



ADVANCEMENTS AND CHALLENGES IN INCREMENTAL LEARNING: A COMPREHENSIVE SURVEY

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Abstract: Incremental learning, an essential facet of artificial intelligence (AI), involves the dynamic acquisition and integration of knowledge from new data or tasks while preserving information from prior experiences. Overcoming catastrophic forgetting and effectively adapting to evolving environments are central challenges in incremental learning [1], [10]. This survey paper comprehensively explores the latest advancements, methodologies, and challenges in incremental learning. We delve into various techniques, ranging from regularization methods and rehearsal strategies to neural network modifications and transfer learning. Through an in-depth analysis, we aim to elucidate the intricate landscape of incremental learning and provide insights to inspire future research and development in this rapidly evolving field.

Index Terms - Incremental Learning, Catastrophic Forgetting, Regularization, Rehearsal Techniques, Neural Network Modification, Transfer Learning, Experience Replay, Generative Replay, Elastic Weight Consolidation (EWC), Synaptic Intelligence (SI), Knowledge Distillation, Fine-Tuning, Data Augmentation, Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Multi-Task Learning, Progressive Neural Networks (PNN), Meta-Learning, Challenges, Advancements.

1. INTRODUCTION

Incremental learning, also known as continual learning or lifelong learning, is an approach in artificial intelligence (AI) and machine learning where a model learns and adapts to new data continuously over time. Instead of training a model from scratch every time new data becomes available, incremental learning allows the model to update its knowledge and parameters incrementally, incorporating new information while retaining previously learned knowledge [2], [5], [6].

The main goal of incremental learning is to enable AI models to efficiently adapt to changing or evolving data distributions, concepts, or tasks without losing the knowledge gained from previous experiences [5]. This is particularly important in scenarios where the model needs to handle a stream of data or adapt to new tasks without sacrificing performance on previous tasks.

2. CHALLENGES IN INCREMENTAL LEARNING

Incremental learning in AI is a challenging research area, and it comes with several notable issues and challenges. Addressing these issues is crucial to ensure that AI models can effectively learn and adapt to new information while retaining previously acquired knowledge. Below are the details of the few notable issues of the incremental learning.

2.1. Catastrophic Forgetting

Catastrophic forgetting, also known as catastrophic interference, is a phenomenon that occurs in incremental learning when a machine learning model, originally trained to perform a set of tasks, significantly and abruptly forgets or loses its ability to accurately perform one or more of those tasks after being trained on new, unrelated tasks. Essentially, the model forgets previously learned information or representations when learning new tasks, leading to a catastrophic decline in performance on the old tasks.

This forgetting happens because as the model is exposed to new data or tasks, it needs to update its internal parameters to learn the new task. However, in the process of updating, the model may unintentionally modify the parameters associated with earlier learned tasks, effectively overwriting the existing representations.

The catastrophic forgetting phenomenon is particularly common in neural networks and other machine learning models with a fixed capacity or limited resources. When the model attempts to optimize its parameters to perform well on the new task, the parameters associated with the old task are adjusted, often leading to a deterioration in performance on the previous task. Catastrophic forgetting is a significant issue in incremental learning that needs to be mitigated.

2.2. Stability-Plasticity Dilemma

In order to understand stability-plasticity dilemma we need to explain the terms stability and plasticity.

Stability: The term stability refers to the ability of a learning system to retain previously learned information without being significantly influenced or disrupted by new data or experiences. A stable system ensures that important and well-established knowledge remains intact and is not easily forgotten or overwritten by new information.

Plasticity: The term plasticity refers to the ability of a learning system to adapt and learn from new information, experiences, or data. A highly plastic system can quickly incorporate and adjust to new information, enabling it to learn and adapt to changing environments or tasks [3], [4].

The stability-plasticity dilemma arises from the inherent tension between these two aspects:

Overemphasizing Stability: If a system prioritizes stability too much, it may become resistant to learning new information, making it difficult to adapt to new tasks or environments. This results in a rigid system that is unable to effectively update its knowledge base with new experiences.

Overemphasizing Plasticity: On the other hand, if a system prioritizes plasticity excessively, it may forget or overwrite previously learned information too quickly, resulting in a system that is unstable and unable to retain important knowledge.

Finding the right balance between stability and plasticity is crucial for achieving efficient and effective lifelong learning in artificial intelligence systems.

2.3. Concept Drift

Concept drift in incremental learning refers to the phenomenon where the statistical properties or the underlying structure of the target variable (the concept) change over time. In other words, the relationships between the input features and the target output may change, making the model's learned knowledge become outdated or less accurate as new data is encountered.

Concept drift can occur due to various reasons:

Environmental Changes: Changes in the environment generating the data, such as shifts in user preferences, market dynamics, or technological advancements, can lead to concept drift. For instance, consumer behaviour in e-commerce may change with trends or economic shifts.

Data Source Changes: If the data source itself changes, such as a sensor being recalibrated, or data being collected from a different source, it can introduce concept drift. This is common in applications like sensor networks or medical monitoring.

Sudden Events: Unforeseen events, such as a sudden market crash or a pandemic, can drastically alter the relationships between features and the target variable, causing abrupt concept drift.

Gradual Evolution: The concept might evolve gradually over time due to a slow change in user preferences, seasonality, or other long-term trends. An example could be changing preferences in fashion.

Concept drift is a critical challenge in real-world applications of machine learning, especially in scenarios where data is dynamic and subject to change. Addressing concept drift ensures that models remain accurate and relevant in continuously evolving environments.

2.4. Limited Memory and Computational Resources

This issue refers to the challenges and limitations associated with processing and storing a large volume of data and knowledge over time in a resource-constrained environment. Real-world applications often have constraints on memory and computational resources.

Limited Memory: In many real-world scenarios, especially in resource-constrained devices or systems, there is a finite amount of memory available to store data and model parameters. Over time, as the system learns from new tasks or experiences, the memory can become saturated, making it difficult to retain all the information from past tasks.

Computational Resources: Incremental learning often requires significant computational resources, including processing power and time, to adapt to new tasks, update model parameters, and manage the continuous influx of data. As the number of tasks and data instances grows, the computational demands increase accordingly. In resource-constrained settings, these computational demands can become a bottleneck, affecting the efficiency and speed of the learning process.

2.5. Data Imbalance

Data imbalance, in the context of incremental learning, refers to a situation where the distribution of classes or categories in the dataset is highly skewed, meaning that one or a few classes have significantly more instances (data points) compared to others. This can cause the learning model to be biased towards the majority class, leading to suboptimal performance on minority classes. In the context of incremental learning, this imbalance can change over time as new data is acquired, making it challenging to maintain model performance across all classes.

For example, consider a medical diagnosis application where there are many more examples of healthy patients (majority class) compared to patients with a rare disease (minority class). If new data introduces more instances of the rare disease, the class distribution changes, and the model must adapt to this shift.

The data imbalance issue present significant challenges in incremental learning.

2.6. Generalization and Transferability

The generalization and transferability issue in incremental learning pertains to the ability of a model to generalize well on new tasks or unseen data and transfer its learned knowledge effectively from previously learned tasks to new, related tasks. These issues are essential in ensuring that a model can learn, retain knowledge, and adapt to novel tasks or data distributions, especially in an incremental learning setting.

Generalization: Generalization refers to how well a model can accurately predict or classify unseen or new data that it hasn't been explicitly trained on. In incremental learning, it is important that the model can generalize well to new data associated with the same or similar tasks. However, as the model learns new tasks incrementally, there is a risk of overfitting to the specific characteristics of the training data for the most recent task, potentially leading to a decrease in generalization performance on past or future tasks.

Transferability: Transferability, in the context of incremental learning, refers to the ability of a model to transfer knowledge or information gained from learning one task to another, related task. Effective transferability implies that the knowledge learned from earlier tasks can positively influence the model's performance on new, related tasks. However, the presence of catastrophic forgetting or interference can hinder the transferability of knowledge, making it challenging to efficiently apply previously learned information to aid in the learning of new tasks.

2.7. Evaluation Metrics

The evaluation metrics issue in incremental learning pertains to the challenges associated with selecting appropriate metrics to evaluate the performance of a model as it learns and adapts incrementally to new tasks or data over time. Traditional evaluation metrics may not effectively capture the model's performance in such dynamic, evolving scenarios, making it essential to carefully choose or adapt evaluation criteria to suit the incremental learning context.

Below are the key aspects of the evaluation metrics issue in incremental learning:

Changing Task/Objective: In incremental learning, the tasks or objectives may change over time as new tasks are introduced. Traditional evaluation metrics may not be directly applicable or meaningful for all tasks, making it challenging to have consistent evaluation criteria across different tasks.

Task Heterogeneity: As tasks may be heterogeneous in nature, each task might require a specific set of evaluation metrics that align with its unique characteristics and goals. Choosing appropriate metrics becomes crucial to accurately reflect the model's performance for each task.

Performance on Previous Tasks: Evaluating the model's performance on previously learned tasks is critical in incremental learning. However, conventional evaluation metrics may overlook the model's ability to maintain good performance on older tasks while learning new tasks, leading to an incomplete assessment of its capabilities.

Trade-offs and Balancing: Evaluating a model's performance in incremental learning often involves trade-offs between optimizing for new tasks and maintaining performance on old tasks. The evaluation metrics need to strike a balance to reflect both aspects adequately.

Incremental learning is an active area of research in AI, Researchers and practitioners are actively working to develop strategies and algorithms that mitigate these issues and advance the field of incremental learning, aiming for models that can continually learn, adapt, and improve their performance over time.

3. METHODS TO MITIGATE CHALLENGES

Addressing the challenges which we discussed above demands a strategic and nuanced approach, one that involves considering the unique intricacies of incremental learning and implementing methods that facilitate seamless adaptation and growth without disrupting existing knowledge structures. This survey explores few of the effective strategies to mitigate these challenges and optimize the process of incremental learning, ensuring a harmonious integration of new knowledge while preserving the foundation of prior learning.

3.1. Rehearsal Techniques

Rehearsal techniques involve storing and utilizing past experiences (data or feature representations) during training on new tasks. By replaying or reusing these experiences alongside new data, the model can retain knowledge and prevent catastrophic forgetting.

Experience Replay: Experience Replay involves storing a subset of data or feature representations from previous tasks in a replay buffer. During training on a new task, a mini-batch of samples is drawn from this buffer and combined with the current task's data. The model is then trained on this mixed dataset, effectively reliving past experiences alongside learning the new task. By continuously exposing the model to older experiences, it can retain knowledge and generalize better to both old and new tasks. Experience Replay

mitigates catastrophic forgetting by periodically reintroducing past experiences, ensuring the model retains knowledge from earlier tasks.

Generative Replay: Generative Replay utilizes generative models like GANs or VAEs to create synthetic data samples resembling those from past experiences. These synthetic samples are mixed with real data from the current task, forming a combined dataset for training. The synthetic data allows the model to learn from past experiences even when the original data is no longer available. Generative Replay addresses catastrophic forgetting by providing a way to include past experiences in the training process, even when the original data is not accessible [8].

3.2. Regularization

Regularization methods impose additional constraints or penalties on the model's parameters during training to prevent drastic changes that might lead to catastrophic forgetting. The objective is to ensure that the important parameters associated with previous tasks are preserved while the model adapts to new tasks.

Elastic Weight Consolidation (EWC): EWC introduces a regularization term into the loss function during training for a new task. This term is based on the importance of each parameter, which is computed using the Fisher Information Matrix. Parameters that were crucial for previous tasks have higher importance values. The regularization term penalizes significant changes in these important parameters, preventing the model from deviating too far from its original configuration in those dimensions. EWC helps retain knowledge by ensuring that the model does not make large changes to the weights associated with previous tasks [7]. It strikes a balance between learning new tasks and maintaining the previously learned knowledge.

Synaptic Intelligence (SI): SI also introduces a regularization term based on the importance of parameters, similar to EWC. However, it estimates parameter importance differently by measuring the change in the loss with respect to each parameter during training on previous tasks. Parameters that had a higher impact on the loss are considered more important and are penalized to retain their values. The regularization term constrains the updates to these important parameters, reducing the risk of catastrophic forgetting [9]. SI is more computationally efficient than EWC and provides a way to estimate parameter importance without storing information about previous tasks. It achieves a similar objective of preserving knowledge from earlier tasks.

3.3. Knowledge Distillation

Knowledge distillation is a technique used to transfer knowledge from a larger, more complex model (referred to as the "teacher") to a smaller, simpler model (referred to as the "student"). The aim is to improve the performance and generalization of the student model by leveraging the knowledge and insights gained by the teacher model.

Below is a step-by-step explanation of how knowledge distillation works:

1. **Teacher Model Training:** Train a larger, more complex model (the teacher) on the task of interest using a standard supervised learning approach. The teacher model achieves high performance and learns complex relationships in the data.
2. **Soft Targets Generation:** For each example in the training dataset, obtain the teacher model's predictions, usually in the form of probabilities or softened outputs (e.g., softmax probabilities over classes) [10]. These softened outputs are referred to as "soft targets."
3. **Student Model Training:** Train a smaller, simpler model (the student) on the same task using the original training dataset. In addition to using the true labels (hard targets) for training, use the soft targets generated by the teacher model.
4. **Loss Function Design:** Define a loss function that guides the student model to mimic the teacher's behaviour. Commonly used loss functions include the Kullback-Leibler divergence or Mean Squared Error (MSE) between the soft targets produced by the teacher and the student's predictions.
5. **Combined Loss Minimization:** Minimize a combined loss that consists of both the traditional cross-entropy loss (using hard targets) and the knowledge distillation loss (based on soft targets). The weights on these losses are often adjusted using a hyperparameter (e.g., temperature) to balance the influence of each component.

$$LC = \alpha * CE(SP, TL) + \beta * DL(SP, ST)$$

Where,

LC: Loss_combined

CE: CrossEntropy

SP: Student_predictions

TL: True_labels

ST: Soft_targets

α and β are hyperparameters controlling the relative importance of the two components.

6. Optimization: Optimize the combined loss using backpropagation and gradient descent (or its variants) to update the parameters of the student model.

The intuition behind knowledge distillation is that the soft targets from the teacher model contain valuable knowledge about the underlying relationships in the data, even beyond what is captured by the hard labels. By incorporating this additional information during training, the student model can learn to generalize better and achieve performance closer to the teacher model.

This technique is particularly useful when deploying models with limited computational resources (e.g., for edge devices) or when aiming for a more efficient and compact model without sacrificing performance.

3.4. Network Modification

Network modification involves altering the architecture or parameters of a neural network to accommodate new tasks or data. This process allows the network to learn and adapt to new information while preserving knowledge from previous tasks.

Fine-Tuning: Fine-tuning begins with a pre-trained model, which could be a neural network or any other machine learning model. The model's parameters are adjusted, typically by reducing the learning rate, during training on a new task. These slight parameter updates allow the model to adapt to the specifics of the new task while retaining the knowledge learned from the initial pre-training.

Network Expansion: Network expansion involves the addition of new layers, nodes, or modules to the existing neural network architecture. The new components are specifically designed to capture the characteristics of the new task, while the previously learned layers remain relatively untouched. This expansion provides the model with increased capacity to learn new concepts without significantly altering the existing network.

Dynamic Network Architectures: Dynamic architectures enable the network to modify its structure to incorporate new knowledge. This can involve adding new units, layers, or modules as the model learns. The dynamic network architecture adapts to the task at hand, allowing for the seamless integration of new information without necessitating extensive retraining.

3.5. Data Augmentation and Synthesis

Generative Adversarial Networks (GANs): GANs consist of two components: a generator and a discriminator. The generator creates synthetic data samples, while the discriminator evaluates the authenticity of these samples. During incremental learning, GANs generate synthetic data similar to the training data from previous tasks. This additional data augments the current training dataset, providing a broader range of examples for the model to learn from.

Variational Autoencoders (VAEs): VAEs are probabilistic generative models that learn a probabilistic representation of the data. VAEs encode the data into a lower-dimensional space and decode it to generate new data samples. During incremental learning, VAEs generate synthetic data samples based on the probabilistic model, creating additional training data to improve the model's ability to generalize to new tasks.

3.6. Transfer Learning:

Multi-Task Learning: Multi-task learning involves training a single model on multiple related tasks simultaneously. The shared features and parameters learned across tasks can aid in transferring knowledge between tasks. The model learns to solve each task while simultaneously benefiting from the knowledge and features acquired from other related tasks.

Progressive Neural Networks (PNN): PNN trains separate neural networks for each new task while retaining connections to the previously learned networks. This allows for knowledge transfer between tasks. As new tasks are encountered, new networks are progressively added to the architecture, and knowledge from previous networks is preserved, avoiding catastrophic forgetting.

Meta-Learning Approaches: Meta-learning trains models to adapt quickly to new tasks by pre-training on a variety of related tasks. The model learns a good initialization or adaptation strategy from the experiences of different tasks. This enables the model to rapidly adapt to new tasks, leveraging prior learning experiences and strategies.

These methods are crucial for addressing the challenges associated with incremental learning in AI, ensuring that the model can adapt and learn efficiently from new data or tasks without forgetting previously acquired knowledge.

4. APPLICATION OF INCREMENTAL LEARNING

Incremental learning, a dynamic approach in the field of machine learning, plays a crucial role in scenarios where data evolves or streams over time. Unlike traditional batch learning methods, incremental learning allows models to continuously update and enhance their knowledge by learning from new data instances without retraining on the entire dataset. This adaptability is invaluable in a multitude of applications. From personalizing recommendations in e-commerce and detecting evolving fraud patterns in financial transactions to predicting traffic flow in smart cities and monitoring patient health in healthcare systems, incremental learning enables real-time adjustments and improvements, making it a powerful tool for managing evolving data and adapting to changing circumstances across various domains. Also, the role of advanced tools required using ML and ESPs [11-93] are becoming important in recent applications, recognition and control.

5. CONCLUSION

In this survey we discussed about the incremental learning technique, challenges to its implementation in real time scenarios, methods to overcome the challenges and its application in the industry. The ability of incremental learning to continuously update and refine models based on incoming data, without the need for retraining on the entire dataset, is a game-changer. As research and technology progress, further advancements in incremental learning techniques and their integration into various domains are anticipated, ultimately contributing to more efficient, adaptive, and responsive AI systems that can keep pace with the evolving world of data and user preferences.

REFERENCES

- [1] Davide Abati, Jakub Tomczak, Tijmen Blankevoort, Simone Calderara, Rita Cucchiara, and Babak Ehteshami Bejnordi. Conditional channel gated networks for task-aware continual learning. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pages 3931–3940, 2020.
- [2] Mohamed Abdelsalam, Mojtaba Faramarzi, Shagun Sodhani, and Sarath Chandar. Iirc: Incremental implicitly-refined classification. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, pages 11038–11047, 2021.
- [3] Wickliffe C Abraham. Metaplasticity: tuning synapses and networks for plasticity. *Nature Reviews Neuroscience*, 9(5):387–387, 2008.
- [4] Wickliffe C Abraham and Mark F Bear. Metaplasticity: the plasticity of synaptic plasticity. *Trends in Neurosciences*, 19(4):126–130, 1996.
- [5] Alessandro Achille, Tom Eccles, Loic Matthey, Chris Burgess, Nicholas Watters, Alexander Lerchner, and Irina Higgins. Lifelong disentangled representation learning with cross-domain latent homologies. *Advances in Neural Information Processing Systems*, 31, 2018.

- [6] Idan Achituve, Aviv Navon, Yochai Yemini, Gal Chechik, and Ethan Fetaya. Gp-tree: A gaussian process classifier for fewshot incremental learning. In International Conference on Machine Learning, pages 54–65. PMLR, 2021.
- [7] Tameem Adel, Han Zhao, and Richard E Turner. Continual learning with adaptive weights (claw). In International Conference on Learning Representations, 2019.
- [8] Aishwarya Agarwal, Biplab Banerjee, Fabio Cuzzolin, and Subhasis Chaudhuri. Semantics-driven generative replay for fewshot class incremental learning. In Proceedings of the ACM International Conference on Multimedia, pages 5246–5254, 2022.
- [9] Hongjoon Ahn, Sungmin Cha, Donggyu Lee, and Taesup Moon. Uncertainty-based continual learning with adaptive regularization. Advances in Neural Information Processing Systems, 32, 2019.
- [10] Hongjoon Ahn, Jihwan Kwak, Subin Lim, Hyeonsu Bang, Hyojun Kim, and Taesup Moon. Ss-il: Separated softmax for incremental learning. In Proceedings of the IEEE/CVF International Conference on Computer Vision, pages 844–853, 2021.
- [11] Sahil Kadadekar, Sumaiya Shaikh, Isheeta Shahir, Hemantkumar Mali, Rupesh Jaiswal, “Digital Currency Price Prediction using Machine Learning”, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, Google Scholar, Mendeley : reference manager, Cite-Factor, Index Copernicus, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 11, Issue IX, pp. 338-355, September 2023, <https://www.ijraset.com/research-paper/digital-currency-price-prediction-using-machine-learning> DOI: <https://doi.org/10.22214/ijraset.2023.55647>.
- [12] Shreyas Purkar, Jaiswal R. C., “Business Information Security”, Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 10, Issue 10 pp. d206-d213, October 2023.
- [13] Rahul Kulkarni, R. C. Jaiswal, “A Survey on AI Chatbots”, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, Google Scholar, Mendeley : reference manager, Cite-Factor, Index Copernicus, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 11, Issue IX, pp. 1738-1744, September 2023.
- [14] Zeel Patel, Jaiswal R.C., “Data-Driven Quantitative Risk Modeling In Financial Engineering”, International Journal “Gradiva Review Journal” (GRJ), UGC Care group-II journal, Open Access, Peer Reviewed, refereed and multidisciplinary Journal, Google Scholar, Scribd, ResearchGate, Scopus indexed, ISSN: 0363-8057; SJR Impact Factor:0.101, Volume 9, Issue IX, pp. 656-668, September 2023., <https://gradivareview.com/volume-9-issue-9-2023/> <https://drive.google.com/file/d/1DVJLeuEmkPz0wokqFiKuJahwnnYWwk5/view?usp=sharing>
- [15] Shreyas Purkar, Jaiswal R.C., M.V. Munot “The Role of Management Information Systems in Organizations”, International Journal “Gradiva Review Journal” (GRJ), UGC Care group-II journal, Open Access, Peer Reviewed, refereed and multidisciplinary Journal, Google Scholar, Scribd, ResearchGate, Scopus indexed, ISSN: 0363-8057; SJR Impact Factor:0.101, Volume 9, Issue IX, pp. 506-516, September 2023., <https://gradivareview.com/volume-9-issue-9-2023/> https://drive.google.com/file/d/1liYzh1qN4w3qoq8Gzg_HJDAW6l8WvbEs/view?pli=1, DOI:10.37897.GRJ.2023.V9I9.23.513425.
- [16] Aarti Jagtap, R. C. Jaiswal, “A Review on the Prospects Engineering Management”, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, Google Scholar, Mendeley : reference manager, Cite-Factor, Index Copernicus, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 11, Issue IX, pp. 218-223, September 2023, DOI: <https://doi.org/10.22214/ijraset.2023.55635>.
- [17] Jaiswal R.C. and Shahul Patil, “Small Businesses Need Project Management”, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 10, Issue XII, pp. 1532-1536, December 2022.
- [18] Jaiswal R.C. and Zeel Patel, “ A Survey Paper on Big Data Analytics in Sales and Marketing”, International Journal of Creative Research Thoughts (IJCRT), Open Access, Peer Reviewed and refereed Journal, indexed in Google Scholar, Microsoft Academic, CiteSeerX, Publons Indexed, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 10 Issue XI, pp. c420-c428, November 2022.
- [19] Aarya Harkare, R. C. Jaiswal, “Object Fetching UAV using Autonomous Flight and Object Detection Algorithms”, International Journal for Research in Applied Science & Engineering Technology

- (IJRASET), Open Access, Peer Reviewed and refereed Journal, Google Scholar, Mendeley : reference manager, Cite-Factor, Index Copernicus, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 11, Issue IX, pp. 602-610, September 2023, DOI: <https://doi.org/10.22214/ijraset.2023.55692>.
- [20] Manasi Thonte, Jaiswal R.C., “Technical review on Synthetic Data Generation”, International Journal “Gradiva Review Journal” (GRJ), UGC Care group-II journal, Open Access, Peer Reviewed, refereed and multidisciplinary Journal, Google Scholar, Scribd, ResearchGate, Scopus indexed, ISSN: 0363-8057; SJR Impact Factor:0.101, Volume 9, Issue VII, pp. 100-109, July 2023.
- [21] Rahul Kulkarni, R. C. Jaiswal, “A Survey on AI Chatbots”, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, Google Scholar, Mendeley : reference manager, Cite-Factor, Index Copernicus, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 11, Issue IX, pp. 1738-1744, September 2023. <https://www.ijraset.com/research-paper/survey-on-ai-chatbots> <https://www.ijraset.com/best-journal/a-survey-on-ai-chatbots>.
- [22] Jaiswal R.C. and Dhas Himanshu, “ A Technical Paper on Stock Prediction Using Machine Learning Algorithms”, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, Google Scholar, Mendeley : reference manager, Cite-Factor, Index Copernicus, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 11, Issue V, pp. 5200-5208, May 2023.
- [23] Jaiswal R.C. and Dhas Himanshu, “ Survey Paper on Stock Prediction Using Machine Learning Algorithms”, International Research Journal of Modernization in Engineering Technology and Science (IRJMETS), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Mendeley Advisor Community, ISSN: 2582-5208; Impact Factor:7.868, Volume 05 Issue IV, pp. 2744-2749, April 2023.
- [24] Jaiswal R.C. and Pranjali Desai, “Network Based Intrusion Detection System”, International Research Journal of Modernization in Engineering Technology and Science (IRJMETS), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Mendeley Advisor Community, ISSN: 2582-5208; Impact Factor:7.868, Volume 05 Issue III, pp. 3851-3857, March 2023.
- [25] Jaiswal R.C. and Samiksha Baral, “ Design & Development of Smart Electric Vehicle Safety Device by using IoT and AI”, 2022 Fourth International Conference on Emerging Research in Electronics, Computer Science and Technology (ICERECT), 26-27 December-2022, 15 March 2023 Published, DOI: 10.1109/ICERECT56837.2022.10059784, INSPEC Accession Number: 22810474.
- [26] Jaiswal R.C. and Minal Tayde, “ Face, Expression and Gesture Recognition & Compilation in Database”, International Journal of Creative Research Thoughts (IJCRT), Open Access, Peer Reviewed and refereed Journal, indexed in Google Scholar, Microsoft Academic, CiteSeerX, Publons Indexed, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 10 Issue XII, pp. d714-d724, December 2022.
- [27] Jaiswal R.C. and Prasad Malwadkar, “ Smart Wellness Program”, International Journal of Creative Research Thoughts (IJCRT), Open Access, Peer Reviewed and refereed Journal, indexed in Google Scholar, Microsoft Academic, CiteSeerX, Publons Indexed, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 10 Issue XII, pp. a22-a29, December 2022.
- [28] Jaiswal R.C. and Nitin Dhevar, “Smart Home Surveillance System”, International Journal of Creative Research Thoughts (IJCRT), Open Access, Peer Reviewed and refereed Journal, indexed in Google Scholar, Microsoft Academic, CiteSeerX, Publons Indexed, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 10 Issue XI, pp. d461-d468, November 2022.
- [29] Jaiswal R.C. and Niraj Sonje, “ Deep Learning for Art Characterization ”, International Journal of Creative Research Thoughts (IJCRT), Open Access, Peer Reviewed and refereed Journal, indexed in Google Scholar, Microsoft Academic, CiteSeerX, Publons Indexed, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 10 Issue XI, pp. a687-a694, November 2022.
- [30] Jaiswal R.C. and Shivani Pande, “ Microservices in Cloud Native Development of Application”, International Journal of Creative Research Thoughts (IJCRT), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 10 Issue X, pp. d170-d183, October 2022.
- [31] Jaiswal R. C. and Chaitanya Srushti, “ Helmet Detection Using Machine Learning”, Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 10 pp. d10-d17, October 2022.

- [32] Jaiswal R. C. and Manasi Satpute, "Machine Learning Based Car Damage Identification", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 10 pp. b684-b690, October 2022.
- [33] Jaiswal R.C. and Aryan Bagade, "Metaverse Simulation Based on VR, Blockchain, and Reinforcement Learning Model", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.538, Volume 10 Issue X, pp. 67-75, October 2022.
- [34] Jaiswal R. C. and Atharva Agashe, "A Survey Paper on Cloud Computing and Migration to the Cloud", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 10 pp. a258-a265, October 2022.
- [35] Jaiswal R. C. and Taher Saraf, "Stock Price Prediction using Machine Learning", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 9 pp. e33-e41, September 2022.
- [36] Jaiswal R. C. and Ritik Manghani, "Pneumonia Detection using X-rays Image Preprocessing", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 9 pp. c653-c662, September 2022.
- [37] Jaiswal R. C. and Apoorva Ushire, "Real Time Water Monitoring System Using NodeMCU ESMP8266", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 9 pp. c1-c8, September 2022.
- [38] Jaiswal R. C. and Firoz Saherawala, "Smart Glasses", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 8 pp. f393-f401, August 2022.
- [39] Jaiswal R. C. and Asawari Walkade, "Denial of Service Detection and Mitigation", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 5 pp. f108-f116, May 2022.
- [40] Jaiswal R. C. and Fiza Shaikh, "Augmented Reality based Car Manual System", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 5 pp. c326-c332, May 2022.
- [41] Jaiswal R. C. and Tejveer Pratap, "Multiparametric Monitoring of Vital Signs in Clinical and Home Settings for Patients", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 5 pp. a701-a705, May 2022.
- [42] Jaiswal R. C. and Sahil Nahar, "Recognition and Selection of Learning Styles to Personalize Courses for Students", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 9, Issue 2 pp. b235-b252, February 2022.
- [43] Jaiswal R. C. and Rushikesh Karwankar, "Demand Forecasting for Inventory Optimization", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed in Google Scholar, Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 12 pp. 121-131, January 2022.
- [44] Jaiswal R. C. and P. Khore, "Exo-skeleton Arm", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, Indexed In Google Scholar,

- Microsoft Academic, CiteSeerX, Thomson Reuters, Mendeley : reference manager, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 12 pp. 731-734, December 2021.
- [45] Jaiswal R. C. and Shreyas Nazare, "IoT Based Home Automation System", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 11 pp. 151-153, November 2021.
- [46] Jaiswal R. C. and Prajwal Pitlehra, "Credit Analysis Using K-Nearest Neighbours' Model", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 5, pp. 504-511, May 2021.
- [47] Jaiswal R. C. and Rohit Barve, "Energy Harvesting System Using Dynamo", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:7.95, Volume 8, Issue 5, pp. 278-280, May 2021.
- [48] Jaiswal R. C. and Sharvari Doifode, "Virtual Assistant", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 10, pp. 3527-3532, October 2020.
- [49] Jaiswal R. C. and Akshat Kaushik, "Automated Attendance Monitoring system using discriminative Local Binary Histograms and PostgreSQL", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 11, pp. 80-86, November 2020.
- [50] Jaiswal R. C. and Danish Khan, "Arduino based Weather Monitoring and Forecasting System using SARIMA Time-Series Forecasting", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 11, pp. 1149-1154, November 2020.
- [51] Jaiswal R.C. and Param Jain, "Augmented Reality based Attendee Interaction at Events", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.429, Volume 8 Issue VI, pp. 1578-1582, June 2020.
- [52] Jaiswal R.C. and Akash Pal, "Cosmetics Application Using Computer Vision", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 6, pp. 824-829, June 2020.
- [53] Jaiswal R.C. and Jaydeep Bhoite, "Home Renovation Using Augmented Reality", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Impact Factor:5.87, Volume 7, Issue 6, pp. 682-686, June 2020.
- [54] Jaiswal R.C. and Aashay Pawar, "Stock Market Study Using Supervised Machine Learning", International Journal of Innovative Science and Research Technology (IJISRT), Open Access, Peer Reviewed and refereed Journal, ISSN: 2456-2165; IC Value: 45.98; SJ Impact Factor:6.253, Volume 5 Issue I, pp. 190-193, Jan 2020.
- [55] Jaiswal R.C. and Deepali Kasture, "Pillars of Object-Oriented System", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 589-591, Nov 2019.
- [56] Jaiswal R.C. and Yash Govilkar, "A Gesture Based Home Automation System", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 501-503, Nov 2019.
- [57] Jaiswal R.C. and Onkar Gagare, "Head Mounted Display", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 535-541, Nov 2019.
- [58] Jaiswal R.C. and Nehal Borole, "Autonomous Vehicle Prototype Development and Navigation using ROS", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed Journal, ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.177, Volume 7 Issue XI, pp. 510-514, Nov 2019.
- [59] Jaiswal R.C. and Vaibhav Pawar, "Voice and Android Application Controlled Wheelchair", Journal of Emerging Technologies and Innovative Research (JETIR), Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Volume 6, Issue 6, pp. 635-637, June 2019.
- [60] Jaiswal R.C. and Shreya Mondhe, "Waste Segregation & Tracking", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Open Access, Peer Reviewed and refereed

- Journal , ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:7.429, Volume 8, Issue 5, pp. 2085-2087, May 2019.
- [61] Jaiswal R.C. and Samruddhi Sonare, "Smart Supervision Security System Using Raspberry Pi ", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 6, Issue 4, pp. 574-579, April 2019.
- [62] Jaiswal R.C. and Manasi Jagtap, "Automatic Car Fragrance Dispensing System", International Journal of Research and Analytical Reviews (IJRAR), ISSN-2349-5138, Volume 6, Issue 1, pp. 315-319, March 2019.
- [63] Jaiswal R.C. and Sumukh Ballal, "Scalable Healthcare Sensor Network", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 6, Issue 2, pp. 350-354, February 2019.
- [64] Jaiswal R.C. and Samruddhi Sonare, "Multiple Camera Based Surveillance System Using Raspberry Pi", International Journal of Research and Analytical Reviews (IJRAR), ISSN-2348-1269, Volume 6, Issue 1, pp. 1635-1637, February 2019.
- [65] Jaiswal R.C. and Reha Musale, "Application of Digital Signature to Achieve Secure Transmission", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887, Volume 7 Issue II, pp. 150-153, February 2019.
- [66] Jaiswal R.C. and Himanshu Mithawala, "Automatic Gate Monitoring System", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162, Volume 6, Issue 1, pp. 88-94, January 2019.
- [67] Jaiswal R.C. and Bernard Lewis, "Dynamic Runway and Gate Terminal Allocation for Flights", Journal of Emerging Technologies and Innovative Research (JETIR), UGC approved Journal, ISSN-2349-5162, Volume 5, Issue 12, December 2018.
- [68] Jaiswal R.C. and Sakshi Jain, "Text Search Engine", Journal of Emerging Technologies and Innovative Research (JETIR), UGC approved Journal ISSN-2349-5162, Volume 5, Issue 11, November 2018.
- [69] Jaiswal R.C. and Arti Gurap, "Design of Different Configurations of Truncated Rectangular Microstrip Patch Antenna For 2.4 GHz And 1.6 GHz ", Journal of Emerging Technologies and Innovative Research (JETIR), UGC Approved Journal, ISSN-2349-5162, Volume 5, Issue 10, October 2018.
- [70] Jaiswal R.C. and Atharva Mahindrakar, " Mine Warfare and Surveillance Rover", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887, Volume 6 Issue III, March 2018.
- [71] Jaiswal R.C. and Saloni Takawale "Multi-Client Server Communication Enhancement through Intranet", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; UGC approved Journal, IC Value: 45.98; SJ Impact Factor :6.887, Volume 6 Issue 1, January 2018.
- [72] Jaiswal R.C. and Nikita Kakade, "Skin disease detection and classification using Image Processing Techniques", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162; UGC approved Journal:5.87, Volume 4, Issue 12, December 2017.
- [73] Jaiswal R.C. and Nikita Kakade, "OMR Sheet Evaluation Using Image Processing", Journal of Emerging Technologies and Innovative Research (JETIR), ISSN-2349-5162; UGC approved Journal:5.87, Volume 4, Issue 12, December 2017.
- [74] Jaiswal R.C. and Swapnil Shah, "Customer Decision Support System", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056; p-ISSN: 2395-0072; UGC approved Journal, SJ Impact Factor:5.181, Volume: 04 Issue: 10 | Oct -2017.
- [75] Jaiswal R.C. and Ketan Deshpande, "IOT Based Smart City: Weather, Traffic and Pollution Monitoring System", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056; p-ISSN: 2395-0072; UGC approved Journal, SJ Impact Factor:5.181, Volume: 04 Issue: 10 | Oct -2017.
- [76] Jaiswal R.C. and Vipul Phulphagar, "Arduino Controlled Weight Monitoring With Dashboard Analysis", International Journal for Research in Applied Science & Engineering Technology (IJRASET), ISSN: 2321-9653; UGC approved Journal, IC Value: 45.98; SJ Impact Factor:6.887, Volume 5 Issue XI November 2017.
- [77] Jaiswal R.C. and Siddhant Sribhashyam, "Comparison of Routing Algorithms using Riverbed Modeler", International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE), ISSN: (Online) 2278-1021; online) 2278-1021 ISSN (Print) 2319 5940; UGC approved Journal, Impact Factor 5.947 Vol. 6, Issue 6, June 2017.
- [78] Sameer Shukla, "Unlocking the Power of Data: An Introduction to Data Analysis in Healthcare," *International Journal of Computer Sciences and Engineering*, Vol.11, Issue.3, pp.1-9, 2023.

- [79] Sameer Shukla, "Developing Pragmatic Data Pipelines using Apache Airflow on Google Cloud Platform," *International Journal of Computer Sciences and Engineering*, Vol.10, Issue.8, pp.1-8, 2022.
- [80] S. Shukla, "Exploring the Power of Apache Kafka: A Comprehensive Study of Use Cases suggest topics to cover," *International Journal of Latest Engineering and Management Research (IJLEMR)*, vol. 8, pp. 71–78, Mar. 2023, doi: 10.56581/IJLEMR.8.3.71-78.
- [81] S. Shukla, "Enhancing Healthcare Insights, Exploring Diverse Use-Cases with K-means Clustering," *International Journal of Management IT and Engineering*, vol. 13, pp. 60–68, Aug. 2023.
- [82] S. Shukla, "Real-time Monitoring and Predictive Analytics in Healthcare: Harnessing the Power of Data Streaming," *International Journal of Computer Applications*, vol. 185, pp. 32–37, May 2023, doi: 10.5120/ijca2023922738.
- [83] S. Shukla, "Streamlining Integration Testing with Test Containers: Addressing Limitations and Best Practices for Implementation," *International Journal of Latest Engineering and Management Research (IJLEMR)*, vol. 9, pp. 19–26, Mar. 2023, doi: 10.56581/IJLEMR.8.3.19-26.
- [84] Sameer Shukla, "Examining Cassandra Constraints: Pragmatic Eyes," *International Journal of Management, IT & Engineering*, vol. 9, no. 3, pp. 267-287, 2019.
- [85] Sameer Shukla "Data Visualization with Python Pragmatic Eyes" *International Journal of Computer Trends and Technology* 67.2 (2019): 12-16.
- [86] S. Shukla, "DEBUGGING MICROSERVICES WITH PYTHON," *IIOAB Journal*, vol. 10, pp. 32–37, Feb. 2019.
- [87] Sameer Shukla, "Debugging Microservices with Pandas, PySpark using Actuators and Logs at Runtime," *International Journal of Computer Sciences and Engineering*, Vol.10, Issue.7, pp.27-30, 2022..
- [88] MV Munot, J Mukherjee, M Joshi, " A novel approach for efficient extrication of overlapping chromosomes in automated karyotyping" *Medical & biological engineering & computing*, 2013, vol: 51 (12), pp. 1325-1338
- [89] SA Panwar, MV Munot, S Gawande, PS Deshpande, "A reliable and an efficient approach for diagnosis of brain tumor using transfer learning" *Biomedical & Pharmacology Journal*, 2021, vol: 14, pp. 283-294
- [90] SA Bhalegaonkar, MV Munot, AD Anuse, RS Kute, "Automated Metaphase Chromosome Image Selection Techniques for Karyotyping: Current Status and Future Prospects", *Turkish Journal of Computer and Mathematics Education*. 2021, vol: 12 (6), pp. 3258-3266
- [91] Ketki Patankar, Jaiswal R.C. , "Design and Simulation of Inset Feed Microstrip Patch Antenna", *International Journal of Creative Research Thoughts (IJCRT)*, Open Access, Peer Reviewed and refereed Journal, indexed in Google Scholar, Microsoft Academic, CiteSeerX, Publons Indexed, Mendeley : reference manager, ISSN: 2320-2882; SJ Impact Factor:7.97, Volume 11 Issue X, pp. a859-a872, October 2023.
- [92] M Munot, M Joshi, N Sharma, "Automated Karyotyping of Metaphase cells with Touching Chromosomes", *International Journal of Computer Applications*, 2011, vol : (12), pp. 14-20
- [93] Jaiswal R.C. and Shreya Mondhe, "Stock Market Prediction Using Machine Learning & Robotic Process Automation", *Journal of Emerging Technologies and Innovative Research (JETIR)*, Open Access, Peer Reviewed and refereed Journal, ISSN-2349-5162, Volume 6, Issue 6, pp. 926-929, February 2019.