Technical Design Paper  
for the Robotics Dojo Competition 2024

First A. Amos Oniare, Second B. Dismas Karimi, Third C. Gareth Kipkoech, and Fourth D. Fundi Brian (KNIGHTS)

First A. Daniel Karume, Second B. Joseph Kirika, Third C. Peaches Njenga, Fourth D. Geoffrey Chege Kimani, and Fifth E. Irke Konzolo (Pentagon)

# INTRODUCTION

Robotics Dojo is a project-based robotics training program under the AFRICA-ai-JAPAN Project at the Jomo Kenyatta University of Agriculture and Technology. Each year, the program holds a competition that challenges student teams to come up with a robot that can perform the requirements accurately and quickly. This year, the challenge is presented as a maze with checkpoints in it that will only be revealed on the day of the competition. A robot is to be made that can autonomously navigate in the maze through the checkpoints. The robot’s performance will be based on its speed of doing the tasks and how accurately it passes through the checkpoints.

## Design Strategy

The following are the steps to be followed until a competition ready robot is made:

* Make a 3-Dimensional model of the robot in a CAD (Computer Aided Design) software that will show the dimension of each part and ensure that they are in line with the competition’s regulations.
* Save the 2-Dimensional drawings of each part on a single pdf file which will be used to Laser cut parts from a sheet of acrylic.
* Create a Bill of Materials (BOM) that includes all the devices that will make up the mobile section, navigation sections and other tools that will be used during assembly such as a glue gun and screws. Ensure to calculate the power of consumed by each device and sum them up to determine the ideal battery and wire gauge to use safely.
* Assemble the robot body and test for rigidity.
* Test the workings of the electrical and electromechanical devices, one at a time, by ensuring that they respond correctly to input signals e.g. Using an Arduino Microcontroller, a battery and a motor driver to vary the speed and direction of a D.C motor.
* Begin learning about Robot Operating System (ROS) and how it can be implemented to the robot to control the differential drive system based on the data it receives from the Lidar.
* Add the electronics to the body of the robot and screw them in place and solder the wire connections.
* Perform mapping of a room by remotely controlling the robot and save the map generated.
* Perform navigation autonomously using the map previously generated to move the robot to specific locations in the room.
* Once mapping and navigation can be performed, test the robot in the competition’s game field and note its speed, number of collisions and accuracy in autonomously positioning itself on locations in the map after receiving a command.
* Perform changes in software, repairs on the body and corrections in electrical wiring if encountering problems in accurately mapping, navigation or even breakdown during a trial.

## Vehicle Design

The robot design is split into two sections, the Mobile Platform and Navigation, that will perform unique functions and communicate effectively with each other to allow the vehicle to map, find a route in the game field to a defined destination and move to the destination without any collision. Autodesk Inventor, a CAD software, will be used to first develop a model of the Robot body which will then be laser cut and assembled before adding in the other components of the mobile and navigation section. A 3-Dimensional model of the robot is as shown below.

* IMAGE OF BOT MODEL.

It is observed that the body is made up of 3 layers supported by 4 supports for each pair. The layers allow of enough space for the hardware and other electrical components to be placed without congestion and reduce the risk of short-circuits. The supports ensure the body is rigid and that each layer is parallel to the one above or below it. Stability will be increased by lowering the center of gravity through placing the heavier components such as the battery on the lowest layer. It is also designed with 4 wheels, 2 being castor wheels and the other 2 are part of the differential drive system. This increases stability of the robot and reduces the weight supported by each wheel hence reducing the structural stresses on the wheel supports. The differential drive wheels are placed at the center of the base to reduce the radius of turning on the spot and allow faster turning which makes the robot more maneuverable.

A 2-Dimensional drawing of each part will be created and put in a pdf file as shown below:

* IMAGE OF PDF FOR LASER CUTTING.

The above file will then be used by the laser cutting machine to cut each part from a sheet of acrylic. The body of the robot will be made from acrylic due the following:

* High impact resistance which is 10 times higher than glass.
* It is Lightweight.
* It has excellent dimensional stability.
* Innate weatherability and UV resistance.
* High optical clarity. (Makes it easier to identify problems in electrical connections within the body)
* Requires less energy when laser cutting as compared to other materials like aluminum.
* Its low price.

1. *Mobile Platform*
2. *Navigation*

## Experimental Results

## Acknowledgements (optional)

## References

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/)

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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.