Review Article

Open Access
CrossMark

Bi-dimensional simulation tool of elementary motions on a sewing workstation

Abstract

In these times of rising costs, increasing competition, and falling sales prices in the garment industry, it is of particular importance that productivity is maximized. This research is focused on the design and development of a tool that can simulate elementary gestures and movements on a sewing workstation and calculate the expected time of each operation using the GSD method which is the adequate predetermined motion time system for the sewn products and apparel industries. The digital simulation of gestures and postures of the operator was possible by using bi-dimensional human digital model, but it is still relatively complex due to the variety and complexity of the human behavioral states.

Keywords: time, 2d simulation, gesture, sewing workstation

Volume 3 Issue 5 - 2017

Nahed Jaffel Memmi, Najeh Maâtoug, Faouzi Sakli

Textile engineering laboratory, University of Monastir, Tunisia,

Correspondence: Nahed Jaffel Memmi, Textile engineering laboratory, University of Monastir, Hadj Ali Soua Avenue, PO Box 68, Ksar Hellal 5070, Tunisia, Tel 216 2606 9428, Email jaffel.nahed@hotmail.com

Received: December 07, 2017 | **Published:** December 20, 2017

Abbreviations: GSD, general sewing data; DHM, digital humans model; O&M, organization & methods; GSD, general sewing data

Introduction

In a competitive industrial environment, time has become the key factor to success as it is a strategic variable in business management. Predetermined motion time system, particularly General Sewing Data (GSD) method allows us to analyze and plan every single operation in the sewing of a garment, whether it's a machine or a manual operation.

Developing adequate tools for time measurement in the industrial environment has become important especially in the textile industry as operating times vary tremendously depending on technological and human factors which are rather difficult to predict.

However, it's possible to create time measurement tools as well as various simulation programs, such as the digital humans model (DHM), which were designed to simulate and reproduce human behavior and gestures.

The goal of this work is to develop a computer tool dedicated to solve the time measurement problematic for human-operated textile workstations while taking into account the various constraints that directly affect the operations execution time. This program will also simulate the operation's course (succession of the elementary gestures involved).

In this paper we describe the process of designing this tool and the different steps preceding its programming. We start up with a feasibility study which is a crucial step in a project of this extent. The feasibility study includes an assessment of the current operations' mode and existing processes and a precise description of the human, material and organizational factors surrounding the pilot workstation. This analysis enabled us to determine the problems of the factory's Organization & Methods (O&M) department identify its needs and create the appropriate solutions. The main problems that we could identify were: the lack of a precise operation's time measurement and prediction tool and the absence of a complete and accurate gesture analysis technique. Therefore, to resolve these problems, we set the following goals according to the SMART Model:[1]

a. Improving operation time measurement.

b. Producing a precise analysis of each operation including its elementary gestures.

The outcome of the study was the definition of the functional specifications of a computer program designed to calculate the execution time of each operation, simulate and visualize its different steps respecting the chronological order predefined by the user.

Design and development of the Program

Primary design

The primary design includes choosing the program's architecture and its division into modules. In this step we translate the user requirements into a computer based solution. To do so, we followed the waterfall development model.[2]

According to the functional specifications, a web application is the best technology for our study case and the adopted architecture is client-server architecture. A computer program following the client-server architecture can be divided into three layers: the data layer, the data processing layer and the data presentation layer. According to this model, our program has three main modules (Figure 1): One for human-machine interfaces that handles data display and interaction with the user, another for Inputs and transformation that makes data usable by the application-level processing mechanisms and a third for the actual data processing that performs the actions requested by the user such as calculations and simulations.

Detailed design

In the detailed design phase we define the different interfaces and diagrams and we choose the programming languages to implement. The diagram of the main menu interface includes the following sections: Home, About, GSD Card, Operations elements and stitching parameters and recorded operations.

For programming the tool, we used XAMPP which is a cross-platform server package that contains APACHE web server, a PHP engine and a MySQL database server. This Web development platform allows our program's PHP scripts to run locally without connecting to an external server.

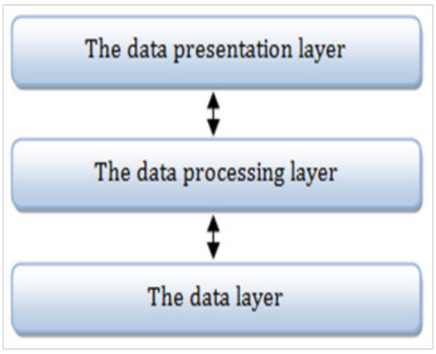

Figure 1 Different layers of a web application.

Programming operation's sam computation

SAM or Standard Allowed Minute is used to measure task or work content of a garment. For the estimation of cost of making a garment SAM value plays a very important role. According to the research study minute value has been defined for each movement needed to accomplish a job. Synthetic data is available for each movement. General Sewing Data (GSD) has defined set of codes for motion data for SAM calculation. General Sewing Data provides the ability to establish and quantify each step or operation in the manufacturing process. This method allows us to analyze and plan every single operation in the sewing of a garment, whether it's a machine or a manual operation. In our study we used the GSD codes to establish Standard Time of a garment.

At first we defined the operation to study: the assembling operation. Then we define all motions of that operation in one complete cycle of work. The next step was to refer GSD synthetic data for TMU (Time measuring unit) values. To obtain the Basic Time in minutes we had to convert TMU value for the assembling operation into minutes. The we calculate Standard allowed minutes as mentioned below:

(SAM) = (Basic minute + Bundle allowances + machine and personal allowances) (1)

Wit: Bundle allowances (10%), Machine and personal allowances (20%) Sabya et al.[3]

Digital modeling of the human-environmrnt system

Context

In our case, digital modeling involves the generation of a digital human model in a work environment to simulate the state of a seated worker assembling a garment in a sewing workstation. We used a bi-dimensional model to represent this operator. In our study, we chose to represent only five basic gestures of the GSD method and their different combinations that constitute the operation of assembling two fabrics, to finally choose the optimal solution.

Anatomical and physiological articular analysis of the human body

Since the operations are repetitive they can be represented by a sequence of points to reach. The target is to generate an automatic movement between different crossing points. The input data of each task are the initial posture of the model and the sequence of points to reach. Our human model is constituted of two blocks (Figure 2):[4]

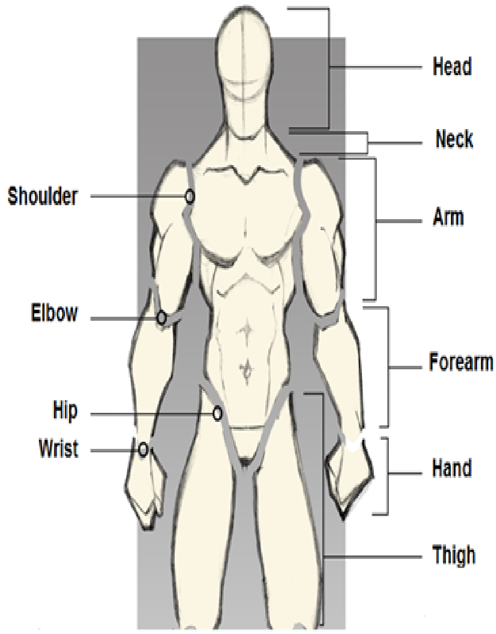

Figure 2 Body segments and joints of the human body.

Bust: consists of three segmental regions corresponding to three groups of vertebrae: lumbar spine, thoracic spine and cervical spine. We focus on the movements of the torso as a whole. As a unit the bust can perform three types of movements: flexion-extension, tilt or lateral bending, and axial rotation movements. The bust is modeled by three flexibility degrees.[5]

Hands: The hand articulations are: shoulders, elbows and wrists. To simplify the model, we neglected the intermediate articulations because we consider the hand as a single block. Accordingly, only the clavicle shoulder will be analyzed. The articular shoulder complex is composed of three bones (scapula, clavicle and humerus) and five joints Rockwood et al.[6] We will consider the clavicle bone group to highlight the link between the bust and shoulders. Thus, the clavicle is modeled by two flexibility degrees that generates two types of movements: the lifting and lowering movements, the anteposition-retroposition movements.

Creating the digital model in an industrial environment

The research starts with handmade sketches picturing an operator, sitting behind a sewing machine (Figure 3). Once our handmade bi-dimensional model was segmented and its appearance defined, we created a bi-dimensional digital model representing the worker, the fabric and the machine. For the general simulation of the bi-dimension digital human model in an industrial environment we followed the approach inspired by literature explained in the following chart Chitescu (Figure 4):[7]

A. We started the modeling process with a digital representation of the operator and the industrial environment separately (Figure 5). The bi-dimensional digital model consists of three segments; the first and the second segments are successively the right and the left hands, and the last segment is the entire torso and head.

B. Thereafter, once the two models were validated, we achieved the digital modeling of the Human-Environment system. Based on this model and the last input of the movement simulation parameters, we performed a series of digital simulation for the basic gestural movements of the GSD method for each of the five movements that constitute the assembling operation which are: take pieces, bring parts under the presser foot, align or adjust the two pieces, sewing operation and evacuating the assembled piece with one hand.

C. This step was followed by a performance assessment for each elementary movement. Once the performance validated, we have conducted the digital simulation of the gestural activities for different combinations of the elementary movements after which we made an overall performance evaluation, to finally choose the optimal solution (Figure 6).

Figure 3 Manual sketch of the sewing workstation and the digital human model.

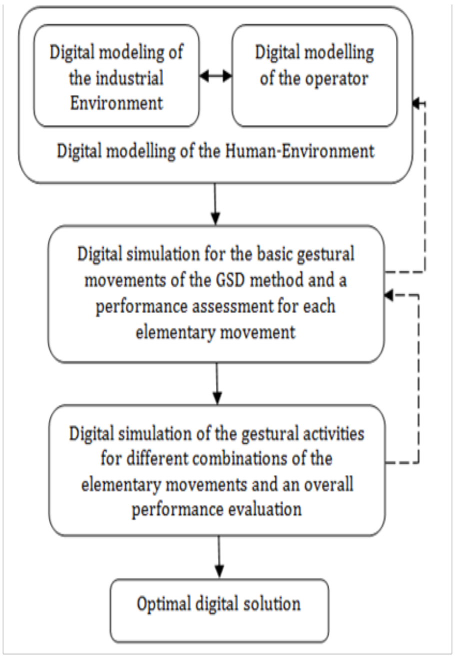

Figure 4 General approach for the digital human model design in its environment.

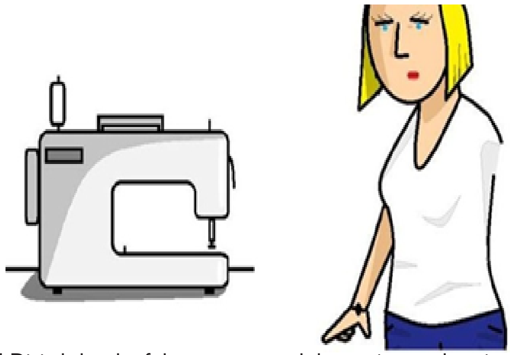

Figure 5 Digital sketch of the operator and the sewing workstation designed with the simulation software

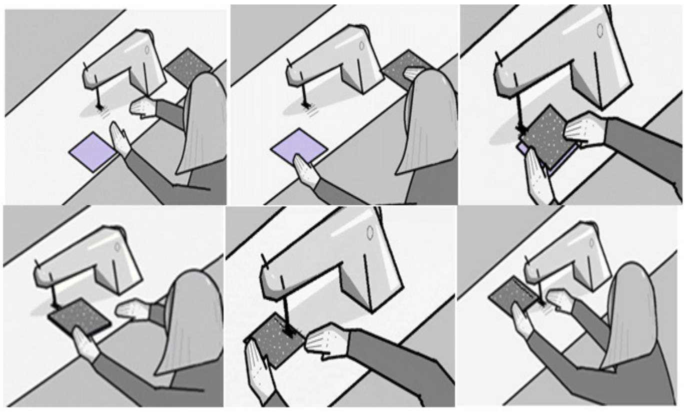

Figure 6 Screenshots of the animated gestural sequence modeling.

Conclusion

The result of this study is a web application with a user-friendly interface that allows us to calculate each operation's time, including the technologic and the human times. The tool allows us to visualize this operation in a 2D simulation. This work does not provide a complete solution to the problems and difficulties encountered, but we tried to develop a pilot application that will be subject to further improvements and studies.

The web application developed in this study allows the simulation of the five basic movements of stitching and their various combinations that constitute the assembling operation and the choice of the optimal solution. To achieve better results, the digital model should be perfected to reach a higher level of accuracy by reproducing all possible movements on a sewing workstation, a more realistic definition of gestures' pace and a realistic representation of fabric's behavior.

Acknowledgements

None.

Conflict of interest

Author declares there is no conflict of interest in publishing the article.

References

1. Mannion M, Keepence B. Smart Requirements. *ACM SIGSOFT Software Engineering Notes*. 1995;20(2):42–47.

Citation: Memmi NJ, Maâtoug N, Sakli F. Bi-dimensional simulation tool of elementary motions on a sewing workstation. *J Textile Eng Fashion Technol.* 2017;3(5):713–716. DOI: 10.15406/jteft.2017.03.00111

2. Munassar NMA Govardhan A. A Comparison between Five Models Of Software Engineering. *International J Computer Science Issues*. 2010;7(5):1694–0814.
3. Sabya SR, Subodh KG, Ripon C. Application of Industrial Engineering in Garments Sewing Floor, Daffodil International University, Bangladesh; 2012. p. 1–80.
4. Manolova A, Debraux P. *Description anatomique du movement*. 2012.
5. Vachon-Gee A. *Exploratory study of the control of unic*. Gradual isometric forces, Canada; 2012.
6. Rockwood CA, Matsen FA, Wirth MA, et al. *The Shoulder*. Philadelphia: Saunders Elsevier; 2009. p. 1704.
7. Chitescu LC. Simulation en ergonomie. Innovation factors in product design, Lorrain. 2005;1:174–193.