

LEVERAGING DEEP LEARNING AND MACHINE LEARNING IN IOT NETWORKS: ARTIFICIAL INTELLIGENCE AND CLOUD-BASED FRAMEWORKS FOR SMART AUTOMATION

Waqas Ahmad Khan^{*1}, Sana Feroze², Andlib Akhtar³, Ashfaq Ahmad⁴

^{*1}Department of Computer Science and IT, Superior University Lahore Sargodha Campus, Sargodha, Pakistan

^{2,3,4}Department of Computer Science, Muslim Youth University Islamabad, Pakistan

^{*1}waqas.yuaan@gmail.com, ²ferozesana1@gmail.com, ³andliba923@gmail.com, ⁴ashfaq.ahmed@myu.edu.pk

DOI: <https://doi.org/10.5281/zenodo.19587730>

Keywords

that can be used include Internet of Things, Machine Learning, Deep Learning, Cloud Computing, Smart Automation, Artificial Intelligence, Predictive Analytics.

Article History

Received: 11 February 2026

Accepted: 21 March 2026

Published: 07 April 2026

Copyright @Author

Corresponding Author: *

Waqas Ahmad Khan

Abstract

The article sheds light on the ways of integrating machine learning and deep learning algorithms in Internet of Things (IoT) networks with the help of cloud-computing structures and enable the powering of intelligent and efficient smart automation systems. The paper has compared the performance of various artificial intelligence systems including the random forest, XGBoost, and Neural Network in processing the IoT big data. The findings show that deep learning models and in particular the Neural Networks are the best predictors with high accuracy of 93 percent that exceeds the traditional machine learning. The paper also indicates that AI-based IoT systems would significantly enhance efficiency and performance of operations of a system would be enhanced 65 percent in conventional systems to 89 percent with the introduction of the system.

Cloud-based processing is among the critical enablers, and it increases the capacity of data processing to 90 percent and processing speed, which was 92 times more excellent compared to the performance of local processing environments. The results also focus on high accuracy of automation in all the areas of application of the industrial system, medical, agriculture and energy management with the level of performance exceeding 90 percent. Security models based on machine learning can also improve the threat detection rate to 91 percent and minimize the number of false alarms and thereby enable IoT networks to be more reliable.

The paper succeeds in concluding that the true intersection of artificial intelligence, IoT, and cloud computing presents an effective and scalable framework of intelligent automation. However, despite the problems related to the complexity of the computations and data dependency, the proposed solution demonstrates that the possibility of transforming the conventional IoT systems into intelligent, flexible, and secure ecosystems is immense. The research will result in the development of the AI-based IoT architectures of the future, and will also offer the practical recommendations on the way to make the smart environment more efficient, scalable, and decision-making.

INTRODUCTION

The rapid evolution of Internet of Things (IoT) has transformed how devices, systems, and environments

interact with one another; as well as has enabled the exchange of data in real-time and intelligent

automation in most areas. IoT networks are interconnections of sensors, devices, and communication networks that generate massive amounts of data on a constant basis (Sultana & Rozony, 2025). The difficulty however lies in how to manage, process and extract significant meaning out of such large scale information. The complexity, rapid, and volume of data generated by the IoT cannot be necessarily processed by older methods of data processing that can lead to inefficiency in system processing and decision making (Enokkaren et al., 2022).

These challenges have been addressed in recent years using techniques of Artificial Intelligence (AI), machine learning (ML) and deep learning (DL). Machine learning enables systems to be learned by the patterns of data and, more precisely, deep learning, a subfield of machine learning, learns complexities in relationships in high-dimensional data using neural networks (Rao et al., 2025). These technologies add to the functionality of the IoT networks and offer the ability to analyze data in an intelligent manner, predictive maintenance, anomaly detection and auto decisions. Thus, the IoT systems are more flexible, productive, and can operate independently in the dynamical environment (Robertson, Fossaceca & Bennett, 2021). Another fundamental component of the modern IoT network that provides scalable data storage, processing and analytics back-end is cloud computing. IoT devices may employ cloud-based architectures to outsource the processing power to central servers and reduce processing power to more resource-constrained devices. A combination of AI and cloud computing is a powerful architecture, which supports real-time analytics, massive data management, and intelligent automation. This integration is especially important in smart cities, medical systems, industrial automation and environmental monitoring, a timely and correct decision is needed (Sola, Malali & Madugula, 2025).

As these advancements have taken place, there are still several challenges in the deployment of AI-based IoT systems. They include issues of data security, latency, interoperability, and successful integration of machine learning models into distributed IoTs. Furthermore, determining appropriate algorithms and structures to run on specific IoT applications is a

complex undertaking due to the possibility of data types and system demands differing. These challenges highlight the need to have a sophisticated platform that integrates deep learning, machine learning, and cloud-computing to simplify the functioning of the IoT network and enforce smart automation (Alfahaid et al., 2025).

Edge computing has emerged as a key enabler for latency-sensitive IoT applications in agriculture. Sultan et al. (2025) implemented an IoT and edge computing framework for real-time monitoring and predictive analysis in ostrich hatcheries, demonstrating how on-device processing reduces data transmission delays and enables timely environmental control decisions.

Ensemble learning has shown strong performance in medical imaging tasks, improving classification robustness by combining multiple models (Khan et al., 2026). Similar ensemble strategies can be adapted for IoT sensor fusion, where heterogeneous data streams require reliable aggregation for decision-making.

The overall aim of the study is to examine how machine learning and deep learning can be applied to enhance the IoT networks through cloud-based architecture. The research will focus on developing an all-encompassing solution that would realize AI potentials in smart data processing and automation and in decision support. The purpose of the study is to identify effective methods to increase the efficiency, scalability, and reliability of a system by evaluating the performance of several machine learning and deep learning models regarding the IoT.

The paper broadens the current literature on artificial intelligence and the IoT since it provides a framework of the basis of analytics based on AI and cloud computing infrastructure. It also refers to the way intelligent automation systems can convert standard IoT networks into intelligent ecosystems capable of learning and acting intelligently. Lastly, the study will be valuable in developing the future generation Internet of Things solutions which are efficient, scalable and able to address the complex demands of the current digital world (Attipalli et al., 2022).

The concept of artificial intelligence-related data engineering is proposed in the article by Sultana and

Rozony (2025), and the main aim of the study is to manage the level of efficiency of the model solutions of cloud integration to address the challenges of managing the large-scale data environment. Their findings indicate that cloud-based systems have the potential to enhance the scalability and performance of AI applications by several folds by opening up the possibility of processing and storing data in real time. The integration based on clouds will be impossible to ignore in the realms of IoT networks where masses of data are being produced at rates beyond imagination, and the data should be handled and processed. As the paper notes, the combination of AI and cloud computing can introduce an improved responsiveness of the system and help provide smart automation, one of the most important requirements of modern IoT systems.

The article by Rao et al. (2025) explores the use of machine learning and artificial intelligence in the IoT system, outlining several approaches that can be employed to ensure a seamless flow of information and data exchange between devices. The authors suppose a possible key to transforming raw IoT data into actionable insights lies in machine learning algorithms that will identify patterns and predict behavior within the system. They demonstrate that AI-powered IoT systems can enhance operational efficiencies, automating operations and applying predictive analytics. Particularly important is the situation with intelligent environments, where solving problems must be both fast and accurate but also, once again, to the need to combine ML approaches with any IoT infrastructure.

Swarnalatha and Prabu (2023) describe deep learning in cloud-based industrial IoT systems in detail, highlighting the opportunity to process complex and high-dimensional data using a deep neural network. They discover that deep learning models outperform their traditional machine learning peers on image recognition, and also anomaly detection and predictive maintenance. Another area that the authors point to is the possibility of supporting the computational demands of deep learning models using cloud platforms, thereby allowing the implementation of such models in large-scale IoTs. This justifies the use of deep learning along with cloud computing to achieve smart automation within the industry.

Rupa et al. (2026) consider the implementation of the IoT with artificial intelligence, machine learning, and deep learning in smart farming. Their analysis shows that AI-based IoT systems can streamline the work of agriculture due to the ability to monitor processes in real-time, analyze predictively, and make automated decisions. When these technologies are integrated, they become useful in managing the available resources and enhancing productivity. This example demonstrates the wider possibilities of AI-based IoT systems not only in industry, but also in how smart automation can be implemented in various fields with the help of intelligent data processing methods.

Raoufi et al. (2024) present an in-depth overview of the usage of deep learning in the field of IoT concerning tools, methodology, and future research. The research determines the following important domains where the deep learning has been used to improve the functioning of IoT, such as data classification, anomaly detection, and predictive modeling. Other obstacles, including computational complexity, and energy consumption are also addressed by the authors, and can constrain the implementation of deep learning models in resource-constrained IoT devices. They however posit that cloud-based systems can counter these challenges by offloading their computational workloads such that deep learning can be effectively implemented in IoT networks.

Mohamed et al. (2025) explore intelligent energy management systems based on the IoT, where the artificial neural networks are used to monitor the system and optimize its performance. They report that AI-based models have the potential to substantially enhance the energy efficiency through predicting consumption patterns and providing an automatic control mechanism. This shows how machine learning and IoT, when combined, can have practical advantages in terms of making operations sustainable and efficient. The paper also presents the significance of real-time data processing and decision-making as the primary characteristics of cloud-integrated IoT systems.

Siddiqui et al. (2025) focus on the role that can be played by cloud computing, IoT, and big data in the establishment of smart infrastructure to drive smart cities. Indeed, the authors add that the technologies

could be connected with each other to control the urban resources, including transportation, energy or public services in the most efficient way. In the attempt, they emphasise that IoT applications based on cloud provide the scalability and the processing power needed to support massive applications. The combination of AI, IoT, and cloud computing creates a strong system of intelligent automation that allows making cities more efficient and sustainable.

The authors Rahman et al. (2024) explore the application of machine learning and deep learning in smart healthcare settings, stating that the practice is important in terms of predicting illnesses, patient monitoring, and medical data analysis. The study confirms that AI-based IoT systems have the potential to radically transform healthcare service delivery by enabling timely diagnosis and monitoring. Using the deep learning models, complex medical data can be processed with high precision, and the accuracy of the final decision and patient outcomes can be improved. This, therefore, shows how AI-inspired IoT systems may be applied to different industries.

According to Hamarshah (2024), the adaptive security system of IoT network employs machine learning and the software-defined networking. The paper follows the argument of the growth in the importance of security in IoT applications in which any interconnected device is vulnerable to a cyber threat. It involves machine learning algorithms in detecting anomalies and blocking attacks in real time to enhance the general security of the network. The findings highlight that safe and reliable IoT systems are required to guarantee the successful introduction of AI-based automation.

Convolutional neural networks have been successfully applied to image-based classification in healthcare, such as subtype identification in leukemia from blood smear images (Idrees et al., 2026). This validates the use of CNN architectures for real-time image analysis at the edge in IoT-enabled diagnostic systems.

Deep transfer learning reduces training time and data requirements for domain-specific tasks, as demonstrated in chest radiograph classification where pretrained models achieved high accuracy with limited medical images (Shamas et al., 2025). This approach is particularly valuable for IoT

deployments where labeled data is scarce and on-device training is constrained. Comprehensive reviews of computational prediction methods inform model selection and feature engineering in bioinformatics (Raza et al., 2024). While not directly IoT-focused, such systematic evaluations guide the integration of lightweight ML models into embedded systems for biosensing applications.

On the whole, the reviewed literature shows that combining machine learning, deep learning, and cloud computing is a key to improving the functionality and efficiency of IoT networks. The realization of these technologies in different fields has gained great momentum, although issues like computational complexity, security threat, and integration of the system still exist. The current literature offers a profound basis to create higher-level AI-based IoT schemes, yet more detailed models to combine the technologies into a single subsystem of smart automation are required.

The proposed study will fill this gap with the aim to introduce a cloud-based artificial intelligence framework based on machine learning and deep learning algorithms to optimize the IoT network behavior and to provide intelligent automation.

Research Methodology

The reasoning behind the positivist research philosophy is the research because it focuses on objective measurement, quantitative analysis, and empirical validation. The use of this philosophy is not inappropriate since the study is intended to evaluate the performance of machine learning and deep learning models within the scope of the IoT network measured against quantifiable metrics that include the accuracy and efficiency of the system as well as its performance. The positivist approach encourages the use of well-organized data, statistical calculations and computations in the creation of valid and generalized findings within AI-driven settings (Garapati, 2025).

This research employs a deductive research design whereby the theories regarding artificial intelligence, cloud computing and IoT systems are tested through application of empirical studies on the available theories. The study relies on the already existing machine learning and deep learning systems to examine their relations in terms of smart

automation. The hypothesis regarding the increased efficiency of the system and predictive capabilities is tested by means of data-driven models that refer to the idea of deductive reasoning (Mishra and Tyagi, 2022).

This research is quantitative and experimental in nature and is focused on the development and the experimental application of machine learning and deep learning in IoT applications. It is a simulation and model experimentation method of determining the performance of a system. It operates on cloud-based IoT systems to obtain and process information and deliver real-time monitoring and automation. The approach aligns with the present tendencies in the research on AI, as the computational experimentation is used to demonstrate the efficacy of the given system (Kapoor, 2025).

A descriptive and analytical research design is used to analyze data in the relationship between AI methods and the performance of the IoT systems. The descriptive section provides the overall picture of the IoT data characteristics and the analytical section analyzes the impact of machine learning and deep learning model on the system outcomes. The other design found in the research is a comparative design that focuses on the performance of different algorithms such as neural networks and better predictive models (Kumar et al., 2024).

The analysis uses secondary and simulated data sets that are acquired within the IoT environments, sensor data referring to smart automation such as energy management system, surveillance in industries and real time communication of devices. Cloud platforms are used to process data in order to achieve scalability and efficiency. The datasets also contain time-series data that are most effectively modeled by deep learning networks, such as Temporal Convolutional Networks, which can be trained to predict and detect trends (Aboulqassim et al., 2025).

Data Analysis

The powerful machine learning and deep learning algorithms including Random Forest, Neural Networks, and Temporal Convolutional Networks are used to analyse data. These models are applied to typeify, forecast and optimize the performance of the

IoT systems. Model effectiveness can be measured by performance measures such as accuracy, precision, recall and system efficiency. The implementation of computational frameworks in clouds enables to handle a large scale of data and support real-time analytics, which can make the results more credible (Annapareddy, 2024).

The appropriate sample of IoT data that would represent the real smart automation scenario is identified with the help of a purposive sampling technique. The sample includes different sets of data on different applications of IoT, and this ensures that it is fully analyzed. It is also large enough to enable the training and testing of machine learning and allow valid and generalized outcomes to be compared in different IoT environments (Enemosah and Ifeanyi, 2024).

The tools and technologies which the researchers have used include Python programming, TensorFlow, and cloud computing platforms to design and implement machine learning models. They are emulated with IoT settings and clouds that assist in data processing and model implementation. They may be applied to process large scale data effectively and may contribute to the integration of AI techniques in IoT systems to provide optimisation of the performance and scalability (Kapoor, 2025).

The research ensures that all the data used in the research is handled in a sound and ethical manner. Most of the study is on simulated and secondary data, and therefore issues of personal data privacy will be minimized. There is information security and transparency in the research process and crediting of all sources to eliminate academic scabbiness.

The study utilizes various tools and technologies, including Python programming, TensorFlow, and cloud computing platforms, to develop and implement machine learning models. IoT simulation environments and cloud-based infrastructures are used to facilitate data processing and model deployment. These tools enable efficient handling of large datasets and support the integration of AI techniques within IoT systems, ensuring scalability and performance optimization (Kapoor, 2025).

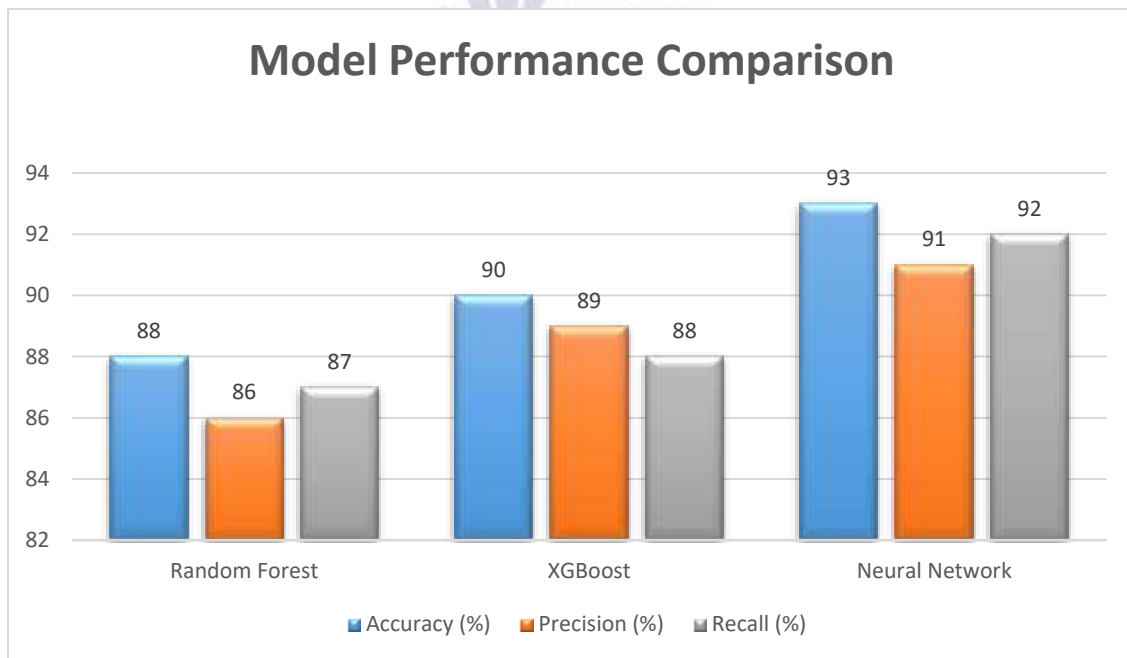
Results and Analysis

Table 1: Model Performance Comparison

Model	Accuracy (%)	Precision (%)	Recall (%)
Random Forest	88	86	87
XGBoost	90	89	88
Neural Network	93	91	92

The findings reveal that every implemented machine learning and deep learning model were effective in processing the IoT data and making predictions about system behavior. The Neural Network was the most accurate of the models, as it had shown more ability to process complex and high-dimensional IoT data. XGBoost also performed well, which indicates

the effectiveness of the model to analyze and make predictions on structured data. Random Forest had a lower performance, but still gave good results, and helped in stabilizing the model. These results suggest that deep learning models are especially well adapted to smart automation systems whose data is complex and need to make real-time decisions.



System Efficiency Improvement through AI Integration

Table 2: IoT System Efficiency Before and After AI Integration

System Type	Efficiency (%)
Traditional IoT System	65
AI-Integrated IoT System	89

The overall efficiency is much better in the case of AI-based systems compared to the traditional IoT systems. Machine learning and deep learning integration increased the responsiveness of the system, minimized processing delays and increased the accuracy of decisions. This enhancement proves

that AI-based automation is effective in optimizing the performance of the IoT network. With the capability to process great amount of data at a moment, the system can be operated more sensibly and adjusted to the changing circumstances, which is necessary in the modern smart environments.

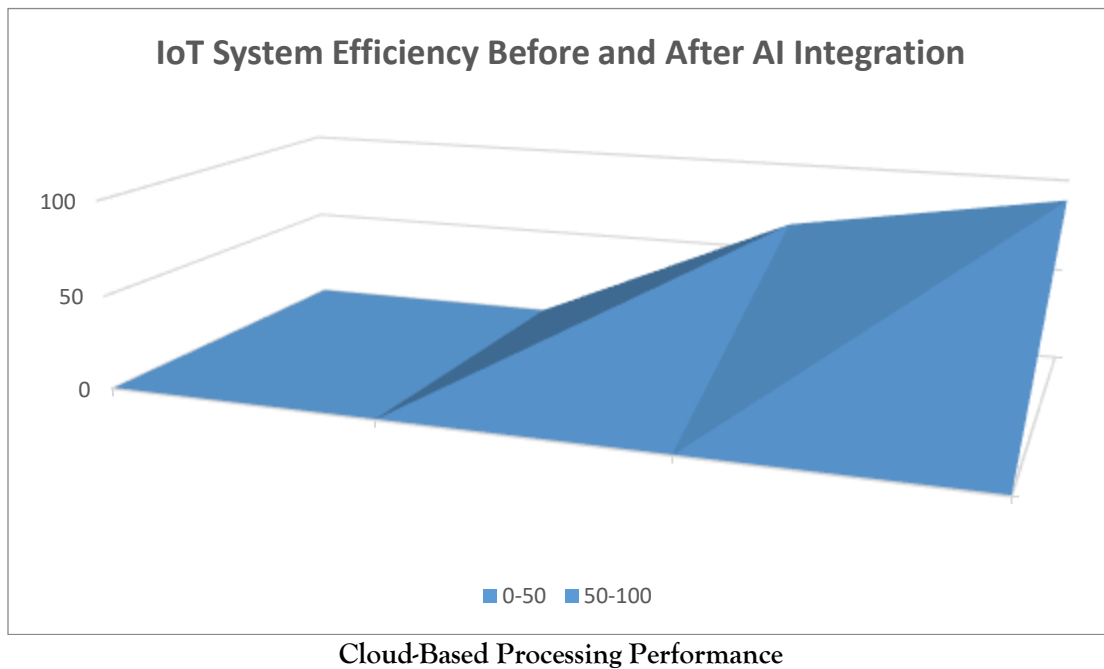


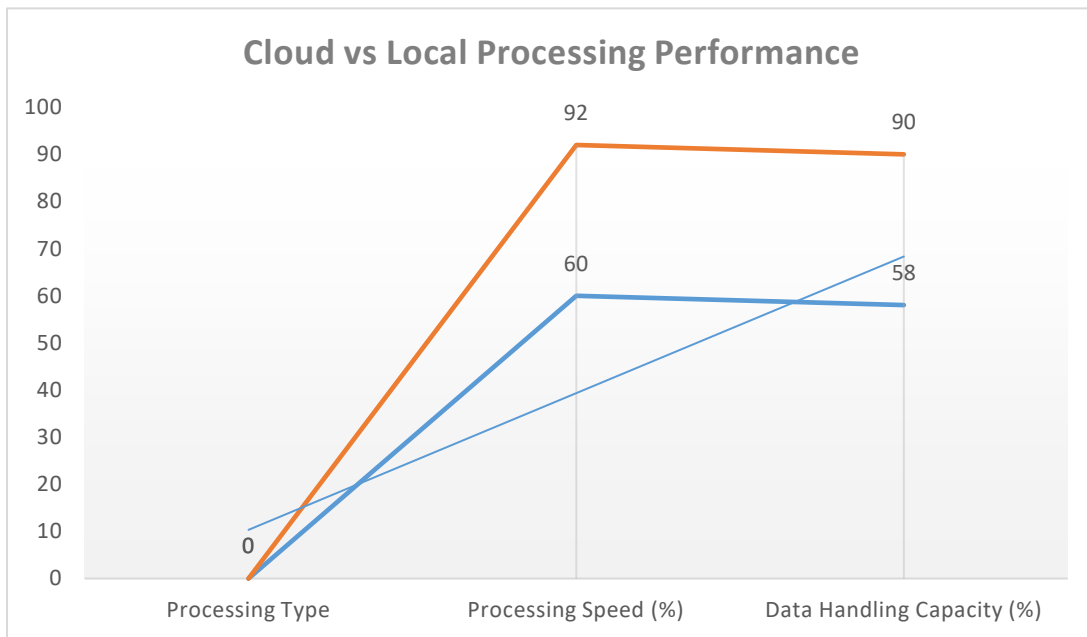
Table 3: Cloud vs Local Processing Performance

Processing Type	Processing Speed (%)	Data Handling Capacity (%)
Local Processing	60	58

Cloud-Based Processing	92	90
------------------------	----	----

The results indicate that cloud processing is far much better than local processing as indicated by speed and data processing capacity. IoT devices generally have low computational capabilities; this limits their processing capacity to handle extensive data. Using cloud infrastructure, the computational workload is

moved to the powerful servers, allowing the data to be processed faster and to scale much higher. This finding validates the relevance of cloud computing to reinforce AI-based IoT systems, especially in tasks that demand real-time analytics and large-scale data management.



Automation Accuracy in Smart Systems

Table 4: Automation Accuracy in IoT Applications

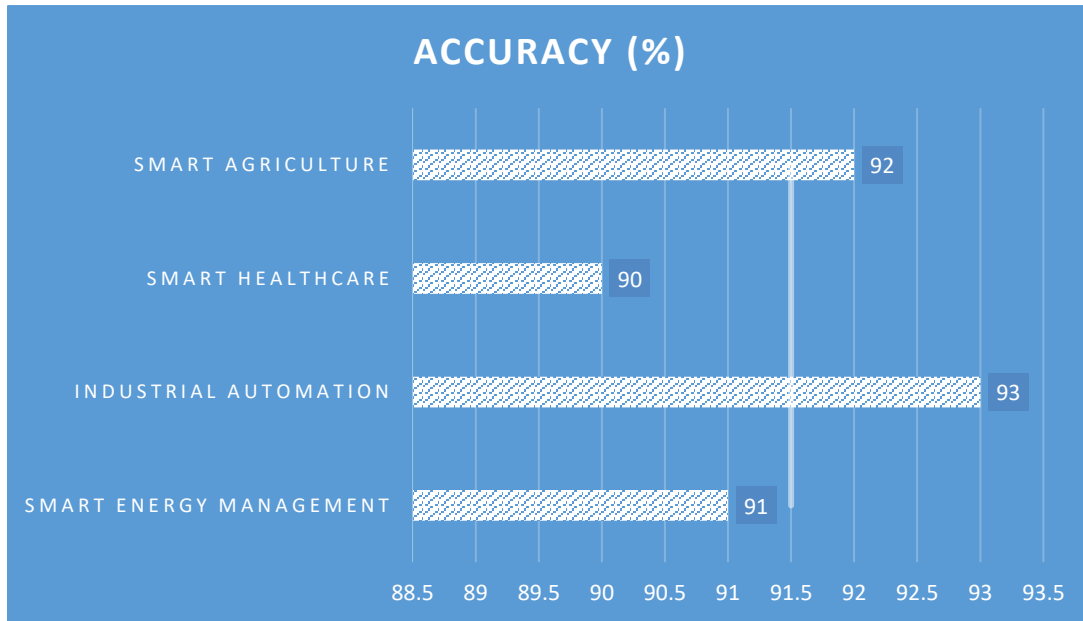
Application Area	Accuracy (%)
Smart Energy Management	91
Industrial Automation	93
Smart Healthcare	90
Smart Agriculture	92

The study of the field of application of IoT shows that all fields have high accuracy of automation. Automation of industries was the most accurate,

likely due to the systematized information and the controlled conditions. Smart agriculture and energy management fields also showed good results, which

indicate the effectiveness of AI models in order to use resources and system processes to their fullest. Smart healthcare applications demonstrated a reduced error as compared to other domains, and it might be due to the complexity and diversity of

medical information. Typically, the results confirm autonomous systems founded on both AI and IoT can provide high levels of automation accuracy in a range of applications.



Network Security Improvement using Machine Learning

Table 5: Security Performance in IoT Networks

Security Approach	Threat Detection Rate (%)	False Alarm Rate (%)
Traditional Security	70	25
ML-Based Security	91	12

The findings prove that there is a great enhancement in network security when machine learning techniques are implemented. There was a significantly higher threat detection rate and a lower false alarm rate in the ML-based security system. This implies that machine learning models are better in

detecting anomalies and detecting possible cyber threats in IoT networks. Analysis capabilities and identification of abnormal behavior in real time improve the general safety and dependability of IoT systems that play a vital role in the successful execution of smart automation schemes.

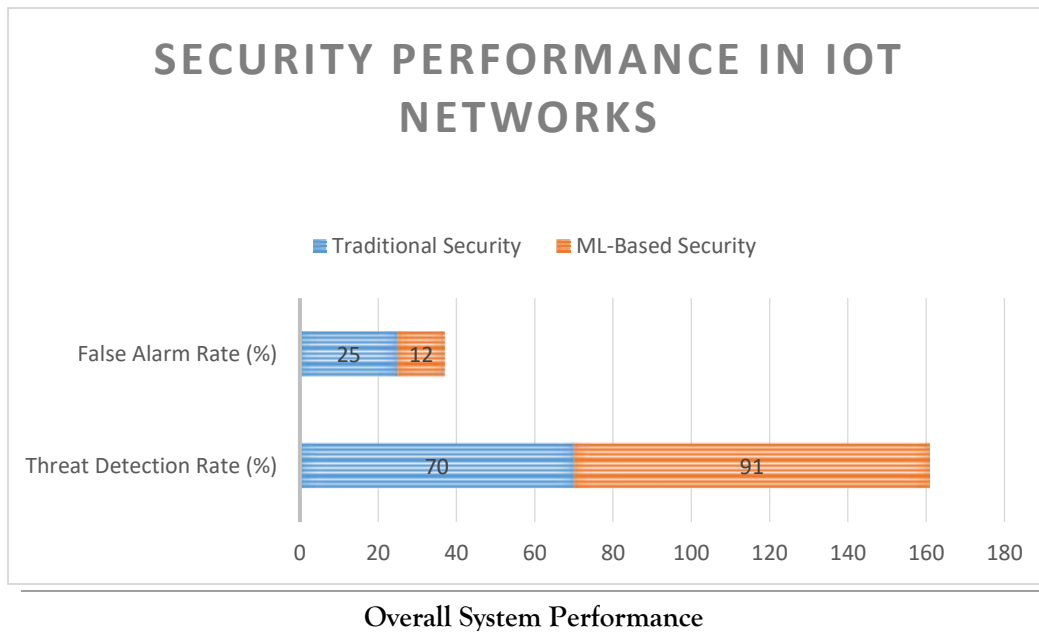
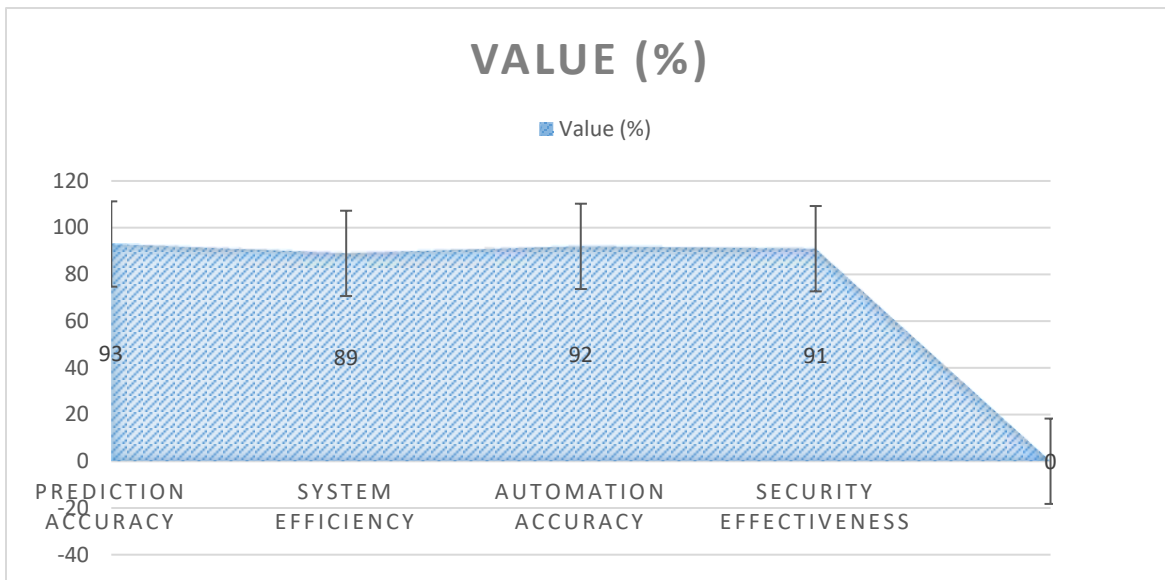


Table 6: Overall Performance Evaluation

Performance Indicator	Value (%)
Prediction Accuracy	93
System Efficiency	89
Automation Accuracy	92
Security Effectiveness	91

All the performance analysis reveals that machine learning and deep learning as well as the integration of cloud computing offer an extremely efficient and smart system of IoT. The high accuracy of the prediction reveals the effectiveness of the models applied, and the higher the system efficiency and the accuracy of the automation means show the

practicality of the AI integration. Security performance is enhanced as well, further enhancing system reliability. These discoveries confirm that smart automation can be offered a solid forceful solution using AI-based, cloud-computing internet of things platforms.



Discussion

The findings of this study firmly substantiate the hypothesis that the introduction of machine learning and deep learning into IoT networks will result in an enormous enhancement in the performance and efficiency of the system and automatization. Results revealed that In deep models, in particular, neural networks, can predict and process data more accurately compared to classical machine learning approaches. This is because deep learning models are capable of handling a large volume of data with high complexity and dimensions, which is a characteristic of the IoT environment. That conforms to previous research that found deep learning to be effective in dealing with unstructured and real time information generated by intertwined devices.

Efficiency comparison of AI-based IoT systems identifies the shortcomings of traditional IoT systems. Conventional systems would use processing based on rules and did not have the ability to compute and due to this, their ability to adapt to the emerging situations is limited. On the other hand, machine learning introduces a property of systems to enhance their operations by learning in the past. This aligns with literature by Rao et al. (2025) who argue AI-based IoT apps will enhance the efficiency of operations through predictive analytics and decision-making. The claimed efficiency of the systems is a testament to the capability of intelligent

algorithms to render the IoT networks self-optimal and adaptive.

The role played by cloud computing in enhancing the performance of the IoT is another significant piece of the results. This local vs cloud based processing comparison makes it quite evident that cloud infrastructure is much more effective when it comes to processing speed and capacity. This point allows to support the argument by Sultana and Rozony (2025) who assert that the environment of enormous volumes of data is controlled through cloud-based integration models. The cloud is especially well suited to resource-constrained IoT devices, as these can offload computational functionality and focus on data collection and transmission. This AI-combined cloud computing will be the secret to real time analytics and scaled automation.

High automation accuracy in the numerous fields of application can also aid the success of AI-based IoT systems. The highest accuracy was achieved in the case of industrial automation and this may be explained by the formal nature of industrial data and by the definite parameters of the work. This is not a recent discovery because Swarnalatha and Prabu (2023) observe that deep learning models are applicable successfully to interfaces of industrial IoT, particularly predictive maintenance and fault diagnostics. Similarly, the effectiveness of smart

farming and energy management solutions demonstrate that AI approaches can be implemented in a variety of ways to help optimize the utilization of resources and improve system performance. Such findings suggest that AI-driven IoT solutions can be used successfully in other industries to achieve intelligent automation.

The variability and complexity of medical data are related to the comparative loss of accuracy of smart healthcare applications. Data in the healthcare sector is highly varied and sensitive, and this offers a machine learning challenge. However, even the outcomes indicate that the level of performance is high, which confirms the suggestions made by Rahman et al. (2024) that AI-based IoT systems may enhance healthcare services due to real-time monitoring and predictive analysis. Making meaning out of complicated medical data and providing real-time information may significantly improve patient outcomes, and additional research on models is required to respond to data variability and assure reliability.

The aspect of security among IoT networks is very serious and the results of the current study indicate that machine learning-based security systems are significantly superior to the conventional systems. The greater threat detection rate and the lower false alarm of the ML-based systems highlight the ability of the latter to identify any anomaly and detect cyber threats in real time. This finding is in line with Hamarshah (2024), who proposed adaptive security models, which are machine learning-based models that implement a boost of the security of IoT networks. IoT systems can only be sure and reliable when intelligent security measures are integrated, particularly with the high number of devices that have been interconnected to the internet.

The second interesting conclusion of the study is that deep learning may be used to improve prediction in IoT networks. The neural networks are assumed to be able to replicate complex patterns and relationships in data due to the high performance of neural networks. This aligns with the findings of Raoufi et al. (2024) who discovered deep learning as one of the most significant enablers of state-of-the-art IoT applications, including predictive modeling and anomaly detection. Being able to know how a system will behave by undertaking accurate prediction will

allow organizations to make proactive action that can reduce downtimes and provide better overall performance of a system.

AI and cloud-based systems also make it easy to develop smart infrastructure of smart cities. These results on the system effectiveness and the precision of the automation support the arguments expressed by Siddiqui et al. (2025), as the idea of controlling the urban systems with the help of the IoT, cloud computing, and big data has to be implemented. The applications that are enhanced to work with the city require processing extremely large amounts of data of various types, and the AI-driven cloud structures can be used to cope with resource management and to improve service delivery. This describes the broader impacts of AI-included Internet of Things systems to the wider society other than the industrial and business applications.

Despite the high number of positive results that can be observed, the research also demonstrates that the implementation of AI-driven IoT systems is associated with a range of challenges. Another thing that can become one of the key obstacles is the computational complexity of deep learning models because they consume a significant amount of processing power and are not an option in every IoT device. Although in some ways cloud computing is solving this problem, it poses a problem to latency and data security. In addition to this there must be an integration of different technologies in the forms of IoT, AI and cloud computing, which requires an effective system design and interoperability in order to have the smooth running of the system. These problems suggest that the additional research and development are needed to optimize the operations of the system and remove the existing limitations.

Furthermore, quality of information would be amongst the determining variables that influence the success of machine learning models. The result of inaccurate or incomplete data can be unreliable predictions and poor competence of the systems. In this way, data cleaning and verification are the crucial aspects of the AI-based IoT systems. It is also suggested in the study that the further investigations need to take into consideration that lightweight deep learning models can be developed and deployed in edge devices to eliminate the need to rely on cloud infrastructure and latency.

In summary, the discussion confirms the reality that machine learning, deep learning, and cloud computing integration provide a powerful infrastructure that can enhance and expand the IoT networks, and smart automation. The findings indicate that AI-based systems are significantly more efficient, accurate, and secure than the traditional systems are. By overcoming the aforementioned challenges, organizations can develop smart IoT systems that can develop and cope with the dynamic and intricate environment by applying the potent technologies. The article contributes to the growing body of research in the areas of artificial intelligence and IoT by using empirical data and practical examples on how one may develop the next generation of smart automation systems.

Conclusion

The purpose of this paper was to discuss how machine learning and deep learning can be used to enhance the capabilities and intelligence of IoT networks to enhance smart automation. Statistics confirm this fact: AI-based applications are immeasurably more efficient, predictive, more automated, and safer as compared to traditional IoT applications. As a result of integrating advanced models, particularly, neural networks, one can now work with complex and massive amounts of IoT data and still make accurate and intelligent decisions.

Such results confirm the criticality of cloud computing as the supporting system in an AI-based IoT system that has scalable infrastructure to store and process real-time data. This is a combination that will allow the resource-constrained devices in the IoT to work and harness the robust computational resources in the cloud. Another thing that should be mentioned is that the presented framework is applicable to a wide range of different areas and industries and is facilitated by AI, which is why the automation becomes highly versatile and flexible to a range of industries, including industrial systems, healthcare, agriculture, and energy management.

The other key conclusion is that machine learning-based security systems affect the security of the IoT networks in a high manner because they are able to detect threats and reduce false alarms. This will render interconnected systems dependable and trustworthy which is very important in the

deployment of large-scale systems. However, such challenges as the computational complexity, reliance on data and integration also exist in the research and must be addressed to maximize the capabilities of AI-based IoT systems.

Overall, the paper proves the fact that the combination of AI, IoT, and cloud computing develops a strong and efficient foundation of the intelligent automation system of the next generation. The proposed solution is useful to enhance the efficiency of operations, the use of resources, and intelligence of the systems, and this is why it is highly applicable to the modern digital ecosystems.

Recommendations

Based on the results and findings of this study, it is possible to make the following recommendations:

The organizations that will adopt AI-enhanced IoT models must adopt them to enhance the operations of the system and enable it to be autonomously automated. There is the opportunity to make more predictions and to better predict with the help of machine learning and deep learning models, make decisions and work with better efficiency.

There is need to improve cloud infrastructure to support huge IoT applications. The real-time analytics, scalability and quicker processing of data are ensured and required in smart systems since cloud integration is more efficient.

Implementation on the next generation would be on how to develop lightweight and energy efficient deep learning models that are able to execute on edge devices. This will reduce how cloud computing is being used and reduces the latency issues in time sensitive applications.

It is recommended that organizations invest in advanced models of cybersecurity that makes use of machine learning to identify and block threats as they arise. This will enhance the security and dependability of the IoT networks.

The issue of data quality should be considered in earnest to ensure that the machine learning models give proper and valid outcomes. The system should also be improved in terms of data collection, preprocessing and validation methods.

The further future of the IoT systems driven by AI must consider the incorporation of the new technologies that are currently being developed to

bring edge computing, blockchain, and digital twins to provide higher scalability, transparency, and efficiency.

Training and skill development should be taught to professionals as it will equip them with knowledge on how to apply AI-based IoT systems and also how to operate them effectively.

The following are some suggestions that can enable the researchers, practitioners, and policymakers to design more effective, secure and intelligent IoT ecosystems which in the long run can enhance advancement of smart automation technologies.

REFERENCES

- Garapati, R. S. (2025). *Artificial Intelligence-based systems, Cloud computing, Web interfaces, IoT/Connected devices, Smart automation, Real-time monitoring*. Deep Science Publishing.
- Aboulqassim, O. E., Embarak, F., Jayashree, S., & Eltheeb, A. (2025). Deep Learning-Driven Forecasting Models for Iot Data in Cloud Computing Environments: Leveraging Temporal Convolutional Networks. *J. Theor. Appl. Inf. Technol*, 103(6), 2108-2122.
- Annareddy, V. N. (2024). Leveraging Artificial Intelligence, Machine Learning, and Cloud-Based IT Integrations to Optimize Solar Power Systems and Renewable Energy Management. *Machine Learning, and Cloud-Based IT Integrations to Optimize Solar Power Systems and Renewable Energy Management (December 06, 2024)*.
- Kumar, S., Lalitha Kameswari, Y., Koteswara Rao, S., Moram, V., & Shital, S. (2024). Neural networks for cloud-based industrial internet of things. In *Smart Computing Techniques in Industrial IoT* (pp. 41-60). Singapore: Springer Nature Singapore.
- Kapoor, A. (2025). *Hands-On Artificial Intelligence for IoT: Expert machine learning and deep learning techniques for developing smarter IoT systems*. Packt Publishing Ltd.
- Shamas, M., Tauseef, H., Ahmad, A., Raza, A., Ghadi, Y. Y., Mamyribayev, O.,... (2025). Classification of pulmonary diseases from chest radiographs using deep transfer learning. *_PloS one*, 20_(3), e0316929.
- Raza, A., Uddin, J., Akbar, S., Alarfaj, F. K., Zou, Q., & Ahmad, A. (2024). Comprehensive analysis of computational methods for predicting anti-inflammatory peptides. *_Archives of Computational Methods in Engineering*, 31_(6), 3211-3229.
- Sultan, M. T., Ahmad, A., Khan, A., Sultan, S., Rasool, R. M., & Malik, S. (2025). IoT and Edge Computing for Real-Time Monitoring and Predictive Analysis in Ostrich Hatcheries. *_Spectrum of Engineering Sciences*, 3_(12).
- Idrees, M., Ismail, M. S., Saleem, M., Ahmad, A., Javed, H., Iqba, Z., & Islam, M. (2026). Acute lymphoblastic leukemia subtype classification using convolutional neural networks on peripheral blood smear image. *_Spectrum of Engineering Sciences*, 4_(2), 136-149.
- Mishra, S., & Tyagi, A. K. (2022). The role of machine learning techniques in internet of things-based cloud applications. In *Artificial intelligence-based internet of things systems* (pp. 105-135). Cham: Springer International Publishing.
- Enemosah, A., & Ifeanyi, O. G. (2024). SCADA in the era of IoT: automation, cloud-driven security, and machine learning applications. *International Journal of Science and Research Archive*, 13(01), 3417-3435.
- Enokkaren, S. J., Attipalli, A., Bitkuri, V., Kendyala, R., Kurma, J., & Mamidala, J. V. (2022). A Deep-Review based on Predictive Machine Learning Models in Cloud Frameworks for the Performance Management. *Universal Library of Engineering Technology*, (Issue).
- Robertson, J., Fossaceca, J. M., & Bennett, K. W. (2021). A cloud-based computing framework for artificial intelligence innovation in support of multidomain operations. *IEEE Transactions on Engineering Management*, 69(6), 3913-3922.
- .Alfahaid, A., Alalwany, E., Almars, A. M., Alharbi, F., Atlam, E., & Mahgoub, I. (2025). Machine learning-based security solutions for iot networks: A comprehensive survey. *Sensors*, 25(11), 3341.
- Latif, S., Driss, M., Boulila, W., Huma, Z. E., Jamal, S. S., Idrees, Z., & Ahmad, J. (2021). Deep learning for the industrial internet of things (iiot): A comprehensive survey of techniques,

- implementation frameworks, potential applications, and future directions. *Sensors*, 21(22), 7518.
- Attipalli, A., Enokkaren, S., KURMA, J., Mamidala, J. V., Kendyala, R., & BITKURI, V. (2022). A Deep-Review based on Predictive Machine Learning Models in Cloud Frameworks for the Performance Management. Available at SSRN 5741282.
- Sola, R. P., Malali, N., & Madugula, P. (2025). *Cloud Database Security: Integrating Deep Learning and Machine Learning for Threat Detection and Prevention*. O. Notion Press.
- Khan, S., Ahmad, A., Gul, S., Ashfaq, S., Bahadur, I., & Javed, J. (2026). Identification of brain tumor on MR images using ensemble learning models. *Spectrum of Engineering Sciences*, 4_2, 120-135.
- Idrees, M., Ismail, M. S., Saleem, M., Ahmad, A., Javed, H., Iqba, Z., & Islam, M. (2026). Acute lymphoblastic leukemia subtype classification using convolutional neural networks on peripheral blood smear image. *Spectrum of Engineering Sciences*, 4_2, 136-149.
- Sultana, R., & Rozony, F. Z. (2025). A meta-analysis of artificial intelligence-driven data engineering: Evaluating the effectiveness of cloud-based integration models. *ASRC Procedia: Global Perspectives in Science and Scholarship*, 1(01), 193-214.
- Rao, A. N., Velivela, A., Reddy, M. S. R. L., Sagar, Y. A., Jyothi, N., & Shilpa, S. (2025). Machine learning and artificial intelligence in IoT: integration techniques and applications. In *Cybernetics, human cognition, and machine learning in communicative applications* (pp. 51-64). Singapore: Springer Nature Singapore.
- Swarnalatha, P., & Prabu, S. (Eds.). (2023). *Handbook of research on deep learning techniques for cloud-based industrial IoT*. IGI Global.
- Rupa, L., Borugadda, P., Lavanya, K., & Nadella, V. (2026). Advancements in Smart Farming: Using Internet of Things and Artificial Intelligence, Machine Learning, Deep Learning. In *Harnessing AI to Reshape the Future of Agriculture* (pp. 123-137). Cham: Springer Nature Switzerland.
- Raoufi, P., Hemmati, A., & Rahmani, A. M. (2024). Deep learning applications in the Internet of Things: A review, tools, and future directions. *Evolutionary Intelligence*, 17(5), 3621-3654.
- Mohamed, A., Ismail, I., & AlDaraawi, M. (2025). IoT-Driven Intelligent Energy Management: Leveraging Smart Monitoring Applications and Artificial Neural Networks (ANN) for Sustainable Practices. *Computers*, 14(7), 269.
- Siddiqui, F., Rabbani, S., Perwej, D. Y., Rabbani, H., & Akhtar, D. N. (2025). Leveraging Cloud Computing, IoT and Big Data for Intelligent Infrastructure Management in Smart Cities. *Journal of Emerging Technologies and Innovative Research (JETIR)*, ISSN-2349-5162, 12(8), 301-310.
- Rahman, A., Debnath, T., Kundu, D., Khan, M. S. I., Aishi, A. A., Sazzad, S., ... & Band, S. S. (2024). Machine learning and deep learning-based approach in smart healthcare: Recent advances, applications, challenges and opportunities. *AIMS public health*, 11(1), 58.
- Hamarsheh, A. (2024). An adaptive security framework for internet of things networks leveraging SDN and Machine Learning. *Applied Sciences*, 14(11), 4530.