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How does AI help in Rural Development in Healthcare Domain: A Short Survey

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Abstract: ***Artificial intelligence (AI) has the potential to revo- lutionize healthcare delivery in rural areas by addressing various challenges such as scarcity of healthcare resources, lack of health-care professionals, and inadequate healthcare infrastructure. In this paper, we explore the role of AI in rural development in the healthcare domain, specifically focusing on how it can be leveraged to improve healthcare outcomes in rural areas. we outline the following main aspects of Artificial intelligence (AI) in rural development based on our findings from the literature review on Artificial Intelligence and various techniques used in the healthcare domain such as Robotics Process Automation (RPA), Machine Learning (ML), Natural Language Processing (NLP), Deep Learning(DL) including a recent breakthrough in AI technology. Identify the challenges and legal barriers in rural areas.***

Overall, this survey paper provides insights into the potential of AI to transform healthcare delivery in rural areas and highlights the need for a comprehensive and sustainable approach to leveraging AI for rural development in the healthcare domain. However, there are many challenges and limitations in their application. In this survey, we review recent Artificial Intelligence techniques that are used. We highlight the main challenges and limitations of current work and make recommendations for future research investigation.

Furthermore, we consider the challenges and ethical concerns associated with AI deployment in rural healthcare settings, such as privacy and security risks, data quality and bias issues, and regulatory and legal barriers. By providing an overview of the current state of the art in AI and rural healthcare, this survey aims to inform and inspire further research and development in this important area.

Index Terms: Artificial intelligence (AI), Healthcare deliv- ery, Rural areas, Healthcare resources Healthcare professionals, Robotics Process Automation (RPA), Machine Learning (ML), Natural Language Processing (NLP), Deep Learning(DL), Pri-vacy and security risks, Data quality and bias issues, Regulatory and legal barriers.

I. INTRODUCTION

The healthcare needs of rural communities are often ne- glected due to the lack of medical facilities, resources, and healthcare professionals. With the rapid advancements in Ar- tificial Intelligence (AI) technology, there is a growing interest in leveraging AI to address the healthcare challenges faced by rural areas. AI-based healthcare solutions have the potential to improve the accessibility, quality, and efficiency of healthcare delivery in rural communities. As a result healthcare industry is looking to implement in rural areas with new rising AI technologies. Artificial intelligence (AI) is a rapidly develop- ing field of computer science that uses computers to simu-late human learning, memory, analysis, and even innovation, which usually require human intelligence [1]–[3]. Artificial intelligence (AI) is a rapidly developing computer technology that has begun to be widely used in the medical field to improve the professional level and efficiency of clinical work, in addition to avoiding medical errors in rural areas [4]. As per the rapid development of health information technology, electronic medical records (EMR), and personal health records (PHR), a huge amount of multimedia information in the format of documents, forms, images, and audio have been generated. Therefore, the application of artificial intelligence (AI) technology is expected to assist patients [5]. AI-assisted clinical trials are capable of handling massive volumes of data and producing highly accurate [6]. Medical AI companies develop systems that assist patients at every level. Patient's medical data is also analyzed by clinical intelligence, which provides insights to assist them to improve their quality of life.[7] Healthcare systems around the world face huge issues, including a lack of access, high costs, waste, and an older population. Pandemics like the coronavirus (COVID-19) put a strain on healthcare systems, resulting in a lack of pro- tective equipment, insufficient or erroneous diagnostic tests, overworked physicians, and a lack of information exchange.

In this short survey, we explore the various ways in which AI technology can contribute to the development of healthcare in rural areas. We examine the existing research on AI-based solutions for rural healthcare and identify the opportunities and challenges of using AI in this healthcare domain.

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Also, we survey the current status of AI in healthcare as well as discuss its future with the usages of the dataset and various AI techniques being used. We first briefly review key relevant aspects that can contribute to the development of healthcare in rural areas.

1) AI-assisted diagnosis and treatment planning
2) AI-powered remote patient monitoring devices/Telemedicine for healthcare
3) AI-powered health education tools
4) Chatbots in healthcare (Software chatbots)/ Robust chattools
5) AI-powered mobile health (mHealth) for healthcare
6) AI-based rural disease surveillance and outbreak predic- tion

a) *Diagnosis and Treatment:* AI-powered diagnostic tools can help healthcare providers in rural areas to accu- rately diagnose various diseases, including infectious diseases, chronic conditions, mental health disorders, clinical disease diagnosis [5], AI-enabled clinical decision-support systems may reduce diagnostic errors and augment intelligence to support decision-making [8]. For instance, AI algorithms can analyze medical images such as X-rays, CT scans, and MRI scans, and provide automated diagnostic reports to healthcare providers [9]–[11]. Similarly, AI-powered treatment planning tools can assist healthcare providers in developing person-alized treatment plans for patients based on their medical history, symptoms, and other relevant factors [12], [13]. For rural patients, virtual care can be a lifesaver since traveling to and from a doctor's office or hospital can present a major challenge [14]. Artificial intelligence (AI) algorithms have been employed to perform analysis of medical images and correlate symptoms and biomarkers from clinical data to characterize an illness and its prognosis [15].

b) *Remote Patient Monitoring:* AI-powered patient monitoring systems can help healthcare providers in rural areas to remotely monitor patients' health status and detect early signs of deterioration. These systems can collect data from various sources such as wearable devices, electronic health records, and patient-reported data, and use AI algorithms to analyze the data and provide alerts to healthcare providers when necessary.[16]. The adoption of artificial intelligence (AI) in healthcare is growing rapidly. Remote patient monitoring (RPM) is one of the common healthcare applications that assist doctors to monitor patients with chronic or acute illness at remote locations, elderly people in-home care, and even hospitalized patients [17]. Remote patient monitoring (RPM) is a rapidly growing field in the healthcare industry to assist patients in rural areas which tends to benefit to track of patient's progress.Telemedicine for rural healthcare: AI-powered telemedicine services can help to improve healthcare access in rural areas by enabling patients to consult with healthcare providers remotely. Telemedicine services can be especially useful in areas where there is a shortage of healthcare professionals or inadequate healthcare infrastructure. For example, AI-powered chatbots can help patients to assess their symptoms and receive medical advice, while video conferencing tools can enable patients to consult with healthcare providers in real-time, Research in the medical industry has started to use AI's strengths in data processing and analysis in telehealth [18]. There are different areas of telemedicine and analyze the effect of AI in the field of health and medicine [19] and Telehealthcare is a broad term used to encompass the delivery of health-care services and information through ICT.

c) *AI-powered health education tools(In rural areas):* AI-powered health education tools can help rural patients learn about their health conditions and how to manage them. These tools make important information readily available by giving patients convenient access online or through mobile apps. And as generative AI tools become more prevalent, organizations will be able to use these systems to build their own patient education programs that appeal directly to their rural populations [14]. AI-powered health education tools can help bridge the gap and provide valuable health information and resources to rural patients using various techniques be-ing used such as accessibility to health information, remote guidance, disease management and monitoring, Language and cultural considerations (AI-based Multi-linguistics technology [20] to assist rural areas with diverse populations and language barriers.).

d) *AI-powered mobile health (mHealth) for rural areas:* As per Author [21]there are more than 97000 AI-enabled mobile healthcare applications(mHa) available on Google Play and Apple's App which would be downloaded by 500 million people. This phenomenon has turned smartphones into medical kits for real-time health monitoring of patient's activities, early predictability, disease screening, and improved medication adherence in patient monitoring [22]. This technology has a few mandatory factors like internet connectivity, affordability of mobile devices, and digital literacy when implementing AI-powered Health solutions in rural areas. Ensuring that these solutions are user-friendly, culturally sensitive, and respect patient privacy and data security is crucial for their successful adoption and impact on rural healthcare [19].

e) *AI-based rural disease surveillance and outbreak pre- diction:* AI-based rural disease surveillance and outbreak prediction systems can play an important role in monitoring, detecting, and responding to disease outbreaks in rural areas [23].COVID-19-like pandemics, a mass surveillance systemin terms of social distancing, mask-wearing, and body tem- perature detection was integrated into the system. Due to emerging threats to the safety of citizens and nations, many e-governments (e.g., China,USA, Australia, Germany, Russia, and so on) have begun tracking the movement and behavior of all residents by installing a number of mass surveillance systems points in all the towns, villages, streets, and public spaces to track and monitor suspects and detect suspicious patterns using various deep learning model.

f) *Healthcare Decision-Making:* AI-powered decision support tools can help healthcare providers in rural areas to make informed decisions about patient care. For instance, AI algorithms can analyze patient data and provide recommen- dations for diagnosis and treatment, as well as predict patient outcomes and identify potential risks [24], [25]. AI-based sys-tems can offer decision-support tools that provide healthcare providers in rural areas with evidence-based recommendations for diagnosis, treatment options, and medication selection. These systems leverage vast amounts of medical literature, clinical guidelines, and patient data to assist providers in making informed decisions and reducing diagnostic errors.

In summary, AI can help to improve healthcare outcomesin rural areas by providing accurate diagnosis and treatment, improving healthcare access, facilitating patient monitoring, and supporting healthcare decision-making. However, the de- ployment of AI in rural healthcare settings also requires addressing several challenges such as privacy and securityrisks, data quality and bias issues, and regulatory and legal barriers.

Recently, healthcare in China's rural areas has been benefiting from medical AI technology. According to a newsreport from South China Morning Post, a portable all-in- one diagnostic station (weighing 11 pounds), which can run11 tests, including blood pressure, electrocardiographs, and routine urine and blood analyses, has been used in village healthcare settings. This device, which was developed by an internet healthcare company supported by the national rural healthcare program, can automatically upload results and medical records to an online data analysis system and generate a diagnosis for village health workers to review and reference. Several large-technology companies in China are also investing in AI-driven smart clinics for rural regions, suchas AI-powered Chabot, which can communicate with patients,provide medical advice, and conduct online training for healthworkers in rural areas [26].

Due to the poor working environment, it is difficult to attract and retain high-quality healthcare providers in rural areas. To compensate for the shortage of physicians, many developing countries launch some abbreviated training pro- grams for becoming a physician, or they authorize nursesto perform certain physician tasks.

For example, there aremany secondary medical vocational schools and junior medical colleges in China, in which students who graduated from middle or high school are given 3 years of medical trainingto become physicians. In 2014 in China, around 52% of physicians (2.9 million) had less than a bachelor's degree,and most of them were working in rural areas of China. Although this can adequately meet the urgent demands for health workers in rural areas, the medical knowledge and skillsof these doctors are insufficient [27].

II. INFORMATION SOURCES

Literature was retrieved from the following bibliographic databases for identifying research articles on Artificial In- telligence technology in healthcare rural development. These are IEEE, ScienceDirect, Springer, PubMed, Xplore, Google Scholar, Multidisciplinary Digital Publishing Institute (MDPI), arXiv to find more relevant articles. Each database was filteredto search the keywords and their combinations in the title, abstract, and keywords these databases provide a good assort- ment of peer-reviewed articles in the fields of Natural Lan- guage Processing(NLP), Artificial Intelligence(AI), Robotics Process Automation (RPA), Machine Learning (ML), Deep Learning (DL), Chatbot in healthcare.

A. *Search strategy*

The objective of this review is to identify journal articles, review articles, and conference papers related to the role of AIto assist in healthcare in rural areas. In this review, the paper address the following below research questions:

1) RQ1 What are the existing AI-based technology used forrural areas in healthcare?
2) RQ2 What are the challenges in adopting AI-basedtechnology in rural areas?
3) RQ3 How does AI transformed to monitoring the patientsremotely?

B. Dataset for Developing and Evaluating AI-based Rural Health Information

There are several datasets available that could potentially be used for developing and evaluating AI-based rural health information systems. Here are a few examples:

1) *Centers for Disease Control and Prevention (CDC):* This dataset includes a variety of health-related data, including information on morbidity and mortality rates, health behaviors, and healthcare utilization. Some of these data are stratified by rural-urban status. [28]
2) *Rural Health Information Hub:* This website provides access to a variety of datasets related to rural health, including data on health disparities, healthcare workforce, and healthcare utilization. Premier Healthcare Database, The Premier Health- care Database includes hospital admissions data from more than 1000 US health-care providers and 231 million patients. Around three-quarters of the data are classified as originating from urban areas, with the remainder from rural regions [29].
3) *Medicare Claims Data:* Medicare provides health insurance coverage for many older adults and individuals with disabilities in the United States. Medicare claims data could potentially be used to develop AI-based rural health informa- tion systems to monitor healthcare utilization and outcomes among Medicare beneficiaries living in rural areas [30].
4) *Electronic Health Record (EHR) data:* EHR data could potentially be used to develop AI-based rural health information systems to monitor healthcare utilization and outcomes among patients seen at rural healthcare facilities [31]. They contain patient demographics, medical history, diagnoses, procedures, and medication information. Collabora- tion with healthcare organizations or research institutions maybe necessary to access such datasets access [32].
5) *Kaggle:* Kaggle is a popular platform for data sci- entists and machine learning enthusiasts. It hosts various datasets, including health-related ones. You can search for datasets related to rural health or healthcare to find poten- tially useful resources [33]–[35].(Eg: Kaggle Monkeypox SkinLesion Dataset (MSLD), Kaggle competition cardiovascular disease datasets)

It's important to note that accessing and using these datasets may require obtaining appropriate permissions and complying with relevant data privacy and security regulations. As the healthcare industry emerges into a new era of digital health driven by cloud data storage, distributed computing, and machine learning, healthcare data have become a premium commodity with value for private and public entities. Current frameworks of health data collection and distribution, whether from industry, academia, or government institutions, are imper- fect and do not allow researchers to leverage the full potential of downstream analytical efforts [29].

III. LITERATURE REVIEW ANALYSIS

In this section, we outline the following main aspects of AI in rural development based on our finding from the literature review: Artificial Intelligence various techniques used in the healthcare domain such Robotics Process Automation (RPA), Machine Learning (ML), Natural Language Processing (NLP),Deep Learning(DL).

A. Artificial Intelligence-based Robotics Process Automation in rural areas

1) Artificial Intelligence-based Robotics Process Automa- tion (AI-RPA) refers to the use of artificial intelligence (AI) techniques, such as machine learning and natural language processing, to automate repetitive and rule- based tasks in a variety of industries, including healthcare[12], [36], [37].
2) In rural areas, where access to healthcare resources is often limited, AI-RPA can help healthcare providers to streamline their workflows and improve the efficiency of their operations. For example, AI-RPA can be used to automate administrative tasks such as patient scheduling, data entry, and record keeping, which can free up health- care providers' time to focus on patient care [13], [38], [39].

B. Artificial Intelligence-powered decision support tools can help healthcare providers in rural areas

1) In rural areas where access to healthcare resources is often limited, AI-powered decision support tools can provide valuable assistance to healthcare providers. For example, these tools can analyze patient data, including medical records, lab results, and imaging studies, to help healthcare providers make more accurate diagnoses and treatment decisions [40].
2) AI-powered decision support tools can also assist health- care providers in managing chronic conditions, such as diabetes or hypertension, by monitoring patients' vital signs and providing personalized recommendations for treatment and self-care [41]–[43].
3) Moreover, AI-powered decision support tools can help healthcare providers to optimize their workflows and improve the efficiency of their operations. For example, these tools can assist with patient triage, scheduling, and follow-up, as well as with medication management and inventory control [44].

C. Artificial Intelligence-based disease diagnosis and treat- ment

1) In healthcare, the ability to accurately and quickly diag- nose diseases is critical for effective treatment and patient outcomes. AI-based disease diagnosis and treatment can provide healthcare providers with advanced tools to im- prove the accuracy and speed of diagnosis, as well as to develop personalized treatment plans for patients [20].
2) For example, AI-based algorithms can analyze large amounts of patient data, including medical histories, imaging studies, and genetic data, to identify patterns and correlations that may not be apparent to human clinicians.AI-based models can then provide diagnostic probabilities, treatment recommendations, and predic- tions for patient outcomes [45].
3) In addition to diagnosis and treatment, AI-based disease diagnosis and treatment can also help with patient mon- itoring and disease management. AI-powered tools can monitor patient data in real-time, such as vital signs and medication adherence, and provide alerts or recommen- dations for healthcare providers to adjust treatment plans accordingly [46].

D. Artificial Intelligence algorithms can analyze patient data and provide recommendations for diagnosis and treatment

1) Artificial Intelligence (AI) algorithms can analyze patientdata to provide recommendations for diagnosis and treat- ment. This approach uses machine learning algorithmsto learn from patterns in large datasets of patient data, including medical histories, lab results, imaging studies, and other health-related information [47].
2) By analyzing this data, AI algorithms can identify pat- terns and correlations that may not be apparent to human clinicians. This can help healthcare providers to make more accurate and timely diagnoses and provide more personalized treatment plans for patients. For example, AI algorithms can predict which patients are at risk for de- veloping certain diseases, and provide recommendations for preventive measures or early interventions [48].
3) In addition to diagnosis and treatment, AI algorithmscan also help with patient monitoring and disease man- agement. AI-powered tools can monitor patient data in real-time, such as vital signs and medication adherence, and provide alerts or recommendations for healthcareproviders to adjust treatment plans accordingly. This can help to prevent complications and improve patient outcomes [16].
4) Overall, the use of AI algorithms to analyze patient data and provide recommendations for diagnosis and treatment has the potential to significantly improve healthcare out- comes by providing healthcare providers with advanced tools for diagnosis, treatment, and disease management. However, there are also challenges associated with the deployment of AI algorithms in healthcare, including issues of data quality, bias, and privacy, which need tobe carefully considered and addressed [49].

IV. CHALLENGES AND ETHICAL CONCERNS ASSOCIATED WITH AI DEPLOYMENT IN RURAL HEALTHCARE

1) *Privacy and Security Risks:* AI systems can collect and process sensitive personal health information, which raises concerns about data privacy and security. Healthcare providersmust ensure that patient data is stored securely and that accessto the data is limited only to authorized personnel [29].
2) *Data Quality and Bias Issues:* The quality of AI-powered healthcare systems depends on the quality of the datathey are trained on. In rural areas, where there may be limited healthcare resources and a smaller pool of patients, the data used to train AI systems may be limited or biased. This can lead to inaccuracies and errors in diagnosis and treatment [8].
3) *Limited Access to Technology:* In some rural areas, there may be limited access to technology and the internet, which can make it difficult to deploy and use AI-powered healthcare systems [50].
4) *Ethical Concerns around Autonomy:* There are con- cerns that AI-powered healthcare systems may reduce patients' autonomy by relying on algorithms to make decisions about their care. Patients may feel that they have less control over their treatment and may not fully understand the decisions being made by the AI system [51].
5) *Lack of Human Interaction:* AI-powered healthcare systems may reduce the amount of human interaction betweenpatients and healthcare providers, which can lead to a loss of empathy and personalized care
6) *Cost and Resource Constraints:* Deploying AI- powered healthcare systems in rural areas may require signif- icant upfront costs, which may not be feasible for healthcare providers with limited resources.
7) *Physician and patient acceptance:* AI-powered healthcare systems may face resistance from physicians and patients who are skeptical of the technology or concerned about its impact on clinical decision-making. Ensuring that these stakeholders understand the benefits and limitations of AI systems is critical to their successful adoption.
8) *Integration with existing workflows:* Integrating AI- powered healthcare systems into existing clinical workflows can be challenging, particularly if the technology requires significant changes to established processes. Ensuring that these systems are easy to use and integrate seamlessly into clinical workflows is essential to their successful deployment.

9) *No human touch:* Although clinical work cannot be completely replaced by AI robot doctors in the foreseeable fu-ture, medical AI technology will play a huge role in electronichealth records (EHRs), diagnosis, treatment protocol devel- opment, patient monitoring and care, personalized medicine, robotic surgery, and health system management [4], [52].
10) *Future work:* AI and machine learning has a lot to contribute to the critical healthcare sector, which is undergoingone of the swiftest digital transformations at the moment,and amenities have the possibility to substantially improve thequality of life for patients [6].
11) *Lack of trust and acceptability:* As per Pew research center, 60% of Americans would be uncomfortable with provider relying on AI in their own health care [53].
12) *Digital literacy when implementing AI-powered:* Re- quire to provide comprehensive training programs to health- care professionals, administrators, and other relevant stake- holders. To cover the basics of AI, its potential applications in healthcare, and hands-on training on how to use AI-powered tools and systems effectively [19].

V. CONCLUSION

In conclusion, AI has the potential to transform healthcare delivery in rural areas, addressing various challenges such as the scarcity of healthcare resources, lack of healthcare professionals, and inadequate healthcare infrastructure. Thedeployment of AI-powered healthcare systems in rural areas can improve healthcare access, provide accurate diagnosis and treatment, and support healthcare decision-making. AI- powered telemedicine services, diagnostic tools, decision sup-port systems, and patient monitoring systems can enable remote healthcare delivery, reducing the need for patients to travel to healthcare facilities. However, the deployment of AI in rural healthcare settings also raises various challenges and ethical concerns, including privacy and security risks, data quality and bias issues, regulatory and legal barriers, limited access to technology, ethical concerns around autonomy, lack of human interaction, and cost and resource constraints.

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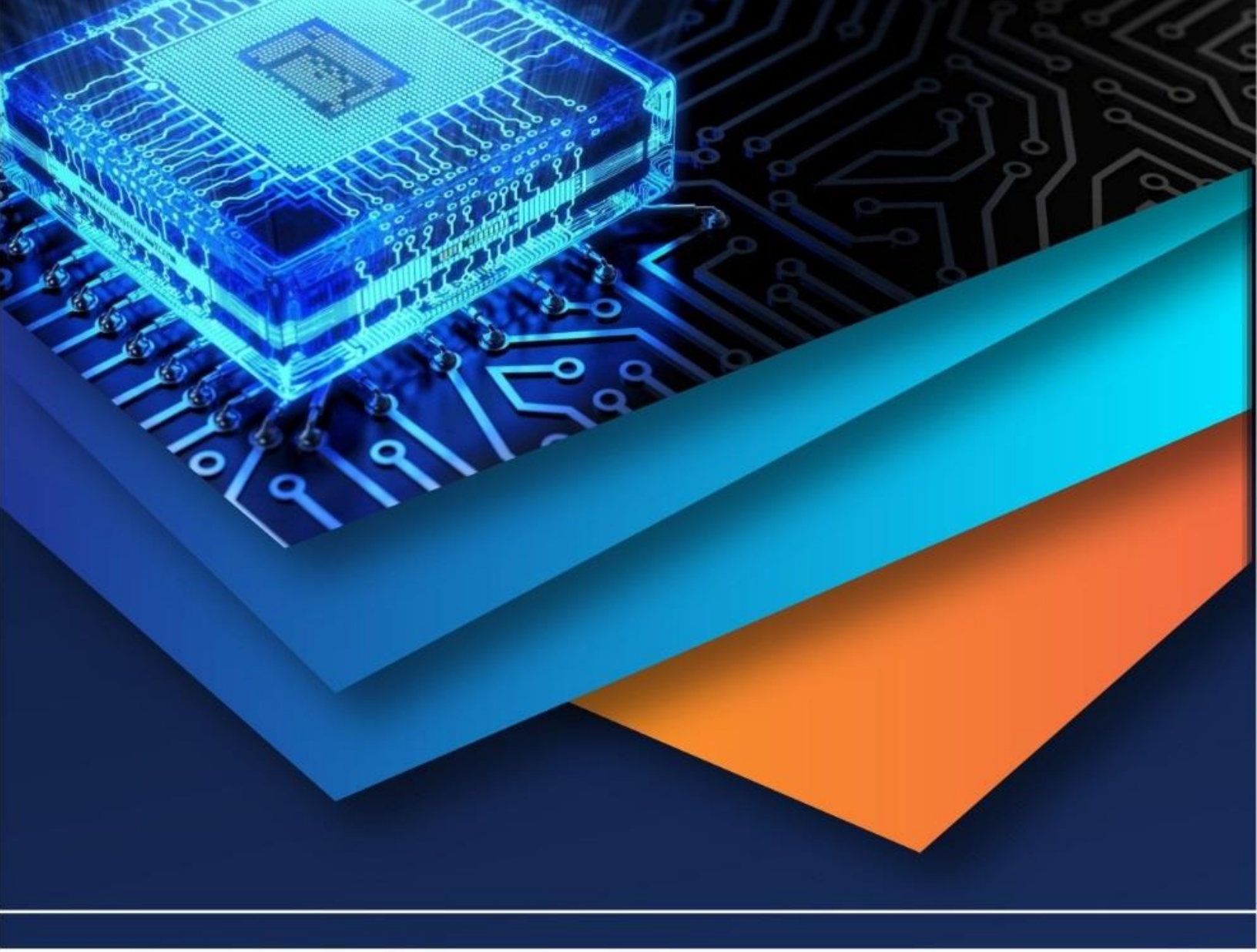
We would like to express our gratitude to all the researchers,healthcare professionals, and stakeholders who have con- tributed to the development of AI-powered healthcare systemsin rural areas. Their work has been instrumental in shapingour understanding of the potential benefits and challengesassociated with AI deployment in rural healthcare settings.

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