Design of a small satellite emergency TT&C communications system

Travis J McKee[[1]](#footnote-1)

*The University of New South Wales at the Australian Defence Force Academy*

Abstract

# Contents

1. Introduction 2
2. Procedure for Paper Submission 2
3. General Guidelines 2
   1. Content of the Final Project Report 3
   2. Final Project Report Review 4
   3. Report Length 4
4. Detailed formatting Instructions 4
   1. Document Text 4
   2. Headings 4
   3. Abstract 4
   4. Footnotes and References 5
   5. Images, Figures, and Tables 5
   6. Equations, Numbers, Symbols, and Abbreviations 6
   7. General Grammar and Preferred Usage 6
5. Conclusions 7
6. Recommendations 7

Acknowledgements 7

References 7

APPENDICES (In supplementary document if required at all)

Appendix A. Detailed Results Data A1

Appendix B. Design of McGuffin A2

Appendix C. Uncertainty Analysis A3

# Nomenclature

*A* = amplitude of oscillation [m]

*a* = cylinder diameter [m]

*Cp*= pressure coefficient

*Cx* = force coefficient in the *x* direction

*Cy* = force coefficient in the *y* direction

*c* = chord [m]

d*t* = time step [s]

*Fx* = *X* component of the resultant pressure force acting on the vehicle [N]

*Fy* = *Y* component of the resultant pressure force acting on the vehicle [N]

# Introduction

The reduced cost of designing, manufacturing and launching a small satellite has led to an increased number of small satellites located within the Low Earth Orbit (LEO) area [].A 30% small satellite failure rate resulting in dead on arrival (DOA) satellites has increased the number of space debris objects in LEO leading to an higher risk of collisions between objects[]. A collision between two objects in space results in a larger number of smaller space debris objects leading to an exponential risk of further collisions between objects, which is known as the Kessler Syndrome []. The inability to track a space debris object and provide a full understanding of the space situational awareness (SSA) within the LEO area increases the risk of a collision for all users of the LEO space environment []. The size of small satellites and in particularly objects below 10 or 10kg are difficult to detect and track using current land and space-based radar and optic equipment []. A low power communication sub-system based upon existing designs that can provide satellite identification and basic Tracking, Telemetry and Control (TT&C) independent of all other sub-systems on the small satellite will allow identification and tracking of DOA satellites []. This system provides an alternative source of tracking information that can be used by space monitoring entities to increase the effectiveness of the SSA in the LEO environment. An alternative tracking system will increase the reliability of identifying and monitoring small sized satellites providing a safer LEO environment for satellite and pass through operations by reducing the risk of collisions between objects [].

# Literature Review

The

# Project Management

The

# Planned methodology

The

# Timeline for completion

The

# Current Progress (Work completed to date)

The

# Future work

The

# Conclusions

The

# Recommendations

The

# References

You are required to use either the (in-text) Harvard system of referencing (refer to [www.lc.unsw.edu.au/onlib/ref.html](http://www.lc.unsw.edu.au/onlib/ref.html)) or the endnote numbering system in which in-text citations are numbered like this[1] or like this2. Whichever method you chose you must stick to. DO NOT mix and match referencing systems. Note that the online Harvard system guidelines above recommend the use of page number as well as author and date for the in-text citation. However in technical writing the page number is not normally included as most references are short journal papers.

The following are intended to provide examples of the different reference types. When using the Word version of this template to enter references, select the “references” style from the drop-down style menu to automatically format your references. If you are using a print or PDF version of this document, all references should be in 9-point font, with reference numbers inserted in superscript immediately before the corresponding reference. You should NOT indicate the type of reference in your list; different types are shown here for illustrative purposes only.

Note that the list of references should be alphabetical when using the Harvard system, while they should be numbered in order of appearance if using the endnote system (NOTE that we are referring to the “endnote” system of referencing here as distinct from the Endnote software which can do either).

*Periodicals*

1Vatistas, G. H., Lin, S., and Kwok, C. K., “Reverse Flow Radius in Vortex Chambers,” *AIAA Journal*, Vol. 24, No. 11, 1986, pp. 1872, 1873.

2Dornheim, M. A., “Planetary Flight Surge Faces Budget Realities,” *Aviation Week and Space Technology*, Vol. 145, No. 24, 9 Dec. 1996, pp. 44-46.

3Terster, W., “NASA Considers Switch to Delta 2,” *Space News*, Vol. 8, No. 2, 13-19 Jan. 1997, pp., 1, 18.

All of the preceding information is required. The journal issue number (“No. 11” in Ref. 1) is preferred, but the month (Nov.) can be substituted if the issue number is not available. Use the complete date for daily and weekly publications. Transactions follow the same style as other journals; if punctuation is necessary, use a colon to separate the transactions title from the journal title.

*Books*

4Peyret, R., and Taylor, T. D., *Computational Methods in Fluid Flow*, 2nd ed., Springer-Verlag, New York, 1983, Chaps. 7, 14.

5Oates, G. C. (ed.), *Aerothermodynamics of Gas Turbine and Rocket Propulsion*, AIAA Education Series, AIAA, New York, 1984, pp. 19, 136.

6Volpe, R., “Techniques for Collision Prevention, Impact Stability, and Force Control by Space Manipulators,” *Teleoperation and Robotics in Space*, edited by S. B. Skaar and C. F. Ruoff, Progress in Astronautics and Aeronautics, AIAA, Washington, DC, 1994, pp. 175-212.

Publisher, place, and date of publication are required for all books. No state or country is required for major cities: New York, London, Moscow, etc. A differentiation must always be made between Cambridge, MA, and Cambridge, England, UK. Note that series titles are in roman type.

*Proceedings*

7Thompson, C. M., “Spacecraft Thermal Control, Design, and Operation,” *AIAA Guidance, Navigation, and Control Conference*, CP849, Vol. 1, AIAA, Washington, DC, 1989, pp. 103-115

8Chi, Y., (ed.), *Fluid Mechanics Proceedings*, SP-255, NASA, 1993.

9Morris, J. D. “Convective Heat Transfer in Radially Rotating Ducts,” *Proceedings of the Annual Heat Transfer Conference*, edited by B. Corbell, Vol. 1, Inst. Of Mechanical Engineering, New York, 1992, pp. 227-234.

At a minimum, proceedings must have the same information as other book references: paper (chapter) and volume title, name and location of publisher, editor (if applicable), and pages or chapters cited. Do not include paper numbers in proceedings references, and delete the conference location so that it is not confused with the publisher’s location (which is mandatory, except for government agencies). Frequently, CP or SP numbers (Conference Proceedings or Symposium Proceedings numbers) are also given. These elements are not necessary, but when provided, their places should be as shown in the preceding examples.

*Reports, Theses, and Individual Papers*

10Chapman, G. T., and Tobak, M., “Nonlinear Problems in Flight Dynamics,” NASA TM-85940, 1984.

11Steger, J. L., Jr., Nietubicz, C. J., and Heavey, J. E., “A General Curvilinear Grid Generation Program for Projectile Configurations,” U.S. Army Ballistic Research Lab., Rept. ARBRL-MR03142, Aberdeen Proving Ground, MD, Oct. 1981.

12Tseng, K., “Nonlinear Green’s Function Method for Transonic Potential Flow,” Ph.D. Dissertation, Aeronautics and Astronautics Dept., Boston Univ., Cambridge, MA, 1983.

Government agency reports do not require locations. For reports such as NASA TM-85940, neither insert nor delete dashes; leave them as provided by the author. Place of publication *should* be given, although it is not mandatory, for military and company reports. Always include a city and state for universities. Papers need only the name of the sponsor; neither the sponsor’s location nor the conference name and location are required. *Do not confuse proceedings references with conference papers*.

*Electronic Publications*

CD-ROM publications and regularly issued, dated electronic journals are permitted as references. Archived data sets also may be referenced as long as the material is openly accessible and the repository is committed to archiving the data indefinitely. References to electronic data available only from personal Web sites or commercial, academic, or government ones where there is no commitment to archiving the data are strongly discouraged (see Private Communications and Web sites).

13Richard, J. C., and Fralick, G. C., “Use of Drag Probe in Supersonic Flow,” *AIAA Meeting Papers on Disc* [CD-ROM], Vol. 1, No. 2, AIAA, Reston, VA, 1996.

14Atkins, C. P., and Scantelbury, J. D., “The Activity Coefficient of Sodium Chloride in a Simulated Pore Solution Environment,” *Journal of Corrosion Science and Engineering* [online journal], Vol. 1, No. 1, Paper 2, URL: <http://www.cp/umist.ac.uk/JCSE/vol1/vol1.html> [cited 13 April 1998].

15Vickers, A., “10-110 mm/hr Hypodermic Gravity Design A,” *Rainfall Simulation Database* [online database], URL: <http://www.geog.le.ac.uk/bgrg/lab.htm> [cited 15 March 1998].

Always include the citation date for online references. Break Web site addresses after punctuation, and do not hyphenate at line breaks. Always remember to include when a web site was cited or last accessed – they go defunct quite often.

*Computer Software*

16TAPP, Thermochemical and Physical Properties, Software Package, Ver. 1.0, E. S. Microware, Hamilton, OH, 1992.

Include a version number and the company name and location of software packages.

*Patents*

Patents appear infrequently. Be sure to include the patent number and date.

17Scherrer, R., Overholster, D., and Watson, K., Lockheed Corp., Burbank, CA, U.S. Patent Application for a “Vehicle,” Docket No. P-01-1532, filed 11 Feb. 1979.

*Private Communications and Web Sites*

References to private communications and personal Web site addresses are discouraged. Private communications can be defined as privately held unpublished letters or notes or conversations between an author and one or more individuals. Depending on the circumstances, private communications and Web site addresses may be incorporated into the main text of a manuscript or may appear in footnotes.

*Unpublished Papers and Books*

Unpublished works can be used as references as long as they are being considered for publication or can be located by the reader (such as papers that are part of an archival collection). If a journal paper or a book is being considered for publication choose the format that reflects the status of the work (depending upon whether it has been accepted for publication):

18Doe, J., “Title of Paper,” *Name of Journal* (to be published).

19Doe, J., “Title of Chapter,” *Name of Book*, edited by… Publisher’s name and location (to be published).

20Doe, J., “Title of Work,” Name of Archive, Univ. (or organization) Name, City, State, Year (unpublished).

Unpublished works in an archive *must* include the name of the archive and the name and location of the university or other organization where the archive is held. Also include any cataloging information that may be provided. Always query for an update if a work is about to be published.

# Appendices (Separate Document)

Appendices may used to archive detailed summaries of data such as images, tables and charts and detailed example calculations such as for the estimation of measurement uncertainty. They may also include design drawings. Raw data, or detailed computer programs and files and extensive design drawings, should not be included. Their archiving should be discussed with your supervisor. Any appendices should be submitted as a SINGLE separate document file if referred to in the main text and be listed in the table of contents at the beginning (Note the use of a separate page numbering scheme).

1. OFFCDT, School of Engineering & Information Technology. ZEIT4500/4501/4297 – delete as appropriate. [↑](#footnote-ref-1)