CHAPTER 6

The Application of Artificial Intelligence in Ergonomics

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6.1 INTRODUCTION

Artificial Intelligence (AI) technology advancement benefits many fields, including ergonomics. Using AI in ergonomics and human factors can identify cause-effect relationships, early detection tools, and injury prevention strategies. One of the most used AI in ergonomics is machine learning which is the machine's ability to 'learn' from human behaviour and improve its analysis using algorithms. Machine learning is a subfield of artificial intelligence that refers to the capacity of machines to mimic intelligent human behaviour. Machine learning not only can handle large amounts of input data but also be able to evaluate and predict human states and capabilities based on the input. Machine learning approaches provide a more robust way of automatically detecting patterns in the relative differences between sensor data, making them useful in industrial settings (Villalobos & Mac Cawley, 2022).

A tree-based machine learning algorithms such as extremely randomised tools such as K-Nearest Neighbor (KNN) Classifier, Random Forest (RF), Decision Trees (DT), Convolutional Neural Network (CNN), Support Vector Machine (SVM) are among the machine learning techniques that are used with ergonomics assessment tool as Rapid Entire Body Assessment (REBA) (Hignett & McAtamney, 2000) and Rapid Upper Limb

Assessment (RULA) (Manghisi et al., 2017; McAtamney & Nigel Corlett, 1993). In this chapter, we discuss the integration of machine learning and ergonomics principles focusing on risk assessment to predict and assist ergonomists in preventing Work-Related Musculoskeletal Disorders (WRMSDs). Future research prospects and difficulties from machine learning and ergonomics perspectives are also explored.

6.2 THE APPLICATIONS OF AI IN ERGONOMICS

Ergonomic is a word taken from Greek, where 'ergon' means work and 'nomos' means law. Ergonomics is the human-machine interface. It is a science-based subject that combines engineering, statistics, physiology, and psychology to improve overall system performance and human well-being. Ergonomics has three primary components: cognitive, physical, and organisational. Cognitive science studies human decision-making, consciousness, memory, and problem-solving skills (Bouargane & Cherkaoui, 2016). Physical studies the human body's interaction with physical activity, working tools, human body burden, working postures, and work environment. Organisational ergonomics optimises socio-technical systems, structures, policies, and procedures. Ergonomics studies indirectly increase the human quality of life by improving safety culture.

Direct measurement, self-evaluation, and observational assessment are all typical methods for determining and assessing the risk of Work-Related Musculoskeletal Disorders (WMSDs) in the human body (Lu et al., 2014). Observational methods such as the REBA, RULA, and Ovako Working Posture Assessment System (OWAS) (Karhu et al., 1977) and were utilised by researchers to determine the risk level of a work posture. These popular and well-used ergonomic risk assessment approaches

require the completion of spreadsheets or the use of manual observational methods, which are time-consuming (Chatzis et al., 2022; Lowe et al., 2019) and have low accuracy (Fagarasanu & Kumar, 2002). When the medical community witnesses a paradigm shift in the definition of "occupational injury", it becomes critical for researchers to have a better knowledge of the cause-effect correlations, early detection tools, and injury prevention strategies.

Integrating AI techniques into ergonomics has opened new avenues for innovative ergonomic design, assessment, and intervention approaches. Researchers have proposed sophisticated tools such as motion capture devices, Microsoft Kinect, picture recognition, and other intelligent strategies to replace manual observation. These methods, also known as observational assessment methods utilising advanced technology, are intended to replace manual observation. AI in assisting these strategies may be beneficial in accomplishing that objective. Implementing AI in ergonomics generally consists of three key steps; target detection, feature extraction, and classification, as shown in Figure 6.1. In target detection, input data are collected from measurement tools such as sensors, cameras, and wearables. Feature extraction is a process of selecting or transforming input data into a set of meaningful, informative, and relevant features that can be used as input for an AI model. In the classification stage, an appropriate machine-learning model must be identified based on the nature of the problem and the data. Integrating existing ergonomic assessment could occur in either the feature extraction or classification stage.

For an extended period, AI models have used established ergonomic principles as the foundation for expert system conclusions to conduct an accurate and rapid evaluation and