

ENHANCED VIDEO SECURITY WITH EDGE AI

Role of Edge AI in Enhancing Real-time Monitoring, Threat Detection,
and Operational Efficiency



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TABLE OF CONTENTS

Executive Summary	Page 3
Introduction	Page 4
Evolution of Video Security and Surveillance	Page 5
Industry Applications	Page 6
Technology Landscape of AI-Based Video Surveillance	Page 8
Challenges	Page 9
Market Forecast and Industry Adoption	Page 11
Conclusion	Page 12

EXECUTIVE SUMMARY

Integrating Artificial Intelligence (AI) on edge devices for video surveillance marks a transformative shift towards superior security and operational efficiency. By embedding AI within video surveillance systems, data processing and incident response are significantly enhanced, leading to improved security outcomes. This decentralized methodology reduces latency, conserves bandwidth, and optimises overall system performance. Edge AI technologies are becoming pivotal across various sectors, such as retail, industrial, logistics, and border security, by helping to streamline operations, mitigate losses, and reinforce safety measures.

This whitepaper examines the progression of video surveillance systems from traditional analog-based to advanced Edge AI-driven solutions. With this study, we aim to provide a comprehensive analysis of how industries adopt these innovations to enhance monitoring and access control and improve operational efficiency. The whitepaper strives to deliver an insightful overview of Edge AI-integrated video surveillance systems, addressing the challenges, exploring industry adoption patterns, and analysing the market trends.

INTRODUCTION

AI adoption in the video surveillance industry amplifies security system efficiency tremendously. With AI integration, video security systems can achieve real-time monitoring, threat detection, and advanced data analytics capabilities. It also addresses human limitations related to analyzing vast amounts of data, pattern recognition, anomaly detection, and incident prediction, making it more proactive. This aspect of AI integration, especially at the edge, enhances asset security and loss prevention.



Traditional CCTV systems require manual monitoring, which restricts the overall capability of a retrospective review of incidents. In contrast, an AI-driven intelligent surveillance system can recognize patterns and detect events of shoplifting or unauthorized access in real-time, allowing for pre-emptive intervention. Edge AI devices process data locally, reducing latency and enabling immediate response. This decentralized approach also reduces bandwidth usage and ensures quicker, more reliable detection of anomalies.

EVOLUTION OF VIDEO SECURITY AND SURVEILLANCE

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Analog Video Surveillance Systems

Video surveillance began with analog systems, which were commonly used in earlier decades. The main issue with analog video security systems is that the recorded visuals are of low quality and low resolution, and with a lack of digital zooming capabilities, identifying individuals and objects with confidence is often challenging. These systems relied on analog cameras connected via coaxial cables to monitor VCRs or DVRs. Storage and retrieval of visuals were difficult as video footage was recorded on physical tapes. Video encryption was also not supported by these systems.

IP-based Cameras

Internet Protocol (IP) cameras transmit digital video streams over networks. These systems offered high-resolution visuals, increased coverage area, and remote monitoring. They enabled the centralization of video storage and monitoring, making it more efficient to manage large-scale surveillance operations. IP cameras also offer better integration with modern network-based security systems.

Advent of Video Analytics

Human monitoring and detection of anomalies presented many challenges, like mis-reporting and missed incidents. Human operators were overwhelmed by the volume of data and sifting through hours worth of video footage was challenging. Video analytics emerged as a response, automating the detection of specific events, such as motion detection, loitering, and perimeter breaches. Early forms of analytics had some latency and limited real-time responsiveness.



Edge AI aiding Real-time surveillance

AI and machine learning models are deployed directly on edge devices (cameras or nearby edge devices), and data is processed at the data generation source rather than being sent to a distant server. Edge AI can work in tandem with centralized systems to minimize data transmission delays and allows for real-time analytics at the point of capture, enabling instant responses to detected incidents.

INDUSTRY APPLICATIONS

Retail

In the retail industry, AI-enabled surveillance systems can monitor the entire outlet to detect suspicious behaviour and shoplifting. New security-related challenges emerge with the rise of cashierless checkouts and self-checkout counters. AI-powered video analytics can identify fraudulent activities such as item swapping and barcode manipulation. By processing data on Edge devices, these systems can issue alerts to store personnel, helping prevent losses before customers leave.



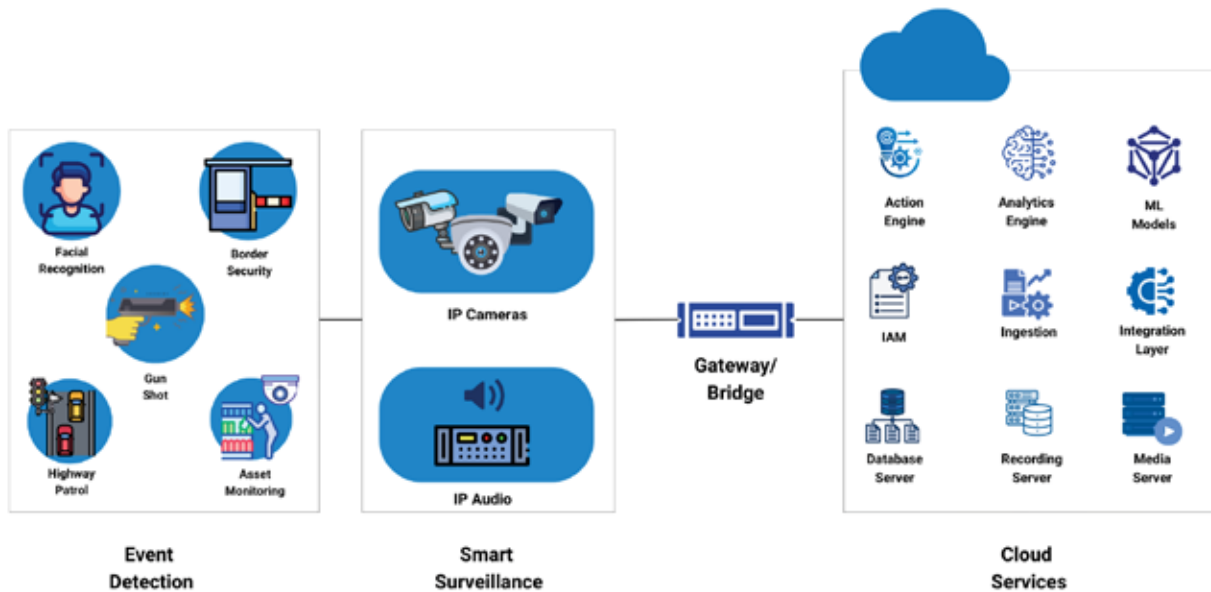
Industrial & Logistics

The risk of unauthorized entry in truck yards is reduced by installing AI-powered cameras that automatically recognize registered drivers and vehicles, streamlining access control. License plate data is cross-referenced with driver identification to ensure that only authorized personnel are granted access. AI-based surveillance can be used to monitor and control access to sensitive areas within industrial facilities. These systems can also assure worker's safety by identifying equipment malfunctions or unsafe working practices and triggering instant alerts to prevent accidents.

Border Security

AI-powered video surveillance systems can enhance the accuracy and efficiency of identity verification processes at border crossings and immigration checkpoints by cross-referencing passports with biometric data such as facial recognition. These systems can analyze video feeds to detect suspicious behaviours, unauthorized entry attempts, or other potential security threats.

TECHNOLOGY LANDSCAPE OF AI-BASED VIDEO SURVEILLANCE



Role of AI/ML in Video Surveillance & Predictive Analytics

By analyzing historical data and using pattern recognition, AI can detect suspicious behaviour and predict potential incidents. Machine learning and Deep learning-based surveillance models can accurately identify specific objects, faces, and behaviours. These models are continuously refined as they process more data, improving their accuracy and reducing the likelihood of false positives.

Edge Computing in Surveillance

Edge computing processes data at the source, reducing transmission needs and cutting response times. This approach allows surveillance systems to function independently of constant network connectivity, enhancing efficiency. Capabilities include object detection, facial recognition, and behavioural analysis, all performed locally to minimize latency and reliance on central servers.

Advanced Camera Systems

Modern surveillance cameras possess advanced capabilities that allow them to capture detailed, high-resolution live feed even under challenging conditions such as low light or high-motion environments. These cameras often include embedded AI processors that allow them to analyze video feeds in real time, identifying specific objects, faces, or behaviours without relying on external servers.

Cloud Integration and Network Connectivity

Cloud services integration allows for scalable surveillance solutions with centralized data storage and management and historical data comparison capabilities. With the advent of 5G - high speed, low latency network connectivity, large data volumes can be transmitted quickly between edge devices and central servers.

CHALLENGES

Data Privacy and Regulatory Guidelines

Continuous and uninterrupted surveillance, especially of public spaces, can potentially lead to the capturing of sensitive and personal data without explicit consent. The possibility of potential misuse or unauthorized access to such data is a significant privacy concern. Governments, organizations, and regulatory bodies have set certain guidelines (like APPs, GDPR etc.) in place to eliminate such breaches of privacy. These guidelines aim to ensure that surveillance systems are used responsibly, with clear limitations on data collection, storage, and use.



Security Threats

Overriding or deceiving facial recognition systems using masks and prosthetics is a security concern. Employing multi-factor authentication systems or other verification systems in addition to AI-based surveillance systems could counteract such attempts and improve security.

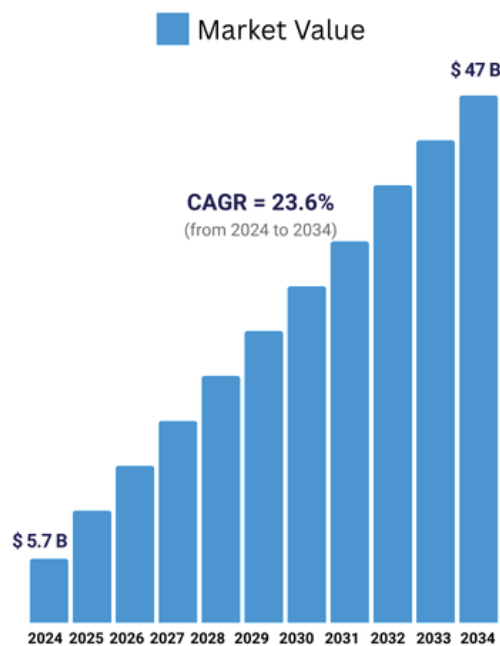
Technological Limitations

Edge devices have limited processing power, storage capacity, and energy efficiency. The vastness of generated data poses challenges in terms of storage, retrieval, and management. While edge computing reduces the need for centralized storage, the data that is retained locally or transmitted to the cloud has to be ensured for security and integrity, especially in legal and regulatory contexts.

MARKET FORECAST AND INDUSTRY ADOPTION

AI integration has been rampantly growing across industries for the past few years, and the video surveillance industry is no exception. The adoption of AI-based analytics in video surveillance has surged recently due to advancements in AI technology and a growing demand for smarter security solutions. The market value of AI-integrated video surveillance systems reached \$5.7 billion in 2024. With the wide adoption of AI-based surveillance systems and its growing success, the global AI in video surveillance market is expected to grow at a CAGR of 23.6%.

Market Value of Edge AI in Video Surveillance



AI integration allows for advanced capabilities like real-time analytics and reduced latency, which makes it impressive for critical segments like healthcare, border security, judiciary, and traffic management. Its ability to process data on-site also allows for immediate responses to security threats, which is crucial in time-sensitive scenarios such as traffic management and retail theft prevention.

The market value of AI-based security systems is expected to reach \$47 billion by 2034. This growth will be propelled by advancements in AI, the expansion of 5G networks, and increased smart infrastructure investments. Many governments have been actively investing in smart cities and elevating security infrastructure.

CONCLUSION

The integration of AI and the introduction of edge computing have significantly contributed to improving security and surveillance systems. With real-time processing, intelligent surveillance, and reduced latency, Edge AI-integrated video surveillance systems have been widely adopted by industries. From retail loss prevention to traffic management, the application of these technologies has resulted in significant improvements in security outcomes and operational efficiency.

Moving forward, the evolution of video surveillance will be increasingly shaped by AI and edge computing. As AI models, edge devices, and network infrastructure continue to advance and regulatory frameworks become more stringent, we can expect broader adoption across various industries, resulting in smarter, more responsive, and more efficient surveillance systems.