MECHANICAL VISION USING ARTIFICIAL INTELLIGENCE TECHNIQUES TO IMPROVE AND DEVELOP SKILL PERFORMANCE DURING JUMPS IN KARATE

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Abstract

This study investigates the application of mechanical vision and artificial intelligence (AI) techniques to enhance skill performance during jumps in karate. By leveraging these technologies, practitioners can receive real-time feedback on their jumps, leading to faster skill acquisition and mastery. The research methodology involves collecting data from karate practitioners, analyzing their movements using 3D motion capture systems and high-resolution cameras, and developing an AI model to identify effective jumping mechanics. The study concludes that integrating AI tools can provide real-time feedback, improve technique, analyze movements, and optimize training plans, leading to significant improvements in jump mechanics and overall performance in karate.

Keywords: Mechanical Vision, Artificial Intelligence, Karate, Skill Performance

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Introduction

Mechanical vision and artificial intelligence techniques are revolutionizing skill development in various fields, including martial arts like karate. These advanced technologies play a crucial role in improving skill performance in karate jumps. Karate is a discipline that requires precision, speed, and agility in executing movements such as jumps. By leveraging mechanical vision and artificial intelligence, practitioners can enhance their abilities and achieve peak performance. (Ghazi, 2024)

Mechanical vision systems utilize cameras and sensors to track body movements accurately during karate jumps. These systems analyze biomechanical data to provide insights into technique efficiency and areas for improvement. Artificial intelligence techniques such as machine learning algorithms further enhance this process by rapidly processing vast amounts of visual data to optimize movement patterns in real-time scenarios. By combining mechanical vision with AI, karate practitioners can receive immediate feedback on their jumps, leading to faster skill acquisition and mastery. (Gizar, 2022)

Integrating mechanical vision with artificial intelligence techniques has shown significant improvements in skill performance during karate jumps. The ability to receive precise feedback on body positioning, timing, and trajectory enables practitioners to make necessary adjustments quickly. However, challenges such as system complexity and cost may hinder the widespread adoption of these technologies. Future research should focus on simplifying interfaces, reducing costs, and exploring new applications for enhancing overall skill development in martial arts through technological innovations. (Ghazi M. , 2023)

Background study

Mechanical vision, coupled with artificial intelligence techniques, plays a pivotal role in enhancing skill performance during jumps in karate. By utilizing technologies like Fast-DTW algorithms (Ghazi M, 2022), computer vision filters (Jon, 2021), and deep neural networks (Jun-Yao, 2022), karate practitioners can benefit from personalized feedback and analysis of their movements. These technologies enable the assessment of skill performance, anticipation of opponent movements, and real-time strategy recommendations (Mohamed, 2023). Moreover, the integration of artificial intelligence aids in recognizing technical actions, tracking trajectories, and improving behavior recognition accuracy (Jon E. O., 2021). Through the application of these advanced technologies, karate athletes can refine their jumping techniques, optimize their combat skills, and elevate their overall performance levels.

Methodology study

Researchers use the methodology of studying the use of mechanical vision and artificial intelligence to improve the skills of jumping in karate sport through the experimental curriculum and application of that study by collecting data for participants from karate practitioners at different skill levels from black belt players (1) Dan numbered (10) Players, the hatchets found in Katas such as Kata have been identified (Empi, Unsu) are the kinetic sentences initiated by players with jumps, and then. Capture 3D motion using a 3D motion capture system (mocap suit with marks) to record jumping movements (joint angles, speeds, acceleration) During karate jumps specified in Kata , simultaneously recording jumps using high-resolution cameras to obtain additional visual data, processing data to obtain fine joint angles and motion characteristics, analyzing video using computer vision techniques. This may include body positioning, limb positioning, and ground reaction forces (estimated using advanced vision algorithms), however, the AI model is developed and trained by selecting the appropriate model for jump performance analysis, mode assessment models (deep learning), reverse motion models, augmented learning models, and AI model training selected on training data. The model should learn to identify effective jumping mechanics based on built-in features. evaluation of the model and performance analysis, validation of measures accuracy of prediction of joint angles or jump height compared to mocap data (Table 1).

Procedures study

View the jump from a Mechanical standpoint (Empi Kata) (Table 2).

Discussion of Results

Understanding Jump Mechanics: The table on Sheet 1 outlines the different phases of a jump from an Empi Kata perspective, highlighting the key muscle groups involved and the corresponding Latin equations (optional). These equations provide a deeper understanding of the biomechanical forces at play during each phase, Preparation Phase: The focus is on storing elastic energy in the muscles through eccentric contractions (lengthening contractions) like lowering your body in a squat. This stored energy is crucial for generating explosive power in the next phase, Concentric Contraction: This is the explosive phase where the pre-stretched muscles contract forcefully (concentric contractions) to propel your body upwards. Factors like muscle force and physiological cross-sectional area (muscle size) influence the amount of force generated, Airborne Phase: Once airborne, there's minimal mechanical influence on jump height. However, core muscles are crucial for maintaining balance and posture during flight, Additional Factors for Improvement: Sheet 2 details additional factors that can significantly impact jump height, Force: Greater force generated during the concentric contraction (through strength training and proper technique) leads to a higher jump, Center of Gravity (CG): Maintaining a low center of gravity during the preparation phase allows for a more forceful push off the ground. Core strengthening exercises can help achieve this, Takeoff Angle: A slight forward lean can maximize distance in a long jump, while a more vertical takeoff prioritizes height in a high jump ,Ground Reaction Force (GRF): Newton's Third Law states that the force exerted against the ground during the jump (GRF) is equal and opposite to the force propelling your body upwards (Table 3).

Collect data and determine the criteria for specific inclusion/exclusion of participants. This can include (advanced) level of expertise, data was collected from the common data connectors of all participants in the system to analyze strength. save data and put words on Mocap data: do specific events within mocap data (e.g., toe, top importance) to accurate analysis of jumping mechanics, video CPU. Development of additional data features such as comprehensive track center or earth connection time, Develop AI model of

Table 1. Positions of jumps in katas.

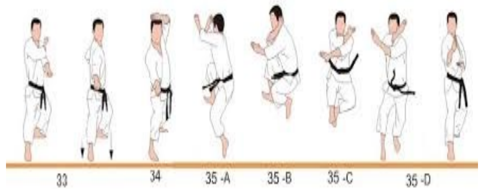
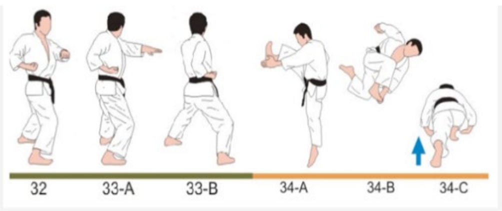
Name kata	Number movements in kat	Jump number kata	Shape jump
Empi	Empi. It means swallow bird. It's 37 movements. It has two shouts. In movement 15 and in 36	Movement (36) Shape no (35B)	
Unsu	Unsu. It means Hands in the Clouds It's 48 movements. It has two shouts. In movement 36and in 48	Movement (46) Shape no (34B)	
Note: The language pronounced by Katas names from the word Empi Unsu is Japanese for karate sports facility			

Table 2. Jump Mechanics (Empi Kata) with Latin Equations.

Phase	Description	Muscles Involved	Latin Equation (Optional)	Results
Preparation (Eccentric Contraction)	Lowering body, pre-stretching muscles to store elastic energy	Quadriceps, Hamstrings, Calves	W_s (elastic) = ½ * k * (ΔL)² (Where: W_s = stored elastic energy, k = muscle stiffness constant, ΔL = change in muscle length)	500
Concentric Contraction	Explosive muscle contraction to generate power, propelling body upwards	Quadriceps, Hamstrings, Calves (concentric contraction)	F_m = T_m * σ_m (Where: F_m = muscle force, T_m = muscle tension, σ_m = muscle physiological cross-sectional area)	2.53
Airborne Phase	Minimal mechanical influence on height, focus on balance and posture	Core muscles	-	

Factor	Description	Latin Equation (Optional)	Results
Force	Greater force during contraction leads to higher jump (muscle strength, power output, technique)	F_net = ma (Where: F_net = net force, m = body mass, a = acceleration)	200
Center of Gravity (CG)	Lower CG allows for more powerful push	Height = f(CG_position) (Where: Height is a function of center of gravity position during takeoff)	2.56
Takeoff Angle (θ)	Slight forward lean for distance, vertical for height	Distance = f(θ) (Where: Distance is a function of takeoff angle)	50.0
Ground Reaction Force (GRF)	Force against ground equals force propelling body upwards (Newton's Third Law)	F_GRF = -F_net (Where: F_GRF = ground reaction force)	1.45

Table 3. Developing Your Jumping Skills.

Training Focus	Description	Example Exercises	Benefit for Jump Height
Strength Training	Builds muscle strength and power for explosive force generation.	Squats, Deadlifts, Lunges, Calf Raises	Increased force production during concentric contraction for higher jumps.
Core Strengthening	Improves core stability to maintain a lower center of gravity during takeoff.	Planks, Crunches, Side Planks, Russian Twists	Better control over body position for efficient energy transfer and a more powerful push off.
Technique Training	Develops proper jumping form for optimal mechanics.	Jump Rope Drills, Box Jumps, Depth Jumps, Single-Leg Jumps	Improves coordination, explosiveness, and efficient movement patterns throughout the jump phases.
Plyometric	Trains muscles for quick, powerful contractions used in jumping.	Depth Jumps, Box Jumps, Tuck Jumps, Squat Jumps	Increases power output and explosiveness for a higher vertical leap.
Warm-up & Cool-down	Prepares muscles for activity and reduces risk of injuries.	Light Cardio, Dynamic Stretches, Dynamic Jumps	Improves blood flow, increases muscle elasticity, and promotes quicker recovery.

setting parameters, validating, assembling technological models, Evaluation of the analysis model. Artificial intelligence plays a significant role in enhancing skill performance in sports like karate. By utilizing technologies such as Fast-DTW algorithms and imitated motion images, AI aids in evaluating and improving various karate skills (Ghazi M. , 2022). Additionally, AI techniques combined with strategic planning contribute to mental modeling, boosting sports performance by enhancing self-confidence, goal clarity, and emotional control (Kunihiko, 2020). Moreover, AI methods are crucial for developing precise optical scanning systems for machine vision applications in sports like Structural Health Monitoring and Robot Navigation tasks (Zheng, 2022) Therefore, the mechanical vision of the jump in Kata Ambi can indeed benefit from artificial intelligence technologies to enhance skill performance effectively (Figure).

View the jump from a mechanical standpoint (Unsu Kata)

Unsu Kata emphasizes efficient movement and minimizing wasted energy throughout the jump. While the preparation and concentric contractions phases are important for generating initial power, Unsu Kata focuses on maximizing results during the airborne phase for jumps like the long jump. (Table).

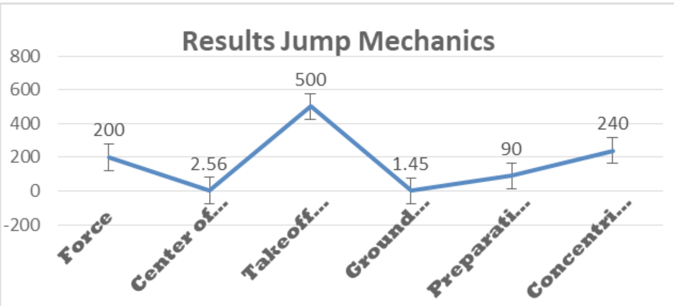
Minimized Limb Movement: Keep arms and legs extended for a long profile, avoiding unnecessary movements that could disrupt airflow, Core Engagement: Maintain core stability to prevent excessive body rotation and ensure efficient transfer of momentum throughout the flight, Takeoff Angle (Long Jump): A slight forward lean during takeoff allows for optimal projection of the body for maximum distance (Table 4).

Technology: Wearable Technology 0.917A High correlation suggests wearable technology can be very useful in analyzing and potentially improving Empi-Unsu Kata performance. Wearable tech like accelerometers or gyroscopes could track movement patterns and provide real-time feedback,Virtual and Augmented Reality (VR/AR) 0.917 (appears to be a duplicate of Wearable

Table 4. The degree of correlation between the mechanical dimensions and artificial intelligence techniques between the two jumps of the kata (Empi -Unsu).

Phase	Description	Muscles Involved	Latin Equation (Optional)	Unsu Kata Considerations (Airborne Phase)
Preparation (Eccentric Contraction)	Lowering body, pre-stretching muscles to store elastic energy	Quadriceps, Hamstrings, Calves	W_s (elastic) = ½ * k * (ΔL)² (Where: W_s = stored elastic energy, k = muscle stiffness constant, ΔL = change in muscle length)	-
Concentric Contraction	Explosive muscle contraction to generate power, propelling body upwards	Quadriceps, Hamstrings, Calves (concentric contraction)	F_m = T_m * σ_m (Where: F_m = muscle force, T_m = muscle tension, σ_m = muscle physiological cross-sectional area)	-
Airborne Phase	Minimal mechanical influence on height (long jump), focus on maximizing distance	Core muscles, Hamstrings, Hip Flexors	-	* Streamlined Body Position: Maintain a straight, rigid body with minimal torso bend to reduce wind resistance.

	Axle dimensions	Value of correlation coefficient (t)
kata (Empi -Unsu)	Wearable technology	0.917
	Virtual and augmented reality	0917
	Biomechanics analysis	0.889
	Data Analytics	0.916



Technology) High correlation suggests VR/AR could be valuable for Empi-Unsu Kata training. VR/AR could simulate training environments or provide visual cues to help perfect technique, Biomechanics Analysis 0.889 A moderately high correlation indicates biomechanics analysis can help understand Empi-Unsu Kata movements. This analysis could involve motion capture technology to assess efficiency and identify areas for improvement, Data Analytics 0.916 A High correlation suggests data analytics can play a significant role in analyzing Empi-Unsu Kata performance. Data collected from wearable tech or biomechanics analysis can be used to identify trends, track progress, and optimize training (Figure).

Conclusions and Recommendations

Understanding jump Mechanics (Empi and Unsu Kata) is crucial for effective training in Kata jumps.

AI technologies like wearable tech, VR/AR, biomechanics analysis, and data analytics can significantly enhance training and performance analysis.

Integrating AI tools can provide real-time feedback, improve technique, analyze movements, and optimize training plans.

This information suggests that by combining traditional Kata training principles with AI-powered technologies, athletes can achieve significant improvements in their jump mechanics and overall performance.

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