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Behavior Analysis for Deep Learning-based Human-Centred Solutions

By

Giorgia Marullo

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Supervisor(s):
Prof. Sandro Moos, Supervisor
Dr. Luca Ulrich, Co-Supervisor

Doctoral Examination Committee:
Prof. Antonio Gloria, Referee, Università degli studi di Napoli Federico II
Prof. Domenico Speranza, Referee, Università degli studi di Cassino e del Lazio Meridionale
Prof. Bartolomeo Montrucchio, Politecnico di Torino
Prof. Igor Stievano, Politecnico di Torino
Prof. Yves Grandvalet, Université de Technologie de Compiègne, CNRS, Heudiasyc

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Abstract

The introduction of new digital technologies has accelerated the digitalization of the industrial sector, influencing human-computer interaction and offering new chances for user-centered solutions. This modification represents the basis of the Industry 5.0 paradigm, which prioritizes human-centric systems and encourages collaboration between humans and sophisticated technology over automation.

In this collaborative framework, people and machines combine their complementary skills to create a mutually beneficial environment. This approach is reflected in the Augmented Humanity concept, in which technology augments human capacities, boosting engagement and productivity rather than replacing human intelligence.

Artificial intelligence (AI), particularly Deep Learning (DL), plays an important role in this transition, as it has moved from a technology-centric focus on output to a human-centric focus on cognitive enhancement. This growing interest in human behavior analysis enables the development of personalized systems that respond to individual user needs, resulting in more meaningful interactions via tailored feedback and increased engagement.

The proposed research framework, described in Chapter 1, consists of five distinct phases, each supported by domain-specific use cases. The methodology starts with a comprehensive literature review to establish the state of the art. It then includes selecting appropriate AI techniques, task analysis, parameter identification for behavior representation, and behavior analysis. This structured approach ensures clarity and validity when developing DL-based, user-centered solutions.

Focusing on applications in healthcare and sports, several case studies were examined demonstrating how DL can enhance healthcare, well-being, and performance assessment.

Chapter 2 addresses the automatic classification of femur fractures from X-ray images. Chapter 3 introduces a DL-based framework to enhance spatial perception in urologic surgery via real-time object tracking and blood accumulation detection.

Chapter 4 investigates hand pose estimation for rehabilitation related to phantom limb syndrome. Chapter 5 evaluates body movement in artistic gymnastics, examining a sophisticated method for performance assessment directly from images, and highlighting the necessity for precise keypoint estimation in intricate postures for future research.

Finally, Chapter 6 provides practical recommendations for implementing the suggested framework in a variety of real-world settings and points out areas for further study.

The analysis presented in this thesis emphasizes the potential of DL-driven user-centered solutions to enhance human capabilities and interactions in many situations, encouraging successful technology integration in improving human productivity and well-being.