## СЕКЦИЯ 3. МИКРО- И НАНОТЕХНИКА

УДК 681

### EXPLORING THE APPLICATION OF ATOMIC LAYER DEPOSITION (ALD) FOR PRECISION NANOFABRICATION FOR STRUCTURAL HEALTH MONITORING FOR COMMERCIAL BUILDING

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A The growing demand for smart infrastructure has led to the development of advanced monitoring techniques for commercial buildings, ensuring their safety, longevity, and structural integrity. Atomic Layer Deposition (ALD) has emerged as a transformative nanofabrication technique for precision engineering, offering unparalleled control over thin-film coatings at the atomic scale. This study explores the application of ALD in Structural Health Monitoring (SHM) systems, focusing on its ability to enhance sensor performance, durability, and sensitivity. ALD enables the deposition of highly uniform, conformal, and defect-free thin films, which significantly improve the functionality of sensors used for real-time damage detection, environmental monitoring, and stress analysis in commercial structures. The exceptional chemical and thermal stability of ALD-coated materials extends sensor lifespan, ensuring long-term reliability in harsh environmental conditions such as temperature fluctuations, humidity, and corrosive agents. Additionally, ALD's precise thickness control at the nano-scale enhances the sensitivity of piezoelectric, piezoresistive, and optical sensors, leading to more accurate data acquisition for predictive maintenance and early fault detection. This integration of ALD-based nanocoatings into SHM systems minimizes maintenance costs, reduces structural failures, and supports the development of resilient, energy-efficient buildings. Furthermore, ALD facilitates the engineering of multifunctional nano-structured surfaces, enabling self-cleaning, anti-corrosive, and mechanically reinforced coatings that further contribute to the robustness of SHM sensors. The potential of ALD in fabricating nano-scale protective layers for microelectromechanical systems (MEMS)-based sensors makes it a promising technology for next-generation infrastructure monitoring. By leveraging ALD for precision nanofabrication, this research highlights its crucial role in advancing smart commercial buildings, improving their sustainability, and ensuring long-term structural safety.

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### QUANTIFICATION OF PROTECTIVE GEAR PRESSURE VALUES + AI VISUAL INTELLIGENT ANALYSIS: ENHANCING THE ACCURACY OF JUDGING IN WTF ELECTRONIC GEAR ERA TAEKWONDO COMPETITIONS

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The World Taekwondo Federation (WTF) has implemented reform measures such as the introduction of electronic protective gear and the best-of-three scoring system, which have put forward higher requirements for the accuracy of judging in taekwondo competitions.

Although the current electronic protective gear can automatically identify valid striking points, there is still a misjudgment rate of 15,7 % and a missed detection rate of 9,3 % (based on the data from the 2023 World Championships). There are significant limitations especially in dimensions such as the quantification of striking impact energy (with an error range of ±3.2N) and the evaluation of the standardization of technical movements [1–3].

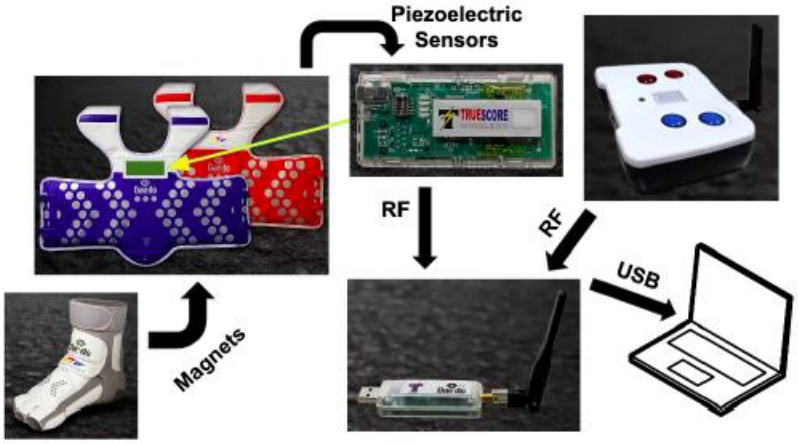


Fig. 1. Electronic protective gear and the scoring system

In order to further improve the accuracy of judging, this study proposes a judging assistance system for the WTF's electronic protective gear. This system combines the quantification of the pressure values of the protective gear with artificial intelligence (AI) visual intelligent analysis.

Based on the existing electronic protective gear, the system integrates pressure sensors to quantify the striking force, and uses AI visual technology to analyze the technical movements of athletes.

It can accurately evaluate key indicators such as the striking force, technical scores, and valid scoring areas.

The aim of this study is to provide a more objective, accurate, and efficient judging solution for taekwondo competitions in the era of the WTF's electronic protective gear, and to promote the development of this sport to a higher level.

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## CONSTRUCTION OF A REAL-TIME FEEDBACK SYSTEM FOR BASKETBALL SKILLS AND TACTICS AND ATHLETES' PHYSIOLOGICAL INDICATORS OF WEARABLE DEVICES AND AI LARGE MODELS

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The intelligent development of basketball has put forward a revolutionary demand for the ability to analyze training and game data in real time. In this study, we innovatively construct a basketball sports intelligent analysis system based on multi-modal data fusion, and achieve a double breakthrough in the dynamic analysis of technical and tactical skills and the monitoring of athletes' physiological status through the deep collaboration between wearable devices and artificial intelligence large models.

In this study, a distributed wearable sensor network (integrating 9-axis IMU, PPG biosensor and UWB positioning module) [1, 2] was used to capture the six-dimensional attitude data of athletes in real time (with an accuracy of ±0,5°) and spatial trajectory (positioning error < 10 cm) and core physiological