

Project 2 Deliverable 3

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Abstract—This is the project report/write-up for D3 of Project 2 for CSCI473 Human Centered Robotics, Spring 2020. It describes my approach and my successes and failures.

I. SENSING FIELD-OF-VIEW

As was described in the assignment, the robot uses LIDAR to observe its environment. My robot divides its LIDAR field of view into 3 directions that it needs to use to make decisions: left, front, and right. In order to distinguish between these directions, only a portion of the LIDAR data is used for each one. Since the LIDAR data is divided into 360 vertical slices, which are enumerated from 0 to 359, 3 specific slices are used to establish the robot's perception. The 0 slice represents the right of the robot, so that slice is used for sensing to the right. Following this, 90 degrees counter-clockwise, or slice 59, is used for sensing to the front. Finally, 180 degrees, or slice 179 is used to sense the left. These 3 points of perception were sufficient for the robot to successfully navigate the maze in D1, so this is where I began for D2.

II. DISCRETIZATION DEFINITIONS

The following subsections describe the way I defined the three parts of the discrete learning space for the Q-learning algorithm: state, action, and reward.

A. State

In order to define a finite number of states that could be used by the algorithm to learn the maze, I defined a series of substates for each sensing direction, which would allow the continuous LIDAR data to be discretized for use in Q-learning. For the left, front, and right sensing directions, I defined substates representing close, medium, and far distances. The substate of each sensing direction was determined by the LIDAR reading for that direction. Substates were enumerated 0 (close), 1 (medium), and 2 (far), and they were returned by the callback function used by the LIDAR subscriber. States were then stored as combinations of substates, in the order (left, front, right). These tuples were used wherever state was needed. For example, if the robot was really close to a wall on the right, the state would be (2, 2, 0), representing a substate of far for the left, far for the front, and close for the right. These tuple states will later be used in the construction and accessing of the Q-table.

B. Actions

There were many possible ways to define actions, but, in order to keep it simple, I chose to only implement 3 possible actions for the robot. The first action is driving straight forward, which consists of giving the robot a positive

y velocity and zero velocity in the x direction. The second and third actions are driving to the left and the right. Because I wanted the robot to always be moving, I chose to make these actions turn while driving, and not turn in place. I did this in hopes that it would prevent the robot from simply spinning in place forever. To implement the turn left action, I provide the robot a positive velocity in the y direction as well as a positive angular velocity. The turn right action similarly consists of a positive velocity in the y direction, but has a negative angular velocity. These actions are enumerated as 0 (turn left), 1 (drive straight), and 2 (turn right). They are enumerated this way for consistency with the enumeration of the states and substates. These actions will later be used in the Q-table with the states.

C. Rewards

The rewards of my Q-learning algorithm are defined in terms of the sensor readings of the robot, just like the states.

D. 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)

E. 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

$$\alpha + \beta = \chi \quad (1)$$

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 . . .

F. Some Common Mistakes

- The word data is plural, not singular.
- The subscript for the permeability of vacuum μ_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*.

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

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

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*.

IV. 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.

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