



U1.5 Seeing the signal

The robot as a system · University · about 20 min

Name _____

Class _____

Date _____

What this lesson is about

plot(): reading a control loop as a chart instead of a column of numbers.

- What to plot
- Reading the shapes
- Plotting truth against belief

Questions

7 marks in all

1. Which three lines, plotted together, answer most questions about a feedback loop? [1 mark]

Tick every answer that is true.

- ☐ A The measurement
- ☐ B The error, target minus measurement
- ☐ C The command you sent
- ☐ D The battery voltage
- ☐ E The loop period

2. The error stays large while the plotted command sits flat at 100. What is happening? [1 mark]

- ☐ A The command is saturated, and no amount of extra gain will fix it
- ☐ B The gain is too low and should be raised
- ☐ C There is a steady state error, which needs an integral term
- ☐ D There is too much delay in the loop

3. The error settles smoothly, but to a steady value that is not zero. What does that shape mean? [1 mark]

- ☐ A A steady state error, which needs an integral term
- ☐ B Under-damped: the gain is a little high
- ☐ C The sign of the correction is wrong
- ☐ D Sensor noise is reaching the motors

4. The error overshoots zero, comes back, and overshoots again by less each time. What does that shape mean? [1 mark]

- ☐ A Under-damped: the gain is a little high, or there is some delay in the loop
- ☐ B The correction has the wrong sign
- ☐ C A steady state error
- ☐ D The loop is saturated

5. The plotted error gets bigger on every tick. What are the likely causes? [1 mark]
- ☐ A The correction has the wrong sign, or the gain is far too high
 - ☐ B A steady state error that needs an integral term
 - ☐ C Sensor noise reaching the motors
 - ☐ D The loop is running too fast
6. A chart shows the error as a fuzzy band around zero, and the rotation command jitters along with it. [1 mark]
What is reaching the motors?
-
-
7. A plot of believed y from odometry() and true y from position() shows two lines that start together and [1 mark]
slowly separate. What does that picture show?
- ☐ A Dead reckoning drifting away from the truth, which state estimation exists to prevent
 - ☐ B A controller that is oscillating
 - ☐ C A command that has saturated
 - ☐ D The lag of the drive after a step

The task: plot the error

Drive into the green zone under proportional control, plotting two lines as you go: `error` and `rotation`.

```
from bugbot import *
connect()

def wrapped(a):
    return (a + 180) % 360 - 180
```

Plan your program here, then type it in and press Run.



Do it on the robot

www.bugbotlab.com/learn/u1-5-seeing-the-signal/

The simulator checks it and tells you when it passes. Nothing to install, no account.

Challenges

1. Plot `heading()` and `imu()[0]` together. What is the gap, and is it constant?
2. Plot the same error with the gain at 1, 3 and 9, one run each, and describe the three shapes.
3. Plot the distance to the wall ahead while driving towards it. Where does the noise become a problem?

