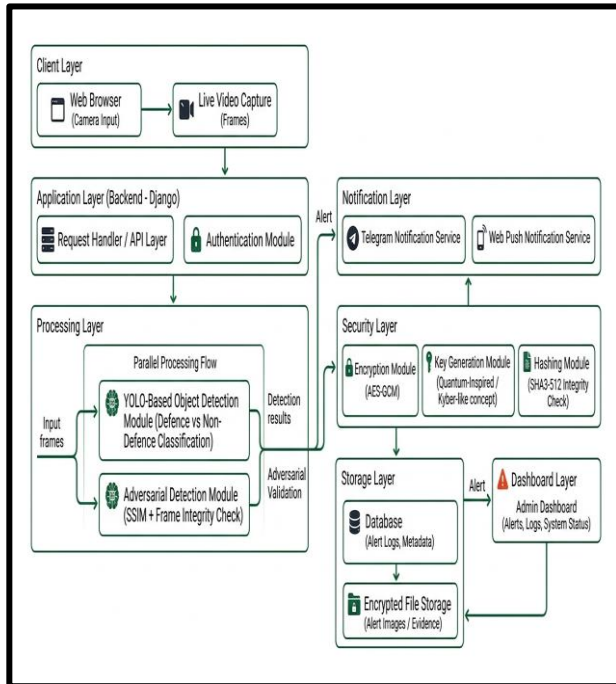


Figure-1: Proposed System Architecture of Hybrid Quantum-Adversarial AI Framework for Defence Vision Security and Content Integrity

The security layer protects surveillance evidence through AES-GCM encryption, quantum-inspired key generation, and SHA3-based integrity verification mechanisms. Encrypted outputs and metadata are stored securely in the database and encrypted storage modules.

The notification layer generates real-time alerts through Telegram and Web Push services whenever suspicious activities are detected. Finally, the dashboard layer provides centralized visualization of alerts, logs, and system monitoring information to assist administrators in rapid decision-making and efficient surveillance management.

The modular architecture supports future integration of advanced AI models, cloud deployment platforms, and additional security enhancements without requiring major architectural redesign.

Layer	Technology Used
Frontend	HTML, CSS, JavaScript
Backend	Django, Python
AI Detection Layer	YOLO (Object Detection)
Adversarial Validation	SSIM, Frame Integrity Validation
Security Layer	AES-GCM Encryption, SHA3-512
Authentication	Django Authentication
Database	SQLite / PostgreSQL (use what your project actually used)
Notification Services	Telegram Bot API, Web Push Notification
Storage Layer	Encrypted File Storage
Cloud Deployment	AWS EC2

Table-II: Technology Stack of Proposed Surveillance Framework

IV. METHODOLOGY

The development of the proposed Hybrid Quantum-Adversarial AI Framework follows a structured and modular methodology to ensure efficient surveillance monitoring, adversarial robustness, secure data protection, and real-time alert generation. The methodology integrates Artificial Intelligence, computer vision, encryption mechanisms, and notification services into a unified surveillance workflow. The proposed framework is designed to perform intelligent monitoring while maintaining system reliability and security under real-world operational conditions [16].

The system follows a workflow-oriented architecture where surveillance data passes through multiple processing stages before producing outputs such as detection results, encrypted evidence, and alert notifications. The overall methodology begins with live video acquisition and continues through object detection, adversarial validation, encryption, secure storage, and dashboard monitoring.

The proposed workflow consists of the following major stages:

- Live Video Capture and Frame Acquisition
- Request Handling and Authentication
- Real-Time Object Detection
- Adversarial Validation and Integrity Checking
- Encryption and Secure Processing
- Alert Generation and Notification Delivery
- Dashboard Monitoring and Storage Management

The surveillance process starts when live video frames are captured through the browser interface and transferred to the backend processing environment. Authentication and request validation mechanisms ensure secure communication between the frontend and backend layers before initiating processing operations [17].

The processing layer performs parallel execution of two important modules. The first module uses the YOLO-based detection model to identify and classify individuals as Defence Personnel or Non-Defence persons in real time. The second module performs

adversarial validation using Structural Similarity Index (SSIM) and frame integrity analysis to identify manipulated inputs such as replay attacks, frame freezing, and abnormal frame patterns.

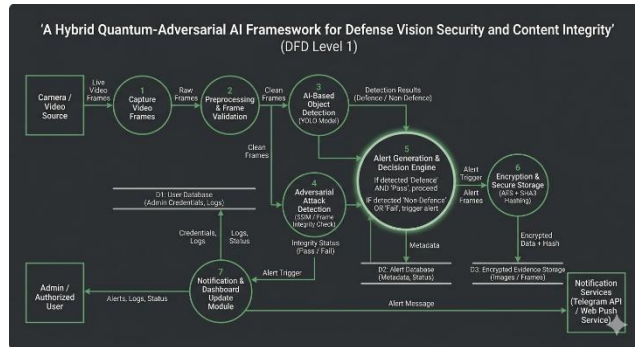


Figure 2: Methodology Workflow of Hybrid Quantum-Adversarial AI Framework

The detection results generated from both processing modules are forwarded to the security layer for further validation and protection. The security layer applies AES-GCM encryption and SHA3-512 integrity verification mechanisms to secure surveillance evidence and alert information before storage [18]. A quantum-inspired key generation mechanism is used to strengthen overall data protection and improve resistance against future computational threats.

The encrypted outputs are stored in secure databases and encrypted file storage systems for maintaining historical records and future analysis. Whenever suspicious activity or unauthorized access is detected, the notification layer automatically triggers Telegram alerts and Web Push notifications to enable immediate response from administrators.

The dashboard module provides centralized visualization of system status, alert logs, detection outputs, and operational information. This architecture improves monitoring efficiency and reduces dependency on manual observation.

The proposed methodology also supports future scalability and extensibility. The modular design enables integration of advanced AI models, cloud deployment infrastructure, additional encryption techniques, and expanded surveillance capabilities without requiring major modifications to the existing system architecture.

V. SYSTEM DESIGN AND IMPLEMENTATION

The proposed Hybrid Quantum-Adversarial AI Framework was successfully implemented as an intelligent web-based surveillance system integrating real-time video processing, AI-based object detection, adversarial validation, secure communication mechanisms, and centralized monitoring services. The implementation focuses on detection accuracy, secure communication, modular architecture, and efficient surveillance management for defense and restricted environments [20].

The overall implementation follows a layered and modular design approach in which each system component performs a dedicated operational role while maintaining seamless communication across the surveillance workflow. This separation of responsibilities improves maintainability, simplifies testing procedures, and supports future expansion without requiring significant architectural redesign.

The frontend interface is developed using web technologies to provide live video access, dashboard visualization, and user

interaction capabilities. Browser-based camera access enables real-time frame acquisition while dashboard modules provide centralized monitoring of alerts, logs, and system activities. Authentication services ensure controlled access to surveillance operations [21].

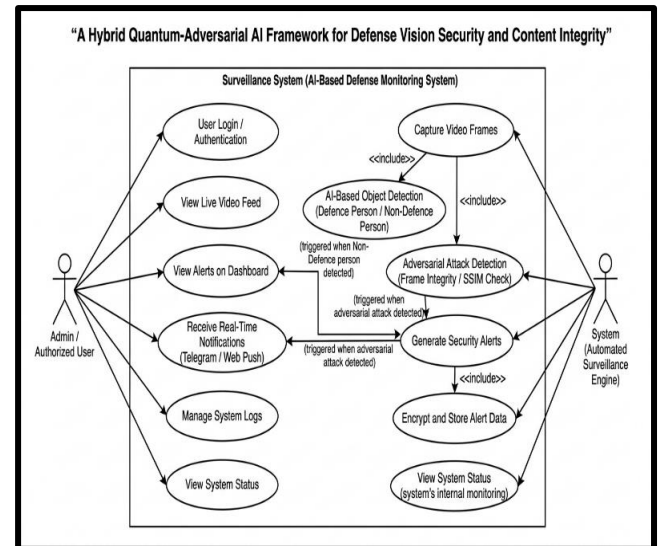


Figure 3: Use Case Diagram of Hybrid Quantum-Adversarial AI Framework

The backend system is implemented using Django and Python to manage request handling, authentication services, detection pipelines, and communication between system modules. The backend coordinates video processing, validation, secure storage operations, and alert generation through integrated APIs and modular execution flows.

The processing layer performs parallel execution of two major modules. The first module applies a YOLO-based detection algorithm for identifying and classifying individuals in surveillance streams. The second module performs adversarial analysis using Structural Similarity Index (SSIM) and frame integrity validation to identify manipulated inputs including replay attacks and frame freezing attempts [22].

User authentication and access management are implemented to restrict unauthorized system usage. Access validation mechanisms ensure secure interaction between frontend services and backend processing modules while maintaining controlled surveillance operations.

The security layer implements AES-GCM encryption for protecting surveillance evidence and SHA3-512 hashing for maintaining integrity verification. A quantum-inspired key generation mechanism enhances security and strengthens protection against future computational threats. Encrypted outputs are securely stored before alert generation and dashboard updates [23].

The notification subsystem integrates Telegram Notification Service and Web Push Notification Service to provide real-time alert delivery. When suspicious activity or unauthorized access is detected, the system automatically sends notifications and records evidence for future investigation.

The dashboard module provides centralized visualization of alerts, encrypted logs, system status, and monitoring information. This interface allows administrators to manage surveillance operations

efficiently and review historical events through secure and organized records.

The implementation also supports future deployment scalability through cloud platforms such as AWS EC2, enabling centralized access, remote monitoring, and efficient resource utilization.

The processing layer performs real-time surveillance analysis using the YOLO-based object detection model integrated within the backend environment. Captured video frames are continuously processed to identify and classify individuals based on predefined detection classes. The detection system generates bounding boxes, confidence scores, and classification labels to improve monitoring accuracy and assist administrators in rapid decision-making.

The object detection module is optimized for low-latency execution and supports continuous frame processing for real-time surveillance environments. Detection results are forwarded to the adversarial validation layer for integrity verification before alert generation and secure storage operations are initiated.



Figure 5: Real-Time YOLO Detection Output

The figure illustrates the real-time object detection mechanism of the proposed framework. The system identifies individuals within surveillance streams and displays detection boundaries, classification labels, and confidence values. This automated detection process reduces dependency on manual monitoring and improves operational efficiency in defense surveillance environments.

The dashboard module provides centralized visualization and management of surveillance activities. Administrators can monitor system status, review detection results, track generated alerts, and analyze operational logs through an integrated monitoring interface. The dashboard improves accessibility and enables efficient management of surveillance operations from a single interface.

The monitoring environment also supports historical record management and real-time status updates, allowing administrators to respond quickly to suspicious activities and maintain secure surveillance workflows.

The dashboard interface shown above demonstrates centralized monitoring capabilities including alert visualization, system logs, detection outputs, and surveillance status information. The

interface improves usability and enhances decision-making by presenting surveillance information in an organized and accessible manner.

When suspicious activity or unauthorized access is detected, the notification subsystem automatically generates real-time alerts and delivers them through integrated communication services. Notification messages include event information and allow administrators to respond immediately without requiring continuous dashboard monitoring.

The notification output demonstrates the alert delivery mechanism implemented in the proposed framework. Real-time notification services improve response speed and strengthen surveillance effectiveness by enabling administrators to receive instant updates regarding abnormal activities and security incidents.

VI. RESULTS AND DISCUSSION

The implementation and experimental evaluation of the proposed Hybrid Quantum-Adversarial AI Framework demonstrate significant improvements in intelligent surveillance, adversarial robustness, and secure evidence management compared to traditional surveillance approaches. The integration of AI-based object detection, adversarial validation mechanisms, encryption techniques, and real-time notification services provides a scalable and efficient surveillance solution for defense and restricted environments [25].

The real-time detection module successfully identified and classified individuals from live surveillance streams using the YOLO detection model. Experimental testing demonstrated stable detection performance with low processing latency and effective classification capability under continuous monitoring conditions. The generated detection outputs included object boundaries, confidence scores, and classification labels that improved operational visibility and monitoring efficiency.

The adversarial validation layer successfully detected abnormal inputs including replay attacks, frame freezing attempts, and manipulated surveillance frames. Structural Similarity Index (SSIM) and frame integrity analysis improved overall reliability by preventing false surveillance interpretation and reducing system vulnerability against adversarial behavior.

The security evaluation confirmed that AES-GCM encryption and SHA3-512 integrity verification effectively protected surveillance evidence and alert information against unauthorized access and tampering attempts. Encrypted storage and secure processing improved confidentiality while maintaining efficient retrieval of historical surveillance records [26].

The integrated notification subsystem successfully generated real-time alerts through Telegram and Web Push services whenever suspicious activities were detected. Alert generation reduced dependency on continuous manual observation and improved response efficiency during surveillance operations.

The centralized dashboard provided administrators with clear visualization of system alerts, surveillance logs, and detection outputs. Monitoring capabilities improved operational awareness and simplified event analysis through organized presentation of surveillance information.

To evaluate overall system effectiveness, the framework was tested against both functional and non-functional requirements.

Parameter	Observation
Detection Accuracy	High
Real-Time Processing	Stable
Adversarial Detection	Successful
Alert Delivery	Real-Time
Encryption Security	Strong
Dashboard Monitoring	Effective
System Scalability	Supported

The experimental results indicate that the proposed framework provides reliable detection performance, secure evidence management, and effective real-time monitoring capabilities. The modular architecture improves maintainability and supports future expansion through integration of advanced AI techniques and cloud-based deployment environments.

Although the proposed system achieved strong performance, certain limitations remain. The current implementation does not include dedicated edge AI acceleration or advanced post-quantum cryptographic algorithms. Future improvements may include GPU optimization, intelligent behavior prediction, enhanced encryption methods, and expanded autonomous surveillance capabilities.

VII. FUTURE ENHANCEMENTS

The proposed Hybrid Quantum-Adversarial AI Framework provides a scalable and secure foundation for intelligent surveillance and defense monitoring applications. Although the current implementation successfully integrates AI-based detection, adversarial validation, encryption mechanisms, real-time notifications, and centralized monitoring, several advanced enhancements can further improve system intelligence, security, and deployment capabilities [28].

Future development can focus on integrating advanced deep learning techniques to improve detection accuracy and adaptive surveillance capabilities. AI models trained on larger and more diverse datasets can enhance recognition performance under varying environmental conditions and reduce false detection rates during continuous monitoring operations.

One major enhancement involves integrating intelligent behavior analysis and predictive threat detection. Instead of only identifying objects or individuals, future versions of the system can analyze behavioral patterns and detect suspicious activities before actual security incidents occur. Such predictive surveillance capabilities would significantly improve response planning and threat prevention.

Another important enhancement is the integration of edge AI and GPU-accelerated processing environments. Deploying detection models directly on edge devices can reduce processing latency, minimize bandwidth consumption, and improve surveillance performance in remote and distributed defense environments.

Future implementations can also incorporate advanced post-quantum cryptographic mechanisms to strengthen long-term data protection. Although the current system uses quantum-inspired key generation with AES and SHA3 security mechanisms, integrating post-quantum encryption algorithms will improve resistance against future quantum computing attacks and enhance overall cybersecurity.

Cloud-native deployment and distributed monitoring infrastructure represent another area for expansion. Integration with containerized deployment environments and scalable cloud architectures will improve fault tolerance, centralized governance, and remote accessibility for large-scale surveillance operations.

Additional enhancements may include drone-assisted surveillance integration and autonomous monitoring systems. Combining intelligent surveillance with drone technologies can improve area coverage and enable efficient monitoring of restricted or difficult-to-access environments.

The framework may also be extended through biometric verification and facial recognition modules for stronger identity validation and access control capabilities. Integration of multi-factor authentication and secure identity verification mechanisms can further strengthen defense applications.

Table III: Future Enhancement Opportunities

Enhancement	Expected Benefit
Edge AI Deployment	Faster real-time processing
Post-Quantum Cryptography	Stronger future security
Behavior Prediction	Early threat detection
Drone Integration	Wider surveillance coverage
Cloud-Native Deployment	Improved scalability
Facial Recognition	Enhanced identity verification
GPU Acceleration	Higher processing efficiency
Autonomous Monitoring	Reduced manual intervention

The modular architecture of the proposed framework enables these enhancements to be integrated without significant redesign of the existing system. The scalability and flexibility of the architecture ensure that the system can evolve into a next-generation intelligent surveillance platform capable of supporting future defense, industrial, and high-security monitoring requirements.

VIII. CONCLUSION

The rapid advancement of Artificial Intelligence, computer vision technologies, cloud infrastructure, and cybersecurity mechanisms has significantly increased the importance of intelligent and secure surveillance systems in modern defense and high-security environments. Traditional surveillance approaches are often limited by manual monitoring, delayed threat identification, insufficient scalability, and vulnerability to manipulated inputs. Therefore, there is an increasing demand for integrated surveillance frameworks capable of delivering real-time detection, secure data handling, and reliable operational performance [31].

This paper presented the design and implementation of a Hybrid Quantum-Adversarial AI Framework for Defense Vision Security and Content Integrity developed to address the limitations of conventional surveillance systems. The proposed framework successfully integrates real-time object detection using YOLO, adversarial validation through Structural Similarity Index (SSIM), secure evidence protection using AES-GCM encryption and SHA3 integrity verification, real-time notification services, and centralized dashboard monitoring within a unified surveillance architecture.

The modular architecture adopted in the framework improves maintainability, scalability, and operational flexibility while supporting efficient interaction between detection, validation, encryption, storage, and notification components. The implementation demonstrates the practical integration of Artificial Intelligence and cybersecurity mechanisms to build intelligent surveillance environments capable of operating under real-world conditions.

Experimental evaluation confirmed that the proposed system successfully performs live surveillance monitoring, object classification, adversarial validation, encrypted evidence management, and real-time alert generation. The framework demonstrated improved surveillance reliability, reduced dependence on manual observation, and strengthened protection against replay attacks and manipulated surveillance inputs.

The implemented notification and monitoring mechanisms further improved operational awareness by enabling administrators to receive alerts and monitor surveillance events through centralized dashboards. Integration with cloud deployment infrastructure also supports scalability and remote accessibility for future large-scale surveillance environments.

Although the current implementation demonstrates effective performance, several opportunities remain for future improvement. Advanced AI models, post-quantum cryptographic mechanisms, edge computing environments, intelligent behavior prediction, autonomous monitoring, and drone-assisted surveillance can further strengthen the capabilities of the proposed framework.

In conclusion, the proposed Hybrid Quantum-Adversarial AI Framework successfully addresses key challenges in modern surveillance by combining intelligent detection, adversarial defense, secure storage, and automated monitoring into a scalable and integrated architecture. The framework provides an effective foundation for future defense surveillance systems and demonstrates the potential of combining AI and advanced security technologies to support next-generation intelligent monitoring environments.

REFERENCES

- [1] J. Redmon, S. Divvala, R. Girshick, and A. Farhadi, "You Only Look Once: Unified, Real-Time Object Detection," *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pp. 779–788, 2016.
- [2] J. Redmon and A. Farhadi, "YOLO9000: Better, Faster, Stronger," *Proceedings of IEEE Conference on Computer Vision and Pattern Recognition (CVPR)*, pp. 7263–7271, 2017.
- [3] Z. Wang, A. Bovik, H. Sheikh, and E. Simoncelli, "Image Quality Assessment: From Error Visibility to Structural Similarity," *IEEE Transactions on Image Processing*, vol. 13, no. 4, pp. 600–612, 2004.
- [4] National Institute of Standards and Technology (NIST), "Advanced Encryption Standard (AES)," FIPS PUB 197, U.S. Department of Commerce.
- [5] National Institute of Standards and Technology (NIST), "SHA-3 Standard: Permutation-Based Hash and Extendable Output Functions," FIPS PUB 202.
- [6] I. Goodfellow, Y. Bengio, and A. Courville, *Deep Learning*, MIT Press, Cambridge, USA, 2016.
- [7] R. Szeliski, *Computer Vision: Algorithms and Applications*, Springer, 2022.
- [8] A. Krizhevsky, I. Sutskever, and G. Hinton, "ImageNet Classification with Deep Convolutional Neural Networks," *Communications of the ACM*, 2017.
- [9] D. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, Pearson Education.
- [10] OpenCV Team, "OpenCV Documentation and Computer Vision Library," 2024.
- [11] Django Software Foundation, "Django Documentation," 2024.
- [12] Python Software Foundation, "Python Documentation," 2024.
- [13] Amazon Web Services, "Amazon EC2 Documentation," 2024.
- [14] Telegram Developers, "Telegram Bot API Documentation," 2024.
- [15] A. Vaswani et al., "Attention Is All You Need," *Advances in Neural Information Processing Systems (NeurIPS)*, 2017.
- [16] C. Szegedy et al., "Intriguing Properties of Neural Networks," *International Conference on Learning Representations (ICLR)*, 2014.