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MODELING COMPLEX STUMP-PROSTHESIS WITH GRAPHICAL USER INTERFACE

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Abstract: The Graphical User Interface applied in biomechanical processes modeling can be found at the interface of two fields: biology and mathematics. The stump-prosthesis is the interface between the human and technology. Discomfort at the level of the prosthetic sockets continues to be a critical challenge for both prosthesis designers and amputees. The quality and comfort of the prosthetic socket determines the daily usage time of artificial limbs. Graphical user interface analysis of the complex prosthetic socket system will likely continue in the future. In this article, we propose a solution for modelling the stump-prosthesis system, which may improve the design of the prosthesis socket, resulting in a better quality of life for the patients. The first objective of this study was to design a graphical user interface (GUI) of the stump-prosthesis system, using MATLAB. Interface was entirely developed using MATLAB 7.3.0 .The proposed (GUI) contains all the screen menus, symbols, work areas and application windows, as well as graphic devices used in the interaction with a computer, icons, buttons and dialogue boxes. The user interface was designed to allow an intuitive interactive display. Finally, the data is exported to COSMOS Works suite for the actual design of the prosthesis. The objective of this paper is, to discuss the limitations of (GUI) investigations, and to speculate on work made possible through advances in domain of stump-prosthesis and computer software. These results are important and can provide a direction for future research.

Keywords: Stump, Prosthesis, Matlab, Graphical User Interface, Statistics.

1. INTRODUCTION

Biomechanics of the assembly and of the biphasic interaction between bone-muscle and stump-prosthesis is a medical field where research by modeling and numerical simulation provides a solution for capturing and investigating issues with high intra- and inter-individual variability. Comfort is one of the most important criteria used to evaluate the quality of a complex stump-prosthetic (see Jia et all, 2004). Graphical user interface analysis has been the computer modeling method used to analyze of complex stump-prosthesis (see Reynolds & Lord, 1992). Stump- prosthetics complex have seen progress based on advances in biomechanics, and applied mathematics (see Hall, 1985). However, discomfort and residuum pain are common among individuals with amputations (see Chan & Tan,

1990). The interface system with Matlab had proved can effectively simplify the complex shape modification process of the socket model (see. Nedoma &. Stehlik,2011) . A Matlab subroutine was written for the processing and analysis of complex stump-prosthesis, which performed the following series of operations (see Dickinson *et all,* 2016).

In last years, several imaging methods have been used in modelling of stump-prosthesis thought the use of video cameras with optical sources (see Fernie *et all,*1985) . The recent development of graphical interface for complex stump-prosthesis the increased interest in biomechanical modeling are requiring accurate tools in a evaluation of reconstruction surgery (see Pearsall &., Costigan,1999) .

2. MATERIALS AND METHODS

The aims of this work are:

- The creation of a Graphical User Interface
- The creation of user-friendly interface that allows the visualization of the gait model with the possibility to export them;
- To provide, finally, a useful device for directly performing Gait Analysis on the collected data.

The first step is the opening of the main GUI's interface, clicking on file named GUI_project .
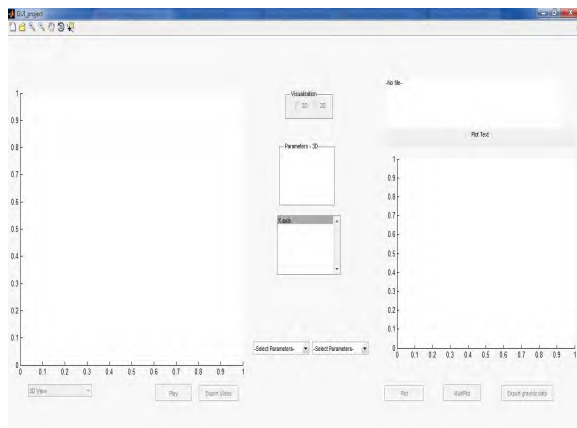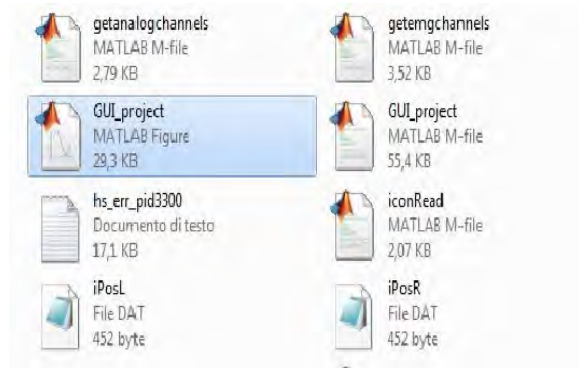

Fig.1 Main GUI's interface

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Fig.2. File GUI_project

This operation will open the main page of the user interface. The user has to click on "New file" and then answer "yes" in the question dialog box that will be opened. The "Reset" button is pressed to re-enter parameter values and the "Analysis" button is pressed to display the graph. To exit the program, the "Close" button is pressed
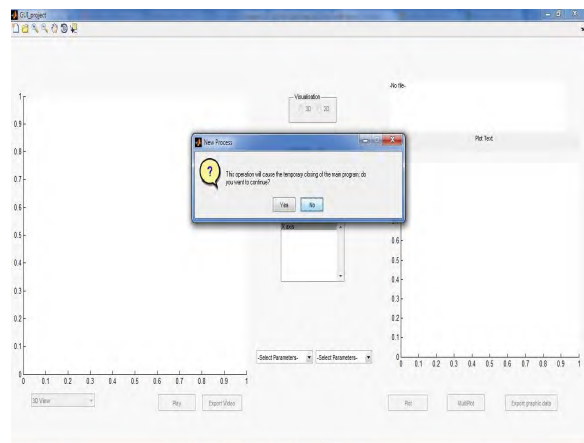

Fig.3. Dialog box imagine

3. RESULTS

For simulation we use three types of materials: muscle tissue (for stump definition), bone (for femur defining properties) and titanium alloy (for prosthesis properties). Figure 3 shows the section containing personal data of the patient, specifying the amputation location. Please note that we did not mention the session of user's logging, identification and rights (of viewing or transmitting data), which is a classical interface, present in all biomedical computer applications. Strength varies substantially over a full cycle of motion (walking, 2 steps or climbing a stair). Highlighting the development of this force in the Z direction is shown in figure 5 (*Gait Cycle*). Successive records under the same conditions show that sometimes movement patterns can vary

widely. As such, it requires a statistical calculation to estimate forces and moments. This statistic is accessed by the Statistics button, which opens a new module of parameters of interest, average and upper and lower extreme limits, calculated using the mean square error SD - *Standard Deviation* (see figure 8). For the movement cycle shown in figure 10, there is a rather important variation thereof, represented by the yellow curve for the second part of the signal, or the light green curve for the firSt part of the signal. One solution would be to make an envelope for maximum values in figure 9 and a lower envelope for the minimum values of the graphs in figure 10. The solution is not appropriate in this case, as the upper limit of the envelope leads to a representation of the force in the movement cycle at values and allure of a completely unrealistic curve.
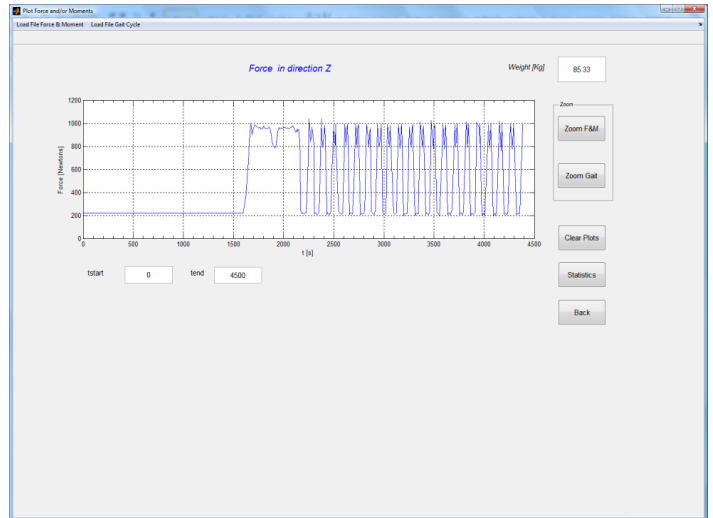
Fig. 6. Graphical representation of the resultant force in the Z direction .
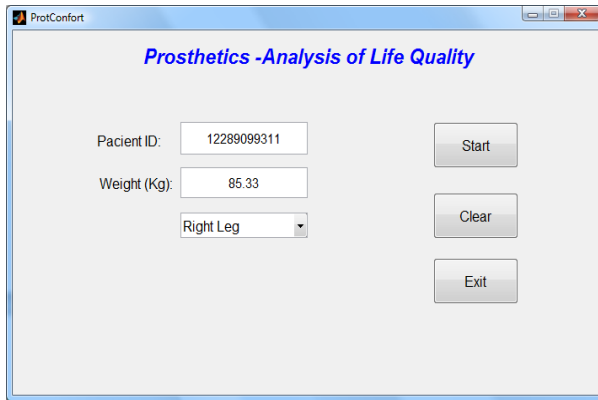
Fig.4. Personal data module (MP) .
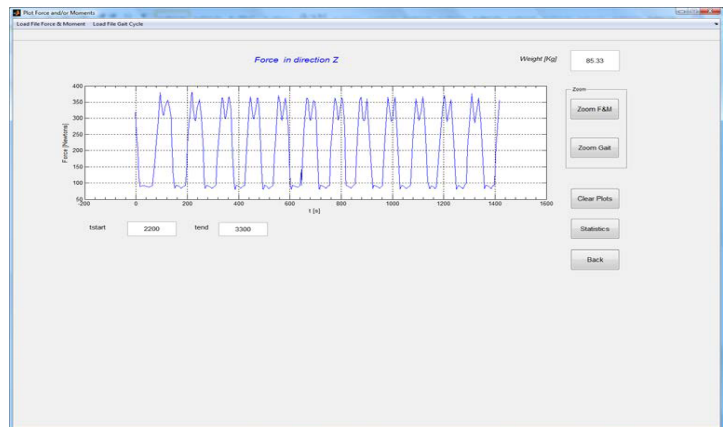
Fig. 7. Graphical representation of the resultant force in the Z direction (in the figure, time is moved by 2100 ms, restarted from 0).
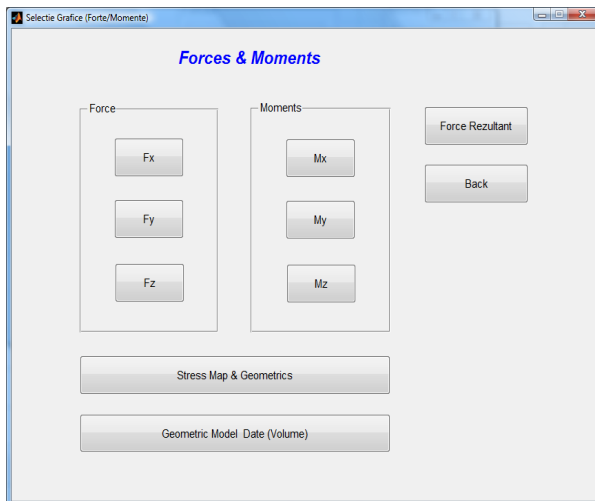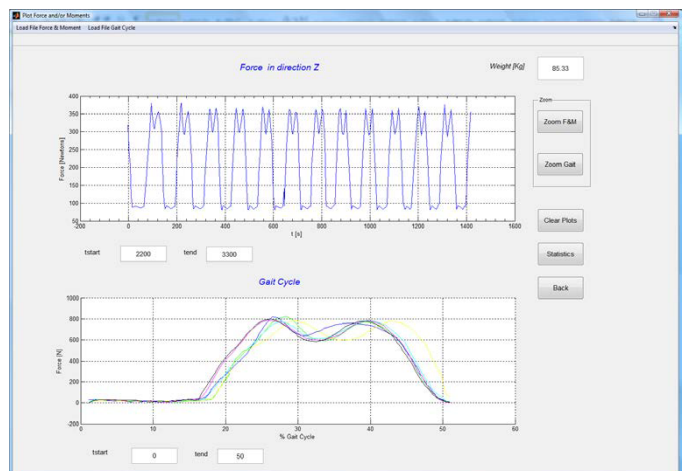

Fig.5. Module of forces and moment .

Fig.5. Force in the Z direction (in the figure, time is moved by 2100 ms, restarted from 0) and movement cycle .
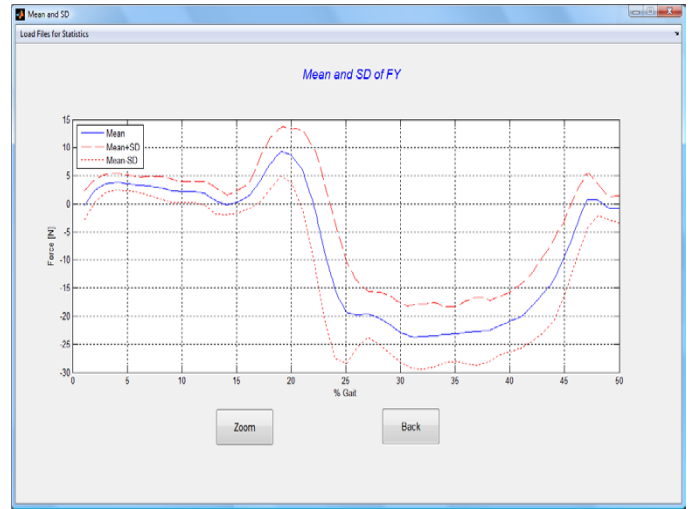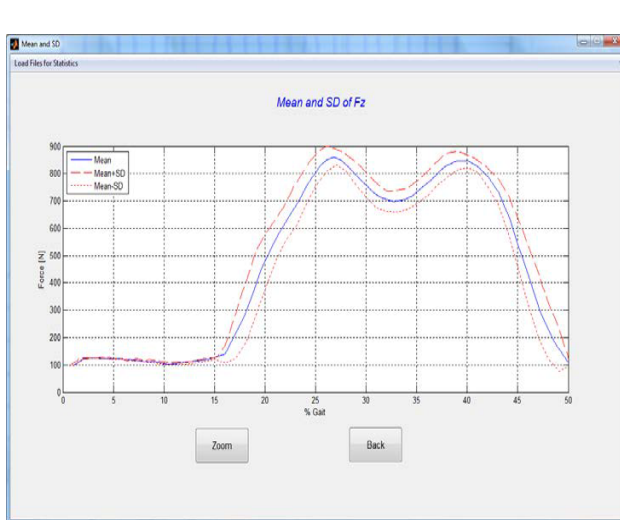
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Fig.8. Statistics for the movement cycle corresponding to data in figure 4.
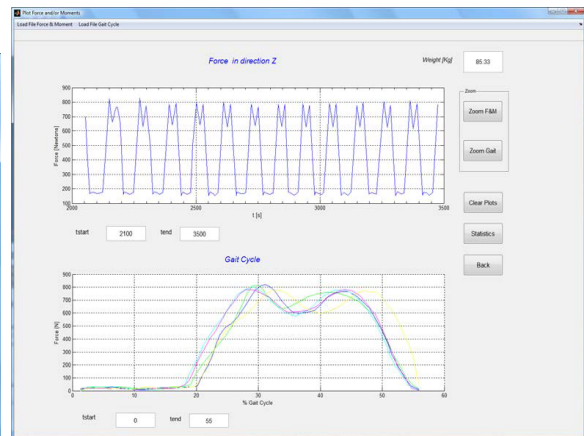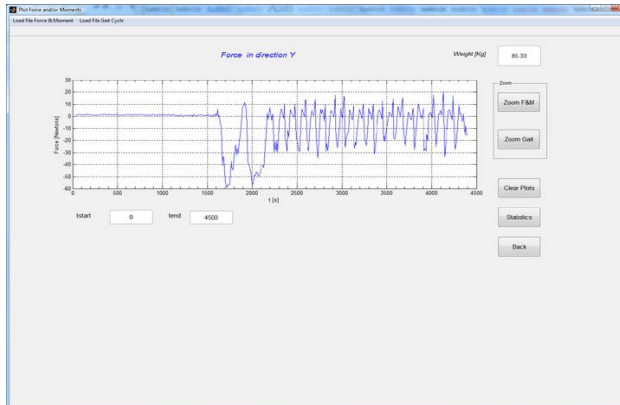

Fig.9. Graphical representation of the resultant force in the Y direction.

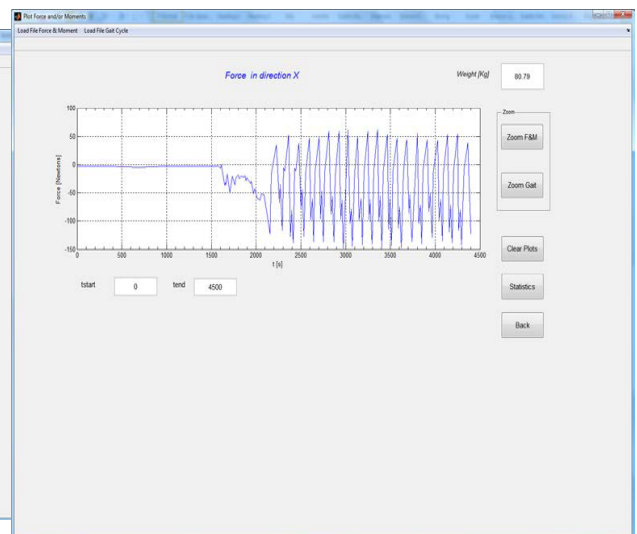Fig. 10. Force in the Y direction and related movement cycle .

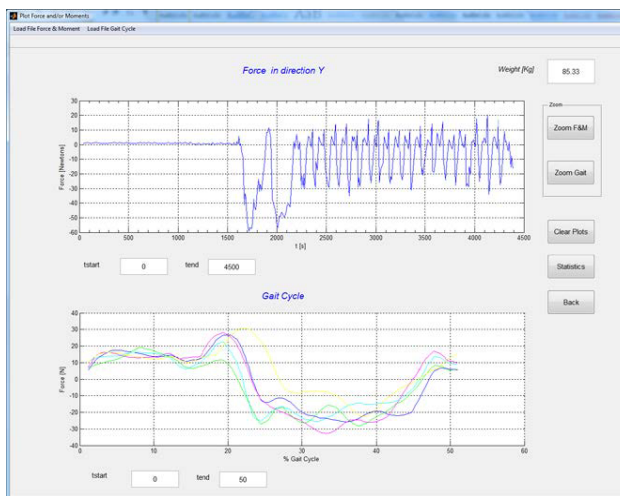Fig. 11. Statistics for the movement cycle in figure 8.

Fig.12. Force graphically represented in the Z direction and zoomed movement cycle .

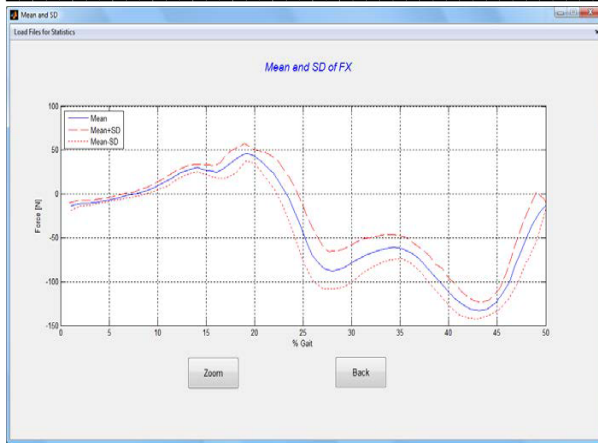Fig.13. Graphical representation of the resultant force in the X direction .

Fig.14. Statistics for the movement cycle corresponding to the values in figure 11.
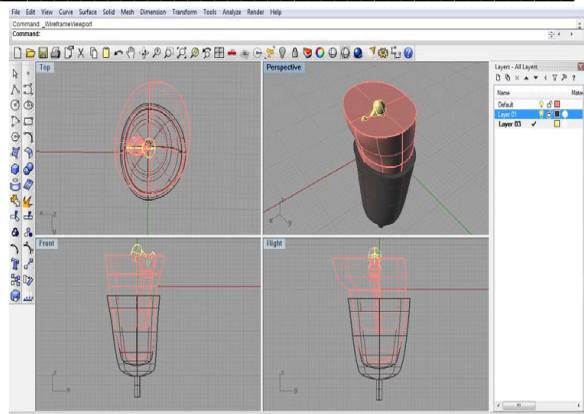

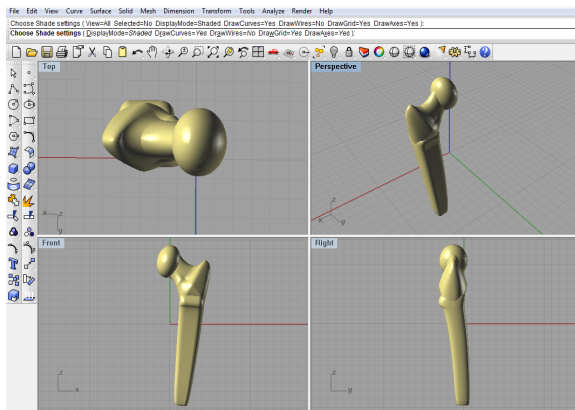Fig.17. 3D modeling of the femur - stump- prosthesis ensemble.
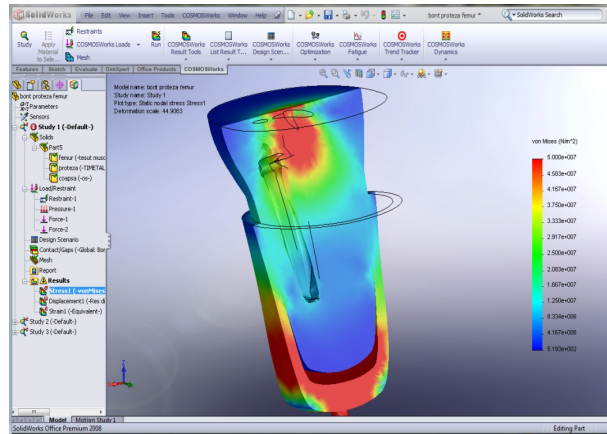

Fig. 15. 3D modeling of the femur.

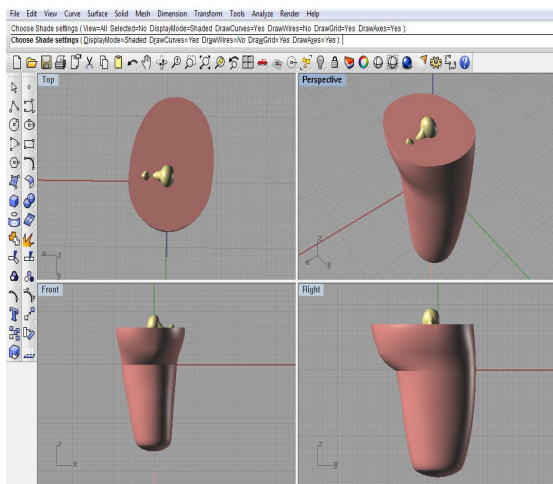
Fig. 18. Section at the stump-prosthesis ensemble.

Fig. 16. 3D modeling of the stump. The stump modeling involves the integration of muscle tissue with bone tissue (femur) .
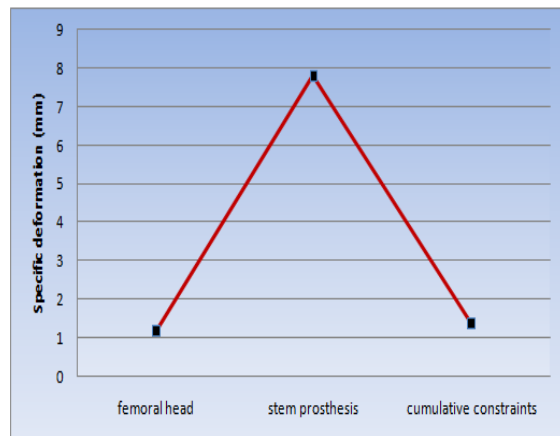

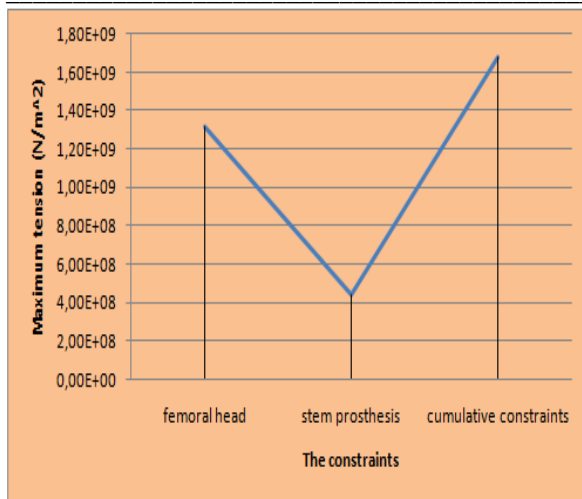Fig 19. The specific deformation depending on the applied pressure

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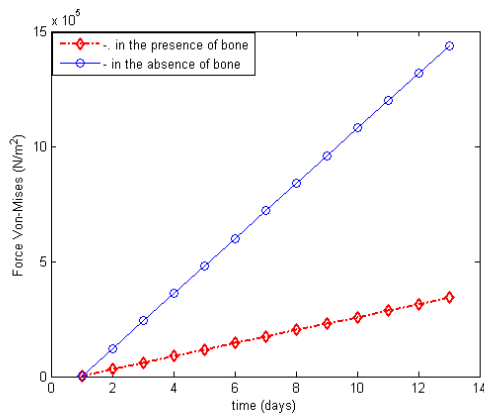Fig 20. The maximum tension depending on the constraints level

Fig 21. Comparative analysis of the presence of bone tissues in the stump-prosthesis system

4. CONCLUSIONS

This paper introduces applications of a computational software package for a stump-prosthesis system .The main objective of this article is to introduce people to the study of the stump-prosthesis system from a user interface. This article is aimed at developing a Graphical User Interface (GUI) for Gait Analysis, using the Matlab 7.3.0. for complex stump-prosthesis. Interface created in this article is aimed at physiotherapist's experts to be used on clinical data and laboratory tests for evaluation. The objective is, to discuss the limitations of graphical user interface investigations, in domain of stump-prosthesis and computer software. Work is developing the different sections and features of the user interface. Evaluation the qualitative and quantitative test results will be reported in the future. To provide a better user interface device, the future developers could work on

is the introduction of the Kinematical consistency for the treated models and the user interface should allow the introduction of the Anthropometric measurements.

5. REFERENCES

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