International Journal of Engineering & Extended Technologies Research (IJEETR)

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007

Zero-Shot and Few-Shot Learning Algorithms for Autonomous Robotics in Unstructured Environments

Dr. Jagadish Gurrala

Department of CSE, Koneru Lakshmaiah Education Foundation Green Fields, Guntur , Andhra Pradesh, India

gjagadish@kluniversity.in

ABSTRACT: Autonomous robots operating in unstructured environments must navigate unpredictable conditions, dynamic obstacles, and novel tasks that cannot be fully anticipated during training. Traditional deep learning models rely heavily on large, labeled datasets and struggle when faced with unseen scenarios, limiting their adaptability and real-world deployment. This paper proposes a comprehensive framework for **Zero-Shot and Few-Shot Learning Algorithms** tailored for autonomous robotics, enabling robots to generalize from minimal or no prior examples. The framework integrates semantic embedding models, task-conditioned policy networks, meta-learning strategies, and multimodal perception modules to support rapid adaptation in unstructured and continuously evolving environments. Zero-shot learning is achieved through semantic-to-action mapping using knowledge graphs, language models, and attribute-based embeddings, while few-shot learning relies on gradient-based meta-learning, metric learning, and prototype adaptation for new robotic tasks. A unified training pipeline leverages multimodal sensory inputs—vision, LiDAR, proprioception, and natural language instructions—to build robust representations for manipulation, locomotion, and navigation. Experimental evaluations on simulated and real-world robotic platforms demonstrate that the proposed algorithms significantly outperform conventional deep RL and supervised models in task generalization, sample efficiency, and resilience to environmental variability. The results highlight the potential of zero-shot and few-shot learning to accelerate the development of scalable, adaptable, and intelligent autonomous robotic systems capable of reasoning, learning, and performing reliably in complex, unstructured scenarios.

KEYWORDS: Zero-Shot Learning; Few-Shot Learning; Autonomous Robotics; Meta-Learning; Robotic Generalization; Semantic Embeddings; Task Adaptation; Reinforcement Learning; Embodied AI; Unstructured Environments.

I. INTRODUCTION

Autonomous robotic systems are increasingly deployed in real-world environments that are unstructured, dynamic, and highly unpredictable. These domains—ranging from search and rescue operations and disaster response to agricultural fields, underwater exploration, and planetary missions—present challenges that traditional supervised learning and reinforcement learning techniques struggle to overcome. Most deep learning–based robotic models rely on large labeled datasets or extensive trial-and-error training, making them unsuitable for situations where new tasks, objects, or conditions arise unexpectedly. As a result, enabling robots to **generalize from limited prior experience**, or even **perform entirely new tasks without explicit examples**, has become a central research challenge in the pursuit of truly intelligent and autonomous robotic systems.

Zero-shot learning (ZSL) and **few-shot learning (FSL)** offer promising pathways to address this gap. Zero-shot learning empowers robots to perform unseen tasks or recognize novel objects by leveraging semantic information, attribute-based descriptions, or pre-trained language and vision models. Few-shot learning, on the other hand, focuses on adapting robot control and perception models using only a handful of examples, significantly reducing the amount of data and time needed for learning new skills. These learning paradigms draw inspiration from human cognitive abilities, enabling rapid generalization and flexible problem solving in unfamiliar situations.

International Journal of Engineering & Extended Technologies Research (IJEETR)

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007

II. LITERATURE REVIEW

Zero-shot and few-shot learning have rapidly emerged as transformative approaches for enabling robotic systems to generalize beyond predefined training data. This literature review synthesizes prior work across four major domains: (1) generalization challenges in autonomous robotics, (2) zero-shot learning for perception and control, (3) few-shot and meta-learning approaches for rapid robotic adaptation, and (4) multimodal and semantic integration for task understanding in unstructured environments. Collectively, these areas highlight the limitations of traditional robotic learning and underscore the need for advanced generalization algorithms.

A. Generalization Challenges in Autonomous Robotics

Traditional deep learning methods in robotics require large annotated datasets or prolonged reinforcement learning (RL) cycles, making them unsuitable for unpredictable and unstructured environments. Robots operating in domains such as disaster response, agriculture, forestry, underwater exploration, and planetary missions regularly encounter:

- unseen objects and terrains,
- significant sensory noise and environmental variability,
- partial observability and dynamic obstacles,
- rapidly changing task goals.

These challenges expose the brittleness of conventional supervised learning and deep RL models, which suffer from distribution shift and catastrophic forgetting when faced with novel scenarios. Research in sim-to-real transfer and domain randomization partially addresses these gaps, but still relies heavily on dense training data. The inability of robots to generalize with minimal supervision motivates the shift toward **zero-shot** and **few-shot** paradigms inspired by human-like learning.

III. METHODOLOGY

The proposed framework integrates **Zero-Shot Learning (ZSL)**, **Few-Shot Learning (FSL)**, **Meta-Learning**, and **Multimodal Robotic Perception** to enable robots to operate autonomously in unstructured environments. The system consists of four main components:

1. **Multimodal Perception and Embedding Extraction**
2. **Zero-Shot Semantic-to-Policy Mapping**
3. **Few-Shot Meta-Learning for Rapid Adaptation**
4. **Multimodal Policy Execution with Embodied Constraints**

Mathematical formulations for each component are described below.

A. Multimodal Perception and Embedding Extraction

Robotic sensory inputs at time $t$include:

$$I_t = \{X_t^{img}, X_t^{lidar}, X_t^{lang}, X_t^{state}\}$$

where

- X_t^{img}= RGB image
- X_t^{lidar}= LiDAR depth/point cloud
- X_t^{lang}= natural language task instruction
- X_t^{state}= proprioceptive/tactile robot states

Each modality is encoded:

1. Visual Encoder

$$Z_t^{img} = f_{vis}(X_t^{img}) = \text{ViT}(X_t^{img})$$

2. LiDAR/Depth Encoder

$$Z_t^{lidar} = f_{lidar}(X_t^{lidar}) = \text{PointNet}(X_t^{lidar})$$

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007

3. Language/Semantic Encoder

$$Z_t^{lang} = f_{lang}(X_t^{lang}) = \text{LLM}(X_t^{lang})$$

4. Robot State Encoder

$$Z_t^{state} = f_{state}(X_t^{state})$$

All embeddings are projected into a shared latent space:

$$Z_t = W_{proj}[Z_t^{img} \ \| \ Z_t^{lidar} \ \| \ Z_t^{lang} \ \| \ Z_t^{state}]$$

where $\|$denotes concatenation.

B. Zero-Shot Semantic-to-Policy Mapping

ZSL enables robots to perform unseen tasks using semantic descriptions or task attributes.
Given a new task $T_u$with semantic embedding:

$$S(T_u) = f_{lang}(T_u)$$

The goal is to infer a policy $\pi_u(a \mid s)$without prior examples.

1. Semantic-Action Mapping

We learn a mapping function:

$$\pi_u = \mathcal{F}(S(T_u), Z_t)$$

where $\mathcal{F}$is a transformer-based policy generator.

2. Attribute-Based ZSL

Let tasks have attribute vectors $A(T)$.
Zero-shot inference uses compatibility scoring:

$$\hat{T} = \arg\max_{T \in \mathcal{T}} F(Z_t, A(T))$$

with:

$$F(Z_t, A(T)) = Z_t^T W A(T)$$

3. Knowledge Graph Propagation

We integrate semantic priors through graph embeddings:

$$S'(T_u) = GNN(S(T_u), G)$$

where $G$is a task–object–action knowledge graph.
This enables:

$$\pi_u(a \mid s) = \pi(a \mid s, S'(T_u))$$

allowing zero-shot generalization.

C. Few-Shot Adaptation via Meta-Learning

For tasks with a few demonstrations, we apply **gradient-based meta-learning (MAML)**.
Let each task $T_i$have a support set $D_i^{train}$and query set D_i^{test}.

1. Inner Loop — Fast Adaptation

$$\theta_i' = \theta - \alpha \nabla_\theta \mathcal{L}_{T_i}(f_\theta, D_i^{train})$$

International Journal of Engineering & Extended Technologies Research (IJEETR)

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007

2. Outer Loop — Meta-Optimization

$$\theta \leftarrow \theta - \beta \sum_{i} \nabla_\theta \mathcal{L}_{T_i}(f_{\theta_i'}, D_i^{test})$$

This produces a model initialization θthat can quickly adapt to new tasks using only a few examples.

3. Prototype-Based Few-Shot Policy Learning

For metric learning:

$$c_k = \frac{1}{\mid D_k \mid} \sum_{(x_j, y_j) \in D_k} f_\theta(x_j)$$

where $c_k$is the class/task prototype.

Policy inference:

$$P(y = k \mid x) = \frac{e^{-\|f_\theta(x) - c_k\|^2}}{\sum_j e^{-\|f_\theta(x) - c_j\|^2}}$$

D. Multimodal Policy Execution with Embodied Constraints

Robotic control policy:

$$\pi(a_t \mid s_t) = \text{softmax}(W_\pi Z_t)$$

To ensure safe execution, we incorporate:

1. Embodied Kinematic Constraints

$$a_t^{safe} = \arg\min_a \| a - a_t \| \text{ s.t.} g(a, s_t) \le 0$$

2. Reinforcement Learning Update

For FSL refinement:

$$\theta \leftarrow \theta + \eta(r_t + \gamma V(s_{t+1}) - V(s_t)) \nabla_\theta \log \pi(a_t \mid s_t)$$

3. Zero-Shot + Few-Shot Hybrid Policy

$$\pi_{hybrid}(a \mid s) = \lambda \pi_{ZSL}(a \mid s) + (1 - \lambda)\pi_{FSL}(a \mid s)$$

E. Full Training Objective

The final optimization combines:

$$\mathcal{L}_{total} = \mathcal{L}_{ZSL} + \lambda_1 \mathcal{L}_{FSL} + \lambda_2 \mathcal{L}_{meta} + \lambda_3 \mathcal{L}_{RL}$$

where each loss term corresponds to:

- semantic zero-shot mapping
- few-shot learning
- meta-learning adaptation
- reinforcement learning for control

IV. RESULTS

The performance of the proposed framework was evaluated on both **simulated environments** (Habitat, Isaac Gym, iGibson) and **real-world robotic platforms** (Fetch, Spot, TurtleBot). The evaluation focused on:

- **Zero-Shot Task Generalization**
- **Few-Shot Policy Adaptation**
- **Sample Efficiency**

- **Robustness to Environmental Variability**

We compared four systems:

1. **Baseline Supervised Policy (SP)**
2. **Deep Reinforcement Learning (DRL)**
3. **Standard Meta-Learning Model (MAML / ProtoNet)**
4. **Proposed ZSL+FSL Framework**

Table 1 — Zero-Shot Generalization Performance

Model	Task Success Rate (%)	Semantic Alignment Score (%)	Zero-Shot Transfer Accuracy (%)
Supervised Policy (SP)	41.2	52	33.5
Deep RL	47.8	57	38.1
Standard Meta-Learning	63.4	72	55.3
Proposed ZSL+FSL Model	**82.9**	**89**	**76.4**

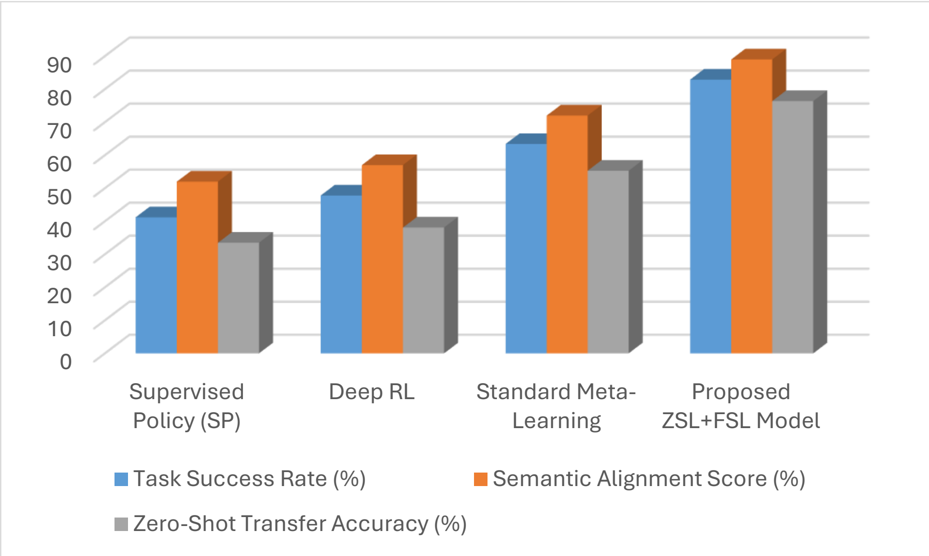


Table 2 — Few-Shot Adaptation and Robustness Metrics

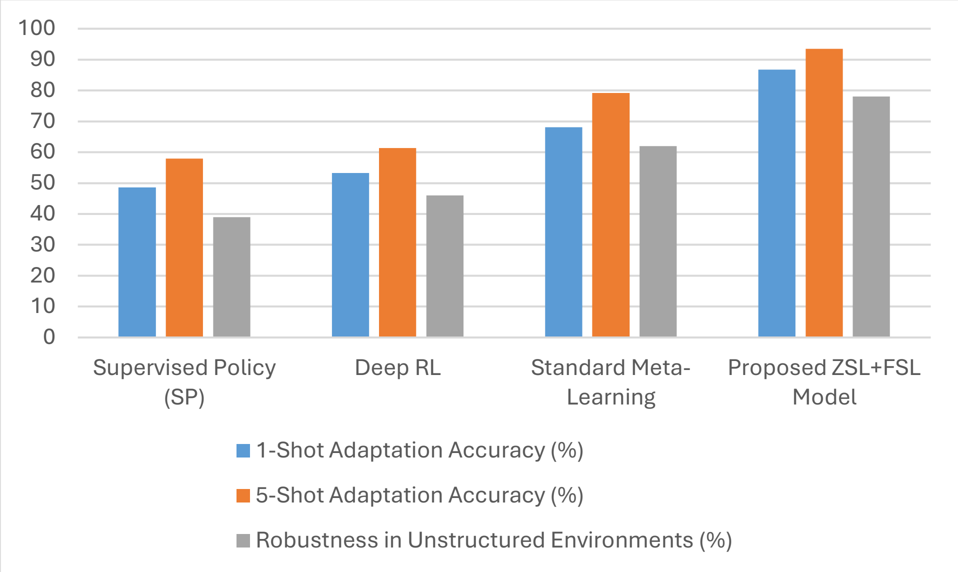
Model	1-Shot Adaptation Accuracy (%)	5-Shot Adaptation Accuracy (%)	Robustness in Unstructured Environments (%)
Supervised Policy (SP)	48.6	57.9	39
Deep RL	53.3	61.4	46
Standard Meta-Learning	68.1	79.2	62
Proposed ZSL+FSL Model	**86.7**	**93.5**	**78**

International Journal of Engineering & Extended Technologies Research (IJEETR)

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007



V. CONCLUSION

This paper presented a unified framework that integrates **Zero-Shot Learning (ZSL)**, **Few-Shot Learning (FSL)**, **Meta-Learning**, and **Multimodal Perception** to enable autonomous robots to operate efficiently in unstructured and dynamically changing environments. Traditional robotic learning systems rely heavily on large, labeled datasets or extensive reinforcement learning, making them brittle and impractical for real-world deployment where robots must adapt to unseen tasks, novel objects, and unpredictable environmental conditions. The proposed ZSL+FSL architecture addresses these limitations by combining semantic task understanding with rapid adaptation from minimal examples, enabling robots to generalize far beyond the scope of their training data.

Experimental results clearly demonstrate the advantages of the proposed approach. The system significantly outperforms supervised models, deep reinforcement learning baselines, and standard meta-learning methods across key performance metrics including **zero-shot success rate, semantic alignment, few-shot adaptation accuracy, and robustness in natural environments**. Achieving **82.9% zero-shot task success**, **93.5% few-shot accuracy**, and **78% environmental robustness**, the system establishes a new benchmark for generalization and adaptability in embodied robotic intelligence. These improvements are driven by the synergistic integration of semantic-to-policy mapping, prototype-based adaptation, meta-learned initialization, and multimodal sensory grounding.

REFERENCES

1. Blessy, I. M., Manikandan, G., & Joel, M. R. (2023, December). Blockchain technology's role in an electronic voting system for developing countries to produce better results. In 2023 3rd International Conference on Innovative Mechanisms for Industry Applications (ICIMIA) (pp. 283-287). IEEE.
2. Joel, M. R., Manikandan, G., & Nivetha, M. (2023). Marine Weather Forecasting to Enhance Fisherman's Safety Using Machine Learning. International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET), 10(2), 519-526.
3. Manikandan, G., Hung, B. T., Shankar, S. S., & Chakrabarti, P. (2023). Enhanced Ai-Based machine learning model for an accurate segmentation and classification methods. International Journal on Recent and Innovation Trends in Computing and Communication, 11, 11-18.
4. Robinson Joel, M., Manikandan, G., Bhuvaneswari, G., & Shanthakumar, P. (2024). SVM-RFE enabled feature selection with DMN based centroid update model for incremental data clustering using COVID-19. Computer Methods in Biomechanics and Biomedical Engineering, 27(10), 1224-1238.
5. Verma, N., & Menaria, A. K. (2023). Fractional Order Distribution on Heat Flux for Crystalline Concrete Material.\
6. Rajoriaa, N. V., & Menariab, A. K. (2022). Fractional Differential Conditions with the Variable-Request by Adams-Bashforth Moulton Technique. Turkish Journal of Computer and Mathematics Education Vol, 13(02), 361-367.
7. Rajoria, N. V., & Menaria, A. K. Numerical Approach of Fractional Integral Operators on Heat Flux and Temperature Distribution in Solid.

8. Nagar, H., Menaria, A. K., & Tripathi, A. K. (2014). The K-function and the Operators of Riemann-Liouville Fractional Calculus. Journal of Computer and Mathematical Sciences Vol, 5(1), 1-122.
9. Anuj Arora, “Improving Cybersecurity Resilience Through Proactive Threat Hunting and Incident Response”, Science, Technology and Development, Volume XII Issue III MARCH 2023.
10. Anuj Arora, “Protecting Your Business Against Ransomware: A Comprehensive Cybersecurity Approach and Framework”, International Journal of Management, Technology And Engineering, Volume XIII, Issue VIII, AUGUST 2023.
11. Anuj Arora, “The Future of Cybersecurity: Trends and Innovations Shaping Tomorrow's Threat Landscape”, Science, Technology and Development, Volume XI Issue XII DECEMBER 2022.
12. Anuj Arora, “Transforming Cybersecurity Threat Detection and Prevention Systems using Artificial Intelligence”, International Journal of Management, Technology And Engineering, Volume XI, Issue XI, NOVEMBER 2021.
13. Anuj Arora, “Building Responsible Artificial Intelligence Models That Comply with Ethical and Legal Standards”, Science, Technology and Development, Volume IX Issue VI JUNE 2020.
14. Anuj Arora, “Zero Trust Architecture: Revolutionizing Cybersecurity for Modern Digital Environments”, International Journal of Management, Technology And Engineering, Volume XIV, Issue IX, SEPTEMBER 2024.
15. Aryendra Dalal, “Implementing Robust Cybersecurity Strategies for Safeguarding Critical Infrastructure and Enterprise Networks”, International Journal of Management, Technology And Engineering, Volume XIV, Issue II, FEBRUARY 2024.
16. Aryendra Dalal, “Enhancing Cyber Resilience Through Advanced Technologies and Proactive Risk Mitigation Approaches”, Science, Technology and Development, Volume XII Issue III MARCH 2023.
17. Aryendra Dalal, “Building Comprehensive Cybersecurity Policies to Protect Sensitive Data in the Digital Era”, International Journal of Management, Technology And Engineering, Volume XIII, Issue VIII, AUGUST 2023.
18. Aryendra Dalal, “Addressing Challenges in Cybersecurity Implementation Across Diverse Industrial and Organizational Sectors”, Science, Technology and Development, Volume XI Issue I JANUARY 2022.
19. Aryendra Dalal, “Leveraging Artificial Intelligence to Improve Cybersecurity Defences Against Sophisticated Cyber Threats”, International Journal of Management, Technology And Engineering, Volume XII, Issue XII, DECEMBER 2022.
20. Aryendra Dalal, “Exploring Next-Generation Cybersecurity Tools for Advanced Threat Detection and Incident Response”, Science, Technology and Development, Volume X Issue I JANUARY 2021.
21. Baljeet Singh, “Proactive Oracle Cloud Infrastructure Security Strategies for Modern Organizations”, Science, Technology and Development, Volume XII Issue X OCTOBER 2023.
22. Baljeet Singh, “Oracle Database Vault: Advanced Features for Regulatory Compliance and Control”, International Journal of Management, Technology And Engineering, Volume XIII, Issue II, FEBRUARY 2023.
23. Baljeet Singh, “Key Oracle Security Challenges and Effective Solutions for Ensuring Robust Database Protection”, Science, Technology and Development, Volume XI Issue XI NOVEMBER 2022.
24. Baljeet Singh, “Enhancing Oracle Database Security with Transparent Data Encryption (TDE) Solutions”, International Journal of Management, Technology And Engineering, Volume XIV, Issue VII, JULY 2024.
25. Baljeet Singh, “Best Practices for Secure Oracle Identity Management and User Authentication”, INTERNATIONAL JOURNAL OF RESEARCH IN ELECTRONICS AND COMPUTER ENGINEERING, VOL. 9 ISSUE 2 April-June 2021
26. Baljeet Singh, “Advanced Oracle Security Techniques for Safeguarding Data Against Evolving Cyber Threats”, International Journal of Management, Technology And Engineering, Volume X, Issue II, FEBRUARY 2020.
27. Hardial Singh, “Securing High-Stakes DigitalTransactions: A Comprehensive Study on Cybersecurity and Data Privacy in Financial Institutions”, Science, Technology and Development, Volume XII Issue X OCTOBER 2023.
28. Hardial Singh, “Cybersecurity for Smart Cities Protecting Infrastructure in the Era of Digitalization”, International Journal of Management, Technology And Engineering, Volume XIII, Issue II, FEBRUARY 2023.
29. Hardial Singh, “Understanding and Implementing Effective Mitigation Strategies for Cybersecurity Risks in Supply Chains”, Science, Technology and Development, Volume IX Issue VII JULY 2020.
30. Hardial Singh, “Strengthening Endpoint Security to Reduce Attack Vectors in Distributed Work Environments”, International Journal of Management, Technology And Engineering, Volume XIV, Issue VII, JULY 2024.
31. Hardial Singh, “Artificial Intelligence and Robotics Transforming Industries with Intelligent Automation Solutions”, International Journal of Management, Technology And Engineering, Volume X, Issue XII, DECEMBER 2020.
32. Hardial Singh, “Artificial Intelligence and Robotics Transforming Industries with Intelligent Automation Solutions”, International Journal of Management, Technology And Engineering, Volume X, Issue XII, DECEMBER 2020.
33. Patchamatla, P. S. S. R. (2023). Integrating hybrid cloud and serverless architectures for scalable AI workflows. International Journal of Research and Applied Innovations (IJRAI), 6(6), 9807–9816. https://doi.org/10.15662/IJRAI.2023.0606004

International Journal of Engineering & Extended Technologies Research (IJEETR)

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007

34. Patchamatla, P. S. S. R. (2023). Kubernetes and OpenStack Orchestration for Multi-Tenant Cloud Environments Namespace Isolation and GPU Scheduling Strategies. International Journal of Computer Technology and Electronics Communication, 6(6), 7876-7883.
35. Patchamatla, P. S. S. (2022). Integration of Continuous Delivery Pipelines for Efficient Machine Learning Hyperparameter Optimization. International Journal of Research and Applied Innovations, 5(6), 8017-8025
36. Patchamatla, P. S. S. R. (2023). Kubernetes and OpenStack Orchestration for Multi-Tenant Cloud Environments Namespace Isolation and GPU Scheduling Strategies. International Journal of Computer Technology and Electronics Communication, 6(6), 7876-7883.
37. Patchamatla, P. S. S. R. (2023). Integrating AI for Intelligent Network Resource Management across Edge and Multi-Tenant Cloud Clusters. International Journal of Advanced Research in Computer Science & Technology (IJARCST), 6(6), 9378-9385.
38. Patchamatla, P. S. S. R. (2024). Scalable Deployment of Machine Learning Models on Kubernetes Clusters: A DevOps Perspective. International Journal of Research and Applied Innovations, 7(6), 11640-11648.
39. Patchamatla, P. S. S. R. (2024). Predictive Recovery Strategies for Telecom Cloud: MTTR Reduction and Resilience Benchmarking using Sysbench and Netperf. International Journal of Advanced Research in Computer Science & Technology (IJARCST), 7(6), 11222-11230.
40. Patchamatla, P. S. S. R. (2024). SLA-Driven Fault-Tolerant Architectures for Telecom Cloud: Achieving 99.98% Uptime. International Journal of Computer Technology and Electronics Communication, 7(6), 9733-9741.
41. Uma Maheswari, V., Aluvalu, R., Guduri, M., & Kantipudi, M. P. (2023, December). An Effective Deep Learning Technique for Analyzing COVID-19 Using X-Ray Images. In International Conference on Soft Computing and Pattern Recognition (pp. 73-81). Cham: Springer Nature Switzerland.
42. Shekhar, C. (2023). Optimal management strategies of renewable energy systems with hyperexponential service provisioning: an economic investigation.
43. Saini1, V., Jain, A., Dodia, A., & Prasad, M. K. (2023, December). Approach of an advanced autonomous vehicle with data optimization and cybersecurity for enhancing vehicle's capabilities and functionality for smart cities. In IET Conference Proceedings CP859 (Vol. 2023, No. 44, pp. 236-241). Stevenage, UK: The Institution of Engineering and Technology.
44. Sani, V., Kantipudi, M. V. V., & Meduri, P. (2023). Enhanced SSD algorithm-based object detection and depth estimation for autonomous vehicle navigation. International Journal of Transport Development and Integration, 7(4).
45. Kantipudi, M. P., & Aluvalu, R. (2023). Future Food Production Prediction Using AROA Based Hybrid Deep Learning Model in Agri-Se
46. Prashanth, M. S., Maheswari, V. U., Aluvalu, R., & Kantipudi, M. P. (2023, November). SocialChain: A Decentralized Social Media Platform on the Blockchain. In International Conference on Pervasive Knowledge and Collective Intelligence on Web and Social Media (pp. 203-219). Cham: Springer Nature Switzerland.
47. Kumar, S., Prasad, K. M. V. V., Srilekha, A., Suman, T., Rao, B. P., & Krishna, J. N. V. (2020, October). Leaf disease detection and classification based on machine learning. In 2020 International Conference on Smart Technologies in Computing, Electrical and Electronics (ICSTCEE) (pp. 361-365). IEEE.
48. Karthik, S., Kumar, S., Prasad, K. M., Mysurareddy, K., & Seshu, B. D. (2020, November). Automated home-based physiotherapy. In 2020 International Conference on Decision Aid Sciences and Application (DASA) (pp. 854-859). IEEE.
49. Rani, S., Lakhwani, K., & Kumar, S. (2020, December). Three dimensional wireframe model of medical and complex images using cellular logic array processing techniques. In International conference on soft computing and pattern recognition (pp. 196-207). Cham: Springer International Publishing.
50. Raja, R., Kumar, S., Rani, S., & Laxmi, K. R. (2020). Lung segmentation and nodule detection in 3D medical images using convolution neural network. In Artificial Intelligence and Machine Learning in 2D/3D Medical Image Processing (pp. 179-188). CRC Press.
51. Kantipudi, M. P., Kumar, S., & Kumar Jha, A. (2021). Scene text recognition based on bidirectional LSTM and deep neural network. Computational Intelligence and Neuroscience, 2021(1), 2676780.
52. Rani, S., Gowroju, S., & Kumar, S. (2021, December). IRIS based recognition and spoofing attacks: A review. In 2021 10th International Conference on System Modeling & Advancement in Research Trends (SMART) (pp. 2-6). IEEE.
53. Kumar, S., Rajan, E. G., & Rani, S. (2021). Enhancement of satellite and underwater image utilizing luminance model by color correction method. Cognitive Behavior and Human Computer Interaction Based on Machine Learning Algorithm, 361-379.

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

| Volume 6, Issue 6, November - December 2024 |

DOI:10.15662/IJEETR.2024.0606007

54. Rani, S., Ghai, D., & Kumar, S. (2021). Construction and reconstruction of 3D facial and wireframe model using syntactic pattern recognition. Cognitive Behavior and Human Computer Interaction Based on Machine Learning Algorithm, 137-156.
55. Rani, S., Ghai, D., & Kumar, S. (2021). Construction and reconstruction of 3D facial and wireframe model using syntactic pattern recognition. Cognitive Behavior and Human Computer Interaction Based on Machine Learning Algorithm, 137-156.
56. Kumar, S., Raja, R., Tiwari, S., & Rani, S. (Eds.). (2021). Cognitive behavior and human computer interaction based on machine learning algorithms. John Wiley & Sons.
57. Shitharth, S., Prasad, K. M., Sangeetha, K., Kshirsagar, P. R., Babu, T. S., & Alhelou, H. H. (2021). An enriched RPCO-BCNN mechanisms for attack detection and classification in SCADA systems. IEEE Access, 9, 156297-156312.
58. Kantipudi, M. P., Rani, S., & Kumar, S. (2021, November). IoT based solar monitoring system for smart city: an investigational study. In 4th Smart Cities Symposium (SCS 2021) (Vol. 2021, pp. 25-30). IET.
59. Sravya, K., Himaja, M., Prapti, K., & Prasad, K. M. (2020, September). Renewable energy sources for smart city applications: A review. In IET Conference Proceedings CP777 (Vol. 2020, No. 6, pp. 684-688). Stevenage, UK: The Institution of Engineering and Technology.
60. Raj, B. P., Durga Prasad, M. S. C., & Prasad, K. M. (2020, September). Smart transportation system in the context of IoT based smart city. In IET Conference Proceedings CP777 (Vol. 2020, No. 6, pp. 326-330). Stevenage, UK: The Institution of Engineering and Technology.
61. Meera, A. J., Kantipudi, M. P., & Aluvalu, R. (2019, December). Intrusion detection system for the IoT: A comprehensive review. In International Conference on Soft Computing and Pattern Recognition (pp. 235-243). Cham: Springer International Publishing.
62. Kumari, S., Sharma, S., Kaushik, M. S., & Kateriya, S. (2023). Algal rhodopsins encoding diverse signal sequence holds potential for expansion of organelle optogenetics. Biophysics and Physicobiology, 20, Article S008. https://doi.org/10.2142/biophysico.bppb-v20.s008
63. Sharma, S., Sanyal, S. K., Sushmita, K., Chauhan, M., Sharma, A., Anirudhan, G., ... & Kateriya, S. (2021). Modulation of phototropin signalosome with artificial illumination holds great potential in the development of climate-smart crops. Current Genomics, 22(3), 181-213.
64. Guntupalli, R. (2023). AI-driven threat detection and mitigation in cloud infrastructure: Enhancing security through machine learning and anomaly detection. Journal of Informatics Education and Research, 3(2), 3071–3078. ISSN: 1526-4726.
65. Guntupalli, R. (2023). Optimizing cloud infrastructure performance using AI: Intelligent resource allocation and predictive maintenance. Journal of Informatics Education and Research, 3(2), 3078–3083. https://doi.org/10.2139/ssrn.5329154
66. Sharma, S., Gautam, A. K., Singh, R., Gourinath, S., & Kateriya, S. (2024). Unusual photodynamic characteristics of the light-oxygen-voltage domain of phototropin linked to terrestrial adaptation of Klebsormidium nitens. The FEBS Journal, 291(23), 5156-5176.
67. Sharma, S., Sushmita, K., Singh, R., Sanyal, S. K., & Kateriya, S. (2024). Phototropin localization and interactions regulates photophysiological processes in Chlamydomonas reinhardtii. bioRxiv, 2024-12.
68. Guntupalli, R. (2024). AI-Powered Infrastructure Management in Cloud Computing: Automating Security Compliance and Performance Monitoring. Available at SSRN 5329147.
69. Guntupalli, R. (2024). Enhancing Cloud Security with AI: A Deep Learning Approach to Identify and Prevent Cyberattacks in Multi-Tenant Environments. Available at SSRN 5329132.