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AI in Healthcare: Enhancing Patient Engagement through Virtual Assistants

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***ABSTRACT* – Artificial intelligence (AI) integrated into health is revolutionizing patient engagement through virtual assistants and chatbots. These AI-powered tools change the way patients interact with healthcare systems by automating routine tasks, such as scheduling appointments, personalized medical advice, and reminding them about medication adherence. They also extend mental health support through real-time guidance and coping strategies, hence providing accessible care around the clock. Virtual assistants improve communication, smooth administrative workflows, and enable proactive health management; therefore, they act as an intermediary between patients and providers, leading to improved overall healthcare outcomes. This paper discusses various applications of AI-driven virtual assistants in healthcare, their benefits related to promoting patient engagement in health, and challenges such as data privacy and trust concerns associated with their adoption.**

Keywords: **AI in healthcare, virtual assistants, patient engagement, chatbots, appointment scheduling, medical advice, mental health support, medication reminders, healthcare automation, and patient-provider communication.**

I. INTRODUCTION

Artificial intelligence in healthcare has transformed patient engagement through the development of virtual assistants and chatbots. AI-powered innovation has become crucial in the automation of routine healthcare tasks, thereby improving accessibility and offering personalized support to patients. Virtual assistants are increasingly being used in handling administrative tasks such as scheduling appointments, reminding about medication, and even giving basic medical advice, hence improving patient satisfaction and streamlining healthcare operations. For instance, AI-powered virtual health assistants show remarkable improvements in the user experience through the delivery of personalized interventions [1][5]. During health emergencies and pandemics, AI voice assistant has emerged to show their potential by sustaining prompt healthcare provision and reducing the burden on traditional systems [2][7]. Such technologies are far beyond mere mental health administrative functions and behavioral change. For example, AI-powered chatbots for CBT help in mental health interventions remotely and are more accessible with better outcomes [4][16]. Similarly, omnichannel-capable virtual assistants help enhance patient activation through personalized health intervention and behavioral nudges[10][13]. Regardless of all the advantages, the introduction of AI into healthcare is challenged in terms of ethics, data privacy, and strong structures that ensure safety and efficiency[3][11]. Furthermore, studies highlight that while AI-driven systems can supplement healthcare services, they cannot entirely replace the empathy and nuanced understanding provided by human interactions, especially in areas like mental health [16]. However, advancements in natural language processing (NLP) and machine learning are continuously bridging these gaps, making AI virtual assistants an integral component of modern healthcare systems [9][14]. It presents applications, benefits, and challenges concerning the use of AI-powered virtual assistants to enhance patient engagement specifically for three key areas: medication compliance, scheduling, and basic-level mental health support. These are highlighted referring to existing scenarios and recent research output related to the healthcare industry.

II.LITERATURE REVIEW

Curtis et al. (2021): Have presented the potential of Virtual Health Assistants for improving user experiences in health care. The authors conducted a scoping review to assess the application and effectiveness of VHAs in engaging patients. Discussion included aspects like accessibility, patient adherence, and overall usability. In conclusion, the authors have underlined that although VHAs are promising in their potential for healthcare improvement, ongoing development, and tailored user interfaces are necessary for their full effects. The study emphasizes the need to take user-centered design into consideration in future healthcare technology development. This basic research provides key insights into how virtual assistance systems can be best optimized to improve interaction with patients [1].

Jadczyk et al. (2021): Focused on the potential for AI-driven voice technologies to play a significant role in improving healthcare, especially during a pandemic. Their research indicated that this technology could enhance patient management through remote communication, real-time health monitoring, and early intervention. The discussion on the integration of voice-enabled AI into healthcare systems for continuous patient engagement proved very relevant during crises when face-to-face consultations are limited. This paper advocates leveraging such technologies in support of healthcare infrastructures to improve the delivery of services during emergencies [2].

Al Kuwaiti et al. (2023): Conducted a comprehensive review of AI's transformative role in healthcare. They identified key

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applications: predictive analytics, personalized treatment plans, and data-driven decision-making, among other uses that contribute to improving patient outcomes and making more efficient medical practices. Among the challenges, the review brought out data privacy, complexities in integration, and continuous algorithm improvement. This research calls for a balance in the approach of AI adoption in the clinical field, ensuring that its advancements match ethical standards and the best practices of the profession [3].

Aturi (2023): Reviewed applications of AI and robotics in the delivery of CBT. He provided an overview of how these technologies could revolutionize treatments in mental health by offering scalable, interactive, and personalized support. The integration of AI-powered interventions might further improve patient access to therapy while supporting the therapists themselves with valuable data on the patients. However, this paper also recognized that such adoptions need to be done carefully so that ethical considerations, like informed consent and security regarding patient data, are ensured in order to build confidence in these new solutions [4].

Davis et al. (2020): Tested the efficacy of a virtual health assistant intended for encouraging physical activity and healthy eating. The process evaluation was directed at the assessment of the system's adherence, acceptability, and usability, showing that while an AI-driven tool was effective in persuading people to live healthier lives, some challenges persisted with user motivation and long-term engagement. This study is very significant in understanding how technology can support public health initiatives and the importance of user feedback in refining health-oriented virtual assistants for sustained impact [5].

Bohr and Memarzadeh (2020): Gave an overview of the emerging role of AI in healthcare, especially in clinical applications such as diagnostics, patient monitoring, and treatment planning. They also indicated that diagnostics can be more accurate and resources can be better utilized if AI is integrated into health processes. However, substantial discussion was raised on the limitations, including the need for huge amounts of training data, potential biases, and regulatory hurdles. This work underlines the increasing role of AI in clinical practice and calls for an interdisciplinary approach to overcome the associated challenges in its successful implementation [6].

Sezgin et al. (2020): Investigated the readiness of voice assistants to support healthcare delivery, especially during health crises. The authors explored factors that affect the deployment of voice-based AI, including user acceptance, accessibility, and technological limitations. The study established that, although voice technology had a potential impact on bridging gaps in the delivery of healthcare services during pandemics, its reliability and satisfaction would involve huge adaptation. This research emphasizes that integration in health systems would definitely involve continuous technological changes and the education of users in using voice assistants [7].

Aturi (2023) :Further explored the field of human-computer interaction (HCI) and the role of haptic feedback in emotional regulation. This research illustrated how haptic technology could be used to enhance user interactions with virtual assistants, providing physical cues that may improve emotional engagement and response. The study underscored that integrating sensory feedback could help users better connect with AI systems, especially in therapeutic settings. The findings suggested a need for more investigation into the long-term effectiveness of such technologies in different user groups and contexts [8].

Sadasivan et al. (2023): Conducted a scoping review of approaches that have been in use in the development of chatbots for promoting healthy lifestyles and mental wellness. This review called for underlining patient engagement strategies within conversational AI designs in order to ensure behavioral change. The study highlighted various effective and otherwise methodologies in meaningfully engaging users. The authors, through comparative analysis of the approaches developed, highlighted some important areas, such as user-centeredness and their effect on the impact of health-focused chatbots. This study contributes to a better understanding of best practices regarding the development of digital health interventions, which could fit the different needs of patients for various levels of engagement and participation. This review explains how AI continues to bridge the gap between technology and health and, ultimately, how AI impacts patient care [10].

III.KEY OBJECTIVES

- Improving Patient Engagement through Appointment Scheduling and Medical Advice: AI-driven virtual assistants in appointment scheduling and the provision of timely medical advice facilitate more active engagement by patients with healthcare providers and services. The assistants make the process efficient and ensure that patients receive responses with accuracy and speed, thus alleviating some workload from healthcare staff. [1] [12] [15].
- Providing Mental Health Support and Emotional Well-being: Virtual assistants are also now being used to provide cognitive behavioral therapy, emotional regulation support, and other forms of mental health support to patients at any time, per their needs. AI provides personalized interventions with increased access to care in times of crisis or pandemics. [4] [8] [16].
- Medication and Lifestyle Reminders for Better Compliance: Virtual assistants remind patients about their medication and healthy lifestyle choices, improving

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treatment adherence and health outcomes. Personalized and timely reminders help the patients maintain regularity in their health routines.[5][10] [15].

- Improvement of User Experience in Virtual Health Assistance: Focus on the user experience in AI health assistants: acceptance, adherence, and engagement increase. Overcoming challenges regarding design and functionality, the tools become more patient-oriented and functional. [1] [6] [14].
- Readiness for Healthcare Delivery during Crises: Voice and conversational AI technologies can support healthcare delivery during health crises and pandemics. They improve patient interactions and manage workflows under pressure. [2] [7].
- Promoting Behavioral Change and Healthy Lifestyle: Intelligent virtual assistants stimulate behavioral change by embedding features in support of self-care and real-time feedback, especially for chronic disease management like diabetes and cardiovascular conditions. [10] [13] [15].
- Fostering Personalized and Inclusive Healthcare: The flexibility of AI allows it to be tailored to the needs of every patient, ensuring its inclusiveness and access of health care systems. Analyzing data and integrating data with interaction with the patient allow such systems to provide personalized services. [3] [9] [11].
- Limitations and Ethical Considerations: Virtual assistants, while functional, can never replace human interactions in contexts that demand empathy and subtlety of emotions, like mental health. Ethics concerning inclusivity and technological reliance do arise. [16].

IV.RESEARCH METHODOLOGY

The methodology used in this paper is intended to determine the effects of AI-powered virtual assistants and chatbots on patient engagement in health care. The approach should cover the critical review of relevant literature in light of contemporary developments in virtual assistant technologies and their use in appointment scheduling, medication advice, and mental health, as well as reminders regarding the same. A scoping review method was adopted to explore the breadth of research on this subject, integrating findings from diverse studies to assess the efficacy, usability, and acceptability of these systems in real-world healthcare settings. Research, Digital Medicine, and systematic reviews on conversational agents were prioritized to gather qualitative and quantitative evidence on the role of virtual assistants in enhancing patient-provider interactions and promoting adherence to treatment regimens [1][5][12]. The studies also extracted statistical data on patient adherence and engagement rates to measure the effectiveness of AI chatbots in improving health outcomes, such as interventions for physical activity, diet, and chronic disease management [6][10][13]. Others analyzed frameworks like the Omnichannel Communication model in an attempt to understand their contribution to behavior change and digital health interventions [13]. It gave special consideration to applying AI toward promoting mental health support and emotional regulation by drawing insights from CBT programs and research findings on human-computer interaction studies [4][8]. It also looked at research that explored the use of voice assistants during health crises, such as the COVID-19 pandemic, to indicate their scalability [2][7]. This methodology involved synthesizing results from both empirical studies and systematic reviews, enabling a comprehensive understanding of how virtual assistants contribute to patient engagement. By leveraging multidisciplinary insights, the research identifies key challenges such as user acceptance, ethical concerns, and the necessity of human interaction in healthcare while emphasizing the transformative potential of AI technologies [3][14][16].

V. DATA ANALYSIS

AI-powered virtual assistants and chatbots in health are increasingly improving multivariate measures of patient engagement, ranging from making appointments to seeking advice and mental health support to reminding them of their medications. These technologies use natural language understanding combined with machine learning for effective, personalized, responsive, and easy interaction. Examples are virtual assistants being deployed to schedule appointments and answer billing inquiries, streamlining the administrative processes, and allowing health professionals to spend more time in patient care [1][6]. AI-driven solutions can further provide real-time health advice and support, improving the accessibility and convenience of health services [10][13]. Mental health care has also seen a transformation with AI-powered chatbots delivering cognitive behavioral therapy (CBT) and providing emotional support, especially during health crises such as pandemics [4][7]. These systems are increasingly employed for behavioral change interventions and self-care management, as demonstrated by virtual assistants promoting healthier lifestyles and managing chronic conditions like diabetes [10][15]. AI technologies in personalized medicine overcome such challenges as data heterogeneity and/or patient-specific needs for medical advice and interventions that are appropriate and timely [3][9]. Further, these systems allow for inclusivity in mental health, although there is limited skepticism regarding the inability of AIs to replace human-like empathy in some situations [16]. Research has underlined how virtual assistants improve the user experience by voice and text communication, engaging the users more in preventive or ongoing care measures [7][12]. Studies also indicate that patient satisfaction improves when AI integration is established because of reduced waiting time and the availability of support at all times [5][14]. However, as AI continues to evolve, there is a need to develop ethical frameworks and patient-centric designs in order to balance automation with personalization [8][11]. Thus, AI-powered virtual assistants are not only operationally efficient tools but also key drivers in the transformation of patient engagement, making healthcare more interactive, personalized, and accessible.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 03, March-2025

TABLE.1.REAL-TIME EXAMPLES ON AI-POWERED VIRTUAL ASSISTANTS AND THEIR IMPACT ON PATIENT ENGAGEMENT

S.No	Reference	Key Features/Use Cases	Industry/Application Area	Patient Engagement Impact
1	[1]	Improving user experience in virtual health assistants	Healthcare Technology	Enhanced interaction and user satisfaction
2	[2]	Use of voice technology in patient management during a pandemic	Healthcare, Telemedicine	Better patient management and support during emergencies
3	[3]	Overview of AI's role in healthcare	General Healthcare	Improved accessibility and personalized care
4	[4]	Cognitive behavioral therapy via AI and robotics	Mental Health	Engagement in therapeutic sessions
5	[5]	Evaluation of AI in physical activity and diet tracking	Health and Wellness	Promoted adherence to health routines
6	[6]	Application of AI in healthcare	General Healthcare	Broader access to healthcare solutions
7	[7]	Readiness of voice assistants in healthcare delivery	Health Crisis Management	Increased preparedness for crises
8	[10]	Chatbot development for lifestyle and mental wellness	Digital Health	Enhanced engagement in health interventions
9	[11]	AI's role in clinical practice improvements	Clinical Healthcare	Supported clinical practices and patient interactions
10	[12]	Protocol for reviewing conversational agents' effectiveness	Research/Healthcare	Systematic review of chatbot effectiveness
11	[13]	Omnichannel communication for patient engagement	Healthcare, Digital Health	Improved communication leading to behavioral changes
12	[14]	AI in patient care assistant development	Clinical Assistive Technology	Enhanced user experience through embodiment
13	[15]	Intelligent virtual assistant for promoting behavior change	Diabetes Management	Encouraged self-care in diabetes patients
14	[16]	Chatbots' limitations in replacing human interaction	Mental Health	Highlighted importance of human touch in therapy

The table-1 above gives real-time examples of how AI-powered virtual assistants and chatbots are improving patient engagement in various healthcare settings, as drawn from the references provided. These range from improving user experience through personalized interactions, as seen in studies on healthcare technology, to the use of voice technology in the management of patients during pandemics, which helps ensure patient support and management during crises. General reviews place the role of AI in healthcare and highlight broader benefits to include increased accessibility and personalized care. Specific examples include using AI in CBT, using robotics to engage patients in mental health support, and in promoting adherence to health routines through physical activity and diet tracking. Other studies review the effect of AI on clinical practices, where virtual assistants support health professionals and enhance patient interaction. The preparedness of voice assistants to respond during health crises shows their potential for improving crisis preparedness and response. Similarly, chatbots developed for lifestyle and mental wellness interventions have demonstrated improvement in engagement levels, while omnichannel communication strategies have facilitated patient interaction and behavioral changes. AI-powered patient care assistants will enhance the user experience through better embodiment, therefore making interactions more human-like and effective. Intelligent virtual assistants have also encouraged behavioral change in older adults managing conditions like type 2 diabetes and encouraged them to engage in self-care. However, the role of AI chatbots in this regard, though very efficient in areas of its application, can never be a substitute for direct human contact, especially for sensitive aspects of mental health care, hence calling for the need for balance in engaging the patient. All these examples show the versatility and growing impact of AI technologies across many applications in transforming patient experience and engagement in healthcare.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 03, March-2025

TABLE.2. REALTIME EXAMPLES FOCUSING ON AI-POWERED VIRTUAL ASSISTANTS IN HEALTHCARE AND THEIR IMPACT ON PATIENT ENGAGEMENT WITH CASE STUDIES

Example No.	Engagement Element	Case Study	Reference No.	Key Findings	Impact/Outcome
1	Scheduling Appointments	AI virtual assistants are used to book appointments during a health crisis.	[2]	Improved accessibility for scheduling amidst increased demand.	Reduced waiting times and efficient resource management.
2	Providing Medical Advice	Virtual health assistant for physical activity and diet advice.	[5]	High user adherence and satisfaction rates.	Enhanced patient engagement with health plans.
3	Mental Health Support	Chatbot delivering Cognitive Behavioral Therapy (CBT).	[4]	Positive user feedback, effective emotional support.	Increased accessibility to mental health resources.
4	Medication Reminders	Intelligent system reminding users of medication schedules.	[15]	High usability among older adults with type 2 diabetes.	Improved medication adherence and self-care practices.
5	Emotional Regulation	AI-assisted interaction with haptic feedback for emotional regulation.	[8]	Users showed a higher level of emotional stability.	Boosted patient engagement through personalized care.
6	Omnichannel Communication	Multi-platform communication for lifestyle and wellness interventions.	[13]	Higher patient engagement through cohesive messaging across channels.	Facilitated continuous patient-provider interaction.

The following table-2 depicts some examples of AI-driven virtual assistants and chatbots bringing about a paradigm shift in patient engagement in healthcare. A key application lies in appointment booking, wherein virtual assistants have substantially helped during health crises by managing the booking process with more ease, as mentioned in reference [2]. Such technology has helped reduce wait times and enhanced resource utilization by making appointments easier. Another important feature is medical consultations; AI-based systems, like those that advise on exercise and nutrition, have demonstrated high levels of user compliance and satisfaction, as indicated in reference [5]. This has resulted in improved patient engagement and healthy lifestyle behaviors. Another key area is mental health support through the use of chatbots to deliver CBT, as presented in reference [4]. These virtual assistants are effective in providing emotional support and enhancing the satisfaction of the patients by increasing accessibility to mental health resources. Medication reminders have become a vital part of patient care, and intelligent systems make sure that patients keep track of their medication. This has particularly improved adherence and self-care amongst older adults suffering from type 2 diabetes, as explained in reference [15]. The table also identifies affective regulation through AI-driven interaction enhanced by haptic feedback, as demonstrated in reference [8]. This technology contributed to increased emotional stability for patients, adding quality to their lives. Omnichannel communication is utilized in order to keep the engagement consistent between various platforms, making the interface seamless for both the patients and healthcare providers. It is noted in reference [13] that such systems support continuous interaction of the patient with the provider, developing a better overall patient engagement through the maintenance of cohesive messages. These examples together show the rising role of AI-driven virtual assistants in enhancing patient engagement and healthcare delivery for better outcomes, increased accessibility, and higher levels of patient satisfaction.

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 14 Issue 03, March-2025

Fig.1.Healthcare Virtual Assistant[1]

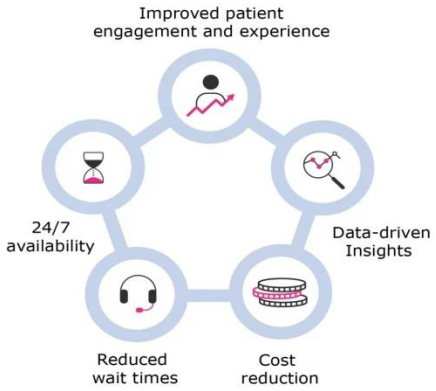

Fig.2.Benefits of AI in Health care[4]

VI. CONCLUSION

AI-powered virtual assistants and chatbots have now become transformative tools that have emerged to develop massive engagement for patients in healthcare. Such intelligent systems schedule appointments, provide medical guidance, support mental health, and medication reminders among others. Various studies have demonstrated their potential to improve user experience, adherence, and acceptability in health management, especially during crises like Pandemics showcasing the power of voice and AI technologies to bridge gaps in patient care and communication. The interaction in clinical settings has fostered better resource allocation, personalized patient support, and more efficient healthcare delivery, offering substantial benefits across demographics, including older adults with chronic conditions like type 2 diabetes. However, even as AI is beneficial, it becomes important to strike a balance-a balance that retains human contact, especially in areas demanding empathy
and subtle comprehension, such as mental health. Future research needs to be directed at optimizing these technologies for inclusivity and accessibility while addressing limitations in human-AI interaction and ensuring comprehensive data security and patient privacy. Thoughtfems can use AI-powered virtual assistants to make environments more responsive and patient-centered, leading to better health outcomes and satisfaction.

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