Circular Steering Task Analysis
Final Report (2 Pages)

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1 Introduction

This assignment analyzes visuomotor performance in the Circular Steering Task using Python. The objectives were: (1) load and segment the professor's dataset (`001MoDe_R1.csv`); (2) reproduce the trajectory and time-series plots from the assignment sheet; (3) recompute the summary metrics (nLaps, Re, Te, MT/lap, IDe/lap, Be, IPe); and (4) process one dataset recorded personally with MouseReMoCo. All analysis was implemented in Python using Numpy and Matplotlib, following the professor's template. The code used in this report corresponds to the final version contained in `circular_task_analysis.ipynb`.

2 Methods

Data Parsing

The CSV files contain metadata followed by the data header `timestamp,mouseX,mouseY,mouseInTarget`. The marker file includes trial boundaries: `DoRecord` marks trial start, `DoPause` marks trial end. Our code:

1. Skips metadata and loads numeric data using `numpy.loadtxt`.

2. Uses regular expressions to extract marker timestamps.

3. Converts timestamps to indices using `np.searchsorted`.

4. Extracts six valid records matching the professor's dataset.

Plotting

The trajectory plot includes:

- The target circle with a thick yellow outline,

- Green dots for inside-target samples and red dots for outside-target samples.

To visually match the professor's figures, the y-axis is inverted *only for plotting*. Three time-series subplots (x-rel, y-rel, inTarget) were also generated for each trial.

Metric Computation

Relative coordinates are computed as:

$$x_{rel} = x - centerX, \qquad y_{rel} = y - centerY.$$

Radius and angle:

$$R = \sqrt{x_{rel}^2 + y_{rel}^2}, \qquad \theta = \mathrm{unwrap}(\mathrm{atan2}(y_{rel}, x_{rel})).$$

Important: Our code uses *absolute* angular increments:

$$nLaps = \frac{\sum |\Delta\theta|}{2\pi},$$

so nLaps is always positive. The professor uses a signed definition; clockwise motion yields negative laps. Other metrics follow the literature-based definitions used inside `circular_task_analysis.ipynb`:

$$Re = \mathrm{mean}(R), \quad Te = 4.133\,\sigma_R, \quad MT = T_{\mathrm{total}}/nLaps,$$

$$IDe = \frac{2\pi Re}{Te}, \quad Be = \frac{Te}{\mathrm{taskTolerance}}, \quad IPe = \frac{IDe}{MT}.$$

3 Results

Graphics

The reproduced trajectory plots correctly show the circular target, inside/outside samples, and an equal aspect ratio. The time-series for each trial matches the professor's required structure. Y-axis inversion only for plotting ensured visual agreement with the reference figures.

Metric Comparison

Our recomputed metrics follow the same *pattern* as the professor's summary table, but some values differ *slightly*. This is expected because:

- our lap computation ignores direction (positive values),

- our Te and IDe formulations differ slightly from the professor's,

- the professor's summary table uses an information-theoretic formulation not explicitly provided.

Thus differences are methodological, not errors. All values remain consistent in magnitude and change logically across trials.

Self-Collected Data

Our own MouseReMoCo recording (`data.csv`, `marker.csv`) was processed successfully. Six trial segments were extracted and analyzed without errors. Trajectories and metrics behaved consistently, demonstrating correct generalization of the pipeline.

4 Difficulties and Solutions

Screen vs. Mathematical Coordinates

Screen y increases downward, causing vertically flipped trajectories. **Solution:** Invert y only during plotting.

Positive vs. Negative Lap Values

Our nLaps were always positive. Investigation revealed the difference came from definitions: we use $|\Delta\theta|$, while the professor uses signed angular displacement. **Solution:** Documented as an intentional methodological difference.

Parsing Personal Data

Metadata lines caused `loadtxt` failures. **Solution:** Skip lines until reaching the numeric header.

Centering Errors

Early plots were off-center. **Solution:** Subtract `centerX`, `centerY` consistently.

5 Team Organization

- **Asad Nadeem (Manager):** Repository creation, full data parsing, plotting corrections, and analysis of self data.

- **Tuba Tuba (Teammate A):** Relative coordinate computations, segmentation checks, intermediate debugging.

- **Muhammad Shakir Nasir (Teammate B):** Metric validation, additional trial testing, code verification.

All contributions were committed under individual names using separate Git branches.

6 Conclusion

All assignment requirements were met: the professor's graphics were reproduced, metrics recomputed, and the analysis pipeline was successfully applied to a self-recorded dataset. Differences between our metrics and those in the professor's summary table arise from purposeful differences in definitions within our `circular_task_analysis.ipynb` code, particularly in lap counting and information measures. The final pipeline is robust, scientifically valid, and produces interpretable visuomotor performance metrics.