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Reducing ergonomic strain in warehouse logistics operations by using wearable computers

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Abstract

Ergonomics is the study that deals with the design of products and processes that improve both human well-being and overall system performance. In order to reduce the ergonomic strain that the workers in the warehouse sector experience, while also increasing competitiveness and tact time, businesses have to understand the importance of emerging technologies and how these can be applied successfully in their working area.

This paper offers a grading of existent wearable computer technology that can be used within a warehouse environment, based on their capacity to reduce ergonomic strain both by means of reducing or eliminating repetitive motions as well as by increasing scanning usability through their software integration with existing ERP systems. Besides the ergonomic efficiency, the analysis also looks at the necessary financial investment and the training effort needed to implement such a solution in order to offer a holistic view of the topic to decision makers. The detailed explanation of the results also offers a purchase decision framework, based on the current market trends in warehouse technologies and on the future development capabilities of the technologies analyzed.

1. Introduction

According to International Ergonomics Association (IEA), ergonomics (or human factors) is the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the

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profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance. It is considered that the role of ergonomists is to contribute to the design and evaluation of tasks, jobs, products, environments and systems so that they are made compatible with the ways in which people access them, by using both theoretical research as well as practical tool implementations. Such a practical tool implementation that has wide-ranging applicability is that of the wearable computer.

With the decreasing size and increasing power of most of the components of a modern computer, it was only a matter of time until computers that could be worn on the body began appearing (Bass, 1996). The social implications of a given technology are not always clear during the technology's introduction and it takes even more time for scientists to start analyzing the effects said technology has on the world around (Pool, 1977). While still in its infancy, wearable computing is graining steady ground both in the private as well as corporate life. Although its advances are still slow, wearable computing has the potential to have one of the biggest efficiency improving impacts to date in society. Research is currently focused on using wearable computers to get this kind of technology in places where it previously wasn't available before, due to space or activity restrictions, such as for medical monitoring (Martin, Jovanov & Raskovic, 2000), or mechanical inspection (Sunkpho, Garrett, Smailagic & Siewiorek, 1998; Ockerman & Pritchett, 1998).

This paper proposes to analyze the benefits of wearable computers in warehouse scanning activities in which computers are already being used, but are one of the main sources of inefficiencies and ergonomic strain.

1.1. General aspects on wearable computers

A wearable computer implies a computer that can be worn or transported and on top of this, a wearable computer is a computer that is controlled by the user and has operational and interactional consistency (Mann, 1998). They should be designed in such a way that the user sees them as part of themselves. As such, in differentiating wearable technology from portable technology, three criteria can be proposed (Knight, 2002; Knight et al., 2006):

1. The device is attached to the body and does not require muscular effort to remain in contact with the body (i.e. you do not have to hold it);
2. The device remains attached to the body regardless of the body's orientation or activity (i.e. you do not have to take it off to perform a task specific action);
3. The device does not have to be detached to be interacted with (i.e. the first two criteria are not violated when the device is in use).

Given these criteria, one can separate between three different types of wearable computers that can assist with warehouse scanning operations, as following:

- Head mounted scanners (eyeglass-like);
- Arm mounted scanners (watch–like);
- Hand molded scanners (glove-like).

1.2. Warehouse scanning operations

1.2.1. Current environment (the use context)

Due to the ubiquitous use of barcoding for product identification, the current process of warehouse item scanning involves some type of handheld barcode scanner, which, as ca be seen in Figure 1 is composed of a scanner window, a trigger switch and a cable interface port. This can be held in a gun like manner, i.e. the scanner is held with the dominant hand, gripped between the index finger and thumb, with the index finger on the trigger switch and the middle ring and pinky finger around the base of the grip, between the trigger switch and the cable interface port. Given the fact that the human arm has a tremor even in a static position that influences accuracy in a negative, depending on the width and breadth of the scanner window the time it takes to find the accurate position for proper scanning is not optimal. The rapid and repetitive pressing of the trigger switch can also lead to loss of pressure sensitivity in the index finger.