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Findings

In recent years, there has been a notable surge in interest regarding the integration of two influential technologies: the Internet of Things (IoT) and Cloud Computing. This study thoroughly inspects the potential benefits and challenges associated with combining these technologies to create innovative and efficient solutions for real-world problems. This research aims to provide valuable insight into this emerging field through a comprehensive exploration of various dimensions, including the advantages, drawbacks, platforms, and practical applications of this integration.

The integration of IoT and Cloud Computing offers numerous advantages, such as enhanced data processing and storage capabilities, improved scalability and reliability, cost reduction, energy efficiency, and strengthened security and privacy measures. However, to fully realize these benefits, addressing the challenges that arise, such as data heterogeneity, interoperability issues, network latency, resource management, and concerns related to trust and governance, is imperative.

To establish a solid foundation, an exhaustive state-of-the-art review is conducted, encompassing the current landscape of IoT-cloud integration. This review highlights the latest advancements, advantages, and challenges and provides a comprehensive taxonomy of IoT-based cloud applications and conducts an in-depth analysis of quality of service (QoS) factors. Furthermore, popular IoT cloud integration platforms are meticulously compared while discussing the anticipated future developments in this dynamic field.

In order to facilitate seamless integration, a robust and adaptable framework is proposed. This generic framework comprises four layers: the device layer, network layer, cloud layer, and application layer. Each layer is equipped with specific functions and components that facilitate seamless interaction between IoT devices and cloud services. Practical applications of this integration, with a particular emphasis on air pollution monitoring, are thoroughly explored and investigated using Power BI.

Furthermore, this study delves into the domain of air pollution monitoring by harnessing the capabilities offered by IoT-enabled devices and cloud-based infrastructure. By utilizing statistical techniques such as correlation and heatmaps, a data set pertaining to air pollution governed by the Ministry of the Environment has been examined. Various factors such as PM2.5, PM10, SPM and RSPM contributing to air pollution are rigorously analyzed, yielding valuable insights into their influences and impacts. Moreover, the profound impact of IoT-enabled air pollution data on human life is meticulously assessed, unravelling crucial insights into the magnitude of the issue and its consequential implications for human well-being. This meticulous investigation serves as a foundation for developing effective strategies and policies to mitigate the detrimental effects of air pollution on human health and the environment.

Furthermore, this study presents a comprehensive study on forecasting the Air Quality Index (AQI) through an IoT-Cloud-based approach. The proposed BO-HyTS model, which ingeniously combines SARIMA and LSTM models through Bayesian optimization, outperforms alternative models regarding accuracy and efficiency. The significant comparison of model performance was conducted using a non-parametric Friedman Test to provide further statistical evidence. This test was employed to strengthen the statistical analysis and validate the findings. The findings obtained from this study provide valuable insights into future AQI patterns, thereby enabling the development of healthcare policies and proactive environmental management strategies.

Finally, a novel hybrid time-series approach (*p*-convex-ARIMA-ANFIS) is presented for air quality monitoring in a cloud environment. This approach effectively captures the time-series linear and non-linear characteristics, resulting in improved accuracy and efficiency. Real-world air pollution datasets are utilized to evaluate the approach, demonstrating its effectiveness in detecting anomalies and monitoring environmental conditions. To evaluate the significance of any observed differences between the performance of the two models, a Wilcoxon signed rank test was employed. This statistical test was chosen to compare the two models and determine if there were any statistically significant disparities in their performance.

During the experimental phase of this research, Cloud-Based Power BI tools are proficiently employed. Furthermore, state-of-the-art AI, time series, machine learning, and deep learning libraries based on Python are utilized to effectively train and test the proposed framework, aiming to identify the most optimal solution. This sophisticated approach significantly enhances the accuracy and depth of the analysis, facilitating the identification of the most effective strategies and solutions. Essentially, this study serves as an all-encompassing evaluation of the integration of IoT and Cloud Computing technologies within real-world applications. With a focus on air pollution monitoring, it explains the advantages, challenges, frameworks, and practical implementations of the integration, focusing on air pollution monitoring.

Moreover, incorporating Cloud-Based Power BI tools, coupled with AI techniques such as time series, machine learning, and deep learning libraries based on Python, enriches the experimental phase, and facilitates the development of optimal solutions. To provide further statistical evidence, both the Friedman test and the Wilcoxon signed rank test were employed to determine the statistical significance and evaluate any observed differences in the performance of the proposed model. Ultimately, the research findings contribute to a comprehensive understanding of how the integration of IoT and cloud technologies can be effectively harnessed to address real-world challenges, paving the way for a more innovative and interconnected future.