WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Future Technologies & AI in Health Care and Their Challenges

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A B S T R A C T

As the world the world moves deeper into the digital geometriesCI, biotechnology,imes, and extended reality will be. This paper talks about the technologies that will change how people and machines interact and how businesses and society work by the year 2025. We look at intelligent systems, brain-computer interfaces, smart environments, and the moral problems that come up with these fast changes from a variety of fields. We finish with some ideas about where research should go in the future and the need for responsible innovation. AI is changing healthcare by making diagnoses more accurate, customizing treatments for each patient, speeding up processes, and getting better results for patients. The rise of electronic medical records (EMRs) full of data, advanced imaging tools, wearable health devices, and genomics has made AI useful and important in many parts of the healthcare value chain.

Keywords: Future technologies, artificial intelligence, quantum computing, biotechnology, extended reality, ethics, medical, imaging, drug, heath, surgery, Security, Challenges.

I. Introduction

Technology has changed a lot of things in a short amount of time in the early 21st century. It has changed industries and the way society works. Deep learning and generative models, such as GPT-4 and DALL-E, are two examples of AI breakthroughs that have changed how we automate, make decisions, and create things. At the same time, it's getting harder to tell the difference between real and digital interactions because of extended reality (XR), which includes augmented reality (AR), virtual reality (VR), and mixed reality (MR). XR can be used for a wide range of things, including immersive training and social media platforms for the next generation. Quantum computing is going from being an abstract area of study to being used in the real world. IBM and Google, for example, have already reached quantum supremacy in some areas. This leap promises big improvements in cryptography, finding new drugs, and making complicated systems work better. At the same time, new biotechnology tools like CRISPR gene editing and mRNA vaccines are making it possible to make medicine more personalized and improve people's lives. AI has a lot of promise to change how healthcare is given, but it also has a lot of big problems and moral issues. These problems need to be fixed so that the implementation is safe, fair, and responsible [1]. .

II. Key Technological Trends

A. Artificial Intelligence and Autonomy

Advanced AI models are changing fields by doing hard mental work for people. Things are changing from systems that have people in the loop to systems that have AI in the loop. For instance, GPT-powered co-pilots are becoming more common in software engineering, and AI-driven diagnostics are becoming more common in healthcare. Now, policy and engineering design are focused on AI's ability to be fair and explain itself. When you add AI to important systems, it raises big questions about fairness, decision transparency, and algorithmic bias. For example, an AI model that is used to hire someone or approve a loan needs to say why it made its choice so that it doesn't unfairly favor one race, gender, or other protected trait over another. Because of this, AI explainability—the ability to understand and check AI decisions—is becoming a basic requirement in system design, especially in fields with strict rules like healthcare, finance, and law.[2]

B. Quantum Computing

Scientists are no longer just trying out new quantum systems. IBM and Google are two companies that are working on real-world quantum algorithms that can be used in cryptography, material science, and financial optimization. People think that hybrid classical-quantum systems will be able to do things that regular computers can't. However, quantum systems aren't widely available or scalable yet because of issues like high error rates, unstable qubits, and the need for cooling. People are using hybrid classical-quantum systems right now. These systems use a classical processor to do simple tasks and a quantum processor to do more complex ones. In the long run, quantum computing could change how we think about how hard it is to do math, but it could also break the encryption methods we use now. This has led to the emergence of post-quantum cryptography as a new field of study. [3]

C. *Biotechnology and Bio-Computing*

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Thanks to progress in CRISPR, synthetic biology, and neural tissue engineering, it is now possible to program biological systems. DNA data storage and genomics that are tailored to each person are two new areas of study in computational biology. Bio-computing does, however, bring up a lot of ethical and technical problems, like keeping genetic data private, biosecurity, and the chance that engineered organisms could cause mutations or damage the environment. [4].

D. ***Extended Reality (XR)***

In fields like education, defense, and healthcare, AR and VR platforms are going from being fun to being very important. People can easily use spatial computing devices, and they can work together in holograms and train with simulations. The high cost of hardware, motion sickness, and privacy concerns (such as gathering information about how people use it and where they are) are the biggest problems with XR. As hardware gets lighter, cheaper, and more powerful, XR is likely to be a big part of the next computing paradigm. [5][6][7]

III. Applications Across Domain

1. ***Medical Imaging and Diagnostics*** **[8]**

AI models, especially those that use deep learning, can look at medical images with a lot of accuracy. Radiologists can use these tools to find problems like: :

Using CT scans or mammograms to find cancer, such as lung, breast, or skin cancer

AI-assisted fundus photography for eye diseases

X-rays and MRIs can show broken bones, bleeding, and lesions.

Examples: , Google's AI for breast cancer screening has been as accurate as or more accurate than expert radiologists. .

, Hospitals use AI platforms from Aidoc and Zebra Medical Vision to look at X-rays in real time

2. ***Predictive Analytics and Risk Stratification*** **[9]**

AI can look at a lot of data to find patterns and figure out what risks patients might be facing. People use these systems to:

Hospital monitoring systems can help find sepsis or cardiac arrest early.

Finding out when patients will come back

Figuring out when a disease will get worse, like when diabetes complications will happen or when dementia will start

AI models help healthcare providers take action before problems happen by putting together data from clinical, demographic, and behavioral sources. This results in better outcomes for patients and lower costs.

3. ***Personalized and Precision Medicine*** **[10]**

AI helps precision medicine by using genomics, lifestyle data, and clinical records to make treatment plans that are different for each person. Here are some ways to use it:

AI algorithms to find the best cancer treatments based on genetic markers

Using AI to guess how drugs will work in people with autoimmune or neurological diseases

Adaptive learning models for figuring out the right amount of medicine to give in critical care

Example:IBM Watson for Oncology, which is no longer sold, used to match cancer patients with the right treatments based on their genetic makeup and medical history.

4. ***Drug Discovery and Development*** **[11]**

AI helps drug research go faster by:

Finding possible drug candidates by using molecular simulations and predicting the structure of proteins

Using old drugs to treat new diseases, like rare ones

Making clinical trials look like they are happening to save time and money

Notable example:AlphaFold from DeepMind is a well-known program that solved the protein folding problem. This helps researchers learn more about how living things work and find new drug targets more quickly.

5. ***Virtual Health Assistants and Chatbots*** **[12]**

AI-powered chatbots and virtual assistants help patients take care of themselves and stay interested by:

Answering health questions

Telling patients to take their meds

Helping with making appointments and figuring out what symptoms mean

Eexample, Babylon Health, Ada Health, and Buoy Health all use AI chatbots to do a first health checkup.

6. ***Robotic Surgery and Clinical Automation*** **[13]**

Robot-assisted surgical systems, like the da Vinci Surgical System, use AI to make surgeries more accurate, less invasive, and faster to heal. AI also takes care of some hospital tasks, like:

Setting up staff schedules and distributing resources

Keeping an eye on important supplies in stock

Automatic documentation from voice or text input

7. ***Remote Patient Monitoring and Wearable's*** **[14]**

AI uses data from wearables like smartwatches and fitness trackers to watch vital signs all the time and find problems.

Healthcare providers can tell when something is wrong by looking at heart rate variability, oxygen saturation, sleep patterns, and ECG data.
AI-enabled monitoring makes it easier to control diabetes, high blood pressure, and COPD over time.
For instance, the Apple Watch and Fitbit use AI to let you know when you fall or when your heart rate is off.

8. *Mental Health and Behavioural Analysis* [15]
We use NLP and emotion AI to:
You can tell if someone is depressed, anxious, or has PTSD by looking at their voice, text, or face.
Give cognitive behavioral therapy (CBT) with virtual counselors.
Watch the user's mood and suggest ways for them to improve their health that are unique to them.
Woebot, Wysa, and Replika are apps that use conversational AI to help people with their mental health, for example.

IV. Challenges And Ethical Issues

1. Data Privacy and Security [16]
Challenge**:** AI systems need to be able to access a lot of patient information, like private health records, imaging data, and genetic information. If you don't follow the rules or use this information the wrong way, you could be accused of identity theft, discrimination, or being shamed.
For instance, Google's Project Nightingale in 2019 made a lot of people angry because it secretly gathered health data from millions of patients without their knowledge. This made people wonder about trust and openness.

2. Bias and Fairness in AI Algorithms [17]
Challenge: AI models that learn from datasets that are biased or missing information may give results that are wrong or unfair. In healthcare, this is especially important because mistakes can lead to wrong diagnoses or treatments.
For instance, a popular U.S. health algorithm didn't consider the needs of Black patients, which made it harder for them to get into high-risk care programs (Obermeyer et al., 2019, Science).

3. Lack of Transparency and Explainability [18]
A lot of AI systems, especially deep learning models, are "black boxes," which means they make choices without explaining why. Clinicians may not trust these systems if they can't figure out how they come to their conclusions.
For instance simply put, an AI system that was used to diagnose diabetic retonsopathy constructively wiorked in tests, but some clinics turned it down because the staff couldn'tha figure outha why it flagged certain cases. said This made it hard to get approval from the government and get people to trust the system.

4. Accountability and Legal Liability [19]
Challenge**:** If an AI system gives the wrong diagnosis or treatment suggestion, it's not clear who is to blame: the developer, the healthcare provider, or the institution?
Example**:** If a robotic surgical assistant that is partly controlled by AI makes a big mistake, should the surgeon who used it be held responsible or the company that made the AI?

5. Informed Consent and Patient Autonomy [20]
Challenge: Patients may not know when AI systems are used to treat or diagnose them. People are less free because they didn't give informed consent, which is an ethical issue.
Example**:** AI chatbots that help with mental health, for instance, might not make it clear that they are not human, which could confuse people who are already in a bad place.

6. Regulatory and Compliance Gaps [21]
Challenge**:** AI in healthcare often evolves faster than existing regulations. Many countries lack comprehensive legal frameworks for approving and monitoring AI-driven medical devices or diagnostics.
Example**:** While the FDA has approved some AI-based tools, it struggles with adaptive AI models that continuously learn post-deployment, requiring new approval paradigms.

V. Future Directions

Human-AI Co-evolution: Developing symbiotic relationships between humans and machines.
Quantum Internet: Creating secure, entangled communication networks.
Synthetic Life Forms: Exploring artificial organisms for industrial and ecological applications.
Neuroethics: Establishing rights and frameworks for mental autonomy and brain data ownership.

VI. Conclusion

New technologies will not only make our lives, work, and interactions better, but they will also change them completely by 2025. To come together, they will need to find a balance between new ideas, morals, and openness. Using AI in healthcare isn't just a new technology; it's a new way to deliver,

experience, and improve medical services. AI could change a lot of things about healthcare, like how diagnoses are made automatically, how treatments are tailored to each patient, how health assistants work in real time, and how people interact with each other. But these improvements also bring up big moral, legal, and social issues. We need to fix data privacy, algorithmic bias, explainability, and regulatory gaps just as quickly as we make new technology. It is important to make sure that AI makes healthcare better in a way that is fair, open, and trustworthy. In the future, people and AI will work together. Machines will help doctors instead of taking their jobs. Neuroethics, quantum-secure communication, and synthetic bio-integrated systems are just a few of the ideas that will shape the next generation of health technology. AI needs to grow with a strong commitment to ethical principles, patient-centered care, and design that is open to everyone if this future is going to be really good.

Acknowledgements

I would like to express my sincere gratitude to all those who contributed to the successful completion of this paper on "Future Technologies & AI in Health Care and Their Challenges"

I extend my thanks to Department of Artificial Intelligence and Data Science, Vivekanand Education Society's Institute of Technology, Chembur-Mumbai for providing the academic resources and environment necessary for research.

I acknowledge the contributions of researchers and developers whose pioneering work in the fields of artificial intelligence, medicine, ethics, and regulatory science provided the foundation for this study

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