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STEREOSCOPIC RECORD IN ERGONOMICS

1. Introduction

In recent years, efforts in health promotion programs have increased. Not with standing, work-related musculoskeletal disorders (wMSDs) remain a widespread and growing issue of concern in the manufacturing industry in European Union. In the future, wMSDs leading to absence and reduced employment ability along with an aging workforce with comparatively high wages will become an even greater challenge to these manufacturing companies facing worldwide competition [1].
The prevention of wMSDs is achieved through improvements in the design of working conditions and tasks as well as through influencing the health promoting behaviour of individuals. So far, many workplace health promotion and prevention programs focus on behaviour – oriented prevention such as fitness programs, control of alcohol and tobacco use and diet programs. In general, these programs, however, affect only certain risk – groups and yield only effects on individual behaviour. In addition, consequences and lasting success of these behavioural changes are seldom evaluated. Another option is using approximate evaluation methods such as RULA, REBA, etc. Their efficiency can be increased by using high quality recordings intended for analysis [3].
This article is summarizing the parts of the results for the research: „Creating of stereoscopic records in ergonomics". It was realized by the Department of Industrial Engineering, Mechanical Faculty, University of Žilina. Project partner is Department of Industrial Engineering, University of Bielsko-Biała. The research is devoted to a comprehensive analysis of the possibilities and potential of creating stereoscopic records in the industrial engineering discipline. This article describes one of the identified applications, which is ergonomics. The article describes specifically the process of evaluation of work by ergonomic analysis. Article briefly describes the process of stereoscopic records and approaches identified advantages and disadvantages of its application in industrial practice, which is evaluated in the end of the article.

2. Practical applications of stereoscopy in the ergonomics

The verification of the practical applicability of stereoscopy as a support tool in the development of ergonomic analysis was carried out in collaboration with Slovak Ergonomic Association (SES). Videos were created in areas of ZIMS (Zilina Intelligent Manufacturing System), which is a common workplace of Central European Institute of Technology (CEIT). It is established to support the creation of innovative solutions. A scenario of manual assembly of coupling fork was created for the purpose of experimental verification. The observed person after a short training period carried out the installation of the coupling fork. The assembly process was recorded using an own developed stereoscopic camera system (Figure 1).
From the generated stereoscopic video 12 ergonomic analyses have been processed [1]. The following methods were used for the analysis of physical activity in cyclical repetition of activities:

- RULA
- REBA
- STRAIN INDEX
- CTD RISK INDEX

Evaluation of parameters for the working process through ergonomic analyses were processed in order to confirm of refute the possible benefits of stereoscopic imaging in the process of ergonomic analysis. Display preview by stereoscopic screen is shown in figure (Figure 2).

2.1. Procedure for creating a stereoscopic recording

Creating of stereoscopic recording in industrial conditions should be conducted in the following four steps (Figure 3):

1. Choosing the appropriate position for the creation of stereoscopic recording.
   The selection of a suitable position for recording is the most important criterion in order to give a detailed analysis of the workplace. It is necessary to record complete work operation taking into account all the elements and movements of the operator. It is also necessary that the recording is carried out under the good light conditions

Figure 1. Stereoscopic camera system

Figure 2. Preview of stereoscopic record

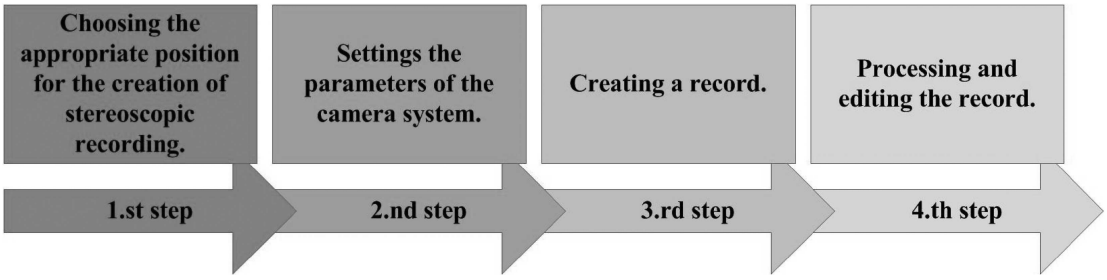

Figure 3. Procedure for creating a stereoscopic record

and all the movements are clearly visible in 3D (not blurred or out of focus).

2. Settings the parameters of the camera system.
   Setting options of developed camera system is described in detail in the research work. Some aspects of the procedures have been previously published [2, 5, 6]. In case of a commercially of this available camera system is necessary to follow the instructions for use.
3. Creating a record.
   The fact that there is at least one complete cycle of analysed operation is important when creating a record. If these cycles are recorded more times it is better to assess the compliance of the workflow.
4. Processing and editing of the record.
   The treatment process consists of the cutting of the recorded results. It is necessary to record the whole process, from the beginning to the end. In this step the stereoscopic video synchronization is also performed.

2.2. Disadvantages of stereoscopic applications in ergonomics

Creating of stereoscopic record requires, at first sight, a large time commitment. It is true, that the creation of stereoscopic video is more time consuming than creating a classic movie. However, the time differences are small. The average time duration of each step of stereoscopic record (Table 1) is determined based on the author´s experience of research.

The time needed for creating a 3D record compared to creating 2D record is 20% higher. However in the presented example it is only seven minutes. These seven minutes arises in two steps.

The first step, with a higher/longer time demand, is the parameter settings of a camera system that records in 2D. With the use of a help calculation file, this step takes an average of only two minutes. These two minutes are also the only extension of the time spent for recording work. Total time spent at work is a very important factor with regard to minimizing disruption of normal work activity operators.

The second step, with greater time-consumption, is processing and cutting the movie. In this step a video clip is processed and edited to ensure that the analysed operation was recorded in its entirety. In this step synchronization of the two images is performed. The first record is completely analysed and the time passages which record the project as a whole are selected. The second entry is already selected by only times edited. By using specialized software for processing of stereoscopic videos this time difference is even smaller.

Steps in the process of stereoscopic	The need of time for steps	
	Creating 2D record	Creating 3D record
Choosing the appropriate position for the camera	3 min	3 min
Setting the parameters of the camera system	0 min	2 min
Creating a record	15 min	15 min
Processing and editing record	15 min	20 min
∑	33 min	40 min
∑	100%	120%

Table 1. Comparison of classical labor content and stereoscopic video

2.3. Benefits of stereoscopic applications in ergonomics analysis

A slight increase in time consumption is offset by the creation of ergonomic analysis of the recorded work. Time compensation is generated by improving the ergonomic analysis of work in spatial vision analysed workplace. Direct spatial vision of the workplace allows an increase in productivity of work in the assessment of workplace ergonomic parameters in the following activities:

1. Analysis of potential risk activities and movements. When analyzing the work, the ergonomist doesn´t create an analysis on all movements and operations of operator in the workplace. That would in fact be very time consuming and inefficient. The ergonomist based on his knowledge and experience needs to identify quickly potentially risky activities and movements, which subsequently will be analysed in detail. Spatial vision of the operation eliminates the need for ergonomics and spatial imagination and allows him to quickly and efficiently identify potentially risky movements and activities.
2. Detailed analysis of selected activities and movements. After selecting potentially risky movements and activities, their detailed analysis is conducted. Detailed analysis of each activity requires information about the spatial orientation of the worker during the analysed situations. Spatial reproduction of the record of the activities of an appropriate support is a tool that provides ergonomics information necessary for fast and high – quality construction of the necessary analyses.

2.4. Evaluation

Practical design analysis support for stereoscopic video confirmed the potential of stereoscopic imaging as an advanced instrument for industrial engineer. The third dimension of the display device has brought a better orientation in the spatial arrangement of the workplace [3, 4, 7]. If the ergonomic analysis is created in support of classic movies the biggest requirement is the spatial imagination of the observer. Spatial reproduction movie establishes an observer semblance direct presence in the workplace and real observation of worker. It eliminates the need for spatial imagination of the observer, and creates a bigger scope for direct focus on specialist factual analysis of considered workplace. Stereoscopic video creates a support for improving ergonomics in following activities:

- creating a load analysis,
- creating a time and motion analysis,
- identification of ergonomic problems in the workplace,
- analysis of compliance workflow.

The need to reduce time required to analyse the current state can be regarded as a very frequent practice requirement. When analysing fast it is important to keep detail, precision and quality of the analysis of the current state. The need to improve the speed and precision are two requirements which should be simultaneously achieved when creating analyses. And 3D imaging device generates the necessary support for fast creation of analysis while promoting quality and precision.

3. Conclusion

In conclusion the surround recording and reproduction brings the necessary value added in the process of ergonomic analysis generated by the movie. Adding a third dimension to an observer compensates the greatest disadvantage of classic movies, which is poor spatial orientation.

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Key words:
ergonomics, stereoscope, productivity, RULA, REBA

Abstract:
The authors are describing the application of stereoscopic records in the industrial engineering discipline. The main focus is to identify the potential for stereoscopic recordings in the field of industrial engineering. Specifically, it focuses on the evaluation of process operator workload with the ergonomic analysis. In the first part of the article, the authors describe the basic process in making stereoscopic records. In the second part, the authors describe the results of the application of stereoscopic video in the evaluation of operator workload. Stereoscopic video was used as the main source of information in the preparation of analyses. The result of the survey was the description of the potential benefits of stereoscopic video in industrial ergonomics.

ZASTOSOWANIE ZAPISÓW STEREOSKOPOWYCH W ERGONOMII

Słowa kluczowe:
ergonomia, stereoskopia, produktywność, metoda RULA, REBA.

Streszczenie:
W pracy przedstawiono możliwości zastosowania zapisów stereoskopowych w zagadnieniach związanych z inżynierią produkcji. Głównym celem pracy było określenie potencjału stereoskopowych nagrań w ergonomicznym kształtowaniu procesów pracy. W szczególności przeprowadzono ocenę nakładu pracy na stanowisku, na podstawie przeprowadzonych nagrań i realizowanych analiz ergonomicznych. W pierwszej części artykułu opisano podstawowy proces tworzenia stereoskopowych zapisów procesu. W drugiej części autorzy opisali wyniki zastosowania stereoskopowego zapisu wideo w ocenie pracy na stanowisku. Określono stereoskopowe wideo jako jedno z głównych źródeł informacji w opracowywaniu analiz ergonomicznych. Przedstawiono potencjalne korzyści stereoskopowego wideo w ergonomii przemysłowej.

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