ENGI 128

INTRODUCTION TO ENGINEERING SYSTEMS

Lecture 9:
Measuring Distance

"Understand Your Technical World"

PS05: Robot Simon

Study Skills Quiz

When is the best time to start your homework?

a. The night before it is due

b. When you get back from a party

c. the day it is handed out

When is the best time to go to office hours?

a. the day before the homework is due

b. never

c. as soon as you think you need help

When should you work with a partner

a. Only when the assignment is really hard

b. Only is (he/she) is *really* cute

c. All the time

Time Management

Measureing Distance

How to Measure Distance?

The hard way: Become a Ancient Greek Bematist

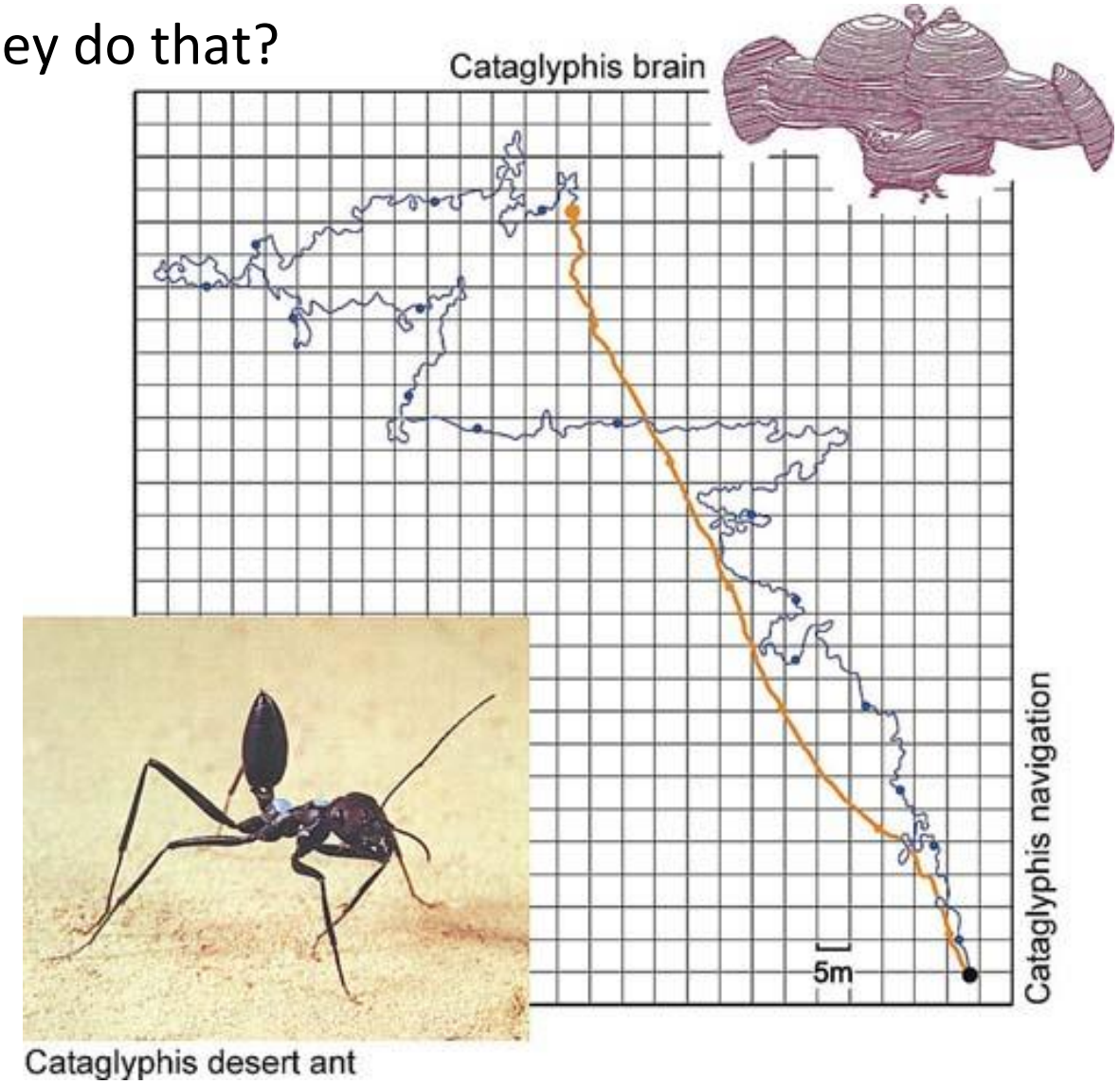
And learn to walk with *very* regular paces

Errors of ~2%

Insects do this quite well…

Orange path length is ~ 130 meters

How do they do that?



Dr. Rüdiger Wehner wondered that too…

Rüdiger Wehner, et. al. *About a bazillion publications*, The last 30 years

Modern Humans Apparently Have De-evolved…

Now we need add-on pedometers

Odometer in Cars

A drive cable from the front wheel connects to the back of the unit

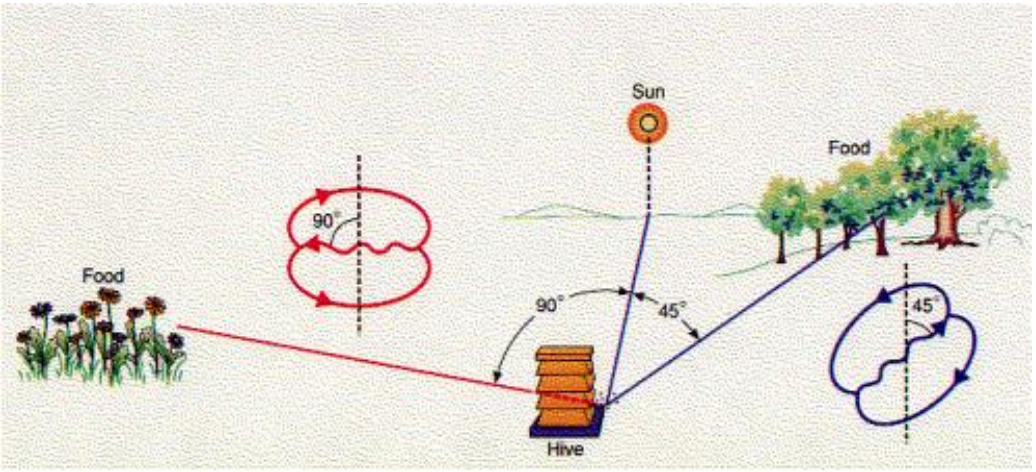
- What's a drive cable?

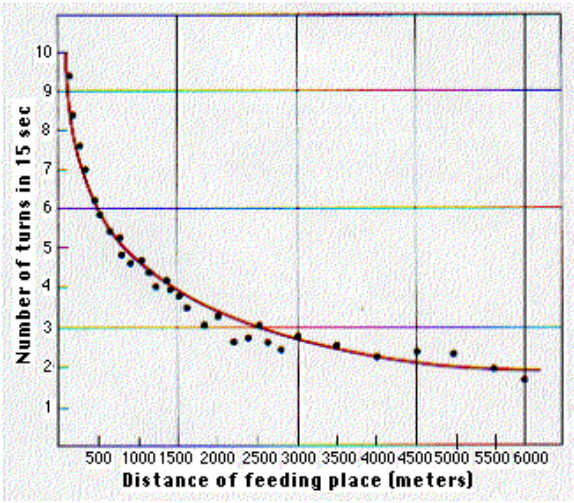
What is the gear ratio between the digits?

Odometers in Bees?

They must have them…

Because they do the “Waggle Dance”





Karl von Frisch, *Aus dem Leben der Bienen*. Springer Verlag Berlin (1927)

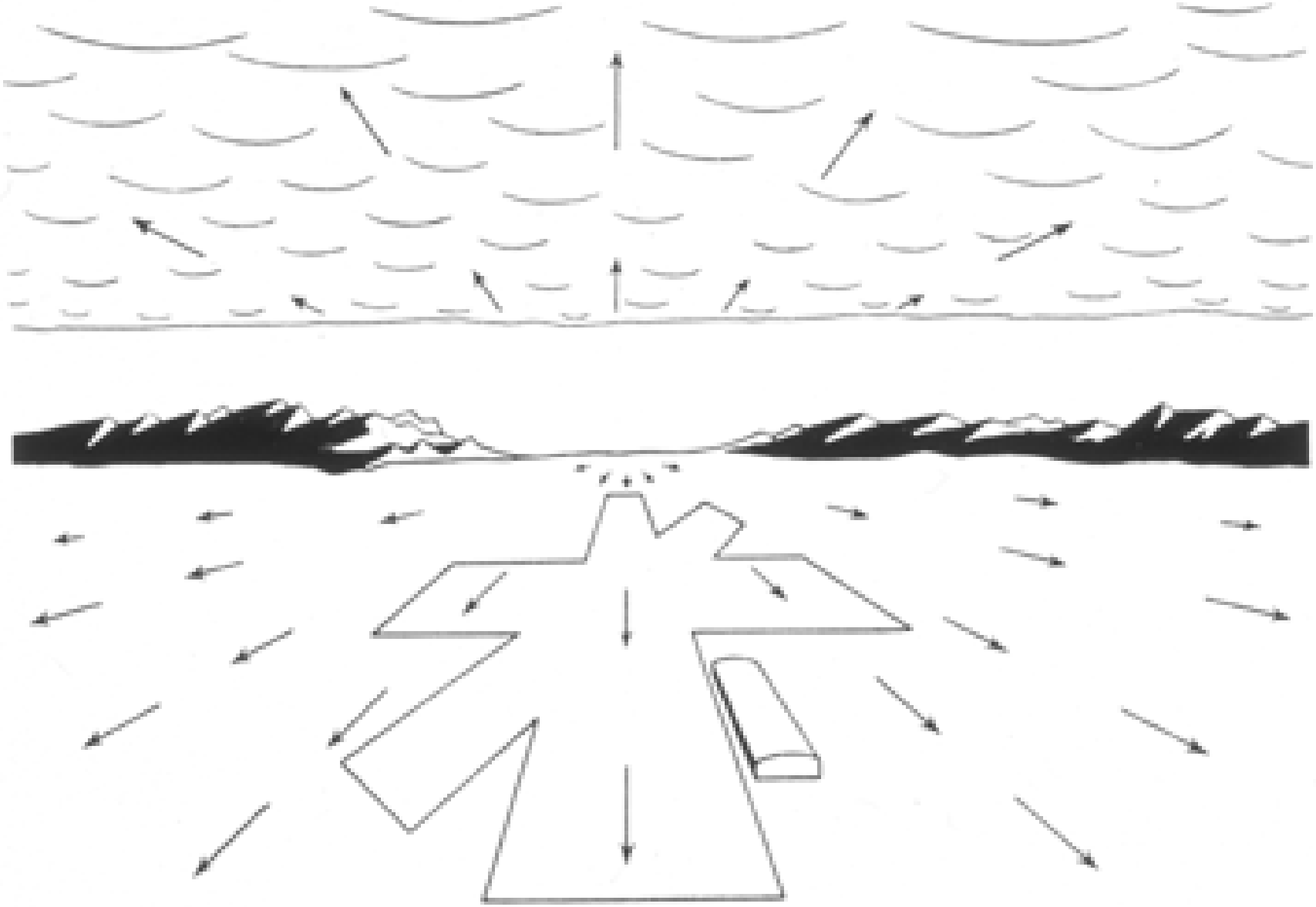
But they don’t touch the ground when they are flying!

How do they measure distance?

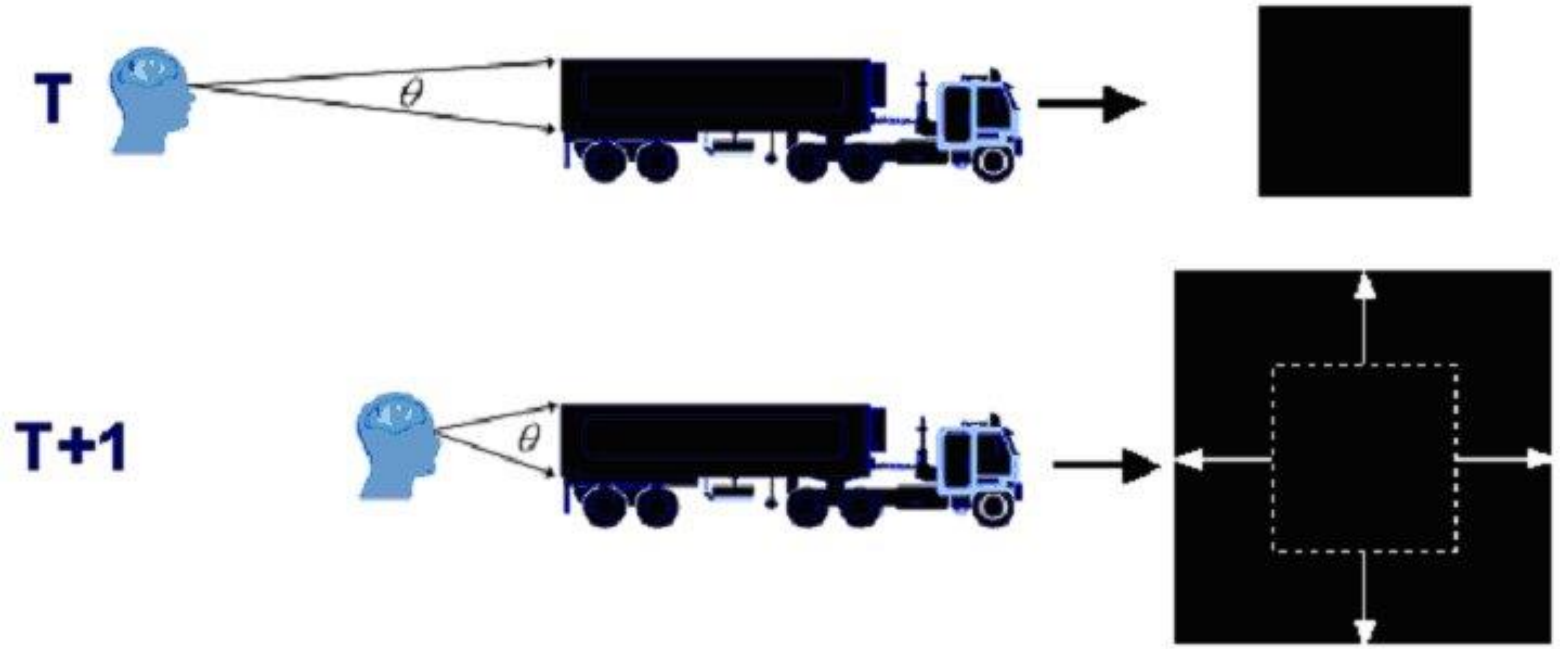
Optic Flow

M.V. Srinivasan, S.W. Zhang, M. Altwein, J. Tautz (2000) *Honeybee navigation: nature and calibration of the 'odometer'*. Science 287, 851 ? 853.

Optic Flow



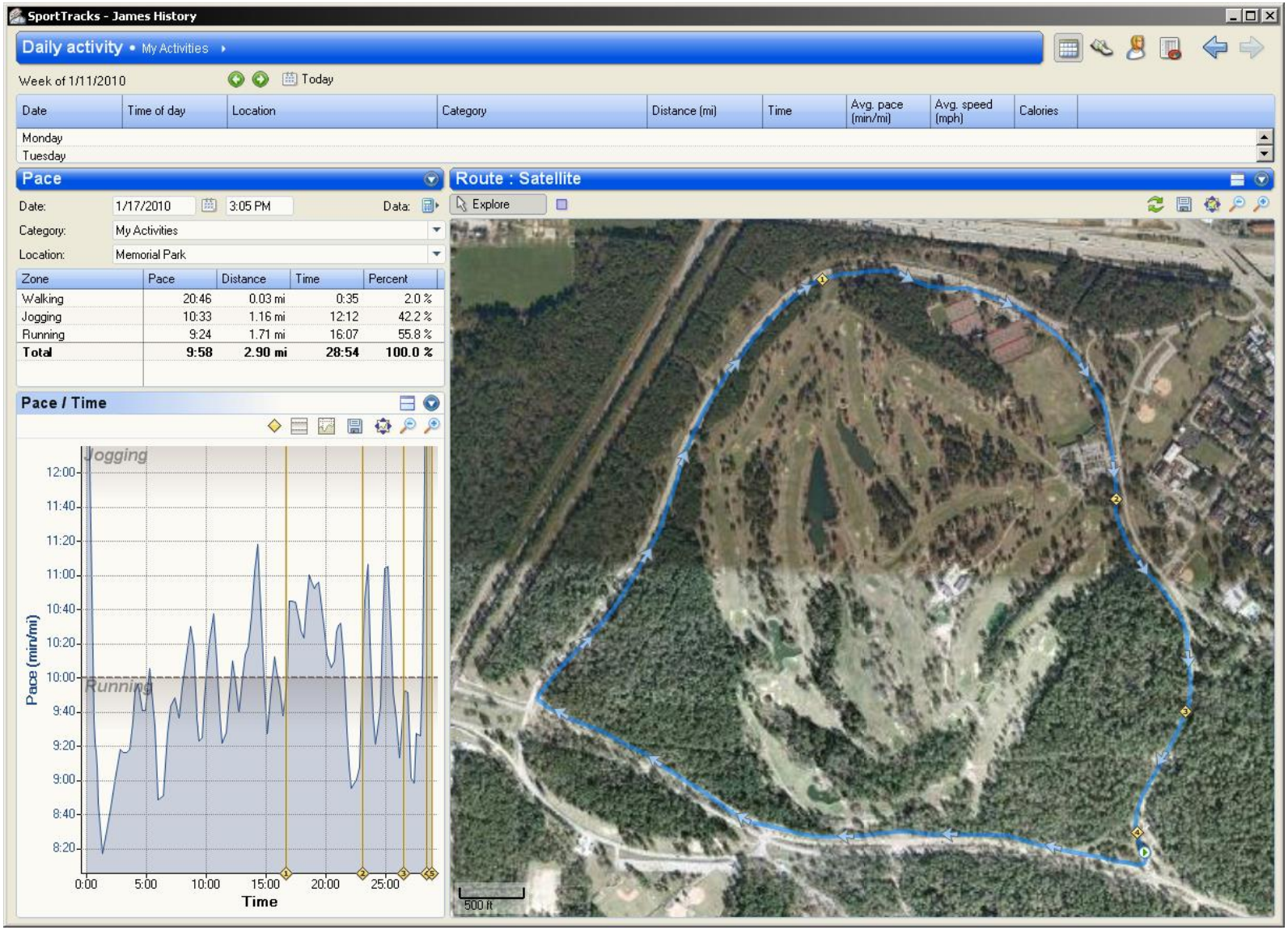
(An Aside: Predicting Time to Collision)



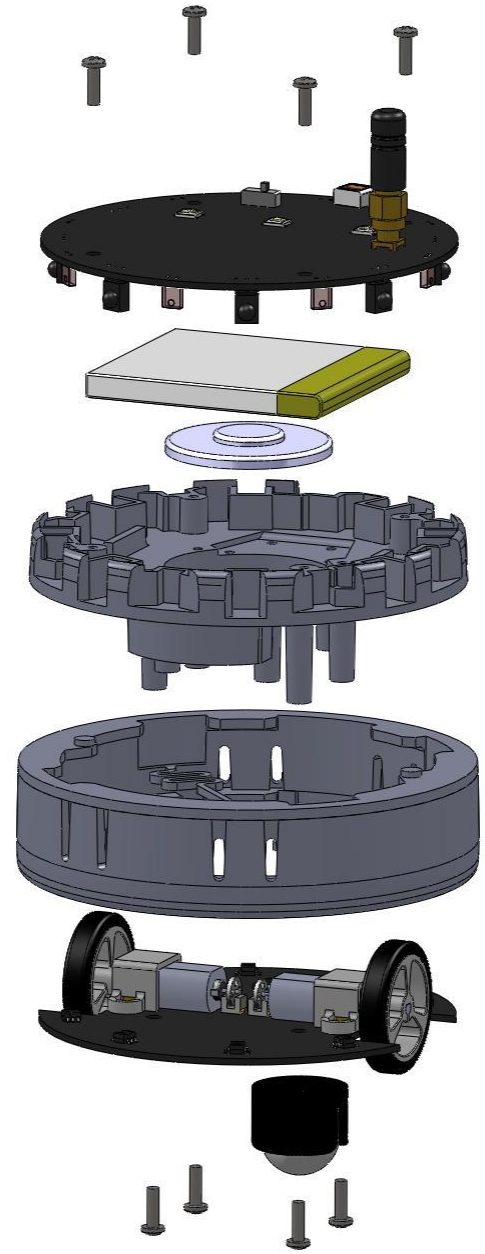
$$\tau = \frac{d\theta}{\left(\frac{d\theta}{dt}\right)}$$

The Ultimate Pedometer:

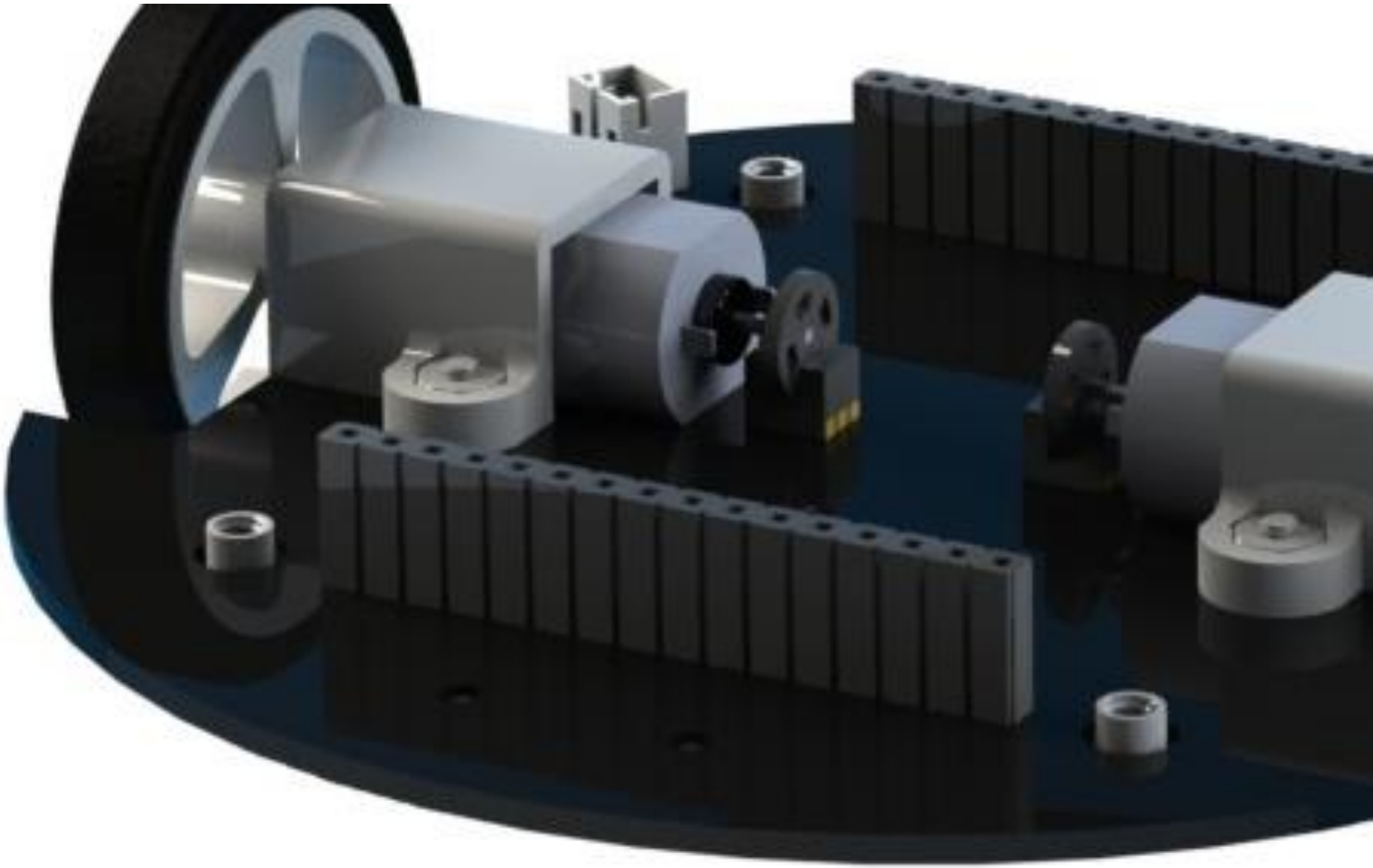
The Global Positioning System

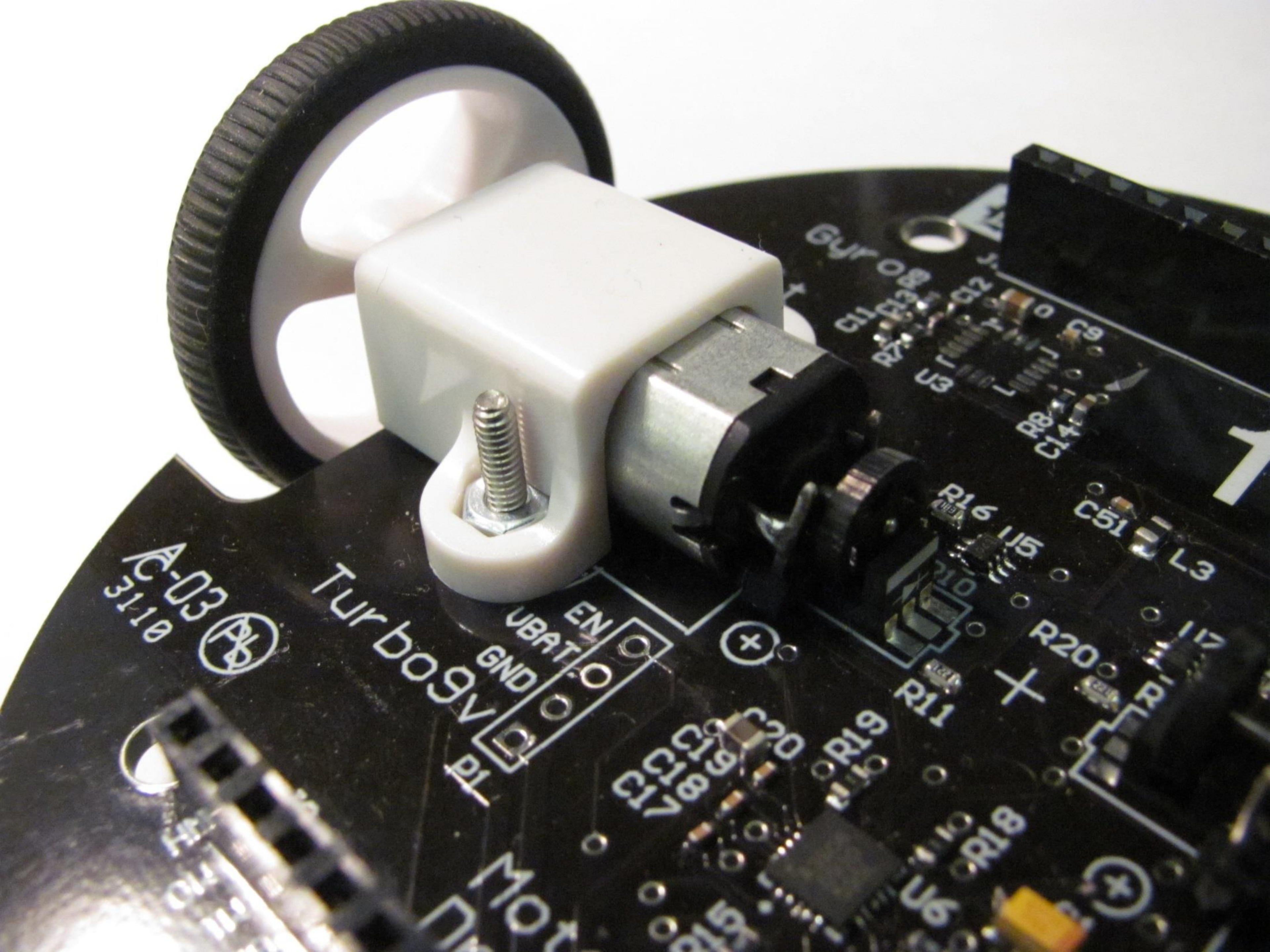


Distance on the r-one



the r-one Optical Quadrature Encoder

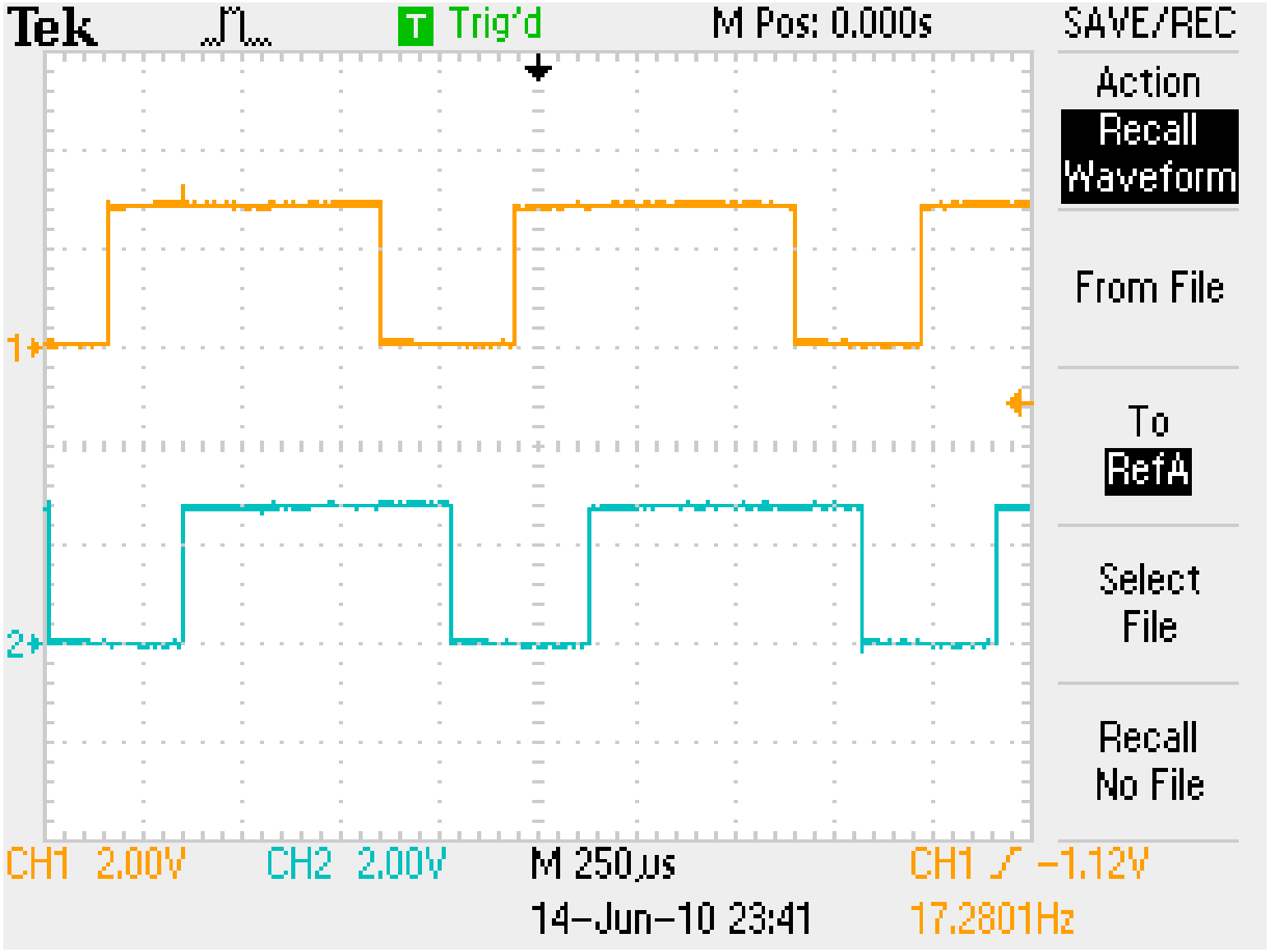




Gyro
C12
C9
U3
R8
C14
R16
U5
C51
L3
EN
VBAT
GND
P1
3110
R20
R11
R19
C20
R18
U6

[whiteboard: rotating encoder wheel]

Encoder Waveforms



[whiteboard: r-one encoder resolution math]

Speed

Speed

Well, it's easy on your robot:

First you…

Well, it's question #1 on your next homework.
And I wouldn't want to spoil the fun…