AI-Driven Conversational System for Personalized Physical Rehabilitation in Diabetes and Osteoarthritis Management

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Abstract. The increasing prevalence of diabetes and osteoarthritis highlights the need for personalized and sustainable rehabilitation strategies. This project explores using a conversational AI system to recommend custom-made physical activities for patients to manage these conditions. AI integrates real-time interactions with patients, their medical history, and physiotherapist-guided rehabilitation plans to generate adaptive activity recommendations. By collaborating with physiotherapy coaches, the system ensures that the exercises are safe, effective, and aligned with each patient's progress. In addition, AI adapts recommendations based on user feedback and physiological responses, enhancing engagement and long-term adherence. The proposed approach uses AI-driven personalization to improve rehabilitation outcomes, fostering a more dynamic and patient-centric healthcare experience.

Keywords: Conversational AI · Rehabilitation · Diabetes · Osteoarthritis · Personalized Healthcare

1 Introduction

The rise in chronic conditions such as diabetes and osteoarthritis demands innovative and sustainable rehabilitation approaches. Diabetes mellitus affects more than 537 million adults worldwide [1], while osteoarthritis is the leading cause of disability in older adults [2]. Conventional rehabilitation methods often fail due to limited personalization, inconsistent patient adherence, and lack of continuous monitoring. These gaps emphasize the need for intelligent, scalable, and adaptable systems that empower patients to manage their health effectively.

Recent advances in artificial intelligence (AI) and natural language processing (NLP) have enabled the development of conversational agents capable of simulating human-like dialogue and decision-making. This paper presents a conversational AI system designed to offer dynamic rehabilitation plans tailored to individual patient needs, thus improving clinical outcomes and patient satisfaction.

2 Related Work

The integration of AI into healthcare has grown significantly, especially in diagnostic support, predictive modeling, and robotic surgery. Chatbots like Woebot [3] and Replika demonstrate the feasibility of AI in mental health support, while tools such as Ada and Babylon Health provide symptoms checks and medical triage through conversational interfaces.

In physical rehabilitation, AI applications have predominantly focused on gait analysis, exercise classification using sensors, and remote monitoring through wearables. However, the domain lacks real-time dialogue-based systems that engage users in natural conversations to deliver and adjust rehabilitation plans.

- **Conversational AI in Health** Several systems, including Microsoft Health Bot and Google Med-PaLM, showcase the ability of AI to understand medical language and provide relevant information. However, their scope is limited to general queries rather than personalized rehabilitation.
- **AI for chronic disease management** Personalized digital health interventions are effective in chronic disease management. For example, digital diabetes coaching platforms (e.g., Omada Health [4]) help users monitor blood glucose levels and lifestyle changes but typically lack the conversational aspect and real-time adaptability provided by the proposed system.

3 System Architecture

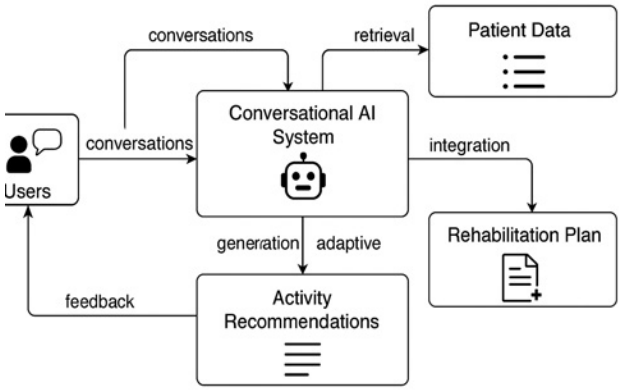

Fig. 1. System architecture showing interaction between components.

The system comprises three primary components (see Fig. 1):

- **Patient Interaction Interface**: Enables bidirectional communication between the user and AI via voice or text.

- **Personalized Recommendation Engine**: Processes patient data, medical history, and AI-inferred insights to generate and adapt rehabilitation plans.
- **Physiotherapist Collaboration Layer**: Ensures medical validity and allows clinicians to guide and adjust system recommendations.

3.1 Data Flow and Processing

Patient data, including demographics, diagnosis, previous medical records, and real-time feedback, is used to generate activity recommendations. NLP models interpret user input, while reinforcement learning techniques allow the system to learn from user outcomes and improve recommendations over time.

3.2 Personalization Mechanism

Personalization is the core of the system. The profile of each patient includes static information (for example, age, diagnosis, BMI) and dynamic input (e.g., pain levels, fatigue, and adherence to previous sessions). The system utilizes the following:

- **Rule-based filtering**: For contraindications and medical red flags.
- **Machine learning models**: For clustering users based on similarity and tailoring progression schedules.
- **Feedback loops**: Adjust plans based on verbal/non-verbal feedback and performance metrics.

Additionally, it also enhances patient engagement using gamification elements such as constant feedback and positive reinforcement are included to motivate users. In addition, the conversational interface fosters a sense of companionship and accountability.

3.3 Physiotherapist Integration

To ensure clinical safety, the system allows physiotherapists to:

- Approve or reject AI-generated plans.
- Provide inputs and constraints based on their professional judgment.
- Monitor user progress and intervene when necessary.

This hybrid AI-human approach ensures a balance between automation, AI governance, and human expertise.

4 Current progress

A comprehensive Quality Function Deployment (QFD) analysis was conducted to systematically identify and prioritize user requirements. These insights were then translated into corresponding technical specifications to inform the selection of the most suitable wearable device for data acquisition. Furthermore, a user interface and user experience (UI/UX) prototype was developed using Figma, incorporating interactive components aligned with the specific needs and preferences of both patients and coaches as identified through the QFD process.

5 Conclusion and Future Work

This paper presents an AI-driven conversational system that brings personalization, engagement, and scalability to physical rehabilitation. Integrating AI with expert human supervision addresses both medical safety and patient motivation. Future developments will include integration with wearable devices for continuous monitoring, real-world clinical trials to validate efficacy, expanded language and cultural support, and enhanced emotional intelligence in AI to better respond to patient mood and stress levels. This approach promises a significant leap toward patient-centric adaptive healthcare models.

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About Aron Samuel Georgekutty

Aron is currently pursuing an Engineering Doctorate (EngD) at Eindhoven University of Technology, The Netherlands, with a focus on the application of artificial intelligence to enhance user interaction. He is an active member of the TREAT consortium, collaborating with academic and industrial partners to develop intuitive interfaces in athletic and medical domains. Aron holds Master's degrees in Mathematics and in Artificial Intelligence & Robotics. With over three years of industry experience as a software developer and embedded machine learning engineer, his work aims to bridge the gap between human-centered design and genAI technologies.

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