Scientific Experimentation and Evaluation

Assignment: 1

Chaitanya Hebbal
José Carlos Mayoral Baños

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Task Description

Our **task** is defined as: *Constructing a LEGO NxT differential drive robot and manually measure the observable pose variation for three different velocity motions.* The goal of this experiment is to observe the variation on the manual measured poses and look at the error distributions.

The layout of this experiment consists on:

1. Five different curves movements are going to be measured: Straight line and 4 arcs (2 left and 2 right).
2. The Device Under Test is a LEGO NxT robot.
3. A third-part library for the software is previously defined.

Plan for the experiment is given below:

1. Define the measurement method (see below).
2. Code a good program which takes into consideration the provided restrictions.
3. Define the curves that must be done according to pre-defined library.
4. Store the information of the final poses.
5. Repeat twenty times every curve measurement.
6. Compute the information to get the error gaussian distribution.

Experiment setup

Device Under Test

The Device Under Test is a LEGO NxT robot, shown at figure 1.

Figure 1: LEGO Nxt Robot

Measured Value

The polar coordinate of the robot (distance to origin, and angle θ).

Measurement System

The measurement value (final pose) is acquired by a LEGO NxT robot which uses the libraries provided by leJOS framework for motion and a large cardboard sheet, light sensor and geometric representation to acquire data.

Measuring Method

To accomplish the task we have defined the experiment as explained in the picture.

The method description of image 3 is:

- A cardboard is used to mark the points of all the experiment.
- Two light sensors are used to mark the points in order to get the pose of the robot.
- Using LEGO light sensors initial pose is marked on the cardboard.
- A perpendicular axis which connects two original points is drawn as a reference.
- The origin is located between wheels so there distance from a sensor to the center must be measured.
- After the robot stops, a projection of the line is drawn between the two measured points pointed by the sensors.

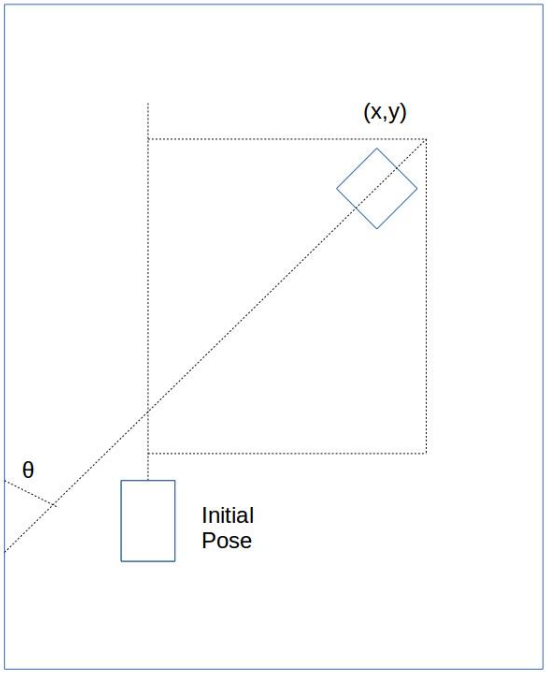


Figure 3: Experiment Description

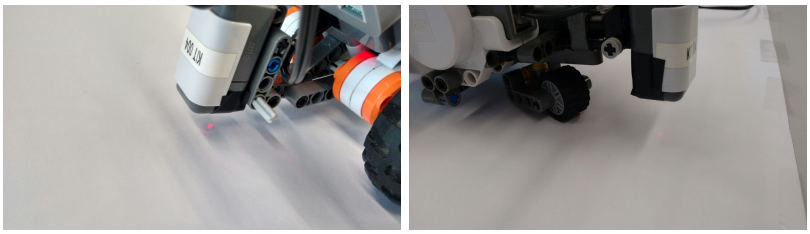
- The angle will be measured between the reference axis and the projected line.
- From the final marks, the new center is calculating extracting distance from initial marker to center along the projected line.
- Linear distance comes from the distance between measured center the and origin.
- For every repetition the initial pose must fit the original pose markers.
- After 5 repetitions, erase marks in order to get better measurements.

The Measurement facilities include:

- One cardboard.
- Two light sensors.
- A pen.
- A protractor.
- A rule.

The used light markers use is shown at image 4.

Figure 4: LEGO Nxt Robot Light Markers



(a) Forward Marker (b) Backward Marker

What difficulties are expected?

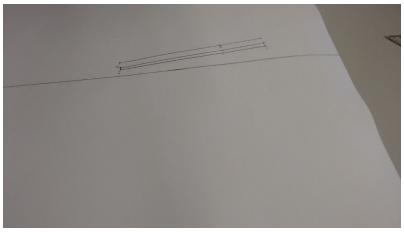
In order to accomplish the current task, we found the following constraints:

- The manual measurement will add errors to the measurement result.
- The precision of the instruments will affect the gaussian distribution.

Experimental Observations

An example of the measurement process can be seen at figure 6.

Figure 6: Measurement Process



The right motor seems to be steeper as the left one, i.e. the straight line deviates to left (image 8).

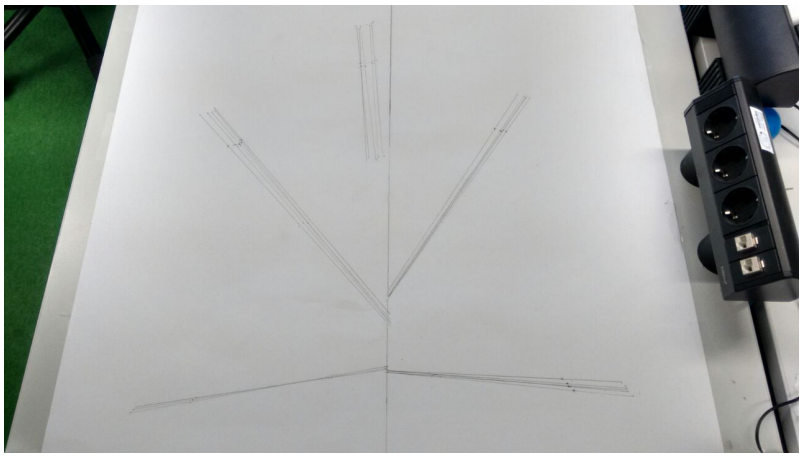
The experiments results are provided in the attached file: "*see_data_.ods*".

Precision and Accuracy

The precision of the experiment relies on the precision of the measurement facilities:

- For Distance Measurement: the rule was used which precision is 1 mm.
- For Angle Measurement: the protractor was used which precision is 1°.

Figure 8: Experiments print



Parameters used to drive the robot

Table 1: Parameters Used

	Arc radius	Angle	Distance	Track Width
Steep left arc	20	90		12
Steep right arc	20	90		12
Soft left arc		40	55	12
Soft right arc		40	55	12
Straight	40	90		12