

DEVELOPMENT OF A METHOD AND SOFTWARE TOOL FOR MONITORING PHYSICAL TRAINING AND REHABILITATION

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Abstract: The increasing importance of personalized healthcare, especially in physical training and rehabilitation, necessitates advanced tools for monitoring and managing individual programs. This study presents the development of a novel method and software tool designed to monitor physical training and rehabilitation processes. The proposed system integrates wearable sensors and machine learning algorithms to provide real-time analysis of key performance indicators, such as movement quality, muscle engagement, and recovery metrics. The software enables personalized adjustments to training plans based on the user's condition and progress. The experimental results indicate a significant improvement in rehabilitation outcomes compared to traditional methods. The findings suggest that this system can enhance training efficiency and recovery speed, offering new opportunities for patient-centered healthcare.

The increasing demand for effective rehabilitation strategies has prompted the integration of modern technologies in physical training and rehabilitation. The growing prevalence of physical training and rehabilitation as essential components of health maintenance and recovery has led to a demand for innovative solutions that can improve the effectiveness of these programs.

While various tools exist for monitoring physical activity, their effectiveness in accurately tracking recovery progress still needs to be improved. Traditional methods of assessing physical progress often rely on subjective evaluation, leading to inconsistent and accurate results. Rehabilitation, in particular, requires accurate monitoring to ensure optimal progress and prevent complications. The need for personalized rehabilitation protocols, combined with advancements in wearable sensor technology and data analytics, offers a unique opportunity to enhance rehabilitation outcomes.

Traditional methods for evaluating physical training and rehabilitation rely heavily on subjective assessments, which can lead to inconsistencies and suboptimal patient outcomes. Wearable technology and machine learning techniques have the potential to address these limitations by providing objective, real-time data that can be used to adjust treatment plans dynamically.

Recent advances in wearable sensor technology and machine learning offer new opportunities to enhance the precision and reliability of monitoring systems. This study addresses the need for a more efficient approach to tracking physical performance and rehabilitation by developing a comprehensive monitoring tool that leverages sensor data and intelligent algorithms.

This study addresses the challenge of optimizing rehabilitation by developing a novel method and software tool incorporating real-time monitoring and personalized intervention recommendations. The main goal is to improve the efficiency of rehabilitation protocols by automating data collection and analysis while providing tailored feedback to users.

This research aims to develop a method and software tool that monitors physical training and rehabilitation using wearable sensors and machine learning algorithms. This system is intended to facilitate the automatic evaluation of movement patterns, muscle activation, and other critical

parameters, enabling the adaptation of training programs based on individual needs. The main objectives of this study include (1) designing a reliable monitoring method that incorporates state-of-the-art sensor technologies, (2) developing an intelligent software tool that uses real-time data to adapt training plans, and (3) validating the proposed system through experimental trials involving participants undergoing physical rehabilitation.

The proposed method utilizes wearable sensors to capture physiological and biomechanical data, including heart rate, electromyography (EMG) signals, and joint kinematics. Data preprocessing techniques, such as noise reduction and signal normalization, are employed to improve data quality. A machine learning framework is then used to analyze the processed data, with supervised learning algorithms applied to detect deviations from standard training patterns. Real-time feedback is provided through the software interface, offering users insights into their progress and enabling adjustments to training or rehabilitation protocols as needed.

The methodology employed in this study combines hardware and software components. Wearable sensors, such as inertial measurement units (IMUs) and electromyography (EMG), collect data on body movements and muscle activity. Data processing uses machine learning algorithms that classify movement quality, detect anomalies, and provide predictive insights regarding the individual's rehabilitation progress. The software's user interface is designed to display real-time feedback to users and healthcare professionals, allowing for immediate adjustments to training plans. Experimental validation was conducted by comparing the rehabilitation outcomes of individuals using the developed tool against those following traditional rehabilitation programs.

The research employs wearable sensor technologies, data analytics techniques, and machine learning algorithms to monitor and evaluate physical training and rehabilitation progress. Biometric data, such as heart rate, muscle activation, and movement patterns, are continuously collected using wearable devices. Data analytics techniques, including time-series analysis and signal processing, are used to preprocess the data, while machine learning models are trained to identify patterns indicative of recovery stages. An experimental study was conducted with athletes undergoing rehabilitation to evaluate the system's accuracy in monitoring recovery progress. Data from conventional rehabilitation methods were used as a benchmark for comparison.

This study introduces a novel integration of wearable sensor technology and machine learning for physical training and rehabilitation. Unlike existing systems that primarily focus on general fitness tracking, the proposed solution emphasizes the automated assessment of rehabilitation progress and the delivery of personalized feedback. The novelty lies in developing adaptive machine learning algorithms that adjust to individual recovery patterns, thus offering more customization. Additionally, the system's real-time feedback capabilities enable prompt adjustments to training protocols, potentially accelerating the recovery process.

Thus, unlike traditional rehabilitation monitoring methods, which rely primarily on manual observations and standard protocols, the proposed system offers automated, adaptive adjustments based on real-time data analysis. This approach enables a more accurate assessment of rehabilitation progress, allowing for a more individualized approach to treatment. The experimental results demonstrate the system's effectiveness in accelerating recovery and improving training outcomes compared to conventional methods.

Conclusions. This study presents a novel method and software tool for monitoring physical training and rehabilitation using wearable sensors and machine learning algorithms. The proposed system significantly enhances rehabilitation outcomes by providing personalized, data-driven

adjustments to training programs. Further research will focus on expanding the range of monitored activities, refining the algorithms for greater accuracy, and integrating additional biometric data to improve the tool's predictive capabilities. The findings suggest that this approach can contribute to evolving personalized healthcare and rehabilitation practices.

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