Advanced Robotics

University of Tehran

First Report

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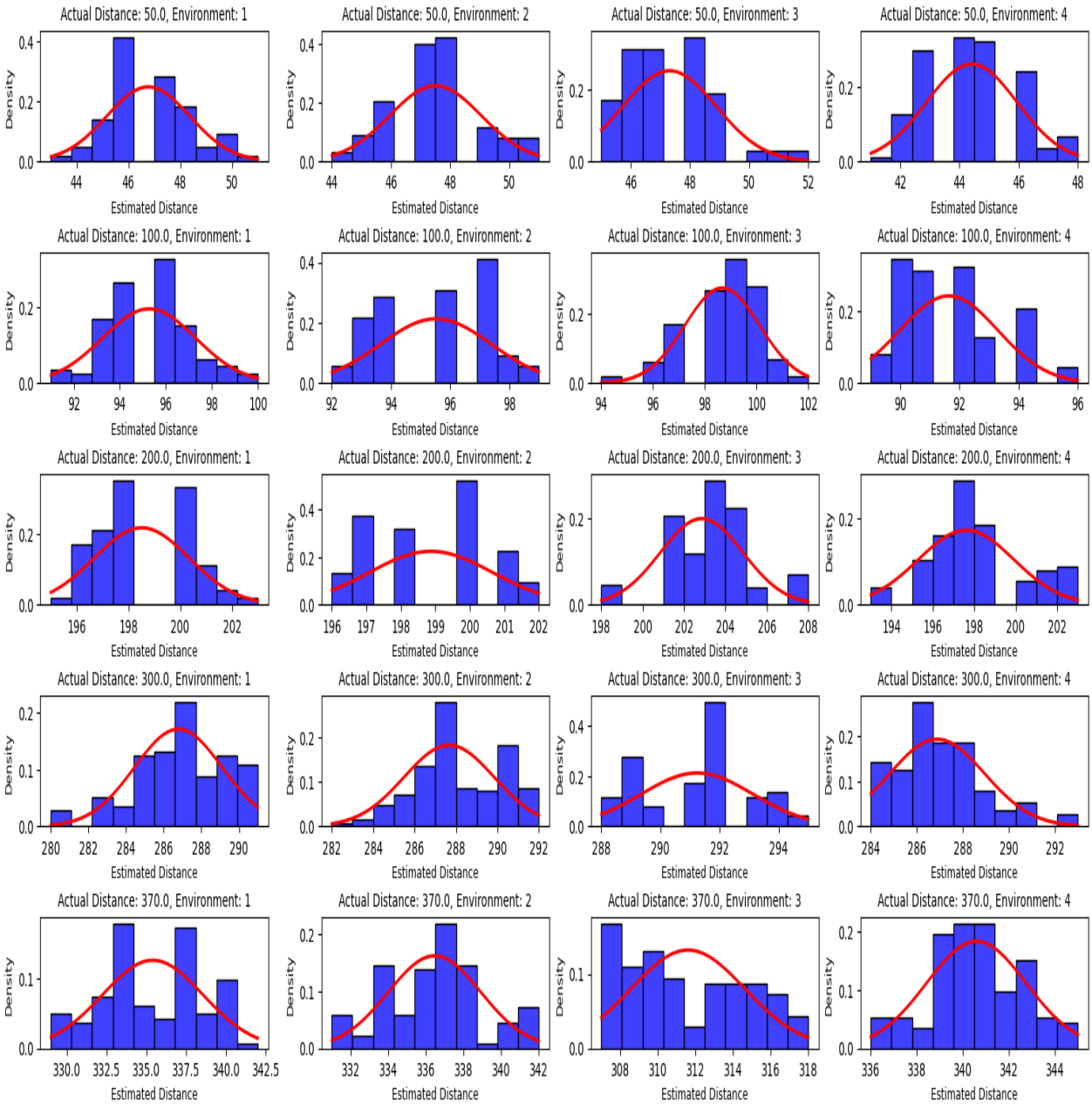
Sensor Modeling

In the first part of the report, we address the modeling of the robot's sensors. Given the varying environmental conditions, we calculate the relevant parameters for each environment to estimate the impact of different conditions on the sensor.

Distance	Number of environments	Mean of Distances	Variance of Distances
50	1	46.76	1.608
50	2	47.5	1.548
50	3	47.3	1.58
50	4	44.41	1.53
100	1	95.27	2.02
100	2	95.52	1.87
100	3	98.67	1.44
100	4	91.64	1.65
200	1	198.51	1.83
200	2	198.87	1.78
200	3	202.84	1.99
200	4	197.6	2.3
300	1	286.77	2.33
300	2	287.66	2.17
300	3	291.24	1.88
300	4	286.88	2.06
370	1	335.4	3.15
370	2	336.45	2.46
370	3	311.6	3.02
370	4	340.59	2.17

Tables 1-1 and Figures 1-1 illustrate the estimated distribution parameters for the data and the actual distribution of the experimental data.

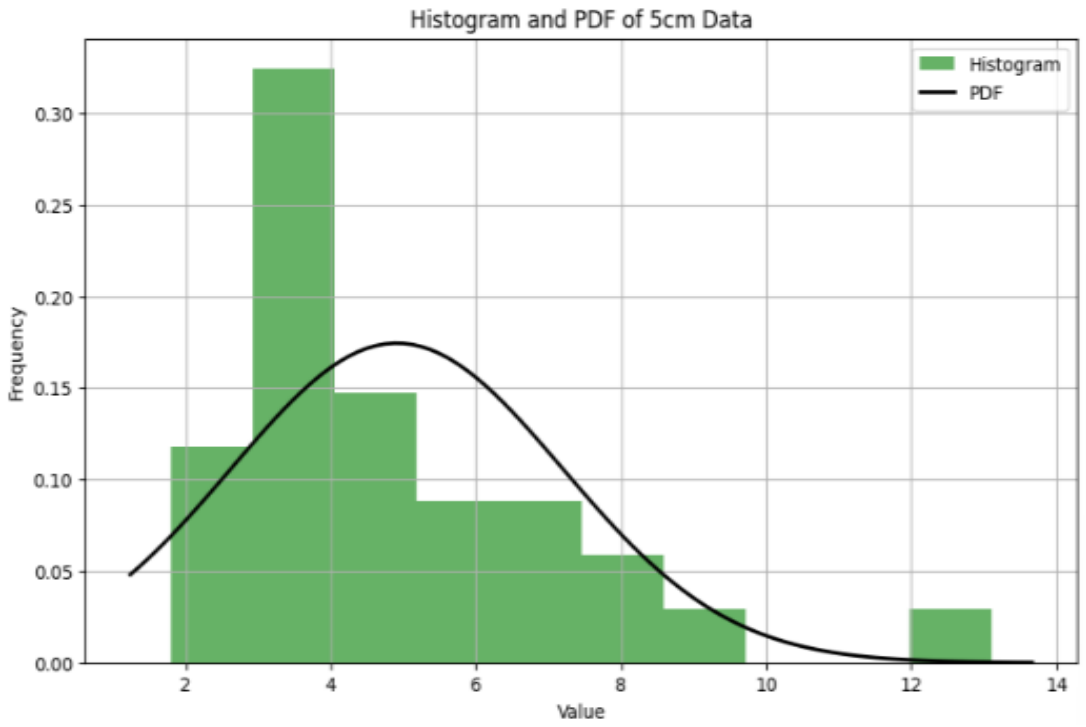


Next, we examine the sensory and motion models of the Vector robot, based on systematic experiments conducted to record its behavior under varying conditions. These analyses are crucial for implementing subsequent algorithms in our robotics project.

Sensor Evaluation:

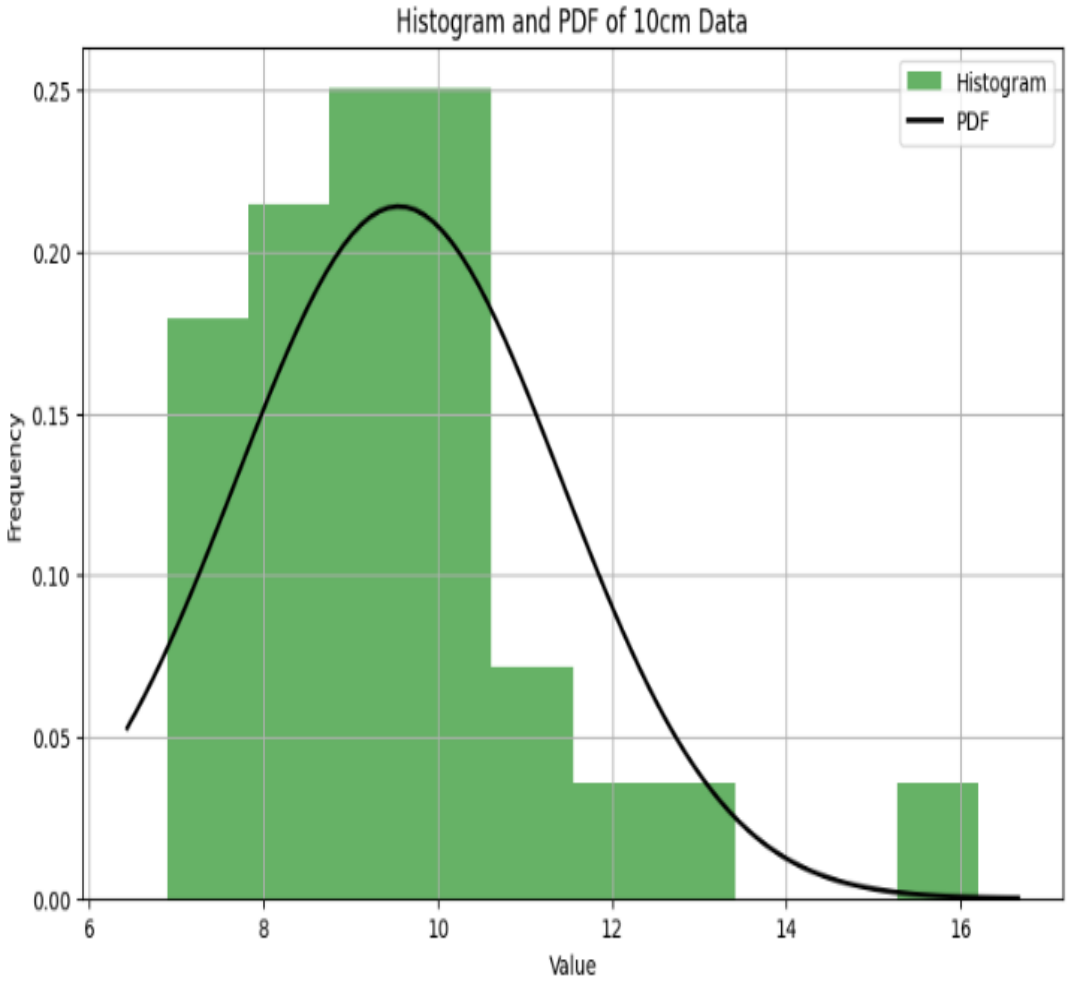
Distance Measurements:

- **5 cm Measurements:**



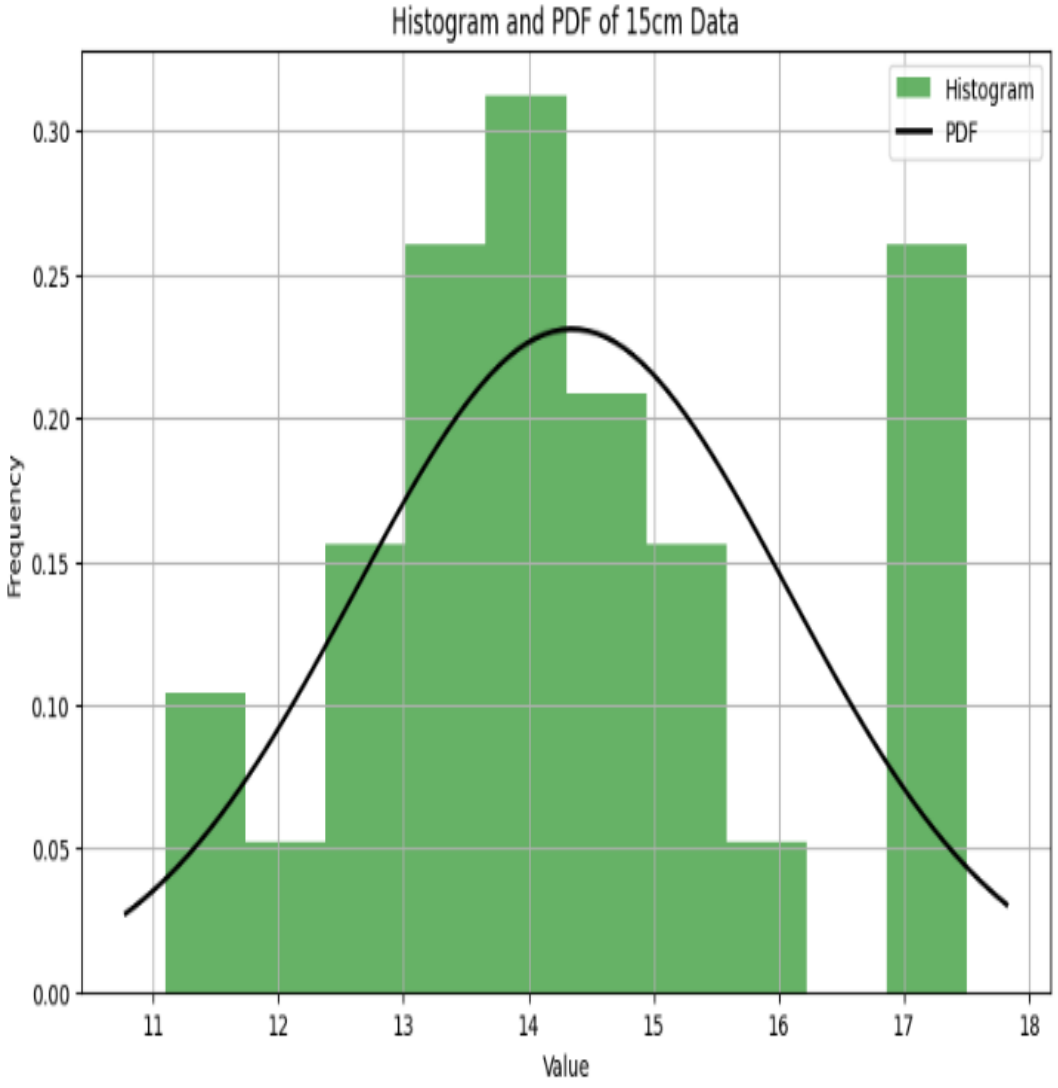
The histogram and probability density function (PDF) in the first chart indicate a right-skewed distribution, reflecting high variance and some values significantly deviating from the expected 5 cm distance, revealing considerable sensor error and noise. The mean is 4.91 and the variance is 5.23. The high dispersion and skewness suggest that, at short distances, the sensor may be influenced by sudden environmental changes or proximity limitations.

- **10 cm Measurements:**



The distribution of 10 cm measurements is slightly right-skewed but less so than the 5 cm measurements. This distribution indicates better accuracy at this distance, though there remains significant variance. The mean is 9.55 and the variance is 3.47.

- **15 cm Measurements:**



The distribution for 15 cm measurements is relatively symmetric, indicating increased accuracy and stability with increased distance, likely due to the reduced impact of proximity effects on the sensor. The mean is 14.35 and the variance is 2.98.

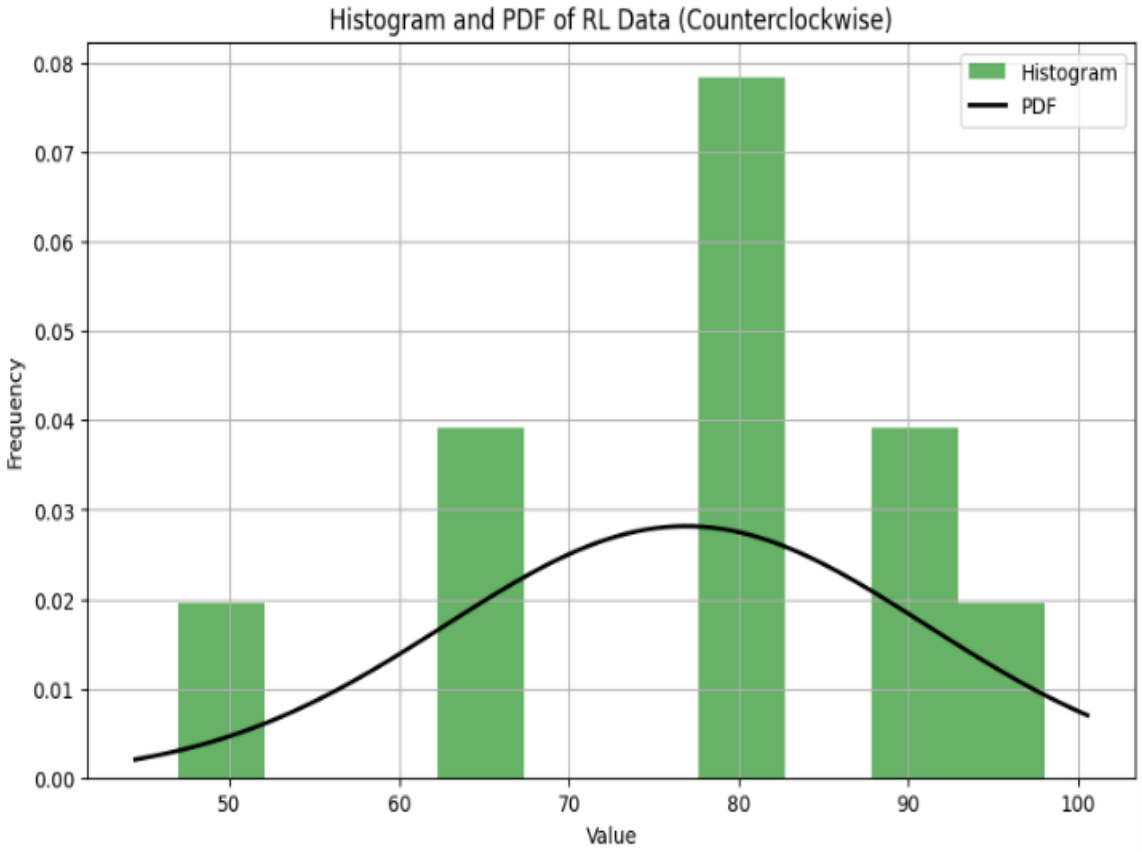
Motion Model Evaluation:

Linear Motion Analysis:

The accuracy of the robot's linear motion was tested at distances of 5 cm, 10 cm, and 15 cm, with each set of movements executed 30 times to assess the stability and error in linear motion. These tests demonstrated increased accuracy with longer movement distances.

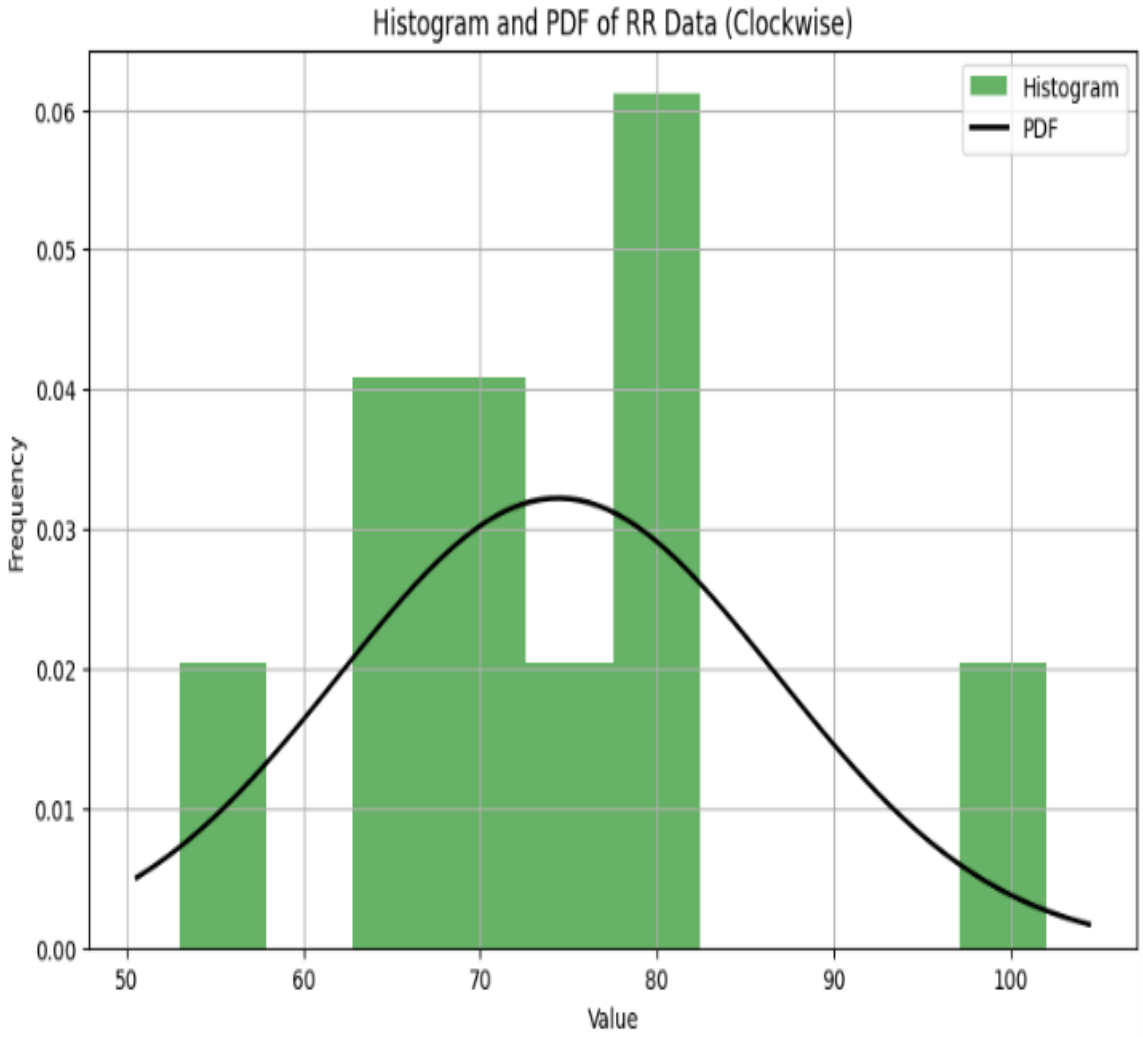
Rotational Motion Analysis:

- **Counterclockwise Rotation:**



The PDF and histogram for counterclockwise rotation show a broad distribution, revealing variability in angle or rotation speed during different tests. The mean is 76.9 and the variance is 200.69.

- **Clockwise Rotation:**



Similar to the counterclockwise results but with slightly lower dispersion, indicating relatively more stable performance in this direction. The mean is 74.4 and the variance is 153.44.

The experiments with the Vector robot across various distances and conditions have provided a rich dataset for analyzing sensor accuracy and dynamic motion characteristics. From close to medium distances, the sensor exhibited increased accuracy. The motion experiments highlighted the challenges of maintaining constant speed and angle during rotations, with significant variance in both directions.

These findings are critical for refining algorithms in the next phase of the project, where precise sensor and motion accuracy are essential for effective localization and navigation. Further adjustments and calibrations based on these results could enhance the robot's performance in real-world tasks.