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## **Exploring Human-Robot Interaction in Healthcare**

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### **ABSTRACT:**

As technology continues to advance, the integration of robots into the healthcare setting has emerged as a promising method to enhance patient care and streamline medical processes. This paper provides a comprehensive exploration of Human-Robot Interaction (HRI) in healthcare, examining its applications, challenges, and future directions.

Keywords: Robots, Robotics, Human-robot interaction, Healthcare

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### **1. Introduction**

#### **1.1 Robot**

The concept of robots traces its roots back to ancient times, where automata and mechanical devices were envisioned. However, with the introduction of electronic computers and development of programmable devices, the modern era of robotics started to take shape in the middle of the 20th century. The term "robot" was first coined by Czech writer Karel Čapek in his 1920 play "R.U.R." (Rossum's Universal Robots), where robots were artificial beings created to serve humans. Since then, the field of robotics has evolved significantly, encompassing a wide range of machines designed to perform tasks autonomously or semi-autonomously. Issac Asimov came up with three rules to guide the behaviour of robots:

Robots must never harm human beings,

Robots must follow instructions from humans without violating rule 1,

Robots must protect themselves without violating the other rules.

There are many types of robots designed for various purposes and environments which includes rehabilitation robots, social robots, personal robots, medical robots, collaborative robots, fixed and mobile robots, industrial robots and police robots. Robots can be applied in almost every field but humans are sometimes better suited for certain applications hence understanding human-robot interaction is crucial.

#### **1.2 Human-robot interaction**

Human-robot interaction is the field of study of interactions between humans and robots. HRI is situated at the congruence of robotics, artificial intelligence, and human-robot interaction. In an era marked by extraordinary technological advancements, the integration of robotics into various dimensions of society has become not only a reality but a life-changing force with the capability to reconstruct industries.

Among the various domains impacted, healthcare stands out as a promising frontier for the application of robotics. As the demand for quality healthcare continues to rapidly rise globally, there is a serious need for technologies that can elevate the efficiency, precision, and accessibility of medical services. HRI offers innovative solutions to address the complex and dynamic challenges within the medical landscape.

HRI can take many forms. Suppose a doctor performing surgery remotely using robots. Think about a robot assisting an athlete in rehabilitation. Picture a robot that can help you cook and clean at home. Robots can be used to diagnose a medical condition.

As we examine the shared relationship between humans and robots in healthcare, we confront ethical considerations, user acceptance challenges, and the intricate interplay of cultural and societal factors influencing the adoption of robotic technologies. Throughout this exploration, the paper aims to provide a nuanced understanding of the benefits and complexities associated with HRI in healthcare.

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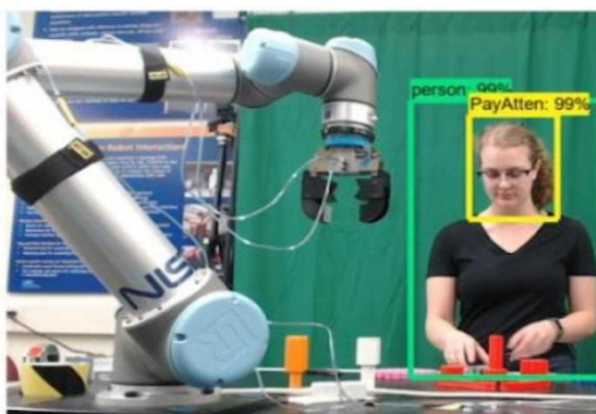
### **2. Literature Survey**

*Sadiku, Matthew N. O., et al. 'Human-Robot Interaction.'*

The paper includes a review of the literature on human-robot interaction and highlights some of the key research findings and trends in the field. The authors also provide examples of current and future applications of human-robot interaction, such as companion robots, rehabilitation, and education.

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Overall, the paper aims to provide insights into the challenges and potential solutions for improving human-robot interaction.



**Fig. 1. Collaboration of industrial arm with human operator**

**1. R.M Stock and M.A. Nguyen, 'Robotic psychology: What do we know about human-robot interaction and what do we still need to learn?'**

The authors of the paper conducted a literature review on human-robot interaction (HRI) with a focus on social service robots. They proposed a model of robotic psychology that integrates psychological antecedents and processes, and identified fundamental psychological mechanisms that determine the relationship between humans and robots.

**2. Bonarini, Andrea, 'Communication in Human-Robot interaction.'**

The author's approach in this paper is to present a comprehensive overview of the multi-faceted aspects of communication between robots and humans in HRI. The paper discusses the various challenges and limitations involved in designing interactive robots that can effectively communicate with humans, and highlights the importance of evaluating the quality of communication to support the effectiveness of robots in performing tasks where communication is needed.

**3. M. Qbadou, et al. "Human-Robot Multilingual Verbal Communication-The Ontological knowledge and Learning-based Models."**

The main problem addressed in the research is the challenge of verbal communication for children with special needs, particularly those who use different natural languages. The authors propose a new approach for human-robot multilingual verbal interaction based on the hybridization of a translation machine system consisting of a neural network model reinforced by a large distributed domain-ontology knowledge database.

**4. Kyranini, Maria, et al. 'A Survey of Robots in Healthcare.'**

The authors of the paper conducted a comprehensive review of the literature on the use of robots in healthcare. The authors analyzed the selected articles to identify the types of robots being used in healthcare, their applications, and the benefits and challenges associated with their use. They also discussed the ethical considerations surrounding the use of robots in healthcare.

**5. Esterwood, Connor, and Lionel P. Robert. 'A Systematic Review of Human and Robot Personality in Health Care Human-Robot Interaction.'**

The authors conducted a systematic literature review to identify studies on personality in health care human-robot interaction. The authors provided guidance for future research in this area, including the need for more studies on the relationship between personality and robot design, as well as the need for more longitudinal studies to assess the long-term effects of personality on health care human-robot interaction.

**6. Gargioni, Luigi. 'Human-Robot Collaboration in Healthcare: New Programming and Interaction Techniques.'**

The problem addressed in this paper is the need for more efficient and effective collaboration between humans and robots in the healthcare industry. The author's method includes conducting interviews with pharmacists to gather the basic requirements for understanding the best interaction to propose. Additionally, the research aims to simplify and streamline the programming process for collaborative robots, reducing the need for technical knowledge and expertise

**7. Diño, Michael Joseph S., et al. 'Nursing and Human-computer Interaction in Healthcare Robots for Older People: An Integrative Review.'**

The article explores the intersection of nursing, healthcare robotics, and human-computer interaction for older adults. They primarily focused on applying healthcare robots in practice settings, physical health, and communication tasks. Using the human-computer interaction framework, it was found that older adults frequently served as the primary users while nurses, healthcare providers, and researchers functioned as secondary users and operators.

8. **Hobbs, Bradley, and Panagiotis Artemiadis.** *'A Review of Robot-Assisted Lower-Limb Stroke Therapy: Unexplored Paths and Future Directions in Gait Rehabilitation.'*

The paper addresses the problem of gait impairment and mobility limitations faced by stroke survivors. It reviews the different methods used by scientists to study and rehabilitate gait in humans and discusses the gaps in research that have yet to be filled, prompting potential new directions in the field.

9. **Prati, Elisa, et al.** *'A Systematic Literature Review of User Experience Evaluation Scales for Human-Robot Collaboration.'*

The analysis of the paper highlighted that the UX aspects are not sufficiently examined in the current HRC design practice, particularly in the industrial field, and there is a lack of standardized scales for UX evaluation in industrial HRC scenarios. The authors proposed a set of dimensions to be considered in a new UX evaluation scale to address this issue.

10. **Xu, Zonghe, et al.** *"Accuracy and Efficiency of Robotic Dental Implant Surgery With Different Human-robot Interactions: An in Vitro Study."*

The authors conducted an experimental study to compare the performance of different implant robots with varying human-robot interactions. They used 30 identical mandibular phantoms and divided them into three groups: semi-active robot group, partially robotic group, and active robot group. The authors concluded that different human-robot interactions have variable surgical efficiencies and that implant placement is accurate when using implant robots with different human-robot interactions.

11. **Andreas Triantafyllidis, Anastasios Alexiadis, Konstantinos Votis, Dimitrios Tzovaras.** *'Social robot interventions for child healthcare: A systematic review of the literature, Computer Methods and Programs in Biomedicine.'*

The authors conducted a systematic review of the literature on social robot-based interventions in child healthcare. The authors analyzed the features and outcomes of the social robot-based interventions in child healthcare, as assessed in pragmatic studies, to provide insights into the development of effective social robot-based health interventions for children.

12. **Naik, Nithesh, et al.** *'Legal and Ethical Consideration in Artificial Intelligence in Healthcare: Who Takes Responsibility?'*

The problem addressed in this paper is the legal and ethical considerations surrounding the use of artificial intelligence in healthcare. The authors highlight the importance of algorithmic transparency, privacy, and protection of all beneficiaries involved, as well as cybersecurity of associated vulnerabilities. Overall, the authors argue that responsible and ethical use of AI in healthcare requires careful consideration of these legal and ethical issues.

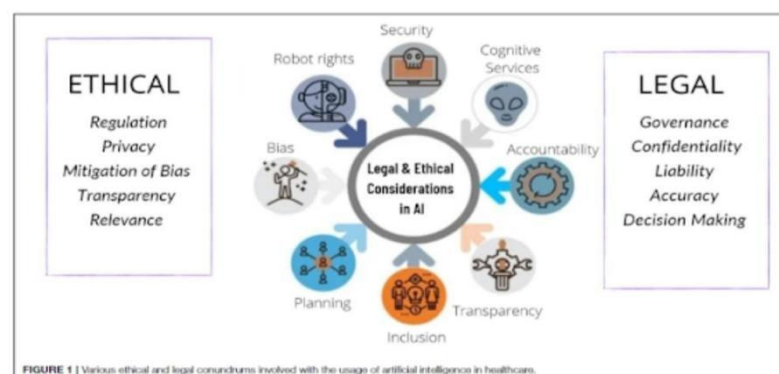


Fig. 2. Various ethical and legal aspects involved in the usage of robots in healthcare

13. **Wullenkord, R., Eyssel, F.** *'Societal and Ethical Issues in HRI.'*

This paper addresses the societal and ethical issues in human-robot interaction, including the challenges associated with robot deployment, behaviour

towards robots, and robot rights. The authors provide an overview of ethical frameworks and guidelines to inspire researchers, developers, and stakeholders to consider ethical issues in their work.

14. *Su Hang, Qi Wen, Chen Jiahao, Yang Chenguang, Sandoval Juan, Laribi Med Amine, 'Recent advancements in multimodal human-robot interaction.'*

The authors explore the use of natural language commands and body tracking with active depth sensors to reshape robot trajectories. The article identifies some of the challenges associated with implementing multimodal human-robot interaction systems, such as high computational requirements and system complexity, which limit their scalability. The authors also emphasize the need for ethical guidelines and regulations to ensure the safe and responsible use of robots in various applications.



**Fig.3.** The various signals of multimodal HRI

The authors explore the use of natural language commands and body tracking with active depth sensors to reshape robot trajectories. The article identifies some of the challenges associated with implementing multimodal human-robot interaction systems, such as high computational requirements and system complexity, which limit their scalability. The authors also emphasize the need for ethical guidelines and regulations to ensure the safe and responsible use of robots in various applications.

### 3. Conclusion

Reflecting on the survey findings, it becomes evident that the landscape of HRI in healthcare is rich with possibilities. It is evident that in the near future there will be seamless integration of technologies with healthcare. It is clear that the path forward involves ongoing research, interdisciplinary collaboration, and a commitment to addressing the challenges that accompany the integration of robots into the intricate fabric of healthcare. As we move forward with this evolving frontier, the promise of HRI in healthcare not just lies in technological advancements but also in the betterment of patient's lives.

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