Artificial Intelligence Applications for Workplace Safety:
An In-Depth Examination

Nikodem Rybak
http://orcid.org/0000-0002-7708-253X
The University of Queensland, Australia

Maureen Hassall
http://orcid.org/0000-0003-1191-5778
The University of Queensland, Australia

ABSTRACT

Workplace safety has been a field of research that increasingly draws attention of the artificial intelligence scientific community. Automations are important to detect and prevent various types of incidents, ranging from accident prevention, human error detection, manual process substitution by robots, continuous surveillance, harassment reporting, crime prevention, and others. After over a decade of ground-breaking advancements in artificial intelligence (AI), relevant applications can be deployed to serve workplace safety automation. A variety of techniques such as computer vision, natural language processing, machine learning, neural networks, robotics, explainable decision making, and interconnected intelligent devices can collaborate to build accurate, modern systems that can be applied in any working environment, targeting a variety of challenges. The predictive power of contemporary AI systems is able to reduce human effort regarding monitoring, reporting, and predicting future incidents, thus enhancing employees' safety and satisfaction at work.

INTRODUCTION

In recent years, artificial intelligence (AI) has emerged as a rapidly expanding field of research, boasting numerous real-world applications. One area that has seen a marked increase in the adoption of AI technologies is workplace safety. Techniques such as computer vision, natural language processing, and speech recognition have substantially bolstered safety-related applications, addressing a wide array of potential concerns that may arise in technologically sophisticated work environments. The success

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of these applications can be attributed to the accelerated progress in machine learning, particularly in the development of deep neural networks. Concurrently, vast quantities of data have been harnessed to effectively train these neural architectures, unearthing concealed patterns that can be utilized to generalize future data instances adhering to similar distributions. The efficacy of a neural network or machine learning system is predominantly assessed based on its generalization capabilities, which determine how adept a model is at predicting previously unseen instances. Consequently, the performance of any AI system reliant on a machine learning model is ultimately a reflection of the model's generalization quality. This underscores the importance of developing machine learning algorithms, which in turn significantly benefits various aspects of workplace safety.

AI-related systems need to collaborate with cyber-physical entities in order to acquire a sense of the world they try to 'understand'. To this end, Internet of things (IoT) sets the general framework which detects and transmits data as inputs for machine learning models. Interconnected sensors act as the data collectors for IoT systems, placed in different positions within a workplace environment. Then, both IoT and AI can collaborate to serve numerous industry needs, with the AI playing the role of the decision-maker, serving needs analyzed in the following sections (Vemuri et al., 2022).

HUMAN ERROR REDUCTION USING AI

One of the main roles of automation in general is to reduce human error. A generic categorization of human failures can lead to more strategies towards preventing them with the usage of AI. Several errors in workplace occur from not properly applying well-defined rules in practice or on the contrary because of lacking the appropriate knowledge to take action in unknown situations (Corrado, 2022). Naturally, those issues can be addressed by either proper generalization, which is successfully served from machine learning and deep learning models, or rule-based systems, which incorporate novel knowledge in a system. A variety of influencing factors can contribute to human error in everyday situations, therefore analyzing causal factors when accidents happen is useful to prevent future situations. Accident reports from various workplace sectors are an ideal data source for large neural network classifiers which can then recognize the factors contributing to human-based accidents and predict possible future occurrences (Morais et al., 2022). Nevertheless, AI has not been deployed in a very large scale for accident prevention as of now, even though machine learning problems have proved their predictive power in individual sectors (Sarkar & Maiti, 2020).

Mining and construction sectors frequently suffer occupational accidents tied to the nature of work. Prior studies exploit a variety of machine learning models, such as logistic regression, decision trees, rule-based systems, support vector machines (SVMs) and Bayesian networks, which unveil the factors contributing to accidents. Such networks are able to incorporate a large number of predictive features, such as the time of the accidents, worker information (age, job type, accident-related training received, personal factors and many others) in an interpretable way, yielding high predictive power in the same time (Rivas et al., 2011). Mining accidents were also studied using Bayesian networks in (Sanmiquel, Rossell, & Vintró, 2015) revealing a variety of contributing factors related to the nature of work, personal characteristics of the worker and workplace-related features.