Technical Design Paper  
for the Robotics Dojo Competition 2024

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# INTRODUCTION

The purpose of the Robotics Dojo competition is to enhance the community of innovators capable of substantive contributions to the domain of autonomous unmanned systems. This enhancement is achieved by providing a venue and mechanism whereby the practitioners of the autonomous systems community may form new connections and collaborations, increase their proficiency and inventiveness, and foster their passion for robotics in the maritime domain.

## Design Strategy

The vehicle design is split into two sections that will perform unique functions and communicate effectively with each other to allow the vehicle to map and find a route in the game field to a defined destination.

1. *Mobile Platform*

-3D printing the body layers and supports to reduce weight.

-Increasing number of supports per layer to increase stability.

-Using a single front wheel to reduce weight, increase speed of maneuvering but at the cost of reduced stability.

-Using two rear wheels in the differential drive system to reduce turning radius and increase speed of turning.

-Steps-Buying all the items on the bill of materials,3D printing the body frame and its layers, assembling the body and its components, using simple code in Arduino microcontroller to test if the vehicle moves as commanded.

1. *Navigation*

## Vehicle Design

In the past, this section (e.g., mechanical, electrical, and software) constituted the bulk of the technical design paper and was often used by teams primarily to catalogue their component choices and resulting design. While the technical design paper should still describe the design, the Robotics Dojo judges would like to encourage teams to increase emphasis on the following:

* Design processes and methodologies employed and their impact on component choices and design results
* Lessons learned from design iterations, testing evolutions, and/or experience at prior competitions. This should also include insight into designs, processes, or practices that did *not* work and should be avoided in the future
* Algorithmic descriptions or software approaches that the team has found to be particularly useful, impactful, or novel as well as any system engineering endeavors pursued by the team that should be continued or refined.

In short, the teams should consider the technical design paper as not only an opportunity to practice scientific writing and advocate for their Robotics Dojo entry, but they should also consider it a means to document and transfer knowledge to their future team members.



1. Both axes of a figure *must* be labeled and the caption should be used to explain why the figure is important to the reader (*i.e.,* do not simply use the caption to name the figure). Note that a figure caption goes below the figure whereas a table caption goes above the table.

## Experimental Results

This section should briefly describe how the team accomplishes testing (*e.g.,* unit and integration testing, simulation, etc.) and provide some notion of how much testing has occurred as of the technical design paper submission. Note that the *actual results* reported in this section will not affect the team’s technical design paper score (*e.g.,* reporting a high performance will neither help nor hurt the technical design paper score). This section should also discuss any studies, calculations, or estimates that the team has performed in the areas of reliability and robustness (e.g., failure analysis, reliability modeling, structural analysis, etc.).

## Acknowledgements (optional)

This is an optional section that teams may wish to utilize to acknowledge particular assistance, sponsors, etc.

## References

As with any scientific publication, original ideas and content that are not generated by the paper’s authors should be properly cited. While there are several reference styles, the Robotics Dojo technical design paper uses the IEEE style, which is detailed in the Appendix. This style uses the bracketed reference, which should be used in line with text as in “The work in [x] states that…” This section does not count against the page limit.

## Appendix—Situational Awareness (optional)

The Appendix is optional and does not count against the page limit. Recall that a foundational purpose of Robotics Dojo is to strengthen and enhance the community. Therefore teams are encouraged to share their approaches to solving operational concerns relevant to the unmanned systems community. A significant challenge to adoption of unmanned systems is user trust. Human users have a need to understand what the unmanned system is doing and why; users must have confidence that the system is behaving as intended. This is particularly important as emergent behaviors become more common. Discuss how you would approach providing information to users such that they would have awareness of the unmanned systems situation, and thus confidence in the unmanned systems intentions. Although this appendix is optional, a special award could be designated for this topic.

# Appendix

This Appendix is taken from the IEEE Transactions template on the IEEE website, and should be followed for citing references, (<https://template-selector.ieee.org/secure/templateSelector/publicationType>).

*Basic format for books:*

1. J. K. Author, “Title of chapter in the book,” in *Title of His Published Book, x*th ed. City of Publisher, Country if not
2. USA: Abbrev. of Publisher, year, ch. *x*, sec. *x*, pp. *xxx–xxx.*

*Examples:*

1. G. O. Young, “Synthetic structure of industrial plastics,” 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.* Belmont, CA: Wadsworth, 1993, pp. 123–135.

*Basic format for periodicals:*

1. J. K. Author, “Name of paper,” *Abbrev. Title of Periodical*, vol. *x,* no. *x,* pp*. xxx-xxx,* Abbrev. Month, year.

*Examples:*

1. J. U. Duncombe, “Infrared navigation—Part I: An assessment   
   of feasibility,” IEEE *Trans. Electron Devices*, vol. ED-11, no. 1, pp. 34–39, Jan. 1959.
2. E. P. Wigner, “Theory of traveling-wave optical laser,” *Phys. Rev*.,   
   vol. 134, pp. A635–A646, Dec. 1965.
3. E. H. Miller, “A note on reflector arrays,” *IEEE Trans. Antennas Propagat*., to be published.

*Basic format for reports:*

1. J. K. Author, “Title of report,” Abbrev. Name of Co., City of Co., Abbrev. State, Rep. *xxx*, year.

*Examples:*

1. E. E. Reber, R. L. Michell, and C. J. Carter, “Oxygen absorption in the earth’s atmosphere,” Aerospace Corp., Los Angeles, CA, Tech. Rep. TR-0200 (4230-46)-3, Nov. 1988.
2. J. H. Davis and J. R. Cogdell, “Calibration program for the 16-foot antenna,” Elect. Eng. Res. Lab., Univ. Texas, Austin, Tech. Memo. NGL-006-69-3, Nov. 15, 1987.

*Basic format for handbooks:*

1. *Name of* Manual*/*Handbook, *x* ed., Abbrev. Name of Co., City of Co., Abbrev. State, year, pp. *xxx-xxx.*

*Examples:*

1. *Transmission Systems for Communications*, 3rd ed., Western Electric Co., Winston-Salem, NC, 1985, pp. 44–60.
2. *Motorola Semiconductor Data Manual*, Motorola Semiconductor Products Inc., Phoenix, AZ, 1989.

*Basic format for books (when available online):*

1. Author. (year, month day). *Title.* (edition) [Type of medium]. *volume (issue).* Available: site/path/file

*Example:*

1. J. Jones. (1991, May 10). *Networks.* (2nd ed.) [Online]. Available: [http://www.atm.com](http://www.atm.com/)

*Basic format for journals (when available online):*

1. Author. (year, month). Title. *Journal.* [Type of medium]. *volume (issue),* pages. Available: site/path/file

*Example:*

1. R. J. Vidmar. (1992, Aug.). On the use of atmospheric plasmas as electromagnetic reflectors. *IEEE Trans. Plasma Sci.* [Online]. *21(3),* pp. 876–880. Available:<http://www.halcyon.com/pub/journals/21ps03-vidmar>

*Basic format for papers presented at conferences (when available online):*

1. Author. (year, month). Title. Presented at Conference title. [Type of Medium]. Available: site/path/file

*Example:*

1. PROCESS Corp., MA. Intranets: Internet technologies deployed behind the firewall for corporate productivity. Presented at   
   INET96 Annual Meeting. [Online]. Available: <http://home.process.com/Intranets/wp2.htp>

*Basic format for reports and handbooks (when available online):*

1. Author. (year, month). Title. Comp an y . C ity, State or Country. [Type of Medium]. Available: site/path/file

*Example:*

1. S. L. Tall een. (1996 , Apr . ). The In t r an et Archi -tecture: M a nagi ng i n f o rm at i on i n t h e ne w paradigm. Amdahl Corp., CA. [Online]. Available:<http://www.amdahl.com/doc/products/bsg/intra/infra/html>

*Basic format for computer programs and electronic documents (when available online):* ISO recommends that capitalization follow the accepted practice for the language or script in which the information is given.

*Example:*

1. A. Harriman. (1993, June). Compendium of genealogical software. *Humanist.* [Online]. Available e-mail: [HUMANIST@NYVM.ORG](mailto:HUMANIST@NYVM.ORG) Message: get GENEALOGY REPORT

*Basic format for patents (when available online):*

1. Name of the invention, by inventor’s name. (year, month day). *Patent Number* [Type of medium]. Available: site/path/file

*Example:*

1. Musical toothbrush with adjustable neck and mirror, by L.M.R. Brooks. (1992, May 19). *Patent D 326 189*

[Online]. Available: NEXIS Library: LEXPAT File: DESIGN

*Basic format for conference proceedings (published):*

1. J. K. Author, “Title of paper,” in *Abbreviated Name of Conf.*, City of Conf., Abbrev. State (if given), year, pp. *xxxxxx.*

*Example:*

1. D. B. Payne and J. R. Stern, “Wavelength-switched pas- sively coupled single-mode optical network,” in *Proc. IOOC-ECOC,* 1985,   
   pp. 585–590.

*Example for papers presented at conferences (unpublished):*

1. D. Ebehard and E. Voges, “Digital single sideband detection for interferometric sensors,” presented at the 2nd Int. Conf. Optical Fiber Sensors, Stuttgart, Germany, Jan. 2-5, 1984.

*Basic format for patents:*

1. J. K. Author, “Title of patent,” U.S. Patent *x xxx xxx*, Abbrev. Month, day, year.

*Example:*

1. G. Brandli and M. Dick, “Alternating current fed power supply,”   
   U.S. Patent 4 084 217, Nov. 4, 1978.

*Basic format**for theses (M.S.) and dissertations (Ph.D.):*

1. J. K. Author, “Title of thesis,” M.S. thesis, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.
2. J. K. Author, “Title of dissertation,” Ph.D. dissertation, Abbrev. Dept., Abbrev. Univ., City of Univ., Abbrev. State, year.

*Examples:*

1. J. O. Williams, “Narrow-band analyzer,” Ph.D. dissertation, Dept. Elect. Eng., Harvard Univ., Cambridge, MA, 1993.
2. N. Kawasaki, “Parametric study of thermal and chemical nonequilibrium nozzle flow,” M.S. thesis, Dept. Electron. Eng., Osaka Univ., Osaka, Japan, 1993.

*Basic format for the most common types of unpublished references:*

1. J. K. Author, private communication, Abbrev. Month, year.
2. J. K. Author, “Title of paper,” unpublished.
3. J. K. Author, “Title of paper,” to be published.

*Examples:*

1. A. Harrison, private communication, May 1995.
2. B. Smith, “An approach to graphs of linear forms,” unpublished.
3. A. Brahms, “Representation error for real numbers in binary computer arithmetic,” IEEE Computer Group Repository, Paper R-67-85.

*Basic format for standards:*

1. *Title of Standard*, Standard number, date.

*Examples:*

1. IEEE Criteria for Class IE Electric Systems, IEEE Standard 308, 1969.
2. Letter Symbols for Quantities, ANSI Standard Y10.5-1968.