6G+AI+ML= Revolution (^{6}GAIML R^2)

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The technologies like Artificial Intelligence (AI), Machine Learning (ML) and sixth generation (6G) echo systems have the potential to generate breakthrough results in the near future. The merger of these technologies will surely give rise to novel services that will improve the quality of user-centric applications. While the potential of 6G technology to assist and impact AI and ML to make revolution **(^{6}GAIML R^2)**. Technology transformations that these technologies will witness in the future, this is extremely important to understand that In India many applications developed by the Govt. or by private sector are unused even the basic applications many a times are not accessible. It will bring a much-needed change and will play a very important role in the under developed countries.

Growth With Telecom

Industry experts have switched their attention to 6G as the rate of deployment of 5G technology accelerate and standards continue to stabilize. The 6G communication networks are targeted to provide one Tbps data rate, one ms end-to-end latency, and up to twenty years of battery life. All these sounds fictitious for now. However, scientifically we have gained notable success in achieving these goals. Along with it, technologies like quantum communications, big data analytics, pervasive AI, and ML are expected to boom. Extensive focus is on pervasive AI and ML, which have the potential to have a significant impact on the future 6G network. AI and ML will play a significant role in enabling optimized 6G networks and developing new.

Requirement and Change

History and Evolution Various schemes such as “Time Division Multiple Access (TDMA)”, “Frequency Division Multiple Access (FDMA)”, “Code Division Multiple Access (CDMA)” and “Orthogonal Frequency Division Multiple Access (OFDMA)” are common in previous generations of mobile communications, especially at the physical layer. With the emergence of electronic and photonic materials, microelectronic fabrication and air interface designs the communication technologies got new dimensions and vivid use cases. Technology advancements in circuit digitization, for example, permit shift-keying signals and channel coding, allowing TDMA-based 2G systems to vastly outperform 1G systems which utilized FDMA in terms of voice capacity. The move from “Digital Signal Processor (DSP)” to “Application Specific Integrated Circuit (ASIC)” considerably enhances the processing power and density of the base-band in base stations, which enhances 4G systems’ capacity gains over 3G systems. Extremely cohesive circuits in the base-band, radio frequency, and optical fibre domains gave rise to active antennas. This allows massive Multiple-Input / Multiple-Out (MIMO) to become a reality in 5G, along with use cases, deployment scenarios, and performance objectives, should be encouraged.

The maximum data rate for 5G networks is twenty GB/s, whereas 6G networks can reach one to ten TB/s because of the use of terahertz and optical wireless bands. When compared to 5G, using AI to improve network management can increase spectrum efficiency by three to five times and energy efficiency by ten times. The utilization of extremely "Heterogeneous Networks (HetNets)", a variety of communication scenarios, and wide bandwidths in high-frequency bands will lead the significant increase in connection density (by ten to hundred times). Due to the motions of ultra-HST and satellites, mobility at speeds greater than thousand km/hr will be possible. The accepted latency would be less than one millisecond.

Reach upto the last leg

To provide global coverage, 6G wireless communication networks will expand from terrestrial to space–air–ground–sea integrated networks. These networks will include the usages of satellites, "Unmanned Aerial Vehicles (UAVs)", terrestrial "Ultra-Dense Networks (UDNs)", underground and underwater communications. To improve data rates, all spectral bands ought to be thoroughly investigated, including sub-six GHz, millimeter-wave, terahertz, and wireless optical bands. To enable comprehensive applications, key technologies and next-generation application will be highly integrated with the use of AI and data science methodologies. Furthermore, AI can boost network performance by allowing dynamic and optimal usage of networking and computing resources. Comprehensive or built-in network security, including physical layer and network layer security, will become increasingly popular while developing 6G networks. This is in contrary to 1G–5G development plans, which prioritize having networks up and running before addressing network security and how to improve network security

Game Changer

AI and ML will play a critical role in the creation of the 6G network. This is due to the fact that these technologies 6G technology will have a huge influence on all of our government stakeholders. Research problems will be become easier as data will be available and AI+ML will ensure the calculation methodology easier and results and the concerned communities will get the result very fast and accurate at the same point and system-level implementation of K of applications in India within different states and globally too issues is required.

Radio Frequency (RF) Networks AI/ML Based Monitoring Algorithm Proper Monitoring of RF Contribute to Global Standards Bodies 6G and Other Prominent Technology Rapid Development and Standerization of 6G Based Networks. 6G Wireless Communication Requirements and Technologies Several demands from end users and technologies will influence the 6G system.

Hassel free Implementation and Optimum Utilization

Dynamic Spectrum Allocation: In 6G networks, great efficiency necessitates tremendous flexibility, Network Slicing: Network operators in new-generation communication network employ dynamic network slicing technology to enable dedicated virtual networks. This helps to facilitate the efficient delivery of any service to a diverse set of customers, cars, equipment, and industries, Smart Antenna Systems: Because of the growing frequency, massive utilization of numerous antenna systems is required. MIMO technique is capable of sending and receiving signals using multiple antennas, Big Data Analytics: Large-scale data collection and processing need both advanced technology and in-depth understanding. The volume of data in 6G will be massive and there will be a wide variety of data types. Big data processing requires an understanding of the underlying patterns and hidden linkages inside data, High-Capacity

Backhaul: For efficient communications, high-capacity backhaul networks are particularly appealing. High-speed optical fibre and "Free Space Optical (FSO)" systems are absolutely fascinating options in the context of excessive backhaul traffic

Integrating Radar Technology with Mobile Technologies: To ensure high precision of geolocation in the field of communication and to make radar communications easier, the radar system will be linked with 6G wireless communications, Integration of Energy Transfer with Wireless Information: Wireless charging of battery devices will be possible with 6G networks. This may facilitate the transfer of information and energy together. Wireless energy transmission necessitates that tiny device, such as cell phones, or big devices, such as automobiles, be charged wirelessly, which not only ensures battery life but also allows charging to occur at any time and in any location. One of the most revolutionary technologies in 6G will be wireless energy transmission, Integration of Sensing and Communication: Continuously observation of the wireless environment and transferring information between multiple nodes along with making dynamic changes would be required in 6G, Artificial Intelligence: Wireless communications will be revolutionized in the future as a result of substantial developments in AI in numerous domains. AI uses intensive analysis to analyse complicated targets, increasing efficiency and lowering communication latency. Terahertz Communications: This is related to high-rate short-distance transmission employing a huge frequency range beyond 100 GHz, transferring long-distance communications to the freed lower frequency band. Terahertz has the benefit of being thinner and having better directionality, making it ideal for MIMO. However, there are concerns with large-scale fading, power usage, and other factors, Optical Wireless Technology: It is based on optical frequency bands, such as Visible Light Communication (VLC), light fidelity, a Free Space Optical (FSO) communication, in both outdoor and indoor situations, optical wireless communication can offer high data throughput and low latency, Accurate Indoor Localization: Indoor localization will become more important in 6G communications. Many promising solutions, such as distributed models, will require highly accurate positioning systems to aid model efficiency. Accuracy is a need for efficiency. The interior communication environment will become increasingly complicated as the number of mobile devices and users grows.

Massive Returns by Both the Technologies

AI and 6G Technology: Even in 6G networks, the importance of the physical layer and networking layer will remain the same. The borders between these layers will grow less tight as a result. Furthermore, AI and ML algorithms are likely to play a big part in this technological development. This might result in increased throughput and network capabilities ,Resource Allocation: Massive IoT deployments utilizing 6G communication technology may be addressed with AI, and ML-based predictive resource allocation algorithms that focus on challenges related to unpredictable network performance issues,Reinforcement Learning: These techniques are widely employed to address challenges with adaptive network access scheduling,Development of Collaborative and Distributive Environment: The exponential proliferation of mobile devices has resulted in a transition from cloud computing to mobile edge computing. IoT technology, which is quickly developing and projected to dominate 6G networks. That this technology will also follow a similar path and speed up AI adoption at the network edge devices, Shared Learning Model: This ML approach allows users to work together to create a shared learning model. This will facilitate preservation of all training data on the network nodes, ensuring data privacy.

Open Radio Access Network (RAN) for AI and ML: The RAN is a new network design that uses infrastructure virtualization, flexibility, and embedded intelligence to provide end-users with more agile services and enhanced capabilities. Open RAN strategy will enable a heterogeneous system of commercialized hardware and software to improve and self-organize in order to satisfy the overall goals, and Key Performance Indicators (KPIs) of the ecosystem, Potential Impact on Cellular Business: The mobile cellular business is still in the early phases of 6G technology. And all manufacturers and service providers are in the early phase of research & undoubtedly be affected by this upcoming and novel technology. Accordingly, THz communication, edge computing, quantum computing, security models, and ubiquitous AI and ML have the potential to revolutionize network interaction and offer new use cases. Opportunities and Challenges for 6G and Beyond In this section, we present future research challenges and open problems in the 6G communication, AI and ML domains.

Collection and Availability of Rich Real-World Datasets: The bulk of futurist wireless communications applications will be based on AI/ML technology. These models require a vast quantity of data during the training phase. However, such publicly available datasets for wireless communication are still in the works. Moreover, making such data sets freely accessible may give rise to issues like users' data protection and privacy. Holographic Type Communication (HTC): True holograms, as a contrast to standard 3D films that use binocular parallax, may meet all visual signals of perceiving 3D things with the naked eye as naturally as feasible. In recent years there have been considerable advancements in this technology. Microsoft's HoloLens is one of the best examples of this. However, the use of HTC requires wider bandwidth in the order of terabits per second.

It also needs ultra-low latency and high-precision synchronization. Extended Reality: This technology is a combination of augmented and virtual reality and is in its adolescent stage in the era of 5G communication technology. In order to achieve a similar visual quality like 2D video streaming, ER devices with a 360-degree field vision will require a substantially higher data capacity. A bandwidth requirement of over 1.6 Gbps per device is predicted by some reports. Digital Twin: is used to create an exact virtual reproduction of a physical (or real) thing, and manufacturers. However, with the introduction of 6G networks, it is expected to be completely deployed. Pervasive Intelligence.

About the Author

Mr. Raj Pareek worked as Head, - Strategic Alliance, Vice President and Business Head in Telecom Industry with more than 21 years' experience. He is alumni of prestigious institutions like Indian Institute of Management, Kolkatta, Amity University, BITS, Pilani and Member of Bar Council of Delhi, India. His specific focus in Customer Service Delivery, Program Management, PMO, Order Management, Life cycle management, Alliances, Strategic Partnership, Channel Management and Business Development. An impressive communicator with honed interpersonal, team building, negotiation, presentation, convincing and analytical skills. Ability to think out-of-the-box and contribute ideas towards achieving business excellence. Pivotal in contributing in all the Govt. Projects for alliances, partnership and technology.