International Journal of Engineering & Extended Technologies Research (IJEETR)

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268

Laser Based Non-Invasive Glucose Monitoring System with Automatic Insulin Injector

G.Malathi[1], M.Aathiga[2], M.Abi[3], E.Abina[4]

Assistant Professor &HOD, Dept. of BME, MAM School of Engineering, Siruganur, Trichy, Tamil Nadu, India[1]

IV Year Student, Dept. of BME, MAM School of Engineering, Siruganur, Trichy, Tamil Nadu, India[2-4]

Publication History: Received: 25.02.2026; Revised: 20.03.2026; Accepted: 25.03. 2026; Published: 28.03.2026.

ABSTRACT: Traditional finger-prick glucose monitoring is painful, invasive, and increases infection risk •Proposed system uses red laser light (650 nm) for non-invasive glucose detection •Red laser provides ~30× higher tissue transmittance than NIR methods •Achieves fast response time (7–10 seconds) with high accuracy and linearity •Glucose level estimated from laser light absorption and scattering in tissue •Integrated with IoT for real-time data transmission and cloud storage •Mobile app enables remote glucose monitoring and insulin dosage adjustment •Improves patient comfort, continuous monitoring, and personalized diabetes care.

KEYWORDS: Non-Invasive Glucose Monitoring, Laser-Based Sensing, IoT Healthcare, Automated Insulin Delivery, Diabetes Management

I. INTRODUCTION

Diabetes mellitus is one of the most prevalent chronic diseases worldwide, requiring continuous monitoring of blood glucose levels to prevent severe complications such as hypoglycemia, hyperglycemia, cardiovascular disorders, kidney failure, and neuropathy. Traditional glucose monitoring methods rely on invasive finger-prick testing or subcutaneous sensor implantation, which can cause pain, discomfort, skin irritation, and reduced patient compliance. Frequent blood sampling is inconvenient and often discourages patients from performing regular monitoring.

OBJECTIVES

The system aims to provide a painless, reliable, and user-friendly solution for long-term glucose monitoring and intelligent insulin therapy, contributing to the development of next-generation smart healthcare devices

II. LITERATURE REVIEW

To eliminate painful finger-prick testing by implementing a 650 nm red laser-based optical sensing method.To detect glucose concentration by analyzing light absorption and scattering variations through skin tissue.To design a signal conditioning and processing unit using a microcontroller for accurate glucose estimation.To convert raw optical sensor data into real-time glucose readings (mg/dL).To display glucose values continuously on an LCD or local display unit.To implement predefined threshold detection for identifying hypoglycemia and hyperglycemia conditions. To automatically control an insulin pump module for precise insulin delivery.To develop a closed-loop insulin management system that operates without manual intervention. To ensure the system is portable, user-friendly, and suitable for long-term monitoring.

III. PROBLEM STATEMENT

The authors proposed an automatic insulin injection system that operates using real-time Continuous Glucose Monitoring (CGM) signals. The system continuously measures glucose levels and automatically adjusts insulin dosage without requiring manual intervention. By eliminating frequent finger-stick testing and reducing human error in insulin administration, the proposed system improves patient comfort and enhances diabetes management efficiency through real-time glucose tracking and automated insulin control.

International Journal of Engineering & Extended Technologies Research (IJEETR)

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268

EXISTING SYSTEM

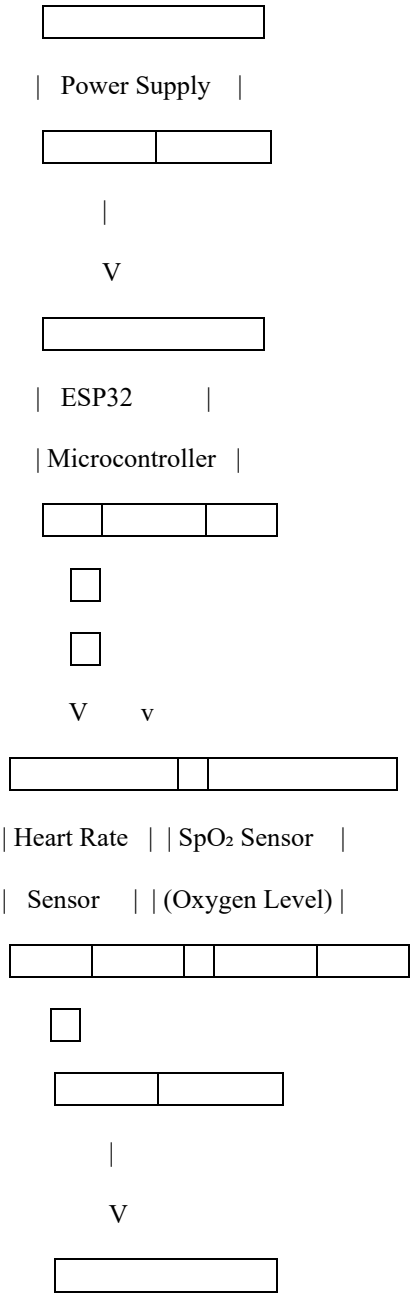
The authors proposed an intelligent insulin pump system based on advanced control algorithms such as feedback linearization and flatness-based control techniques. Unlike conventional systems that require manual bolus insulin during meals, the proposed system aims to achieve fully automated insulin delivery without supplementary injections.

PROPOSED SYSTEM

The proposed system demonstrates the feasibility of combining non-invasive optical glucose sensing with automated insulin control to create a closed-loop diabetes management solution. By eliminating invasive testing methods, the system improves patient comfort and compliance while enabling continuous real-time monitoring. The automatic insulin delivery mechanism enhances safety and reduces the risk of delayed treatment.

BLOCK DIAGRAM

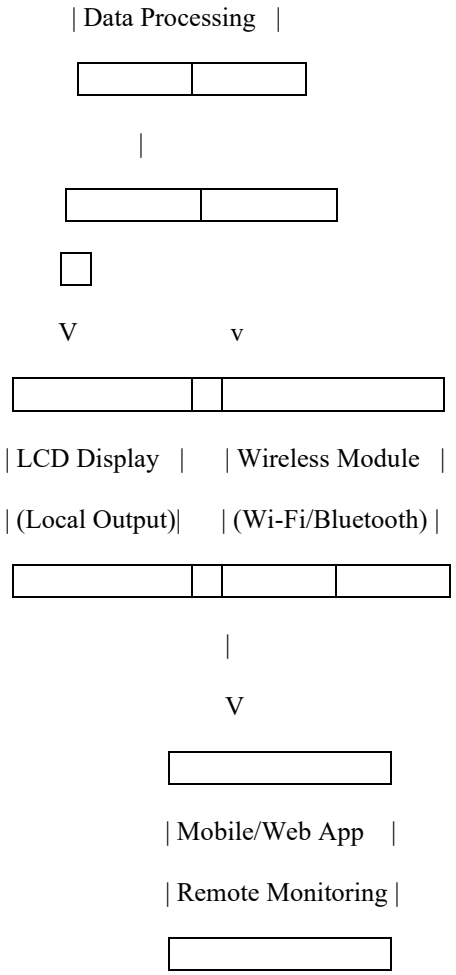
The overall working of the system can be represented using the following block diagram:



|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268



HARDWARE COMPONENTS

Power Supply Unit
- Laser
- Photo detector
- SCU
- Arduino Uno
- Esp8266
- Relay
- LCD
- Insulin Infusion Mechanism

SOFTWARE REQUIREMENTS

Arduino IDE

IV. CONCLUSION

The proposed system demonstrates the feasibility of combining non-invasive optical glucose sensing with automated insulin control to create a closed-loop diabetes management solution. By eliminating invasive testing methods, the system improves patient comfort and compliance while enabling continuous real-time monitoring. The automatic insulin delivery mechanism enhances safety and reduces the risk of delayed treatment.

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268

REFERENCES

1. Dewanjee S, Chakraborty P, Mukherjee B, De Feo V: Plant-based antidiabetic nanoformulations: the emerging paradigm for effective therapy. Int J Mol Sci. 2020, 21:2217. 10.3390/ijms21062217
2. Sun H, Saeedi P, Karuranga S, et al.: IDF diabetes atlas: global, regional, and country-level diabetes prevalence estimates for 2021 and projections for 2045. Diabetes Res Clin Pract. 2022, 183:109119. 10.1016/j.diabres.2021.109119
3. C.Nagarajan and M.Madheswaran - 'Stability Analysis of Series Parallel Resonant Converter with Fuzzy Logic Controller Using State Space Techniques'- Taylor &Francis, Electric Power Components and Systems, Vol.39 (8), pp.780-793, May 2011. DOI: 10.1080/15325008.2010.541746
4. C.Nagarajan and M.Madheswaran - 'Experimental verification and stability state space analysis of CLL-T Series Parallel Resonant Converter' - Journal of Electrical Engineering, Vol.63 (6), pp.365-372, Dec.2012. DOI: 10.2478/v10187-012-0054-2
5. C.Nagarajan and M.Madheswaran - 'Performance Analysis of LCL-T Resonant Converter with Fuzzy/PID Using State Space Analysis'- Springer, Electrical Engineering, Vol.93 (3), pp.167-178, September 2011. DOI 10.1007/s00202-011-0203-9
6. S.Tamilselvi, R.Prakash, C.Nagarajan,"Solar System Integrated Smart Grid Utilizing Hybrid Coot-Genetic Algorithm Optimized ANN Controller" Iranian Journal Of Science And Technology-Transactions Of Electrical Engineering, DOI10.1007/s40998-025-00917-z,2025
7. S.Tamilselvi, R.Prakash, C.Nagarajan," Adaptive sliding mode control of multilevel grid-connected inverters using reinforcement learning for enhanced LVRT performance" Electric Power Systems Research 253 (2026) 112428, doi.org/10.1016/j.epsr.2025.112428
8. S.Thirunavukkarasu, C. Nagarajan, 2024, "Performance Investigation on OCF and SCF study in BLDC machine using FTANN Controller," Journal of Electrical Engineering And Technology, Volume 20, pages 2675–2688, (2025), doi.org/10.1007/s42835-024-02126-w
9. C. Nagarajan, M.Madheswaran and D.Ramasubramanian- 'Development of DSP based Robust Control Method for General Resonant Converter Topologies using Transfer Function Model'- *Acta Electrotechnica et Informatica Journal* , Vol.13 (2), pp.18-31,April-June.2013, DOI: 10.2478/aeei-2013-0025.
10. C.Nagarajan and M.Madheswaran - 'DSP Based Fuzzy Controller for Series Parallel Resonant converter'- *Springer, Frontiers of Electrical and Electronic Engineering*, Vol. 7(4), pp. 438-446, Dec.12. DOI 10.1007/s11460-012-0212-0.
11. C.Nagarajan and M.Madheswaran - 'Experimental Study and steady state stability analysis of CLL-T Series Parallel Resonant Converter with Fuzzy controller using State Space Analysis'- *Iranian Journal of Electrical & Electronic Engineering*, Vol.8 (3), pp.259-267, September 2012.
12. C.Nagarajan and M.Madheswaran, "Analysis and Simulation of LCL Series Resonant Full Bridge Converter Using PWM Technique with Load Independent Operation" has been presented in ICTES'08, a IEEE / IET International Conference organized by M.G.R.University, Chennai.Vol.no.1, pp.190-195, Dec.2007
13. Suganthi Mullainathan, Ramesh Natarajan, "An SPSS and CNN modelling based quality assessment using ceramic materials and membrane filtration techniques", Revista Materia (Rio J.) Vol. 30, 2025, DOI: https://doi.org/10.1590/1517-7076-RMAT-2024-0721
14. M Suganthi, N Ramesh, "Treatment of water using natural zeolite as membrane filter", Journal of Environmental Protection and Ecology, Volume 23, Issue 2, pp: 520-530,2022
15. Iacobini C, Vitale M, Pesce C, Pugliese G, Menini S: Diabetic complications and oxidative stress: a 20-year voyage back in time and back to the future. Antioxidants (Basel). 2021, 10:727. 10.3390/antiox10050727
16. **Kiran, A., Rubini, P., & Kumar, S. S. (2025).** Comprehensive review of privacy, utility and fairness offered by synthetic data. *IEEE Access.*
17. **Gopinathan, V. R. (2024).** Real-Time Financial Risk Intelligence Using Secure-by-Design AI in SAP-Enabled Cloud Digital Banking. *International Journal of Computer Technology and Electronics Communication, 7(6), 9837-9845.*
18. **Udayakumar, R., Elankavi, R., Vimal, R., & Sugumar, R. (2023).** Improved Particle Swarm Optimization with Deep Learning-Based Municipal Solid Waste Management in Smart Cities. *Environmental & Social Management Journal, 17(4).*
19. **Anand, L. (2023).** An Intelligent AI and ML–Driven Cloud Security Framework for Financial Workflows and Wastewater Analytics. *International Journal of Humanities and Information Technology, 5(02), 87-94.*
20. **Soundappan, S. J. (2020).** Big Data Analytics in Healthcare: Applications for Pandemic Forecasting. *International Journal of Advanced Research in Computer Science & Technology, 3(1), 2248-2253.*
21. **Rajasekar, M. (2024).** Real-Time Predictive DevOps Intelligence for Risk-Aware Digital Business Processes in Cloud and SAP Ecosystems. *International Journal of Advanced Research in Computer Science & Technology, 7(4), 10713-10718.*

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268

22. **Poornima, G., & Anand, L. (2024, May). Novel AI Multimodal Approach for Combating Against Pulmonary Carcinoma. In 2024 5th International Conference for Emerging Technology (INCET) (pp. 1-6). IEEE.**
23. **Prabha, P. S., & Rengarajan, A. (2025).** Adaptive Cloud Resource Allocation Using Attention-Driven Deep Reinforcement Learning. *Engineering, Technology & Applied Science Research, 15(6), 29334-29340.*
24. **Jagadeesh, S., & Sugumar, R. (2017).** A Comparative study on Artificial Bee Colony with modified ABC algorithm. *European Journal of Applied Sciences, 9(5), 243-248.*
25. **Varma, K. K., & Anand, L. (2025, March). Deep Learning Driven Proactive Auto Scaler for High-Quality Cloud Services. In International Conference on Computing and Communication Systems for Industrial Applications (pp. 329-338). Singapore: Springer Nature Singapore.**
26. **Kumar, S. A., & Anand, L. (2025). A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS, 19(11), 3841-3855.**
27. **Poornima, G., & Anand, L. (2025). Medical image fusion model using CT and MRI images based on dual scale weighted fusion based residual attention network with encoder-decoder architecture. Biomedical Signal Processing and Control, 108, 107932.**
28. **Archana, R., & Anand, L. (2025). Residual u-net with Self-Attention based deep convolutional adaptive capsule network for liver cancer segmentation and classification. Biomedical Signal Processing and Control, 105, 107665.Kumar, S. A., & Anand, L. (2025).** A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. *KSII Transactions on Internet and Information Systems, 19(11), 3841-3855.*
29. **Rengarajan, A. (2025).** Cloud-Based AI-Driven Threat Detection Framework for Smart Grid Cybersecurity. *International Journal of Future Innovative Science and Technology, 8(6), 16065.*
30. **Murugeshwari, B., Sudharson, K., Panimalar, S. P., Shanmugapriya, M., & Abinaya, M. (2020).** SAFE–Secure Authentication in Federated Environment using CEG Key code.
31. **Raj A. A., & Sugumar, R. (2023).** Early Detection of COVID-19 with Impact on Cardiovascular Complications using CNN Utilising Pre-Processed Chest X-Ray Images. *2023 International Conference on Applied Intelligence and Sustainable Computing (ICAISC), IEEE.*
32. **Jagadeesh, S., & Sugumar, R. (2017). A Comparative study on Artificial Bee Colony with modified ABC algorithm. European Journal of Applied Sciences, 9(5), 243-248.**
33. **Selvi, G. V., Anbarasan, A. B., Murthy, B. A., & Prabavathy, S. (2023).** An Application Oriented Integrated Unequal Clustering Algorithm for Wireless Sensor Network. In *Underwater Vehicle Control and Communication Systems Based on Machine Learning Techniques* (pp. 140-154). CRC Press.
34. **Sruthi, R. S., Ananya, S., & Murugeshwari, B. (2010).** Web Based Virtual Control System Laboratory and On-Line Temperature Control of Electrophoresis Equipment using LabVIEW. *International Journal of Computer Applications, 975, 8887.*
35. **Vimal Raja, G. (2021).** Mining Customer Sentiments from Financial Feedback and Reviews using Data Mining Algorithms. *International Journal of Innovative Research in Computer and Communication Engineering, 9(12), 14705-14710.*
36. MATHEW, A. R. (2025). Neurosecurity and Brain-Computer Interfaces.
37. Soundappan, S. J. (2024). AI-Driven Customer Intelligence in Enterprise Lakehouse Systems Sentiment Mining Governance-Aware Analytics and Real-Time Data Synchronization. International Journal of Advanced Engineering Science and Information Technology (IJAESIT), 7(5), 14905.
38. Mathew, A. (2025). Human–AI Collaboration in Security Operations: Measuring Alert Trust, Automation Bias, and Analyst Upskilling in AI-Augmented SOC Environments. International Journal of Computer Technology and Electronics Communication, 8(5), 11375-11380.
39. Soundappan, S. J. (2022). AI-Based Fault Detection and Isolation for Reliability in Modern Power Systems. International Journal of Research Publications in Engineering, Technology and Management (IJRPETM), 5(4), 7106-7110.
40. **Poornima, G., & Anand, L. (2024, April). Effective Machine Learning Methods for the Detection of Pulmonary Carcinoma. In 2024 Ninth International Conference on Science Technology Engineering and Mathematics (ICONSTEM) (pp. 1-7). IEEE.Garg, V. K., Soundappan, S. J., & Kaur, E. M. (2020).** Enhancement in intrusion detection system for WLAN using genetic algorithms. *South Asian Research Journal of Engineering and Technology, 2(6), 62–64.*
41. Rengarajan, A., Jayakumar, C., & Sugumar, R. (2012). Optimization Of Recent Attacks Using Internet Protocol. National Journal of System and Information Technology, 5(1), 8.
42. Mathew, A. (2024). AI TRiSM: Trust, Risk, and Security Management in Cybersecurity. Cybersecurity, 4(3), 84-90.

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268

43. Mathew, A. (2025). Deep seek vs. ChatGPT: A deep dive into AI Language mastery. Int J Multidisciplinary Res, 7(1), 1-5.
44. Nishikawa T, Edelstein D, Brownlee M: The missing link: a single unifying mechanism for diabetic complications. Kidney Int Suppl. 2000, 77:26-30. 10.1046/j.1523-1755.2000.07705.x
45. Rolo AP, Palmeira CM: Diabetes and mitochondrial function: role of hyperglycemia and oxidative stress . Toxicol Appl Pharmacol. 2006, 212:167-78. 10.1016/j.taap.2006.01.003
46. **Kiran, A., Rubini, P., & Kumar, S. S. (2025).** Comprehensive review of privacy, utility and fairness offered by synthetic data. *IEEE Access.*
47. **Gopinathan, V. R. (2024).** Real-Time Financial Risk Intelligence Using Secure-by-Design AI in SAP-Enabled Cloud Digital Banking. *International Journal of Computer Technology and Electronics Communication, 7(6), 9837-9845.*
48. **Udayakumar, R., Elankavi, R., Vimal, R., & Sugumar, R. (2023).** Improved Particle Swarm Optimization with Deep Learning-Based Municipal Solid Waste Management in Smart Cities. *Environmental & Social Management Journal, 17(4).*
49. **Anand, L. (2023).** An Intelligent AI and ML–Driven Cloud Security Framework for Financial Workflows and Wastewater Analytics. *International Journal of Humanities and Information Technology, 5(02), 87-94.*
50. **Soundappan, S. J. (2020).** Big Data Analytics in Healthcare: Applications for Pandemic Forecasting. *International Journal of Advanced Research in Computer Science & Technology, 3(1), 2248-2253.*
51. **Rajasekar, M. (2024).** Real-Time Predictive DevOps Intelligence for Risk-Aware Digital Business Processes in Cloud and SAP Ecosystems. *International Journal of Advanced Research in Computer Science & Technology, 7(4), 10713-10718.*
52. **Poornima, G., & Anand, L. (2024, May). Novel AI Multimodal Approach for Combating Against Pulmonary Carcinoma. In 2024 5th International Conference for Emerging Technology (INCET) (pp. 1-6). IEEE.**
53. **Prabha, P. S., & Rengarajan, A. (2025).** Adaptive Cloud Resource Allocation Using Attention-Driven Deep Reinforcement Learning. *Engineering, Technology & Applied Science Research, 15(6), 29334-29340.*
54. **Jagadeesh, S., & Sugumar, R. (2017).** A Comparative study on Artificial Bee Colony with modified ABC algorithm. *European Journal of Applied Sciences, 9(5), 243-248.*
55. **Varma, K. K., & Anand, L. (2025, March). Deep Learning Driven Proactive Auto Scaler for High-Quality Cloud Services. In International Conference on Computing and Communication Systems for Industrial Applications (pp. 329-338). Singapore: Springer Nature Singapore.**
56. **Kumar, S. A., & Anand, L. (2025). A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS, 19(11), 3841-3855.**
57. **Poornima, G., & Anand, L. (2025). Medical image fusion model using CT and MRI images based on dual scale weighted fusion based residual attention network with encoder-decoder architecture. Biomedical Signal Processing and Control, 108, 107932.**
58. **Archana, R., & Anand, L. (2025). Residual u-net with Self-Attention based deep convolutional adaptive capsule network for liver cancer segmentation and classification. Biomedical Signal Processing and Control, 105, 107665.Kumar, S. A., & Anand, L. (2025).** A Novel EEG-Based Deep Learning Framework for Enhancing Communication in Locked-In Syndrome Using P300 Speller and Attention Mechanisms. *KSII Transactions on Internet and Information Systems, 19(11), 3841-3855.*
59. **Rengarajan, A. (2025).** Cloud-Based AI-Driven Threat Detection Framework for Smart Grid Cybersecurity. *International Journal of Future Innovative Science and Technology, 8(6), 16065.*
60. **Murugeshwari, B., Sudharson, K., Panimalar, S. P., Shanmugapriya, M., & Abinaya, M. (2020).** SAFE–Secure Authentication in Federated Environment using CEG Key code.
61. **Raj A. A., & Sugumar, R. (2023).** Early Detection of COVID-19 with Impact on Cardiovascular Complications using CNN Utilising Pre-Processed Chest X-Ray Images. *2023 International Conference on Applied Intelligence and Sustainable Computing (ICAISC), IEEE.*
62. **Jagadeesh, S., & Sugumar, R. (2017). A Comparative study on Artificial Bee Colony with modified ABC algorithm. European Journal of Applied Sciences, 9(5), 243-248.**
63. **Selvi, G. V., Anbarasan, A. B., Murthy, B. A., & Prabavathy, S. (2023).** An Application Oriented Integrated Unequal Clustering Algorithm for Wireless Sensor Network. In *Underwater Vehicle Control and Communication Systems Based on Machine Learning Techniques* (pp. 140-154). CRC Press.
64. **Sruthi, R. S., Ananya, S., & Murugeshwari, B. (2010).** Web Based Virtual Control System Laboratory and On-Line Temperature Control of Electrophoresis Equipment using LabVIEW. *International Journal of Computer Applications, 975, 8887.*

|ISSN: 2322-0163| www.ijeetr.com | A Bimonthly, Peer Reviewed, Scholarly Indexed Journal |

| Volume 8, Issue 2, March - April 2026 |

DOI:10.15662/IJEETR.2026.0802268

65. **Vimal Raja, G. (2021).** Mining Customer Sentiments from Financial Feedback and Reviews using Data Mining Algorithms. *International Journal of Innovative Research in Computer and Communication Engineering, 9(12), 14705-14710.*
66. MATHEW, A. R. (2025). Neurosecurity and Brain-Computer Interfaces.
67. Soundappan, S. J. (2024). AI-Driven Customer Intelligence in Enterprise Lakehouse Systems Sentiment Mining Governance-Aware Analytics and Real-Time Data Synchronization. International Journal of Advanced Engineering Science and Information Technology (IJAESIT), 7(5), 14905.
68. Mathew, A. (2025). Human–AI Collaboration in Security Operations: Measuring Alert Trust, Automation Bias, and Analyst Upskilling in AI-Augmented SOC Environments. International Journal of Computer Technology and Electronics Communication, 8(5), 11375-11380.
69. Soundappan, S. J. (2022). AI-Based Fault Detection and Isolation for Reliability in Modern Power Systems. International Journal of Research Publications in Engineering, Technology and Management (IJRPETM), 5(4), 7106-7110.
70. **Poornima, G., & Anand, L. (2024, April). Effective Machine Learning Methods for the Detection of Pulmonary Carcinoma. In 2024 Ninth International Conference on Science Technology Engineering and Mathematics (ICONSTEM) (pp. 1-7). IEEE.Garg, V. K., Soundappan, S. J., & Kaur, E. M. (2020).** Enhancement in intrusion detection system for WLAN using genetic algorithms. *South Asian Research Journal of Engineering and Technology, 2(6), 62–64.*
71. Rengarajan, A., Jayakumar, C., & Sugumar, R. (2012). Optimization Of Recent Attacks Using Internet Protocol. National Journal of System and Information Technology, 5(1), 8.
72. Mathew, A. (2024). AI TRiSM: Trust, Risk, and Security Management in Cybersecurity. Cybersecurity, 4(3), 84-90.
73. Mathew, A. (2025). Deep seek vs. ChatGPT: A deep dive into AI Language mastery. Int J Multidisciplinary Res, 7(1), 1-5.