Presenting the sensation of flying with flapping virtual wings independent of the limbs

Ken Endo[1] and Ikuo Mizuuchi[2]

Fig. 1. Flying with flapping virtual wings independent of the limbs

***Abstract*— Since ancient times, people have longed to fly in the sky. Actual flying involves risks and costs, but using a VR device makes it easy to experience flight. In this study, we propose a method of presenting the sensation of flying with flapping virtual wings independent of the limbs, such as a flying lizard. Unlike studies that presents the sensation of flapping wings by moving the arms, new applications that use the limbs during the flight experience can be expected by flying without moving the limbs. In this paper, we proposed a method of presenting the sensation of manipulating the wing without using the limbs and a method of transmitting the force acting on the wing to humans. We conducted experiments using these methods and obtained subjective evaluations. From the experiment, it was confirmed that the operation by static muscle contraction is also effective for operationing wings. It was also shown that the tactile presentation using EMS has a higher overall evaluation. Finally, we obtained the result that the body image expansion of the virtual wing which proposed in this study is possible.**

I. INTRODUCTION

Since ancient times, people have longed to fly in the sky.

This template provides authors with most of the formatting specifications needed for preparing electronic versions of their papers. All standard paper components have been specified for three reasons: (1) ease of use when formatting individual papers, (2) automatic compliance to electronic requirements that facilitate the concurrent or later production of electronic products, and (3) conformity of style throughout a conference proceedings. Margins, column widths, line spacing, and type styles are built-in; examples of the type styles are provided throughout this document and are identified in italic type, within parentheses, following the example. Some components, such as multi-leveled equations, graphics, and tables are not prescribed, although the various table text styles are provided. The formatter will need to create these components, incorporating the applicable criteria that follow.

*This work was not supported by any organization

[1]Albert Author is with Faculty of Electrical Engineering, Mathematics and Computer Science, University of Twente, 7500 AE Enschede, The Netherlands albert.author@papercept.net

[2]Bernard D. Researcheris with the Department of Electrical Engineering, Wright State University, Dayton, OH 45435, USA b.d.researcher@ieee.org

II. PROCEDURE FOR PAPER SUBMISSION

A. Selecting a Template (Heading 2)

First, confirm that you have the correct template for your paper size. This template has been tailored for output on the US-letter paper size. It may be used for A4 paper size if the paper size setting is suitably modified.

B. Maintaining the Integrity of the Specifications

The template is used to format your paper and style the text. All margins, column widths, line spaces, and text fonts are prescribed; please do not alter them. You may note peculiarities. For example, the head margin in this template measures proportionately more than is customary. This measurement and others are deliberate, using specifications that anticipate your paper as one part of the entire proceedings, and not as an independent document. Please do not revise any of the current designations

III. MATH

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar:

A. Abbreviations and Acronyms

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

B. Units

- Use either SI (MKS) or CGS as primary units. (SI units are encouraged.) English units may be used as secondary units (in parentheses). An exception would be the use of English units as identifiers in trade, such as ?3.5-inch disk drive?.
- Avoid combining SI and CGS units, such as current in amperes and magnetic field in oersteds. This often leads to confusion because equations do not balance dimensionally. If you must use mixed units, clearly state the units for each quantity that you use in an equation.
- Do not mix complete spellings and abbreviations of units: ?Wb/m2? or ?webers per square meter?, not ?webers/m2?. Spell out units when they appear in text: ?. . . a few henries?, not ?. . . a few H?.
- Use a zero before decimal points: ?0.25?, not ?.25?. Use ?cm3?, not ?cc?. (bullet list)

C. Equations

The equations are an exception to the prescribed specifications of this template. You will need to determine whether or not your equation should be typed using either the Times New Roman or the Symbol font (please no other font). To create multileveled equations, it may be necessary to treat the equation as a graphic and insert it into the text after your paper is styled. Number equations consecutively. Equation numbers, within parentheses, are to position flush right, as in (1), using a right tab stop. To make your equations more compact, you may use the solidus (/), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in

$$\alpha + \beta = \chi \tag{1}$$

Note that the equation is centered using a center tab stop. Be sure that the symbols in your equation have been defined before or immediately following the equation. Use ?(1)?, not ?Eq. (1)? or ?equation (1)?, except at the beginning of a sentence: ?Equation (1) is . . .?

D. Some Common Mistakes

- The word ?data? is plural, not singular.
- The subscript for the permeability of vacuum ?0, and other common scientific constants, is zero with subscript formatting, not a lowercase letter ?o?.
- In American English, commas, semi-/colons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited, such as a title or full quotation. When quotation marks are used, instead of a bold or italic typeface, to highlight a word or phrase, punctuation should appear outside of the quotation marks. A parenthetical phrase or statement at the end of a sentence is punctuated outside of the closing parenthesis (like this). (A parenthetical sentence is punctuated within the parentheses.)
- A graph within a graph is an ?inset?, not an ?insert?. The word alternatively is preferred to the word ?alternately? (unless you really mean something that alternates).
- Do not use the word ?essentially? to mean ?approximately? or ?effectively?.
- In your paper title, if the words ?that uses? can accurately replace the word ?using?, capitalize the ?u?; if not, keep using lower-cased.
- Be aware of the different meanings of the homophones ?affect? and ?effect?, ?complement? and ?compliment?, ?discreet? and ?discrete?, ?principal? and ?principle?.
- Do not confuse ?imply? and ?infer?.
- The prefix ?non? is not a word; it should be joined to the word it modifies, usually without a hyphen.
- There is no period after the ?et? in the Latin abbreviation ?et al.?.
- The abbreviation ?i.e.? means ?that is?, and the abbreviation ?e.g.? means ?for example?.

IV. USING THE TEMPLATE

Use this sample document as your LaTeX source file to create your document. Save this file as **root.tex**. You have to make sure to use the cls file that came with this distribution. If you use a different style file, you cannot expect to get required margins. Note also that when you are creating your out PDF file, the source file is only part of the equation. *Your TEX → PDF filter determines the output file size. Even if you make all the specifications to output a letter file in the source - if your filter is set to produce A4, you will only get A4 output.*

It is impossible to account for all possible situation, one would encounter using TEX. If you are using multiple TEX files you must make sure that the "MAIN" source file is called root.tex - this is particularly important if your conference is using PaperPlaza's built in TEX to PDF conversion tool.

A. Headings, etc

Text heads organize the topics on a relational, hierarchical basis. For example, the paper title is the primary text head because all subsequent material relates and elaborates on this one topic. If there are two or more sub-topics, the next level head (uppercase Roman numerals) should be used and, conversely, if there are not at least two sub-topics, then no subheads should be introduced. Styles named ?Heading 1?, ?Heading 2?, ?Heading 3?, and ?Heading 4? are prescribed.

B. Figures and Tables

Positioning Figures and Tables: Place figures and tables at the top and bottom of columns. Avoid placing them in the middle of columns. Large figures and tables may span across both columns. Figure captions should be below the figures; table heads should appear above the tables. Insert figures and

TABLE I
AN EXAMPLE OF A TABLE

One	Two
Three	Four

We suggest that you use a text box to insert a graphic (which is ideally a 300 dpi TIFF or EPS file, with all fonts embedded) because, in an document, this method is somewhat more stable than directly inserting a picture.

Fig. 2. Inductance of oscillation winding on amorphous magnetic core versus DC bias magnetic field

tables after they are cited in the text. Use the abbreviation ?Fig. 1?, even at the beginning of a sentence.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity ?Magnetization?, or ?Magnetization, M?, not just ?M?. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write ?Magnetization (A/m)? or ?Magnetization A[m(1)]?, not just ?A/m?. Do not label axes with a ratio of quantities and units. For example, write ?Temperature (K)?, not ?Temperature/K.?

V. CONCLUSIONS

A conclusion section is not required. Although a conclusion may review the main points of the paper, do not replicate the abstract as the conclusion. A conclusion might elaborate on the importance of the work or suggest applications and extensions.

APPENDIX

Appendixes should appear before the acknowledgment.

ACKNOWLEDGMENT

The preferred spelling of the word ?acknowledgment? in America is without an ?e? after the ?g?. Avoid the stilted expression, ?One of us (R. B. G.) thanks . . .? Instead, try ?R. B. G. thanks?. Put sponsor acknowledgments in the unnumbered footnote on the first page.

References are important to the reader; therefore, each citation must be complete and correct. If at all possible, references should be commonly available publications.

REFERENCES

[1] G. O. Young, ?Synthetic structure of industrial plastics (Book style with paper title and editor),? in Plastics, 2nd ed. vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15?64.
[2] W.-K. Chen, Linear Networks and Systems (Book style). Belmont, CA: Wadsworth, 1993, pp. 123?135.
[3] H. Poor, An Introduction to Signal Detection and Estimation. New York: Springer-Verlag, 1985, ch. 4.
[4] B. Smith, ?An approach to graphs of linear forms (Unpublished work style),? unpublished.
[5] E. H. Miller, ?A note on reflector arrays (Periodical style?Accepted for publication),? IEEE Trans. Antennas Propagat., to be publised.
[6] J. Wang, ?Fundamentals of erbium-doped fiber amplifiers arrays (Periodical style?Submitted for publication),? IEEE J. Quantum Electron., submitted for publication.
[7] C. J. Kaufman, Rocky Mountain Research Lab., Boulder, CO, private communication, May 1995.
[8] Y. Yorozu, M. Hirano, K. Oka, and Y. Tagawa, ?Electron spectroscopy studies on magneto-optical media and plastic substrate interfaces(Translation Journals style),? IEEE Transl. J. Magn.Jpn., vol. 2, Aug. 1987, pp. 740?741 [Dig. 9th Annu. Conf. Magnetics Japan, 1982, p. 301].
[9] M. Young, The Techincal Writers Handbook. Mill Valley, CA: University Science, 1989.
[10] J. U. Duncombe, ?Infrared navigation?Part I: An assessment of feasibility (Periodical style),? IEEE Trans. Electron Devices, vol. ED-11, pp. 34?39, Jan. 1959.
[11] S. Chen, B. Mulgrew, and P. M. Grant, ?A clustering technique for digital communications channel equalization using radial basis function networks,? IEEE Trans. Neural Networks, vol. 4, pp. 570?578, July 1993.
[12] R. W. Lucky, ?Automatic equalization for digital communication,? Bell Syst. Tech. J., vol. 44, no. 4, pp. 547?588, Apr. 1965.
[13] S. P. Bingulac, ?On the compatibility of adaptive controllers (Published Conference Proceedings style),? in Proc. 4th Annu. Allerton Conf. Circuits and Systems Theory, New York, 1994, pp. 8?16.
[14] G. R. Faulhaber, ?Design of service systems with priority reservation,? in Conf. Rec. 1995 IEEE Int. Conf. Communications, pp. 3?8.
[15] W. D. Doyle, ?Magnetization reversal in films with biaxial anisotropy,? in 1987 Proc. INTERMAG Conf., pp. 2.2-1?2.2-6.
[16] G. W. Juette and L. E. Zeffanella, ?Radio noise currents n short sections on bundle conductors (Presented Conference Paper style),? presented at the IEEE Summer power Meeting, Dallas, TX, June 22?27, 1990, Paper 90 SM 690-0 PWRS.
[17] J. G. Kreifeldt, ?An analysis of surface-detected EMG as an amplitude-modulated noise,? presented at the 1989 Int. Conf. Medicine and Biological Engineering, Chicago, IL.
[18] J. Williams, ?Narrow-band analyzer (Thesis or Dissertation style),? Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993.
[19] N. Kawasaki, ?Parametric study of thermal and chemical nonequilibrium nozzle flow,? M.S. thesis, Dept. Electron. Eng., Osaka Univ., Osaka, Japan, 1993.
[20] J. P. Wilkinson, ?Nonlinear resonant circuit devices (Patent style),? U.S. Patent 3 624 12, July 16, 1990.