



Introduction and configuration of a collaborative robot in an assembly task as a means to decrease occupational risks and increase efficiency in a manufacturing company

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ABSTRACT

Occupational risk factors (e.g. awkward postures, excessive effort, and repetitive movements) are a growing concern in the manufacturing industry due to their relationship with the incidence of musculoskeletal disorders (MSDs). In this sense, collaborative robots developed purposely for performing manufacturing tasks have emerged as an attractive solution to the problem. This paper presents a project developed in a manufacturing company, where we propose the implementation of a collaborative robot to reduce the incidence of occupational risks among the employees of an assembly station and thus increase their safety and improve the performance of the entire assembly line. To implement the collaborative robot, we made a mechanical design of the workstation; then, the collaborative robot was configured by using the console method. Later, we performed a risk analysis of the collaborative robot with the formats provided by the manufacturing company and tested the collaborative robot's reliability following specific criteria. Finally, company technicians and operators were trained in terms of collaborative robot maintenance and operation, respectively. Our results revealed that the collaborative robot frees employees from potential occupational risks. Moreover, we detected better performance of the assembly line after the collaborative robot was implemented.

1. Introduction

Occupational risk factors, such as awkward postures, excessive effort, and repetitive movements can cause musculoskeletal disorders (MSDs) [1]. For instance, repetitive movements can be the source of occupational diseases such as tenosynovitis, carpal tunnel, tendinitis, and De Quervain's disease, among others [2]. According to the literature, repetitive movements are a major issue in the manufacturing industry around the world [3]. In Mexico, the Mexican Social Security Institute (IMSS, by its Spanish acronym) registered more than 302,886 occupational accidents and diseases from 2005 to 2016 [4], and 1444 occupational fatalities in 2015. For a graphic representation of this information, Figs. 1 and 2 illustrate, respectively, the evolution of occupational accidents/diseases and occupational fatalities in the above-mentioned time period. Similarly, Fig. 3 depicts the incidence of occupational risks registered in Mexico in 2016 and classified by

economic activity. As can be observed, the manufacturing industry reported the highest occurrence rate of occupational risks, which often result in little organizational efficiency and higher corporate costs.

Manufacturing companies seek to reduce the incidence of occupational risks while they increase efficiency in productivity. To this end, they adopt solutions such as job rotation [3], adding more employees in a same task, decreasing work pace [5], designing ergonomic workstations [6], and introducing advanced manufacturing technology. In this context, collaborative robots have become a major trend that provides fast and long-term solutions to ergonomic problems [7]. As previously mentioned, this paper explores the implementation of a collaborative robot in the Mexican manufacturing industry. Namely, we explore the collaborative robot's impact in a manufacturing company located in the city of Tijuana. The company operates 24 hours a day, seven days a week, and employs 6000 workers, distributed along three work shifts. Unfortunately, the company employees usually perform

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