

Integrated and Automated CCTV System: A Comprehensive Review of Current Challenges and Methods, Future Trends and Prospects for Emerging Electronics Engineering with AI Integration

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GOAL OF THE STUDY

The purpose of the study is represented by the analyze of how AI and electronics engineering transform traditional CCTV into integrated and automated systems. The study identifies key technical challenges and outlines future directions for intelligent, scalable, and privacy-aware surveillance architectures.

METHODOLOGY OF THE INVESTIGATION

A systematic review and comparative analysis of recent research (2019–2025) on CCTV technologies.

Methods include evaluation of analogue, IP, and AI-enhanced systems and synthesis of signal processing, data fusion, and edge-computing approaches.

MAIN RESULTS FROM THE STUDY

False alarms reduced by over 90 % through AI analytics.
Multi-sensor cameras expand coverage and cut costs.
Edge computing improves speed and data privacy.
Integration with access and fire systems enables automated, intelligent responses.

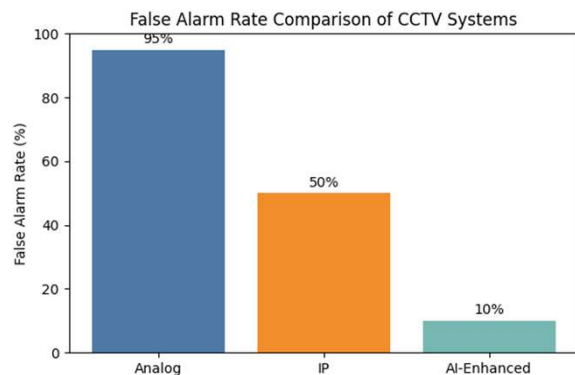


Fig. 1. Comparison of false alarm rates for analogue, IP and AI-enhanced CCTV systems.

Table 1. CCTV SYSTEMS COMPARISON

No.	Aspect	Analog CCTV	IP CCTV	AI-Enhanced CCTV
1	Resolution	Low resolution; limited detail	High-definition (1080p–4K) imaging	High definition plus HDR and multi-sensor fusion
2	Connectivity	Coaxial cabling; separate power	Ethernet/Wi-Fi with PoE; remote access	Same as IP plus edge computing
3	Scalability	Limited expansion with dedicated cabling	Highly scalable via network switches	Highly scalable with cloud or hybrid platforms and AI analytics
4	False Alarm Rate	High rate; simple sensors trigger on minor movements	Moderate; improved motion detection and remote verification	Low; AI distinguishes genuine threats and reduces false alarms by ~90 %
5	Analytics Capability	Minimal; manual monitoring	Basic motion detection and remote viewing	Advanced object detection, facial recognition and behavior analysis
6	Cost	Low initial cost; limited features	Higher cost due to HD imaging and networking	Highest cost; includes AI processing but yields long-term savings
7	Maintenance	Manual inspection and calibration	Firmware updates and network configuration; remote diagnostics	Automated health checks, self-diagnostics and over-the-air updates
8	Data Management	Local DVR storage; limited retention	NVR and cloud storage; user-managed retention	AI-assisted retention and redaction; privacy compliance

CONCLUSIONS

Integrated and automated CCTV systems unify sensing, analytics, and control within intelligent networks.

Advances in electronics engineering, AI, and networking overcome key challenges of legacy systems, delivering high-resolution imaging, automated event detection, and real-time decision support.

Future research should target predictive analytics, sensor fusion, and human–AI collaboration to achieve resilient and ethically governed security ecosystems.