ISSN: 2752-3829 **Vol. 2 No.2, (December, 2022)**

Stochastic Modelling and Computational Sciences

IOT-ENABLED AUTOMATION INTEGRATION IN MECHANICAL ENGINEERING

[1]Shelke Rahul Dnyanoba and [2]Dr. Deepak Kumar
[1]Research Scholar and [1]Research Guide
[1,2]Department of Mechanical Engineering, NIILAM University, Haryana
[1]rahuldshelke@gmail.com

ABSTRACT*The term "Internet of Things" (IoT) encapsulates the convergence of information technology (IT) and operational technology (OT), pivotal domains within modern businesses. While IT manages digital data, OT oversees physical processes and data collection. Successful IoT solutions necessitate seamless integration of both realms, whereas they have historically operated independently. Operational technology excels in physical data gathering but faces challenges in integrating with diverse legacy systems. IoT solutions also demand robust security measures to safeguard data transmission and connectivity among interconnected devices and systems. This paradigm shift underscores the imperative synergy between IT and OT for unlocking connected technologies' full potential, enhancing efficiency and productivity, and fostering innovation.*

INTRODUCTION

The realm of mechanical engineering is experiencing a groundbreaking shift, all thanks to the seamless fusion of the Internet of Things (IoT). This innovative technology is reshaping the landscape, granting engineers unprecedented control over the design, monitoring, and optimisation of mechanical systems. Through the interconnectedness of devices, sensors, and machinery, IoT integration is unlocking a plethora of advantages, driving the industry towards enhanced efficiency, data-driven decision-making, and sustainable practices.

Imagine a manufacturing floor where every machine, sensor, and component communicates effortlessly, providing real-time insights into performance, maintenance needs, and quality control. This level of connectivity enables engineers to preemptively address issues, minimise downtime, and maximise productivity like never before. For instance, IoT-enabled predictive maintenance continuously monitors mechanical systems, enabling proactive maintenance measures to prevent costly breakdowns and optimize equipment lifespan.

Moreover, IoT integration fosters a culture of data-driven decision-making. By collecting vast amounts of operational data from various sources, engineers can analyse trends, identify patterns, and uncover opportunities for optimization. Whether it's refining production processes, fine-tuning equipment settings, or optimising energy usage, access to actionable insights empowers engineers to make informed decisions that drive efficiency and improve overall performance.

Additionally, IoT plays a crucial role in promoting sustainability within the mechanical engineering industry. By monitoring energy consumption, optimising resource utilisation, and reducing waste, IoT-enabled systems contribute to eco-friendly practices. Through intelligent automation and optimisation algorithms, manufacturers can minimise their environmental footprint while maximising resource efficiency, aligning with the growing emphasis on sustainability in today's industrial landscape.

In essence, the integration of IoT technology marks a paradigm shift in mechanical engineering, ushering in an era of unprecedented control, efficiency, and sustainability. As engineers continue to harness the power of interconnected systems and data-driven insights, the industry is poised to evolve towards greater innovation and excellence, shaping a future where mechanical systems operate smarter, safer, and more sustainably than ever before.

Figure 1: IoT Harmony between Physical Data and Operational Objectives

Techniques to Amplify Efficiency and Drive Productivity

With the integration of IoT sensors into mechanical systems, engineers gain immediate access to vital information about machinery performance and health. This data provides valuable insights into operational efficiency, allowing engineers to pinpoint inefficiencies, fine-tune processes, and decrease downtime. As a result, productivity experiences a substantial increase while operational costs decrease. This technological advancement enables businesses to maintain competitiveness within fast-paced markets by leveraging real-time data to drive continuous improvement and optimization.

Predictive Maintenance with IoT: Transforming Mechanical Engineering Practices

The integration of IoT technology into mechanical engineering has revolutionized maintenance practices, particularly through predictive maintenance. No longer are businesses reliant on reactive repairs and the costly consequences of unexpected breakdowns. Instead, IoT-enabled sensors continuously monitor the condition of mechanical systems, detecting anomalies and early signs of wear. This proactive approach empowers engineers to schedule maintenance tasks precisely when they are needed, preventing unexpected failures and extending the lifespan of critical machinery. By adopting predictive maintenance strategies, businesses can minimize downtime, reduce maintenance costs, and optimize overall operational efficiency, leading to improved productivity and profitability.

Analysis

The term "Internet of Things" aptly captures the convergence of information technology (IT) and operational technology (OT), two distinct but interconnected domains within businesses. IT deals with digital data management and processing, while OT focuses on physical processes and data collection. Traditionally, these areas operated independently, but for IoT solutions to succeed, they must seamlessly integrate both.

Operational technology has long been proficient in gathering physical data, honing its capabilities over time. However, the challenge lies in integrating this data with the myriad of customised or legacy systems prevalent in many organizations. While these systems may function adequately in isolation, they pose difficulties in terms of scalability and sustainability when integrated.

Moreover, IoT solutions demand robust security measures for data transmission and connectivity. Ensuring the confidentiality, integrity, and availability of data is paramount in an interconnected environment where numerous devices and systems communicate with each other.

In essence, the Internet of Things represents a paradigm shift where the synergy between IT and OT is essential for unlocking the full potential of connected technologies. Bridging the gap between these domains not only enhances efficiency and productivity but also enables innovation and new business opportunities.

In the experimental design system, basic IoT Automation tools have been utilized to enable control through the internet. This type of automation architecture is based on switching and controlling systems, facilitating communication with electrical devices, machineries, and other appliances. Additionally, data from various types of sensors can be collected and stored in cloud storage within a short time frame. Continuous automation processes without human interface are facilitated within a short time span through the utilization of internet-connected wireless communication technology.

Figure 2: Wireless-Enabled Automation: Streamlining Electrical Device Management

Figure 3: Internet-Powered Switching, Control, and Data Monitoring System

Sensing the Future: Ensuring Data Integrity in IoT Sensor Networks

The DHT11 sensor is a versatile tool often employed in laboratory settings for tracking temperature and humidity levels. Its compatibility with Android-based smartphones enables convenient monitoring via mobile devices. This data, crucial for maintaining optimal laboratory conditions, lays the groundwork for automation in air conditioning and fan systems. By integrating with platforms like "Thingspeak" through API protocols, this sensor facilitates seamless data retrieval, making real-time adjustments easier.

Moreover, coupling the DHT11 sensor with motion detection capabilities enhances its utility beyond mere environmental monitoring. When motion is detected, such as in a designated area, it triggers alerts through devices like buzzers. This feature finds applications in surveillance systems or can even control electrical functions, adding a layer of security and automation to various environments.

In essence, the DHT11 sensor, coupled with motion detection technology and IoT integration, offers a robust solution for both environmental monitoring and automation, with potential applications ranging from laboratories to smart home systems.

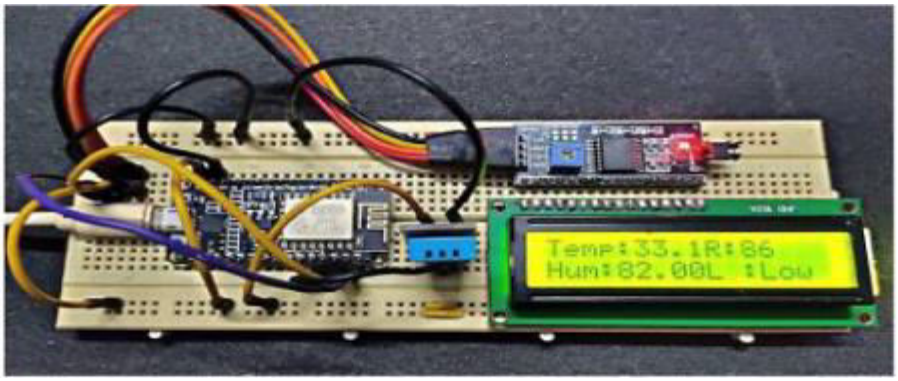

Figure 4: Enhancing Data Reliability: Leveraging IoT with Diverse Sensor Technologies

CONCLUSION

This study utilized basic IoT automation tools to streamline device management and data monitoring, enabling internet-controlled systems. The integration of wireless communication technology facilitates continuous automation processes, minimising human intervention. Additionally, the DHT11 sensor's versatility and motion detection capabilities offer a robust solution for environmental monitoring and automation. Through seamless integration with IoT platforms, real-time data retrieval and adjustments become feasible, offering applications across various domains, from laboratories to smart home systems. This research underscores the criticality of bridging the gap between IT and OT, emphasising the transformative potential of IoT in enhancing operational efficiency, productivity, and innovation across diverse sectors.

REFERENCES

W., Ulasyar, A., Mehmood, M. U., Khattak, A., Imran, K., Zad, H. S., & Nisar, S. (2021). Hierarchical Control of Microgrid Using IoT and Machine Learning Based Islanding Detection. IEEE Access, 9, 103019–103031. https://doi.org/10.1109/ACCESS.2021.3098163

Alizadeh, M., Andersson, K., & Schelen, O. (2020). A survey of secure internet of things in relation to blockchain. Journal of Internet Services and Information Security, 10(3), 47–75. https://doi.org/10.22667/JISIS.2020.08.31.047

Anik, A. A. Mamun; Adhikary, S., & Habib, Istiak; Gafur, Dr. A. (2022). IoT Based Mechanized Robot: An Integrated Process Involving Fulltime Multipurpose Control, Automation and Surveillance System. 1–6. https://doi.org/10.1109/soli54607.2021.9672395

Ashokkumar, M., & Thirumurugan, D. T. (2018). Integrated IOT based design and Android operated Multi-purpose Field Surveillance Robot for Military Use.

Chandrasekhar, R., Tanenbaum, A. S., Rangan, P. V., Association for Computing Machinery. Special Interest Group on Security, A., Association for Computing Machinery, & ACM Digital Library. (n.d.).

SecurIT 2012: The first International Conference on Security of Internet of Things: Proceedings: August 17-19, 2012, Amrita University, Amritapuri Campus, Kerala, India.

Chen, X.-Y., & Jin, Z.-G. (2012). Research on Key Technology and Applications for Internet of Things. Physics Procedia, 33, 561–566. https://doi.org/10.1016/j.phpro.2012.05.104

Huang, H., Zhu, J., & Zhang, L. (2014). An SDN_based Management Framework for IoT Devices. Kosmatos, E. A., Tselikas, N. D., & Boucouvalas, A. C. (2011). Integrating RFIDs and Smart Objects into a UnifiedInternet of Things Architecture. Advances in Internet of Things, 01(01), 5–12. https://doi.org/10.4236/ait.2011.11002

Li, B., & Yu, J. (2011). Research and application on the smart home based on component technologies and Internet of Things. Procedia Engineering, 15, 2087–2092. https://doi.org/10.1016/j.proeng.2011.08.390

Lin, J., Yu, W., Zhang, N., Yang, X., Zhang, H., & Zhao, W. (2017). A Survey on Internet of Things: Architecture, Enabling Technologies, Security and Privacy, and Applications. IEEE Internet of Things Journal, 4(5), 1125–1142. https://doi.org/10.1109/JIOT.2017.2683200

Liu, M., Yang, K., Zhao, N., Chen, Y., Song, H., & Gong, F. (2021). Intelligent Signal Classification in Industrial Distributed Wireless Sensor Networks Based Industrial Internet of Things. IEEE Transactions on Industrial Informatics, 17(7), 4946–4956. https://doi.org/10.1109/TII.2020.3016958

Pease, S. G., Trueman, R., Davies, C., Grosberg, J., Yau, K. H., Kaur, N., Conway, P., & West, A. (2018). An intelligent real-time cyber-physical toolset for energy and process prediction and optimisation in the future industrial Internet of Things. Future Generation Computer Systems, 79, 815–829. https://doi.org/10.1016/j.future.2017.09.026

Qin, S. J. (2014). Process data analytics in the era of big data. AIChE Journal, 60(9), 3092–3100. https://doi.org/10.1002/aic.14523

Salman, A. D. (2020). Mobile Robot Monitoring System based on IoT. Journal of Xi'an University of Architecture & Technology, XII(III). https://doi.org/10.37896/jxat12.03/501

Shah, D., Wang, J., & Peter He, Q. (2019). An internet-of-things enabled smart manufacturing testbed. IFAC-PapersOnLine, 52(1), 562–567. https://doi.org/10.1016/j.ifacol.2019.06.122

Shahbazi, Z., & Byun, Y. C. (2021). Integration of blockchain, iot and machine learning for multistage quality control and enhancing security in smart manufacturing. Sensors, 21(4), 1–21. https://doi.org/10.3390/s21041467

SUPRIYONO, H., ROCHMAN, P. A. N., & TOKHI, M. O. (2021). IoT Technology Involving Wheeled Line Follower Robot for Restaurant Services Automation. ELKOMIKA: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika, 9(1), 100.