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Transforming Education: Optimizing Learning Environments through the Fusion of Signal Processing and IoT

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Abstract

The education sector is not an exception to the widespread use of "Internet of Things (IoT)" applications. The Internet of Things' ability to create smart cities provides a workable answer to the difficult problems of cost-effectiveness, sustainable development, and energy management in light of growing urban populations and environmental demands. Along with privacy and security of data issues in Internet of Things installations, the study also discusses the ethical and legal implications of data collection. Future developments and opportunities for IoT use in education are also covered by the study, including the blending of artificial intelligence and machine learning. The results demonstrate notable decreases in energy use, financial savings, and noteworthy contributions to the eradication of greenhouse gas emissions, ultimately leading to an increase in environmental sustainability.

Keywords: Internet of Things (IoT), Artificial Intelligence, Optimal energy management, deep learning.

1 Introduction

In the next years, context-awareness—a combination of data processing, network communication, and environment sensing techniques—will improve the connection between virtual computer entities and the physical world in the context of the Internet of Things (IoT). Developments in technology have made it possible to create sophisticated Internet of Things programs, including intelligent healthcare, intelligent

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building systems, intelligent energy, and intelligent transportation. Both complex IoT-based service providers and the basic IoT sensor networks are part of the unified framework of IoT networks [1].

Technology is advancing quickly, which has a significant impact on a variety of sectors, including education. The most cutting-edge technologies that have the power to fundamentally alter how education is received and delivered are "artificial intelligence (AI) and the internet of things (IoT)". An array of networked devices that trade and gather data to facilitate real-time communication and monitoring is known as "the Internet of Things, or IoT". IoT in education may refer to a broad variety of gadgets, such as wearable technology and sensors that monitor student performance and participation, as well as interactive whiteboards and smartboards. On the other side, artificial intelligence (AI) involves the development of systems that are able to learn, understand, solve problems, and make decisions—tasks that often need human cognition. Automated grading schemes, intelligent tutoring software, and adaptable learning platforms are a few instances of AI's use in education. IoT and AI have a wide range of applications in education, touching on many facets of the educational environment. Smart classrooms, where gadgets talk to one other to provide an engaging and dynamic learning environment, are made possible by the Internet of Things. For example, sensors can keep an eye on the lighting and temperature in the classroom and make adjustments to improve the learning environment. Wearable technology can monitor kids' health and physical activity levels, giving educators important information for individualized lesson planning. With the use of AI technology, this data may be analyzed to provide individualized lesson plans, pinpoint problem areas for pupils, and recommend remedial actions to raise test scores. Additionally, administrative activities like scheduling, grading, and attendance monitoring may be streamlined by AI-powered systems, freeing up teachers to concentrate more on instruction [2].

2 Literature Review

(Aljohani, 2024) [4] A novel architecture using deep learning methods is presented in the paper to optimise energy usage in IoT-connected smart cities. Using deep learning models, particularly "recurrent neural networks (RNNs) and neural networks", the suggested method efficiently forecasts demand while tracking changing consumption trends. Through extensive simulations and real-life case studies carried out in several smart cities all over the world, the research study illustrates the effectiveness of the "deep learning-based methodology". The results demonstrate notable decreases in energy use, financial savings, and noteworthy contributions to the eradication of greenhouse gas emissions, ultimately leading to an increase in environmental sustainability. Furthermore, the framework's adaptability and scalability demonstrate how it may be used in a range of urban contexts. This research paper addresses contemporary energy management concerns while also establishing.

(Meylani, 2024) [5] The integration and impacts of the Internet of Things (IoT) in education are examined in this study, which highlights the need of changing conventional teaching and learning methodologies. It looks at the IoT's early applications, historical expansion, evolution, and acceptance tipping points. In addition, this research looks at a range of IoT platforms, tools, and technologies in the field of education, such as wearables, smart devices, virtual and augmented reality, collaborative

learning, and gamification. It also explores the potential benefits of IoT-enabled infrastructure, energy-efficient smart campuses, and enhanced safety and security for campus management. In addition, privacy and security issues with Internet of Things installations are discussed, as well as the ethical and legal implications of data collection in the classroom. Future trends and opportunities for IoT are also covered in the study.

(Kumar et al., 2024) [6] The incorporation of the Internet of Things (IoT) and artificial intelligence (AI) into traditional teaching and learning methodologies is revolutionising the educational environment. The revolutionary potential of IoT and AI in educational contexts is examined in this study, with particular attention paid to the prospects they provide for improved student engagement, tailored instruction, and effective administrative procedures. It also looks at the difficulties in implementing them, including issues with data privacy, exorbitant expenses, and moral dilemmas. This study offers insights into the present situation, upcoming trends, and best practices for using IoT and AI to enhance educational results via a thorough analysis of the literature and case studies. The study ends with suggestions on how researchers, educational institutions, and legislators might best use these technologies to help students and teachers.

(Fawzy et al., 2023) [7] "The Triple Phases Resource Utilized Data Fusion (TPRUDF)" system is the first resource utilization that uses data fusion based on the Internet of Things while taking cost into account, and this paper describes it. The different aspects of IoT data are examined via three rounds of data fusion: "(1) data in – data out, (2) data in – feature out, and (3) feature in – decision out". The uncorrelated data characteristics are subsequently combined by TPRUDF using Principal Component Analysis. Last but not least, it uses two distinct resource usage strategies: (1) Particle Swarm Optimization and (2) Genetic Algorithms, combining their outputs using the voting logic fusion approach. Three practical smart city datasets are used on a public edge computing simulator to assess TPRUDF.

(Dake et al., 2023) [8] In this study, we go over the particular advantages of IoT applications in education and look more closely at implementation issues in Ghanaian higher education institutions. In addition to providing current and upcoming possibilities to improve educational results, this study looks at relevant applications for IoT advantages in education. This study addresses several facets of the educational field and talks about the revolution regarding IoT installations in education. Employers should embrace IoT connection even if use cases for Industry 4.0 and Education 4.0 have surfaced. Research directions in the area of Internet of Things (IoT) in education are increasingly focused on specialised applications for educational institutions, driven by the newest generation of disruptive technologies, such as 5G. The effective adoption of IoT in education will create a society where everyone in the educational environment has access to it, and it will also benefit all parties involved.

(Almalki et al., 2023) [9] "As Internet of Things (IoT) technology" develops and becomes more prevalent in smart cities, it is changing our way of life and working and contributing to the advancement of civilisation. However, there are a number of negative aspects to IoT technology as well. For example, smart cities generate more e-waste, consume more energy, and release harmful pollutants. Green IoT is

needed because eco-friendly applications are necessary for smart cities. Smart cities are more suited for the more sustainable ecology that green IoT produces. Discussing methods and approaches to lessen the risks related to inefficient traffic, pollution, energy and resource consumption, public safety, quality of life, cost control, and environmental sustainability is thus essential. Providing a comprehensive review of the strategies and tactics used in the development of smarter, more sustainable, and eco-friendly cities is the main objective of this study. The poll also emphasizes the Internet of Things and how it might be integrated with other elements to meet the demands of smart cities. We conclude by outlining the difficulties and prospects for further study on smart city applications.

(Kamruzzaman et al., 2023) [10] This entails giving students knowledge, tests, and feedback that are specifically designed to fit their individual learning preferences and speeds. For learners who are incapable to attend traditional classroom settings, IoT technology additionally provides it feasible to remotely track and evaluate student work. Also, "artificial intelligence (AI) and the Internet of Things" may be used to build smart PLEs, which are learning spaces that provide students interactive, tailored, and adaptable lessons. By integrating Internet of Things (IoT) devices like smart microphones and cameras with AI-driven algorithms, the PLE may adapt to the needs and preferences of the learner in real-time with the help of support and feedback. By providing students with personalised, real-time feedback and support and opening up new opportunities for faraway and disadvantaged students, sustainable learning that incorporates AI and the internet of things has the ability to radically alter the way people learn. "AI and the Internet of Things" must be incorporated into education in a way that is morally and responsibly acceptable if we are to ensure that every student has fair access to the benefits of emerging technology.

(Fei et al., 2022) [11] The energy system uses a variety of sources to meet huge buildings' energy needs. The management of energy in large-scale structures is crucial. Energy storage devices, electric cars, and solar photovoltaics make up the suggested system. The impact of dynamic demand response (DR) on operational expenses has not been well studied, despite the fact that many studies include DR systems. This research considers demand response tactics including "real-time pricing (RTP), critical peak pricing (CPP), and time of use (ToU)" in addition to renewable energy sources and storages. After converting the suggested system into a linear model, linear programming (LP) is used in MATLAB to simulate it. Investigated are several case studies that take into account dynamic demand response techniques. Several systems show more savings based on real-time price information (58% save) compared to the ToU and CPP. The model's effectiveness is shown by the obtained findings, which decreased both the operating cost and greenhouse gas (GHG) emissions.

(Abdel-basset et al., 2021) [12] However, there is a dearth of current literature on the topic of managing energy in regulated IoT networks. When it comes to smart cities, optimal energy management (EM) relies on intelligent load forecasting. This work develops a unique deep learning (DL) system to make sure that energy providers and consumers can communicate effectively and predict short-term energy demand. Within each module, the stacked spatiotemporal modules that comprise the proposed Energy-Net stack are composed of "the Temporal Transformer (TT) and Spatial Transformer (ST)" sub-modules.

The TT model examines the temporal patterns in the load data, whereas the ST sub-module combines layers of inversion to reveal hidden spatial information. It also has an enhanced self-attention mechanism. Energy-Net is superior than contemporary state-of-the-art DL models, as shown by experimental assessment on the ISO-NE and IHPEC datasets, with RMSE values of 0.535 and 0.354, respectively. A shared IoT-cloud server that interacts with linked smart grids to control energy may be connected to dependable, resource-constrained IoT devices (like fog nodes or edge nodes) due to Energy-Net's computational complexity.

(Ahmad & Zhang, 2021) [13] For this purpose, a thorough and important Internet of Things research on commercial applications and smart energy systems was carried out. "Data visualisation, mining, energy forecasting, anomaly detection, status monitoring, and estimate" are some of the ways the Internet of Things (IoT) is being used in smart energy systems. "Cloud, edge, and quantum computing services" are made possible by IoT in data transmission networks. IoT is used in energy production via various pricing, load management, and renewable source approaches. Critical thinking and a clear vision are used to generate many innovative ideas for smart energy systems, and important sectors for IoT application development and income production are discussed. By reviewing the best available literature, this research set out to provide a comprehensive overview of the latest innovations in "smart energy systems for IoT devices". IoT energy was projected to have a worldwide market value of more than USD 6.8 billion in 2015. The expected growth rate from 2016 to 2023 is 15.5% CAGR, which would bring it to USD 26.5 billion.

(Nižetić et al., 2020) [14] Enhancing the quality of life via increased network (technology or process) performance and process simplification are the primary objectives of "Internet of Things (IoT) technologies". Understanding the intricate and interrelated impacts of IoT technologies on communities and their prospective consequences on sustainability in general has been made easier by the research that was presented and debated at the SpliTech2019 conference. The advancements achieved as well as the many IoT technology application areas were covered. The editorial that followed covered the latest developments in four main areas: IoT technologies for smart cities enabled by IoT, e-health and ambient supported living systems, transportation and low-carbon goods, and IoT methods for sustainable energy and environment. The review introduction article's key conclusions improved understanding of the current status of technological development in IoT application fields and the environmental effects linked to the increasing usage of IoT products.

3 Conclusion

These days, smart environments are commonplace in many communities, necessitating the cooperation and communication of an enormous variety of “Internet-of-Things (IoT) devices”. A smart environment makes use of "Internet of Things (IoT) technologies" to enhance quality of life via data processing and sharing across several device types. Because IoT equipment is growing exponentially, there are many different IoT situations, and IoT data has extra complex features, it is more costly to manage and assess IoT data using standard methodologies. The results demonstrate notable decreases in energy use,

financial savings, and noteworthy contributions to the eradication of greenhouse gas emissions, ultimately leading to an increase in environmental sustainability. Furthermore, the framework's adaptability and scalability demonstrate how it may be used in a range of urban contexts. In addition to addressing present energy management concerns, this research paper lays the groundwork for an efficient and ecologically sensitive urban future. IoT energy policy solutions, which promote integration solutions among other things, regulate energy usage and lessen its influence on the environment. In the majority of businesses, including retail, manufacturing, energy, and logistics, IoT improves operational efficiency and process automation. The paper claims that real-time pricing is especially economical for both utilities and end users. It is much superior than the current works that the cost was decreased.

References

[1] R. Krishnamurthi, A. Kumar, D. Gopinathan, A. Nayyar, and B. Qureshi, “An Overview of IoT Sensor Data Processing, Fusion, and Analysis Techniques,” no. i, pp. 1–23, 2020.

[2] S. Abbas et al., “Modeling , Simulation and Optimization of Power Plant Energy Sustainability for IoT Enabled Smart Cities Empowered With Deep Extreme Learning Machine,” IEEE Access, vol. 8, pp. 39982–39997, 2020, doi: 10.1109/ACCESS.2020.2976452.

[3] F. Alam, R. Mehmood, I. Katib, N. N. ALBOGAMI, and A. ALBESHRI, “Data Fusion and IoT for Smart Ubiquitous Environments : A Survey,” no. February 2018, 2017, doi: 10.1109/ACCESS.2017.2697839.

[4] A. Aljohani, “Deep learning-based optimization of energy utilization in IoT-enabled smart cities : A pathway to sustainable development,” Energy Reports, vol. 12, no. September, pp. 2946–2957, 2024, doi: 10.1016/j.egyr.2024.08.075.

[5] R. Meylani, “Transforming Education with the Internet of Things : A Journey into Smarter Learning Environments,” no. February, 2024, doi: 10.46328/ijres.3362.

[6] A. Kumar, M. Rani, D. R. Sisodia, Y. Perwej, A. C. Kakde, and F. M. Rakhimjonovna, “Transforming Education Through Iot And AI Opportunities And Challenges,” vol. 30, no. 5, pp. 11610–11622, 2024, doi: 10.53555/kuey.v30i5.4982.

[7] D. Fawzy, S. M. Moussa, and N. L. Badr, “An IoT-based resource utilization framework using data fusion for smart environments,” Internet of Things, vol. 21, no. November 2022, p. 100645, 2023, doi: 10.1016/j.iot.2022.100645.

[8] D. K. Dake, G. K. Bada, and A. E. Dadzie, “INTERNET OF THINGS (IOT) APPLICATIONS IN EDUCATION: BENEFITS AND IMPLEMENTATION CHALLENGES IN GHANAIAN TERTIARY INSTITUTIONS,” no. August, 2023, doi: 10.28945/5183.

[9] F. A. Almalki et al., “Green IoT for Eco-Friendly and Sustainable Smart Cities : Future Directions and Opportunities,” pp. 178–202, 2023.

[10] M. M. Kamruzzaman et al., “AI- and IoT-Assisted Sustainable Education Systems during Pandemics, such as COVID-19, for Smart Cities,” pp. 1–17, 2023.

[11] L. Fei, M. Shahzad, F. Abbas, H. A. Muqeet, M. M. Hussain, and L. Bin, "Optimal Energy Management System of IoT-Enabled Large Building Considering Electric Vehicle Scheduling, Distributed Resources, and Demand Response Schemes," 2022.

[12] M. Abdel-basset, H. Hawash, R. K. Chakrabortty, and M. Ryan, "Energy-Net : A Deep Learning Approach for Smart Energy Management in IoT-based Smart Cities," vol. 4662, no. c, pp. 1–14, 2021, doi: 10.1109/JIOT.2021.3063677.

[13] T. Ahmad and D. Zhang, "Using the internet of things in smart energy systems and networks," Sustain. Cities Soc., vol. 68, no. December 2020, p. 102783, 2021, doi: 10.1016/j.scs.2021.102783.

[14] S. Nižetić, Petar Solic, G.-A. D. Lopez-de-Ipina, and L. Patrono, "Internet of Things (IoT): Opportunities, issues and challenges towards a smart and sustainable future," no. January, 2020.