GLIMPSE - Journal of Computer Science • Vol. 3, No. 2, JULY-DECEMBER 2024, pp. 4-9

CLOUD COMPUTING UNVEILED: TRENDS, CHALLENGES, AND FUTURE DIRECTIONS

Jaishree Jain
Associate Professor, Department of CSE, Ajay Kumar Garg Engineering College Ghaziabad
jainjaishree@akgec.ac.in

***Abstract*—Cloud computing has become an essential part of modern IT architecture, providing businesses with scalable resources, cost savings, and enhanced operational performance. This review paper offers a thorough analysis of the fundamental concepts, architectural models, deployment techniques, and emerging trends in cloud computing. The survey begins by outlining the fundamental concepts and characteristics of cloud computing, including its service models (Software as a Service, Platform as a Service, and Infrastructure as a Service) and deployment techniques (public, private, hybrid, and multi-cloud). It looks at the benefits of cloud computing, such as scalability, affordability, and global accessibility, that have contributed to its widespread adoption by enterprises. The report then looks at the key advancements that have shaped cloud computing. It examines the exponential growth of edge computing and its ability to work with cloud services to reduce latency and analyze data in real time. It also discusses the growing popularity of serverless computing, containerization, and micro services design, which contribute to the agility and resource efficiency of cloud settings. The poll also examines the relationship between cloud computing and cutting-edge technologies like artificial intelligence (AI), machine learning, and block chains. To lessen the dangers associated with cloud-based solutions, it highlights the need for robust security measures, compliance protocols, and techniques for encryption. Lastly, this comprehensive analysis provides a comprehensive review of the current state of cloud computing by presenting the most recent developments, challenges, and possible future paths in the field.**

***Keywords*—Cloud Computing; Survey; Infrastructure, IT, Services**

I. INTRODUCTION

The way that organisations and people access, store, and use data and applications has been revolutionised by cloud computing. It does away with the requirement for local infrastructure and eases the load of administering complicated IT systems by offering on-demand access to a shared pool of computing resources through the internet. The present discussion of cloud computing is meant to provide readers a quick understanding of its fundamental ideas and importance in the current digital environment. Cloud computing's fundamental concept is the pay-as-you-go delivery of computing services, such as servers, storage, databases, networking, software, and analytics, via the internet [1]. The underlying infrastructure is managed and maintained by cloud service providers that provide these services in exchange for a fee. Users may use the infrastructure whenever they need it. In contrast to conventional on-premises IT architecture, cloud computing provides a number of clear benefits. It offers scalability in the first place, enabling users to quickly scale up or down their resource use in response to demand. Without making substantial upfront expenditures or experiencing delays, this flexibility allows organizations to react rapidly to changing business demands. By moving the responsibility for infrastructure administration and upkeep to the cloud service provider, cloud computing also provides cost effectiveness. Users may reduce expenses and do away with the requirement for substantial upfront capital investments by just paying for the resources they use. Improved accessibility and cooperation are other benefits of cloud computing. From any location with an internet connection and via a variety of devices, users may access their data, apps, and services [2]. Cloud service providers often use redundant infrastructure and backup procedures to provide high availability and data redundancy. By doing this, the possibility of data loss is decreased, and any downtime caused by hardware malfunctions or natural calamities is minimized. Cloud computing has advantages, but there are drawbacks as well. With organizations having to entrust third-party suppliers with their sensitive data, data security and privacy are key problems. It becomes essential to make sure that there are adequate access controls, encryption, data security measures, and regulatory compliance.

Vendor lock-in and the compatibility of cloud services are two other potential issues. The mobility of apps and data stored in the cloud has to be carefully assessed by organizations, and they should think about ways to reduce their reliance on a single provider. An overview of cloud computing's development through time is provided here: Utility and time-sharing computing from the 1960s through the 1990s: Mainframe computers of the 1960s were costly, occupied a significant amount of space, and needed many resources. Several people may use the same computer at once thanks to time-sharing solutions that were created. The sharing of resources and remote access that are core components of cloud computing were established by this idea. 1980s: Distributed computing and virtualization: The emergence of virtualization technologies in the 1970s and 1980s together with the development

of distributed computing systems had a significant impact on the development of cloud computing. A single physical server could host many virtual computers thanks to virtualization, which improved resource utilization and isolation. Internet and web-based services from the 1990s to the 2000s: In the 1990s, the internet expanded rapidly and web-based services became more popular, paving the way for modern cloud computing. The infrastructure needed to offer services via the internet was made possible by improvements in networking technology and internet access. The first cornerstones of cloud computing were laid by businesses when they began to provide web-based storage and application services. Cloud computing's development in the 2000s: Early in the new millennium, the phrase "cloud computing" attracted a lot of interest and became quite well known. When the Amazon Elastic Compute Cloud (EC2) and Amazon Simple Storage Service (S3) were introduced in 2006, Amazon Web Services (AWS) significantly contributed to the widespread adoption of cloud computing. Infrastructure as a Service (IaaS) was made possible by these services that let consumers rent virtualized computer resources and storage space on demand. Alongside the launch of their own cloud platforms, other significant technology firms like Google and Microsoft also saw the promise of cloud computing. In contrast to Microsoft's 2010 introduction of Azure (PaaS and IaaS), Google announced Google App Engine (PaaS) in 2008. 2010s-Present: maturation and growth. The decade of 2010 saw cloud computing see rapid development and broad acceptance. The advantages of scalability, cost effectiveness, and agility provided by the cloud were acknowledged by organizations across all sectors. SaaS, or software as a service, allowed users to access apps directly from the cloud without the need for local installs, broadening the scope of available cloud services. The introduction of specialized services like server less computing, containerization, artificial intelligence, and machine learning tools by cloud service providers shows how they are continuing to develop and broaden their offerings. Cloud computing is now a crucial component of the IT environment. Failures may be handled in cloud settings, which also provide users dependable services. 5. Swift Application and Service Deployment: Cloud computing makes it possible for swift application and service deployment [3].

II. CLOUD COMPUTING ARCHITECTURAL MODELS

A. Infrastructure as a Service (IaaS): Under the IaaS paradigm, customers may access virtualized computer resources including virtual machines, storage, and networks from cloud service providers. The operating systems, apps, and data that are installed on the infrastructure are all under user control. Without the need for investments in physical infrastructure, IaaS offers businesses a flexible and scalable infrastructure basis on which they can create and operate their own virtualized environments.

B. Platform as a Service (PaaS): When compared to IaaS, PaaS offers a greater degree of abstraction. Users may create, distribute, and manage applications using a platform that comes with preset runtime environments, development tools, and middleware. Because PaaS isolates the underlying infrastructure, developers can concentrate on creating applications rather than managing it. Scalability, a shorter time to market, and easier application deployment and maintenance are all benefits.

C. Software as a Service (SaaS): SaaS makes fully operational programmes available online and accessible through web browsers or APIs. Software applications may be used by users without the requirement for installation, upkeep, or infrastructure administration. The SaaS provider ensures upgrades and availability by hosting and maintaining the software and data. Because SaaS does not need software installation or continuous maintenance, it is convenient, scalable, and less expensive [4].

D. Function as a Service (FaaS): Also referred to as server less computing, FaaS enables programmers to build and run code in the cloud without having to take care of the supporting infrastructure. Developers concentrate on creating discrete functions or compact pieces of code that do certain goals. FaaS solutions control resource allocation and scalability automatically depending on incoming demands. This methodology makes cost optimisation and quick scaling possible for event-driven and micro services systems.

E. Backend as a Service (BaaS): BaaS offers prebuilt backend services that can be connected into apps, including databases, user authentication, push alerts, and file storage. These services may help developers create applications more quickly and with less work while setting up and maintaining the backend infrastructure.

F. Architectural model comparisons

When compared to PaaS and SaaS, IaaS offers the greatest control and flexibility over the underlying infrastructure but also involves more administrative work. PaaS provides a more simplified development experience, requiring less infrastructure administration thanks to pre-set runtime environments and tools. SaaS offers ready-to-use apps, doing away with the requirement for infrastructure administration, installation, and maintenance. To find the best match based on their desired degree of control, scalability, managerial effort, and cost concerns, organizations should carefully analyse various models [5].

III. CLOUD COMPUTING DEPLOYMENT MODELS

Deployment models for cloud computing specify how cloud services are set up and made accessible to consumers. The

four main cloud computing deployment models are as follows:

A. Public Cloud: In a deployment architecture that uses a public cloud, cloud infrastructure and services are owned and managed by outside cloud service providers. The services are made accessible to the general public or a sizable clientele online. The infrastructure is shared by several organizations and users, and each user pays as they go to access resources and services. Public cloud installations provide accessibility, scalability, and cost effectiveness. They enable the supply of resources quickly and do away with the requirement for initial infrastructure expenditures. Due to the shared nature of resources, public clouds could provide few customization possibilities and pose privacy and security issues.

B. Private Cloud: In a private cloud deployment architecture, a single organization uses a dedicated cloud infrastructure. The infrastructure may be maintained by a third-party service provider or housed on-site in the company's own data centre. Private clouds provide you more control, flexibility, and security since you manage and own the infrastructure yourself. Organizations with stringent compliance standards, sensitive data, or certain regulatory restrictions should use this approach. Compared to public cloud installations, private clouds provide more data privacy and control but may also come with higher upfront expenses and ongoing upkeep [6].

C. Hybrid Cloud: By combining components of both public and private clouds, hybrid cloud deployment enables businesses to take use of both models' advantages. It entails integrating and managing services and applications across various cloud environments, including as public and private clouds as well as on-premises infrastructure. Due to its flexibility, hybrid clouds enable the dynamic distribution of workloads across various environments in accordance with variables like security, performance, and compliance needs. Private clouds allow businesses to benefit from the scalability and cost-effectiveness of public clouds while yet maintaining control over important data and applications. Although hybrid cloud deployments simplify managing and integrating various environments, they add complexity to data and application mobility across environments [7].

D. Community Cloud: Organizations with similar interests, such as those in a particular sector or industry, share a community cloud deployment strategy. Members of the community share the infrastructure, which may be housed on-site or by a different service provider. Community clouds provide cooperative settings where businesses may share resources, apps, and data while attending to particular community needs and compliance rules. Greater control, individualization, and cost sharing among community members are all possible under this paradigm.

IV. SECURITY AND PRIVACY IN CLOUD COMPUTING

Security and privacy protection are becoming top priorities as businesses depend more and more on cloud computing services. The following are some crucial components of security and privacy in cloud computing [8]:

A. Data protection: In cloud computing, data security is crucial. To secure sensitive information that is stored or processed on the cloud, organisations must take precautions including encryption, access controls, and data segregation. To stop unauthorised access, effective authentication methods should be used, such as multi-factor authentication.

B. Compliance and Regulatory Requirements: When using cloud services, organisations must adhere to requirements unique to their industry and data protection legislation. This entails dealing with questions of data sovereignty, establishing adequate data handling procedures, and adhering to privacy and security laws. Organisations should evaluate the cloud service providers' compliance capabilities and make sure that contracts adhere to their unique compliance needs.

C. Risk of Data Breach: While it is the responsibility of cloud providers to secure their infrastructure, it is the responsibility of organizations to safeguard their data. Applications' vulnerabilities, improper setups, or insider threats may all result in data breaches. To reduce the risk of data breaches, regular vulnerability assessments, security audits, and incident response planning are essential.

D. Cloud Service Provider Security: Before entrusting cloud service providers with their data, organizations should carefully assess their security procedures and certifications. This include evaluating their network security, physical security measures, and compliance with industry standards and best practises.

E. Shared Responsibility Model: Cloud computing uses a shared responsibility model in which the client is in charge of protecting their data and applications while the cloud provider is in charge of protecting the underlying infrastructure. To make sure that security obligations are properly stated and adequately handled by all parties, it is crucial to comprehend this paradigm.

F. Privacy Issues: When gathering, storing, and processing personal data in the cloud, organisations must handle privacy issues. To control the handling of personal data and ensure compliance with relevant data protection laws, privacy policies and procedures should be implemented. In cloud settings, user privacy may be protected with the use of clear permission processes, data anonymization methods, and privacy-enhancing technology.

G. Incident Response and Business Continuity: Companies have to have policies in place for detecting, responding to, and recovering from security events or service interruptions. The implementation of backup and disaster recovery plans is necessary to guarantee company continuity in the case of data loss or service interruptions.

H. Vendor Lock-In and Exit Strategies: When using cloud services, businesses should think about vendor lock-in. Organisations may improve the security and privacy of their data in the cloud by putting in place strong security measures, keeping up with new threats, and maintaining solid governance practices [9].

V. EMERGING TRENDS IN CLOUD COMPUTING

Due to changes in business requirements and technological breakthroughs, cloud computing is always evolving. The following new trends are influencing the direction of cloud computing [10]:

A. Edge Computing: Edge computing reduces latency and enables real-time processing and analysis by bringing computational capabilities closer to the source of data collection. Organizations can meet the needs of latency-sensitive apps, IoT devices, and bandwidth-intensive workloads by putting resources at the network edge.

B. Server less Computing: Also known as Function as a Service (FaaS), server less computing abstracts infrastructure administration so that developers may concentrate on creating and deploying specific functions or micro services. Developers may run code in response to certain events or triggers using server less architecture without having to create or maintain servers. This trend offers automated scaling and pay-per-use pricing structures, which improve scalability, lower expenses, and streamline application development.

C. Multi-Cloud and Hybrid Cloud Strategies: To take advantage of the advantages of various cloud providers and infrastructure models, organizations are using multi-cloud and hybrid cloud strategies. In contrast to hybrid cloud, which provides seamless integration between public and private clouds and offers flexibility, data sovereignty, and workload optimization, multi-cloud enables organizations to choose the best services from various providers depending on unique needs.

4. Cloud-Native apps: Using a micro services architecture, containerization, and orchestration technologies like Kubernetes, cloud-native application development focuses on creating apps expressly for the cloud environment. These programmes may effectively use cloud resources and services and are very robust and scalable.

5. Machine learning (ML) and artificial intelligence (AI) workloads in the cloud: Cloud computing offers the processing power, storage space, and scalable infrastructure needed for ML and AI workloads. Organisations may use pre-trained models, create and train their own models, and make use of cutting-edge analytics capabilities thanks to cloud-based AI and ML services.

6. Improvements to data security and privacy: As the need for data security grows, cloud service providers are making significant investments in security and privacy capabilities. Data loss protection, identity and access management, encrypted storage, and compliance certifications are becoming commonplace services. Differential privacy and secure multi-party computing are two privacy-enhancing technologies being developed to solve privacy issues while processing sensitive data in the cloud.

7. Quantum machine: By more effectively resolving complicated issues than conventional computer techniques, quantum computing has the potential to revolutionize cloud computing.

VI. CLOUD SERVICE PROVIDERS

Enterprises known as cloud service providers (CSPs) provide businesses and consumers with a range of cloud computing services and infrastructure. A few well-known cloud service companies are listed below:

1. Amazon Web Services (AWS): AWS is one of the top cloud service providers in the world and is a division of Amazon.com. It provides a full range of cloud services, including networking, machine learning, analytics, databases (RDS), storage (S3), and IoT services. Customers are able to deploy their apps and services in data centres all around the globe thanks to AWS's extensive global infrastructure [11].

2. Microsoft Azure: Microsoft Azure is a platform for cloud computing that it offers. Virtual machines, storage, databases, machine learning, analytics, and developer tools are just a few of the many services it provides. For businesses using Microsoft technology, Azure is a popular option because of its tight connection with other Microsoft goods and services.

3. Google Cloud Platform (GCP): GCP provides a range of cloud computing services, including analytics, AI, machine learning, databases, storage, networking, and computing. A scalable and dependable infrastructure is offered by GCP, supported by Google's extensive worldwide network. Additionally, it provides services like Big Query for data analytics and Google Kubernetes Engine (GKE) for container orchestration [12].

4. IBM Cloud: For organizations, IBM Cloud offers a variety of cloud services and solutions. In addition to virtual

servers, storage, databases, AI, machine learning, analytics, and blockchain services, it also provides platform services, infrastructure services, and software services. With a significant emphasis on hybrid cloud deployments, IBM Cloud is renowned for its enterprise-grade capabilities.

5. Oracle Cloud: Oracle Cloud provides a wide range of cloud services, such as platform, infrastructure, and software services. It offers services including computing, storing, databases, artificial intelligence, machine learning, analytics, and business applications. Oracle Cloud places a strong emphasis on its ability to integrate with other Oracle technologies and offers solutions for multi-cloud and hybrid cloud deployments.

6. Alibaba Cloud: A member of the Alibaba Group, Alibaba Cloud is a well-known cloud service provider in China and is growing internationally. It provides many different services, including as computing, storage, databases, AI, machine learning, analytics, and IoT. Alibaba Cloud is well-known for its substantial market share in China and has data centres spread throughout the globe.

7. Salesforce: Salesforce is a customer relationship management (CRM) platform that is cloud-based and provides a number of services for sales, marketing, customer care, and other activities that are focused on the needs of the client. It offers cloud-based programmes and services that support businesses in automating procedures, managing customer interactions, and drawing conclusions from customer data [13].

VII. CHALLENGES AND CONSIDERATIONS IN CLOUD COMPUTING

Although cloud computing has many advantages, there are also issues and things to think about that businesses need to take into account [14]. These consist of:

1. Security and Privacy: One of the main concerns with cloud computing is ensuring the security and privacy of data. The security mechanisms put in place by cloud service providers, such as data encryption, access restrictions, and vulnerability monitoring, must be carefully assessed by organizations.

2. Data Governance and Compliance: In order to properly manage data in the cloud, organizations must set up clear data governance rules and processes. This entails establishing data ownership, data categorization, and data retention as well as making sure that all applicable laws and regulations are followed. It's critical to comprehend data residency and sovereignty challenges, especially when working across various countries [15].

3. Vendor Lock-In: Moving to the platform of a cloud service provider sometimes entails moving a significant quantity of data and making adjustments to infrastructure and applications. The hazards of vendor lock-in should be carefully considered by organisations, and measures should be taken to lessen them. This might include using standards-based technology, implementing multi-cloud or hybrid cloud strategies, or keeping the flexibility to switch to other providers [16].

4. Performance and dependability: The user experience and company operations may be impacted by cloud service performance and dependability. The service-level agreements (SLAs) that cloud service providers provide, which include uptime, response time, and scalability assurances, must be evaluated by organizations. To guarantee optimum performance, they should also take into account variables like network latency, data transfer rates, and the geographic dispersion of data centers [17].

5. Data Transfer and Bandwidth Costs: Cloud computing requires data transfers between various cloud services as well as between on-premises infrastructure and the cloud. Businesses should think about the costs of bandwidth and data transmission since these expenses might change based on the amount of data transported and the distance between data centers.

6. Application Compatibility and Integration: When designing cloud-native apps or transferring existing applications to the cloud, compatibility and integration issues must be taken into account. Businesses should evaluate how well their apps work with the selected cloud platform and make sure that their systems are properly integrated. Applications may need to be refactored, APIs may need to be implemented, or the cloud service provider's integration services may be used.

7. Cost Management and Optimisation: Although the use of the cloud may result in cost savings, it is crucial to efficiently manage and optimize cloud expenditures. To maximize expenditure, businesses should keep an eye on resource utilization, establish cost-allocation plans, and use the tools offered by cloud service providers.

8. Governance and Control: Compared to conventional IT infrastructure, cloud computing presents new governance and control concerns. To retain visibility and control over their cloud resources, organizations should set up the proper rules, controls, and monitoring systems. To maintain compliance and reduce risks, this involves limiting user access, putting change management procedures in place, and carrying out routine audits [15].

VIII. CONCLUSION

In conclusion, this cloud computing study has given a thorough review of the important factors and concerns involved. The survey covered a wide range of topics, including the definition and fundamental ideas of cloud computing, its historical

context and evolution, the advantages and difficulties of using it, architectural models, deployment models, cloud computing services, privacy and security issues, emerging trends, and research opportunities. To guarantee a successful and safe cloud deployment, organizations must carefully assess their needs, choose suitable cloud service providers, and put in place strong security controls and governance structures. Overall, this cloud computing study has offered insightful information on the status, difficulties, advantages, and future prospects of cloud computing. It acts as a base for businesses and academics to further investigate and take use of cloud computing's possibilities, enabling its responsible and successful adoption in the changing digital world.

REFERENCES

[1] Lu G, Zeng WH. Cloud computing survey. In Applied Mechanics and Materials 2014 (Vol. 530, pp. 650-661). Trans Tech Publications Ltd.

[2] Ward JS, Barker A. A cloud computing survey: Developments and future trends in infrastructure as a service computing. ArXiv preprint arXiv: 1306.1394. 2013 Jun 6.

[3] Avram MG. Advantages and challenges of adopting cloud computing from an enterprise perspective. Procedia Technology. 2014 Jan 1; 12:529-34.

[4] Bokhari MU, Shallal QM, Tamandani YK. Cloud computing service models: A comparative study. In2016 3rd International Conference on Computing for Sustainable Global Development (INDIACom) 2016 Mar 16 (pp. 890-895). IEEE.

[5] Odun-Ayo I, Ananya M, Agono F, Goddy-Worlu R. Cloud computing architecture: A critical analysis. In2018 18th international conference on computational science and applications (ICCSA) 2018 Jul 2 (pp. 1-7). IEEE.

[6] Savu L. Cloud computing: Deployment models, delivery models, risks and research challenges. In2011 International Conference on Computer and Management (CAMAN) 2011 May 19 (pp. 1-4). IEEE.

[7] Aryotejo G, Kristiyanto DY. Hybrid cloud: bridging of private and public cloud computing. InJournal of Physics: Conference Series 2018 May 1 (Vol. 1025, No. 1, p. 012091). IOP Publishing.

[8] Zhou M, Zhang R, Xie W, Qian W, Zhou A. Security and privacy in cloud computing: A survey. In2010 Sixth International Conference on Semantics, Knowledge and Grids 2010 Nov 1 (pp. 105-112). IEEE.

[9] El Makkaoui K, Ezzati A, Beni-Hssane A, Motamed C. Cloud security and privacy model for providing secure cloud services. In2016 2nd international conference on cloud computing technologies and applications (CloudTech) 2016 May 24 (pp. 81-86). IEEE.

[10] Hosseinian-Far A, Ramachandran M, Slack CL. Emerging trends in cloud computing, big data, fog computing, IoT and smart living. Technology for smart futures. 2018:29-40.

[11] Gupta B, Mittal P, Mufti T. A review on Amazon web service (AWS), Microsoft azure & Google cloud platform (GCP) services. InProceedings of the 2nd International Conference on ICT for Digital, Smart, and Sustainable Development, ICIDSSD 2020, 27-28 February 2020, Jamia Hamdard, New Delhi, India 2021 Mar 11.

[12] Challita S, Zalila F, Gourdin C, Merle P. A precise model for google cloud platform. In2018 IEEE international conference on cloud engineering (IC2E) 2018 Apr 17 (pp. 177-183). IEEE.

[13] Manchar A, Chouhan A. Salesforce CRM: A new way of managing customer relationship in cloud environment. In2017 Second international conference on electrical, computer and communication technologies (ICECCT) 2017 Feb 22 (pp. 1-4). IEEE.

[14] Moreno-Vozmediano R, Montero RS, Llorente IM. Key challenges in cloud computing: Enabling the future internet of services. IEEE internet Computing. 2012 May 22; 17(4):18-25.

[15] Gou Z, Yamaguchi S, Gupta BB. Analysis of various security issues and challenges in cloud computing environment: a survey. Identity Theft: Breakthroughs in Research and Practice. 2017:221-47.

[16] Jain J., "Cloud Cryptography to ensure security and privacy in Cloud", published in 'Glimpse' National Journal of Computer Science, Volume 13, No. 1, January-June 2022.

[17] Jain J., Sagar N.,Chauhan J.,"Brain Tumor detection model CNN and Threshold Segmentation" published in Glimpse-Journal of Computer Science, Volume. 14, No. 2, 02nd July to Dec 2023.

[18] Jain J.,Tyagi R. and Verma R., "A Review on Distinctic Hybrid Cloud Mode" published in 'Glimpse'Journal of Computer Science, Volume. 10, No. 2, 02nd July to Dec 2020.

ABOUT THE AUTHOR

Dr. Jaishree Jain, Associate Professor in Computer Science & Engineering Department, Ajay Kumar Garg Engineering College, Ghaziabad, affiliated to AKTU, Lucknow, Uttar Pradesh, INDIA. She has 14 years teaching experience in CSE & IT Departments that include Chandigarh University, Punjab and college of AKTU, University, Lucknow since July 2010. She had done her B.Tech. in Information Technology from Uttar Pradesh Technical University, Lucknow. She had done her M.Tech. in Software Engineering from MNNIT, Allahabad. She had qualified GATE two times in 2007 & 2008 with 94.86 percentile. She had done her Ph.D. from TMU, Moradabad in 2023. She had Published more than 50 research papers in SCI/SCOPUS/ UGC-Care/ UGC/ National and International Journals, Conferences and 5 Book chapters published in International Book. She has received several best paper awards for her research papers at various international conferences. She had also been Published 30 patents with 5 patents granted. She is also the author of three Books Published by International standard Publisher. Her research interests include Image Processing, Cloud Security, and Watermarking. She is also the reviewer of Journal of Supercomputing, IEEE Conferences which is listed in Springer Journal and reviewed many papers till now. She has been the session chair of many IEEE Conferences and other International Conferences. She is the member of professional bodies' i.e. life time member of ISTE, lifetime member of ICSES, IEEE Society and member of Engineering Council of India (ECI) and position entitled as a "Professional Engineer" by ECI. INDIA