Template for LaTeX-Produced IFToMM Papers for Conference Proceedings

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Abstract—*The Abstract must be a self-contained, comprehensive, concise summary of the paper, limited to 150 words and to one single paragraph. The paper should be interesting to the audience targeted by the conference organization, as spelled out in the conference scope; moreover, the paper should be comprehensive and concise, written in good English. Authors are free to choose either American or British English, but should not use a mixture of both. The format described herein applies to all IFToMM-sponsored or IFToMM-organized conferences that publish CD or printed proceedings. IFToMM conferences that publish their papers in book form need not follow this format, as the book publisher specifies the format.* **Authors are kindly requested to refrain from using footnotes, figures and references in the Abstract!**

Keywords: clear, concise, interesting, original, pertinent paper

I. Introduction

Always start your paper with an Introduction, giving the background and the motivation for the work reported therein. This section should also include the literature survey and an outline of what the reader will find in the paper. Below we include the **Manuscript Guidelines**:

- **font**: desirable font is 10-point Times New Roman.
- **spacing**: single spacing must be used.
- **pages**: maximum length is ten pages.
- **layout**: If the author writes his paper in this file, with the accompanying iftomm.cls file, the proper layout will be produced. If the author is of the adventurous type, the paper layout is indicated in Fig. 1 and the accompanying text. However, we discourage this approach.

```
\topmargin       0mm
\oddsidemargin   -4.7mm
\evensidemargin  -4.7mm
\textheight      23cm
\textwidth       17.5cm
\columnsep       9mm
\parindent       1.0em
\headsep         8mm
\headheight      0pt
\footskip        10mm
\lineskip        1pt
```

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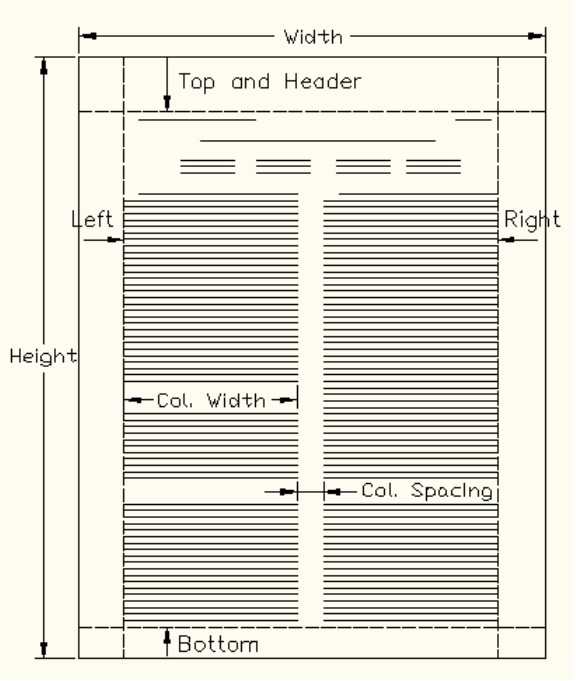

Fig. 1. Layout of an IFToMM Paper.

```
\normallineskip 1pt
\def\baselinestretch{1}
```

- **Page header**: to be typed at the top of each page, with 8-pt fonts. Flush to the left, type Name of the Conference, City, Country, Month "from"-day–"to"-day, year.
- **Title, author(s), affiliation**: title is centered and typed using boldface 14-point fonts, with initial capitals as in the title of this document. Leaving one line empty, list each author and her/his affiliation using one column per author; E-mail addresses will be included as footnotes automatically by the `IFToMM.cls` file accompanying this document.
- **abstract**: as described above, followed by a maximum of six and a minimum of three keywords in boldface font and alphabetical order.
- **main text**: double column.
- **headings**: major in boldface fonts, roman numbering; sub-headings in italic fonts, letter numbering; sub-sub-headings: italic fonts numbered using the sub-heading letter followed by a number.
- **references**: list all bibliographical references at the end of the paper using the "number" reference citation format.

Important: Reference numbers must follow the order of citation, with first reference being [1], followed by [2], then [3], etc. **Do not list references at the end of the paper in alphabetical order, but rather in the order of citation!**

• **Figures and Tables**: to be included within the text, numbered in order of appearance, and accompanied by a short caption.

• **equations**: The main equations must be numbered, with the number in parentheses, and flush to the right.

• **page number and identification**: number all pages; name the PDF file with the name of the first author and paper number, as provided by the organizing committee, e.g., `Euler123.pdf`.

II. On the Display of Math Symbols

Notice that the interline space between the section heading and the first line is approximately the same as the spacing used throughout the document. However, there is extra space between the first section heading and its first line of text.

It is well known that the performance of parallel robots is highly sensitive to robot geometry. In this paper we consider a Gough-Stewart platform, but the approach may be extended to any type of parallel robot as long as its inverse Jacobian can be expressed in closed form; we intend to determine the geometry of this type of robot such that the errors in the positioning of the platform lie within prescribed intervals.

Error analysis is a complex problem that has been mostly addressed in the literature by finding the positioning errors of a given robot at some specific points of its workspace [1], [2]. We consider here not only specific platform poses, but the whole workspace.

It is highly recommended that authors represent vector quantities, like the positioning error $\mathbf{e}$ of the platform pose, by lower-case boldface fonts. Matrices, like the two Jacobians $\mathbf{A}$ and $\mathbf{B}$ of parallel robots, should be represented with upper-case boldface fonts. The two Jacobians relate the vectors of actuated joint rates $\dot{\boldsymbol{\theta}}$ and twist $\mathbf{t}$ in the form

$$\mathbf{A}\mathbf{t} = \mathbf{B}\dot{\boldsymbol{\theta}} \tag{1}$$

where $\mathbf{A}$ and $\mathbf{B}$ are known as the *forward* and the *inverse* Jacobians. These matrices depend on both the robot posture and the geometric parameters, grouped in the vector array $\mathbf{p}$, that define the robot geometry. Lower-case boldface Greek letters cannot be obtained with the usual command for lower-case boldface Latin letter—which works also for their upper-case counterparts. These are obtained with the line[1]

```
\newcommand{\gbf}[1]
{\mbox{\boldmath${#1}$\unboldmath}}
```

[1]Column width does not allow for the display of the text below in one single line. Look at the source file of this document for the single-line display.

Design parameter	R_1	r_1	α_i	h
Units	mm	mm	degree	mm

TABLE I. The design parameters

Notice that $\mathbf{A}$, $\mathbf{B} \in \mathbf{R}^{n\times n}$, where $n = 3$ for planar and spherical robots, while $n = 6$ for spatial robots. It is noteworthy that the real field $\mathbf{R}$ is obtained with the line

```
\newcommand{\R}{\hbox{I \kern -.5em R}}
```

Authors are strongly recommended against the use of the command `\Re` as an alternative representation of the real field. In fact, this command produces the symbol $\Re$, which represents instead the real part of a complex variable.

The robot geometry is defined by the design parameters of Table I. In this table, notice that the physical units are SI, which should be prefered over other units, and displayed in roman fonts, as they should appear throughout the whole paper. The design parameters are illustrated in Fig. 2.

PUT YOUR FIGURE HERE

Fig. 2. The design parameters of the robot

III. Theoretical Analysis

Include here an introduction to the new section.

A. Dealing with manufacturing tolerances

Expand on this specific part of the theoretical analysis.

B. Solving interval linear systems

Highlight the main issues in this part of the analysis.

B.1 The classical approach

Here we find the solution $\mathbf{x}$ of the linear system

$$\mathbf{A}\mathbf{x} = \mathbf{b} \tag{2}$$

where $\mathbf{A} \in \mathbf{R}^{n\times n}$ and $\mathbf{b}$, $\mathbf{x} \in \mathbf{R}^n$. This system is to be solved using an innovative approach.

B.2 An innovative approach

We may also consider taking into account the derivatives in the Gauss elimination scheme.

IV. Implementation and results

The foregoing algorithms have been implemented using the `BIAS/Profil` interval arithmetics package, which implements basic operations of interval arithmetics, and the C++ library `ALIAS`, which implements high-level interval analysis procedures such as bisection, linear-system solving and interval evaluation using the derivatives.

Our results compare favorably well with those reported in [3], [4], although only as well as those reported by Masory et al. [5].

V. Conclusions

Notice the plural in the title of the section, which is established practice.

The synthesis of parallel manipulators in light of accuracy requirements is a difficult problem. The approach proposed here, based on interval analysis, is intended to solve this problem with the additional advantage of providing not only one solution, but a continuous set that allows the user to take into account manufacturing errors.

In the list below, notice the *endash* (–) **in page-ranges, which is longer than the** *dash* (-) **in the first line of [1], but shorter than the** *emdash* (—) **in the parahraph below eq.(1).**

References

[1] Han C. and Merlet, J-P. Kinematic sensitivity analysis of the 3-UPU parallel manipulator. *Mechanism and Machine Theory*, 37(8):787–798, August 2002.

[2] Brisan C., Franitza D., and Hiller M. Modelling and analysis of errors for parallel robots. In *1st Int. Colloquium, Collaborative Research Centre 562*, pp. 83–96, Braunschweig, May, 29–30, 2002.

[3] Patel A.J. and Ehmann K.F. Volumetric error analysis of a Stewart platform based machine tool. *Annals of the CIRP*, 46/1/1997:287–290, 1997.

[4] Ryu J. and Cha J. Volumetric error analysis and architecture optimization for accuracy of HexaSlide type parallel manipulators. *Mechanism and Machine Theory*, 38(3):227–240, March 2003.

[5] Masory O., Wang J., and Zhuang H. On the accuracy of a Stewart platform-part II: Kinematic calibration and compensation. In *IEEE Int. Conf. on Robotics and Automation*, pp. 725–731, Atlanta, May 2–6, 1993.