**Development of an Electronic System for Static and Dynamic Analysis of Plantar Pressure**

I.A. Morales Ledezma1

1 Universidad del Valle/Bioingeniería, Ingeniería Biomédica, Cochabamba, Bolivia

Abstract The main goal of this project is to develop an electronic system for dynamic and static analysis of plantar pressures for the biomechanics study of gait cycles and from feet in normal or pathologic parameters.

In order to reach the objective, the methodology implies in the analysis of the known technics used in the clinic area. Secondly, in the hardware modelling that considers the design of an electronic template to transduce the physics force into electric energy and an electronic circuit for digitalization of the electric signal of the template. Finally, in the software modelling for a friendly visualization of data.

As a result, two templates are built with 24 key points that allows the user to visualize the footprint of the plantar pressure in concordance to the clinical standards. The static model captures a picture that contains nine pressure thresholds of the footprint (e.g. 6,78 kgf/cm2 for internal heel area of a woman of 23 years old). The dynamic model shows 80 footprint pictures in a period of 5 seconds (16 frames per second).

The search of a simple technic that facilitates the quantitative study of the plantar footprint makes it necessary the development of this electronic system for baropodometry. The developed system then is enough to observe three complete gait cycles and the changes in time of the pressure of the feet's sole. Moreover, it counts with a support database that allows the user to recover the patient’s information and the test’s results that have taken place with the system for its tracking.

Keywords— Baropodometry, plantar pressure, gait cycle, biomechanics, force.

*Resúmen* **El objetivo de este trabajo es desarrollar un sistema electrónico de análisis dinámico y estático de las presiones en la planta del pie para el estudio biomecánico de la marcha y el pie en parámetros normales o patológicos.**

**Para alcanzar el objetivo la metodología implica en el análisis de las técnicas utilizadas en el medio clínico; en el modelaje del hardware considerando el diseño de plantillas electrónicas que transducen la fuerza física en energía eléctrica y un circuito electrónico para la digitalización de la señal eléctrica de dicha plantilla; y el modelaje del software para la visualización amigable de los datos.**

**Como resultado, se obtienen dos plantillas con 24 puntos clave para cada pie que permiten al usuario la visualización de la imagen de la huella plantar en consonancia a los estándares clínicos. El modelo estático, captura una imagen que contiene los 9 umbrales de presión de la planta del pie (ej. 6,78 kgf/cm2 para área interna del talón de una paciente de 23 años). El modelo dinámico, muestra 80 imágenes plantares en un periodo de 5 segundos (16 cuadros por segundo).**

**La búsqueda de un técnica sencilla que facilite el estudio cuantitativo de la huella plantar hace necesario el desarrollo de estos sistemas electrónicos para baropodometría. El sistema desarrollado es suficiente para observar tres ciclos de marcha completos y los cambios en el tiempo de presión en las plantas de los pies. Además, cuenta con una base de datos de apoyo para recuperar la información del paciente, usuario y los resultados de los exámenes que se realicen en el sistema para su seguimiento.**

Palabras clave – Baropodometría, presión plantar, ciclo de marcha, biomecánica, fuerza

INTRODUCTION

These are the instructions for preparing papers for the IFMBE Proceedings Series. English is the official language. Please, do not forget to prove the spelling with your spell checker. Set the language to English (U.S.). Read the instructions in this sample paper carefully before typing.

The papers should be submitted in their final form. The publisher will perform no further adjustments. In the Proceedings the papers will be reproduced directly from the files submitted by the authors. The authors must upload their paper in MS Word and Pdf format through the conference management system.

Detailed instructions for preparing the papers are listed in chapter II. Writing the paper. When you write the paper, you can either follow the descriptive rules presented in subchapter A. Descriptive rules, or install the macros prepared by the publisher, as described in subchapter B. Using macros.

Writing the paper

Descriptive rules

Paper Size: Select the custom size of paper, i.e. 21 x 27.9 cm in Page Setup in your Word Processor. Only this paper size can be accepted.

Length: The maximum document size for regular and Young Investigator Competition papers is four pages. Abstracts only will not be published.

Margins: The page layout should be "mirror margins". Leave 2.5 cm margin at the top, 4 cm at the bottom, 1.9 cm on the inside and 1.4 cm at the outside side of the page.

Page Layout: Type the paper in two columns 85,5 mm wide with a space of 6 mm between the columns. Each column should be left and right justified.

Fonts: Use Roman typeface (e.g. Times, Times New Roman) and single line spacing throughout the paper.

Title: The title should be no longer than two lines. Avoid unusual abbreviations. Center the title (14 point bold). Authors’ names and affiliations (Institution/Department, City, Country) shall span the entire page. Leave one blank line (8 point) after the title, one blank line (10 point) after the authors’ names and affiliations. Leave one blank line (20 point) between author’s info and the beginning of the paper.

Abstract: Provide an abstract of the paper (9 point bold) no longer than 300 words.

Style: Use separate sections for introduction, materials and methods, results, discussion, conclusions, acknowledgments (when appropriate), and references.

Headings: Enumerate Chapter Headings by Roman numbers (I., II., etc.). For Chapter Headings use ALLCAPS. First letter of Chapter Heading is font size 12, regular and other letters are font 8 regular style. Leave one blank line (20 point) before and one blank line (10 point) after each Chapter Heading. Subchapter Headings are font 10, italic. Enumerate Subchapter Headings by capital letters (A., B., etc.). Leave one blank line (15 point) before and one blank line (7,5 point) after each Subchapter Heading.

Body Text: Use Roman typeface (10 point regular) throughout. Only if you want to emphasize special parts of the text use Italics. Start a new paragraph by indenting it from the left margin by 4 mm (and not by inserting a blank line). Font sizes and styles to be used in the paper are summarized in Table 1.

Tables: Insert tables where appropriate (as close as possible to where they are mentioned in the text). Prefer positioning them at the top or at the bottom of the column. If necessary, span them over both columns. Enumerate them consecutively using Arabic numbers and provide a caption for each table (e.g. Table 1, Table 2,..). Use font 10 regular for Table caption, 1st letter, and font 8 regular for the rest of table caption and table legend. Place table captions and table legend above the table. Leave one blank line before (15 point) and one after (5 point) the captions. Please keep in mind the distinction between tables and figures: tables only contain alphanumerical characters and no graphical elements.

Table 1 Font sizes and styles

|  |  |  |
| --- | --- | --- |
| Item | Font Size | Font Style |
| Title | 14 | Bold |
| Author | 12 | Regular |
| Authors’ info | 9 | Regular |
| Abstract | 9 | Bold |
| Keywords | 9 | Bold |
| Body text | 10 | Regular |
| Chapter heading, 1st letter | 12 | Regular |
| Chapter heading, other letters | 8 | Regular |
| Subchapter heading | 10 | Italic |
| Table caption, 1st letter | 10 | Regular |
| Table legend | 8 | Regular |
| Column titles | 8 | Regular |
| Table data | 8 | Regular |
| Figure caption, 1st letter | 10 | Regular |
| Figure legend | 8 | Regular |
| Acknowledgment | 8 | Regular |
| References | 8 | Regular |
| Author’s address | 8 | Regular |

Figures: Insert figures where appropriate (as close as possible to where they are mentioned in the text). Prefer positioning them at the top or at the bottom of the column. If necessary, span them over both columns. Enumerate them consecutively using Arabic numbers and provide a caption for each figure (e.g. Fig. 1, Fig. 2,..). Use font 10 regular for Figure caption, 1st letter, and font 8 regular for the rest of figure caption and figure legend. Place figure legend beneath figures. Leave one blank line before (5 point) and one after (15 point) the captions. Please keep in mind the distinction between tables and figures: tables only contain alphanumerical characters and no graphical elements. Do not use characters smaller than 8 points within figures. Figures are going to be reproduced in color in the electronic versions of the Proceedings, but when choosing graph colors, keep in mind that they might be printed in black and white color. Figure 1 is intended to illustrate the positioning of a figure and shows the logo of the IFMBE.

Equations: For inserting equations, use the Equation Editor. Enumerate the equations using Arabic numbers in brackets on the right hand side of the equation.

Itemizing: In case you need to itemize parts of your text, use either bullets or numbers, as shown below:

First item

Second item

Numbered first item

Numbered second item

References: Use Arabic numbers in square brackets to number references in such order as they appear in the text . List them in numerical order as presented under the heading ‘REFERENCES’ at the end of this Instructions.

Using macros

### a) Word2003:

Macro security: Change in MSWord the basic setting “macro security” as described:

Menu bar: “Tools → Macro → Security   
→ Middle or Medium“

### b) Word2007:

Macro security: Change in MSWord the basic setting “macro security” as described:

Menu bar: “Trust Center →Macro Settings→ Security   
→Warnings for all macros “

Activating the “Developer tab” in order to display the macro buttons.

Click the Microsoft Office Button and then click “Word Options”. Click “Popular”, and then select the “Show Developer tab” in the Ribbon check box.

Now the macro buttons can be found at “Add-Ins” in the menu.

### c) Word2003 and Word2007:

Restart MS Word again. A message will appear on the screen stating that the file you are using contains Macros. Click at “Enable Macros”.

File deposition: Copy the file IFMBE\_Proceedings\_  
Template\_2.dot into the same folder in which your   
word-templates are usually located (e.g. the template   
“normal.dot”).

Writing the article: When you start working with the template you have (amongst others) the following two options:

Highlight the file IFMBE Proceedings\_Template\_2.dot in the Explorer and choose in the menu “File → New”.

Open a new or an existing word-document and select in menu Tools the item “Templates and Add-Ins”. Click   
in the Window on “Connect”, choose IFMBE\_  
Proceedings\_Template\_2.dot, set a check on “Update Templates Automatically” and click OK.

Page setup: The page setup in this template is set to custom size of paper, i.e. 21 x 27.9 cm. The margins should be preset to “mirror margins”. In case the margins are not preset as “mirror margins”, use the macro [margins] and choose the option [mirror margins] on the menu bar.

Document structure: The first part contains a column with the paper title, the author(s) names, initials and authors’ affiliation information. The title should be no longer than two lines. Avoid unusual abbreviations. Authors’ names and affiliations (Institution/Depart­ment, City, Country) shall span the entire page. The second part includes two columns and starts with Abstract and Keywords. For formatting any of these items, you may use macros from the menu bar [article head]. Click on the [article head] button and choose the appropriate format from the falling menu.

Heading styles: Templates for paragraphs are defined with attributes of paragraphs (justification, distances in front and after a paragraph etc.) and font. If you use the Heading1 [H1] macro from the menu bar for formatting the headings of the paragraphs - the first letter will be written in capital letters and formatted two points larger than the other letters in the heading. Please write the text and then click button [H1] on the menu bar once again. If second level heading - Heading2 [H2] immediately follows Heading1 use macro [heading2\_heading1] from the menu bar to format the heading. This macro prevents double distances between Heading1 and Heading2.

Macros for characters: With macros [characters template] you can format individual characters or words within a paragraph in font style: bold, italic, symbol, initial etc.

Table 2  Table caption

|  |  |  |
| --- | --- | --- |
| Table legend |  |  |
| Table data |  |  |

Importing Tables: This template enables you to format tables within one column. In order to insert a table please use the macro [table] from the menu bar and click on [create table complete].

You will be asked for the number of rows and columns in your table. Please enter the number of rows and columns into the Input box. The table will be inserted in the document and completely formatted.

The first letters in the caption of Table and Figure will be formatted two points larger as described for Heading1. You have to use the macro [initial\_10] from the menu offered by clicking on the button [characters template] menu.

To align the table to the column width, click the button [table] on the menu bar, and then choose [table column width] from the offered menu.

Importing figures: In order to insert a figure, click the button [figure] on the menu bar, and then choose [insert figure complete] from the offered menu. Select in the window the figure you want to import and click on “insert”.

The figure caption is formatted with the macros and the [figlegend] and [counter figure] from the menu bar.

Equation: Write the equation in equation editor.Equations are formatted with the macro [equation].

A + B = C (1)

In order to insert the equation number click the button [equation] on the menu bar and then choose [counter equation] from the offered menu. Separate the equation and the equation number by using the right tab on the keyboard. In order to achieve the requested spacing between the paragraphs and the equation click the button [equation] on the menu bar and then choose [template equation] .

 (2)



Fig. 1 IFMBE logo

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itemize

Macro: [item–itemize]

1. enumerate
2. Macro: [item–enumerate]

To continue numbering:

Macro: [item–enumerate (cont)].

Acknowledgment:For formatting the headlines without numbering (e.g. Acknowledgment and References) use the style “heading1\_withoutNr“ from the style drop menu.

References: For automatically numbering of your references use the style: [reference\_Item] from the menu bar. The Internet addresses should be formatted with [reference\_available].

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CONCLUSIONS

Send your papers only in electronic form. Papers must be uploaded before the deadline. After a paper is accepted for oral or poster presentation, one of the authors must complete a registration form and pay the appropriate fees before the paper can be published in the Proceedings. Please pay attention to the registration deadline.

To view the prescribed text boundaries of the paper use macro [view] on the menu bar and then choose [recommended view]. In order to reset this option choose option [undo recommended] from the menu bar [view].

ACKNOWLEDGMENT

Format the Acknowledgment and References headlines without numbering.

Conflict of Interest

Every paper must contain a declaration of conflicts of interest. If there are no such conflicts write “The authors declare that they have no conflict of interest”.

REFERENCES

The list of References should only include papers that are cited in the text and that have been published or accepted for publication. Citations in the text should be identified by numbers in square brackets and the list of references at the end of the paper should be numbered according to the order of appearance in the text. Examples of citations for Journal articles [1], books [2], the Digital Object Identifier (DOI) of the cited literature (which should be added at the end of the reference in question if available) [3], Proceedings papers [4] and electronic publications [5].

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1. Smith J, Jones M Jr, Houghton L et al. (1999) Future of health insurance. N Engl J Med 965:325–329dot_trans
2. South J, Blass B (2001) The future of modern genomics. Blackwell, London
3. Smith J, Jones M Jr, Houghton L et al (1999) Future of health insurance. N Engl J Med 965:325–329 DOI 10.10007/s002149800025dot_trans
4. Lock I, Jerov M, Scovith S (2003) Future of modeling and simulation, IFMBE Proc. vol. 4, World Congress on Med. Phys. & Biomed. Eng., Sydney, Australia, 2003, pp 789–792
5. IFMBE at <http://www.ifmbe.org>

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