

ERGONOMIC ANALYSIS SUPPORTED BY VIRTUAL REALITY: A REVIEW OF RECENT PATENTS

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Abstract: Research has shown that ergonomic conditions have a direct influence on safety of employees, on the cost and quality of production. This study aims to review recent patent documents of Virtual Reality apply to ergonomic analysis in industry, related to interaction of people with his workplace. This study analyzes the active patents to map out the technological progress in this area. On this basis, 141 patents were found with an increasing number of publications per year and a spread application. We conclude that, although there are a huge number of new technologies present these recent patents, none of them is related directly to industrial process and people's workplace. Therefore, technologies and method available should be combined in order to support this application.

Keywords: Virtual Reality; Ergonomics; Industry; Workplaces.

Resumo: Estudos mostram que as condições ergonômicas influenciam a segurança, custo e a qualidade na produção. Este trabalho tem como objetivo revisar as patentes recentes do uso Realidade Virtual para análise de problemas ergonômicos na indústria, relacionados à interação das pessoas com seu ambiente de trabalho. Assim, patentes ativas foram analisadas buscando mapear o progresso tecnológico. Foram encontradas 141 patentes com números crescentes de publicações por ano, em aplicações diversas. Concluímos que, embora existam muitas tecnologias nas patentes recentes, nenhuma delas está relacionada à análise dos processos industriais e ao local de trabalho das pessoas. Assim, as tecnologias e os métodos disponíveis, podem ser combinados para dar suporte a esta aplicação.

Palavras-chave: Realidade Virtual; Ergonomia; Indústria; Locais de Trabalho.

1. INTRODUCTION

Technological advances and the automation of production processes have created a favorable scenario for the use of robots, interconnected computer systems for the analysis and monitoring of activities. However, even though these technologies are widely used in manufacturing industries worldwide, many activities still require manual operations [1]. For them, ergonomic conditions have a direct influence time, cost and quality of production, since when an operator works in an ergonomically unsuitable location for a long time, physical or emotional stress will influence the result of this job [2].

Therefore, the workstation, its devices, and the products to be handled must be designed in a way that the worker performs operations with improved movements, using less energy, reducing and mitigating the risk of injuries [3].

Late identification of product characteristics that may influence ergonomic conditions will require greater cost and time compared to problems identified in normal development phases [4]. In this context, Virtual Reality (VR) technology applied during different phases of product development can allow the identification of potential ergonomic problems and consequently define of actions to solve or at least, mitigate them [4] and [5].

Virtual Reality is defined as the one in which the observing participant is fully immersed and able to interact with a completely synthetic world. This world can mimic the properties of some real-world environments, existing or fictional; however, it can also exceed the limits of physical reality, creating a world in which physical laws normally govern space, time, mechanics, material properties, etc. [6].

Virtual Reality tools use computer modeling and simulation technology that has been widely used in education, health, entertainment, culture, sports, engineering, armed forces and other sectors for more than half a century, but only recently has it become a practical tool for the manufacturing industries [7]

This study aims to review recent patent documents of Virtual Reality apply to ergonomic analysis in industry, related to interaction of people with his workplace.

This paper is organized as follows: Section 2 describe the methodology. Section 3 describes the results observed and discuss them. Finally, Section 4 presents our conclusions and further research needed.

2. METHODOLOGY

The research methodology is based on [8].

The selected keywords were Virtual Reality, Ergonomics, Process, Product Development and Industry, as well as their synonyms. These words were combined and the selected descriptors are highlighted in Table 1.

Table 1. List of descriptors and patents found

Word Combination Number	Keywords	All Patents	Number of Patents alive
1	(Virtual ADJ Reality) AND (Ergonomics)	5671	2985
3	((Virtual ADJ Reality) OR(virtual ADJ environment)) AND ((Ergonomics) OR (human ADJ factors) OR (discomfort AND condition))	15242	7830
10	((Virtual ADJ Reality) OR(virtual ADJ environment)) AND ((Ergonomics) OR (human ADJ factors)) AND (Production OR manufacturing) AND (Automotive)	707	374
6	((Virtual ADJ Reality) OR (virtual ADJ environment)) AND ((Ergonomics) OR (human ADJ factors)) AND (Production OR manufacturing) AND ((Product ADJ Development) OR (product ADJ design)) AND Industry	328	141
7	(Virtual ADJ Reality) AND (Ergonomics) AND ((Process OR manufacturing)) AND (Product ADJ Development) AND (Industry)	143	44
9	(Virtual ADJ Reality) AND (Ergonomics) AND (Production OR manufacturing) AND (Product ADJ Development) AND (Automotive)	17	9
11	(Virtual ADJ Reality) AND ((Ergonomics) OR (human ADJ factors)) AND (Production OR manufacturing) AND (Automotive) AND (Product ADJ Development)	19	11
14	(Virtual ADJ Reality) AND (Ergonomics) AND (manufacturing) AND (Product ADJ Development)	164	48

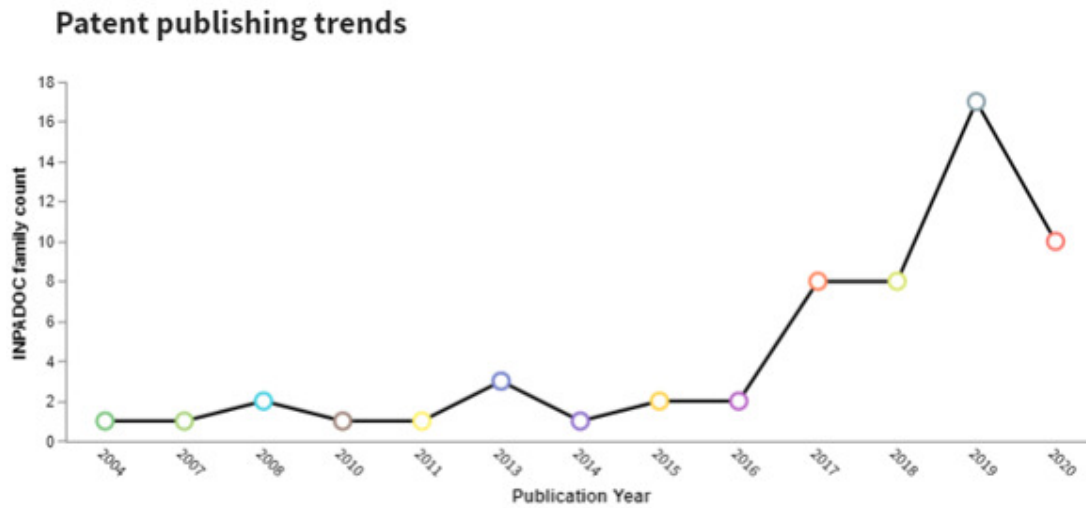
Search was conducted in July 2020 in the Derwent Innovation database and found 141 alive patent (active patents) that will be review in the next section.

3. RESULTS AND DISCUSSION

3.1 Patent Publishing Trends

Trend chart (Figure 1) shows that annual patent publishing has significantly increase from 2004 to 2019. Even though 2020 have not full year matured data, a different behavior can be seen in preliminary results where actual patents published number is almost half of what was counted last year. This last year result must be impact by global crisis caused by Coronavirus (Covid-19) anyway the number of patent documents in 2020 should not less than in 2019.

Figure 1. Patent Publishing Trends

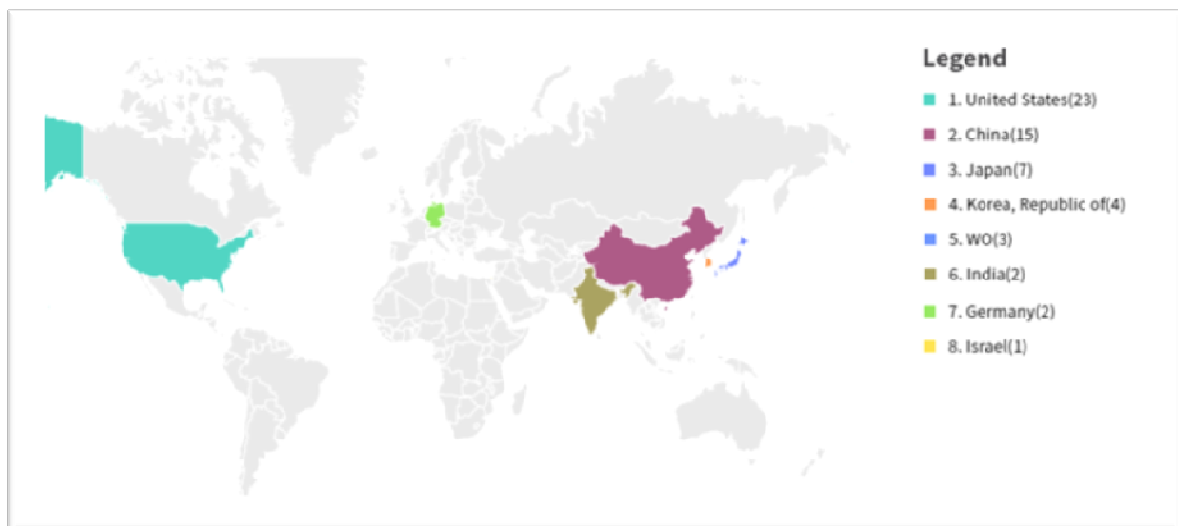


3.2 Patents Origin Location

Although European community have expressive number of industries they are not figured between the top ones for alive patents identified. United States and Asian countries (China, Japan and Korea) are leading the number of patents with 40% and 46% respectively, as described in the Figure 2.

According to the patent documents analysis, regardless of the patent's origin, the application of the technologies developed from these patent documents are applied in several other countries, including emerging countries like Brazil, Mexico and India.

Figure 2. Registered Patents by country



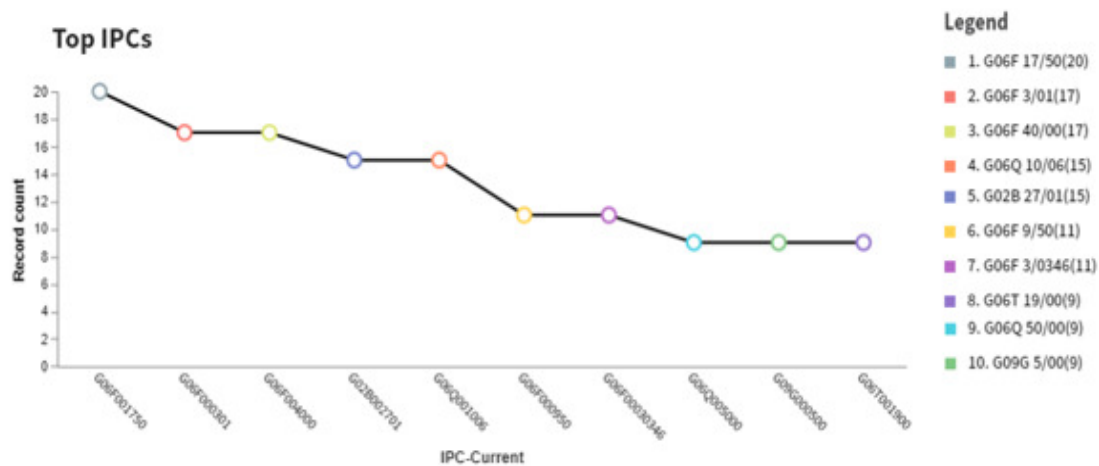
3.3 International Patent Classification

The International Patent Classification which is most often referred to as the IPC, has now existed for 25 year and is the worldwide classification system for technical information [9]. This classification supports the search for patent documents and facilitates access to the technological information contained in these documents [8]. Figure 3 highlights distribution of alive patents according to the IPC classification.

The code G06F is most common classification, however industrial applications are spread across of health, automotive and aeronautics area.

We do not expect to find this spread application, since ergonomic aspect are common in the mass production and manual production companies like as automotive, that apply technology to improvements process condition.

Figure 3. International Patent Classification (IPC)



3.4 Terminology Used

To identify the patents documents main topics, Figure 4 illustrates a word cloud drawn from their titles and abstracts

We already expected to find these words since patents searched focused on Virtual Reality and Ergonomic. This could be due to fact that patents published explores how the new technology works, emphasizing the method and resources used. This could explain why words like System, Display, User, Device, Method and Data are most cited.

Patents on Virtual Image and Head Mounted Display technologies are closest to this study focus, however findings point that application is not referring to analysis of ergonomic problems related to people's interactions with his workplace, in industrial process (e.g.: repetitive strain injuries, vibration, force, and posture).

4. CONCLUSION

This study aimed to review recent patent documents of Virtual Reality apply to ergonomic analysis in industry, related to interaction of people with his workplace. The prospective analysis showed that the number of patent publication since 2004 had a huge increasing, jumping to one annual patent in 2004 to 17 in 2019. Global crisis caused by Covid-19 may impact 2020 patents publication, fact that can minimize the increasing behavior in this year

A large range number of available technologies was found, more twenty-five, whose application is spread across different types of industry, such as Touch, Blockchain, Head Mounted Display. This range of technologies points to recent innovations and indicates how the market is committed to provide new solutions.

Therefore, we conclude that although recent patents approach many new technologies, none of them to industrial process and people's workplace. For that reason, technologies and method available should be combined in order to support this application.

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