E-Puck – a mobile robot

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Outline

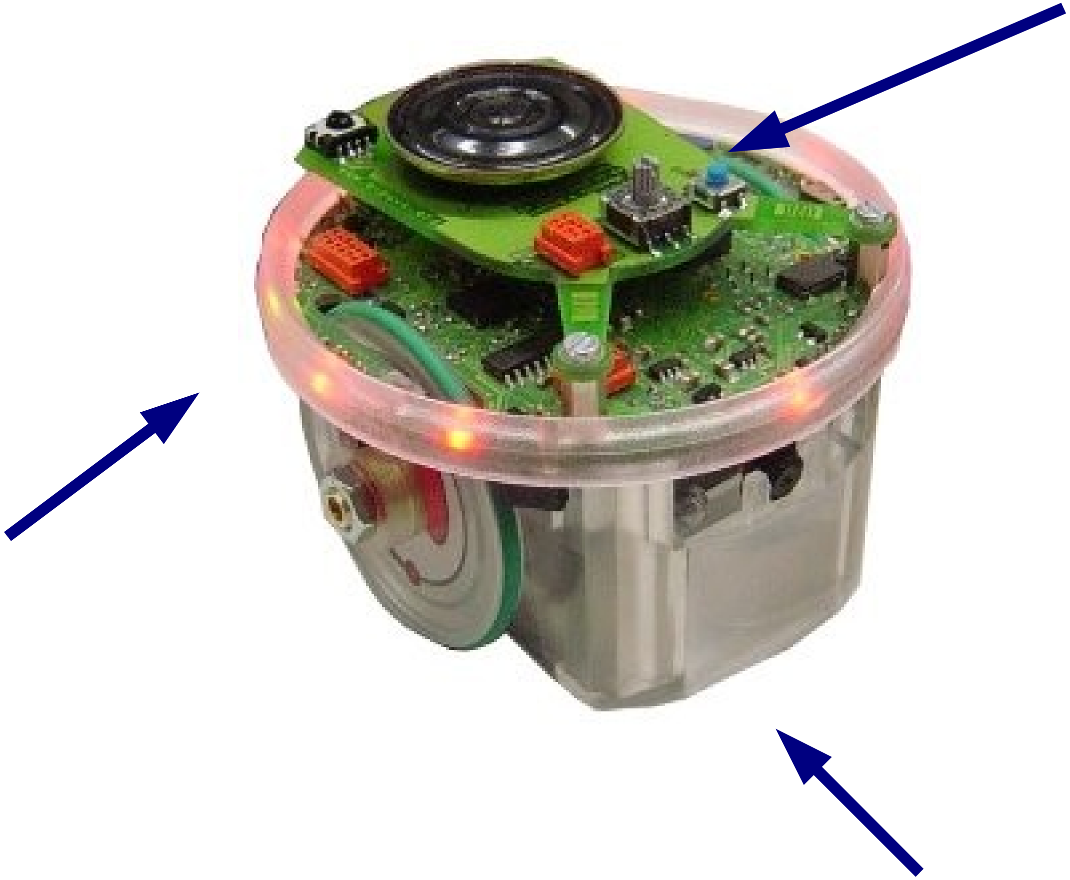
- Introducing the E-Puck
- Communication
- Motors
    - Odometry
- Sensors
    - Calibration
- Case study Braitenberg vehicle

Always intermingled with MATLAB knowledge!

Mobile Robots at INI

Introducing the E-Puck

Introducing the E-Puck

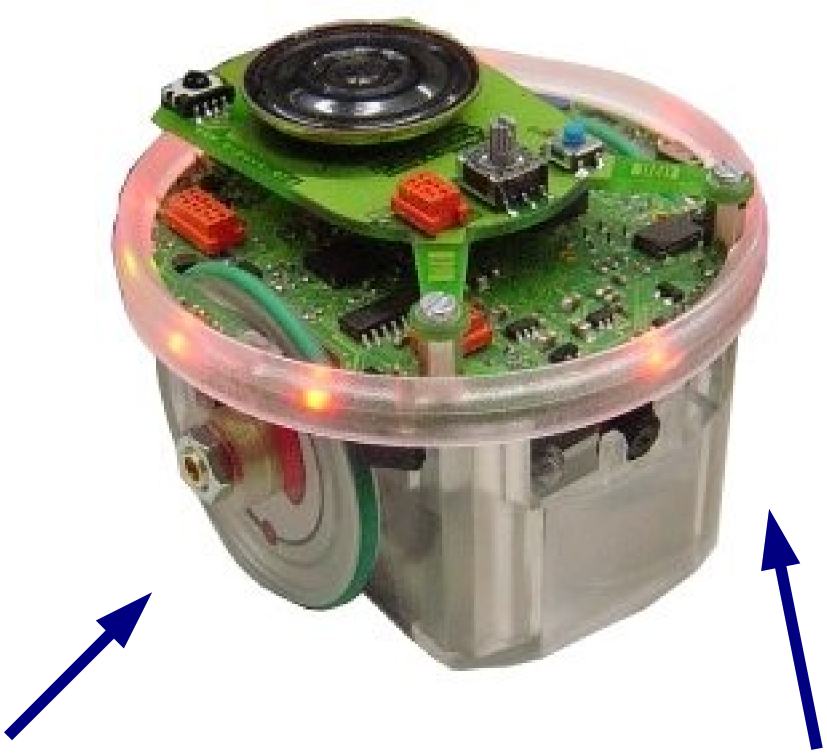


Reset button

On/off switch

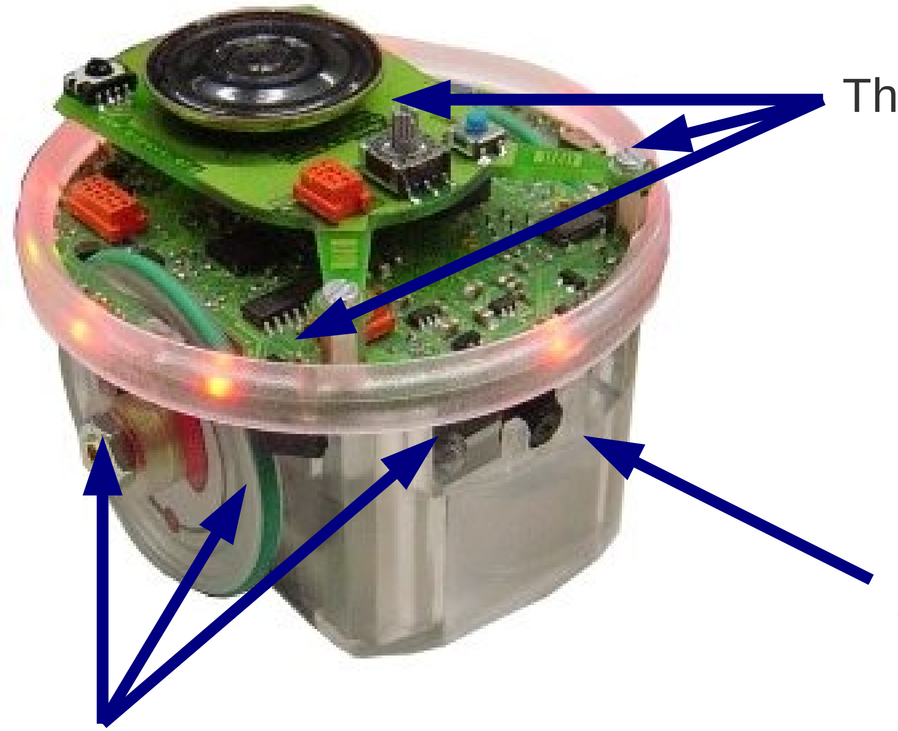
Battery

Introducing the E-Puck



Two wheels with separate motors and encoders

Introducing the E-Puck



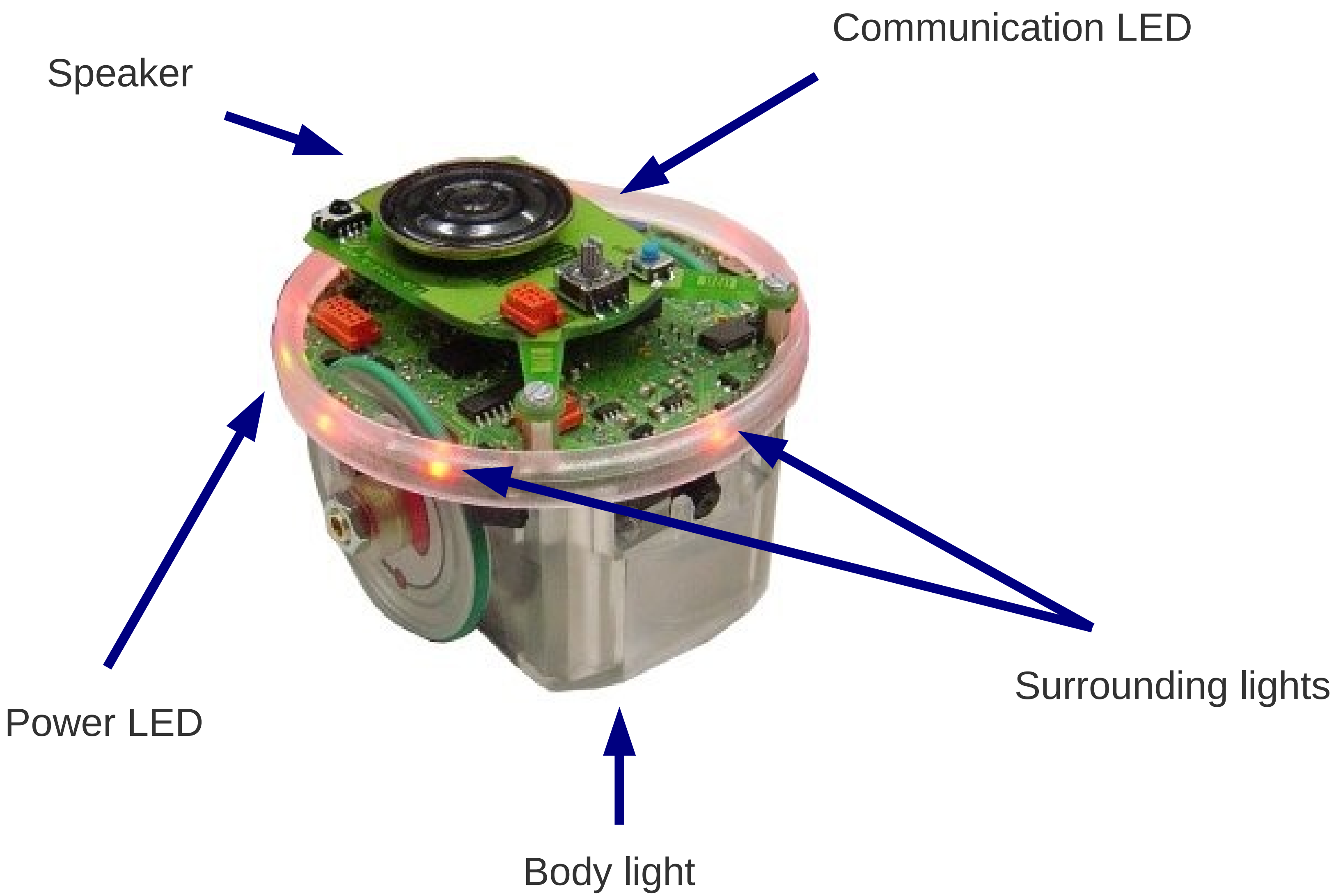
Accelerometer

Three microphones

VGA camera

Eight active infrared sensors

Introducing the E-Puck



Communication LED

Speaker

Power LED

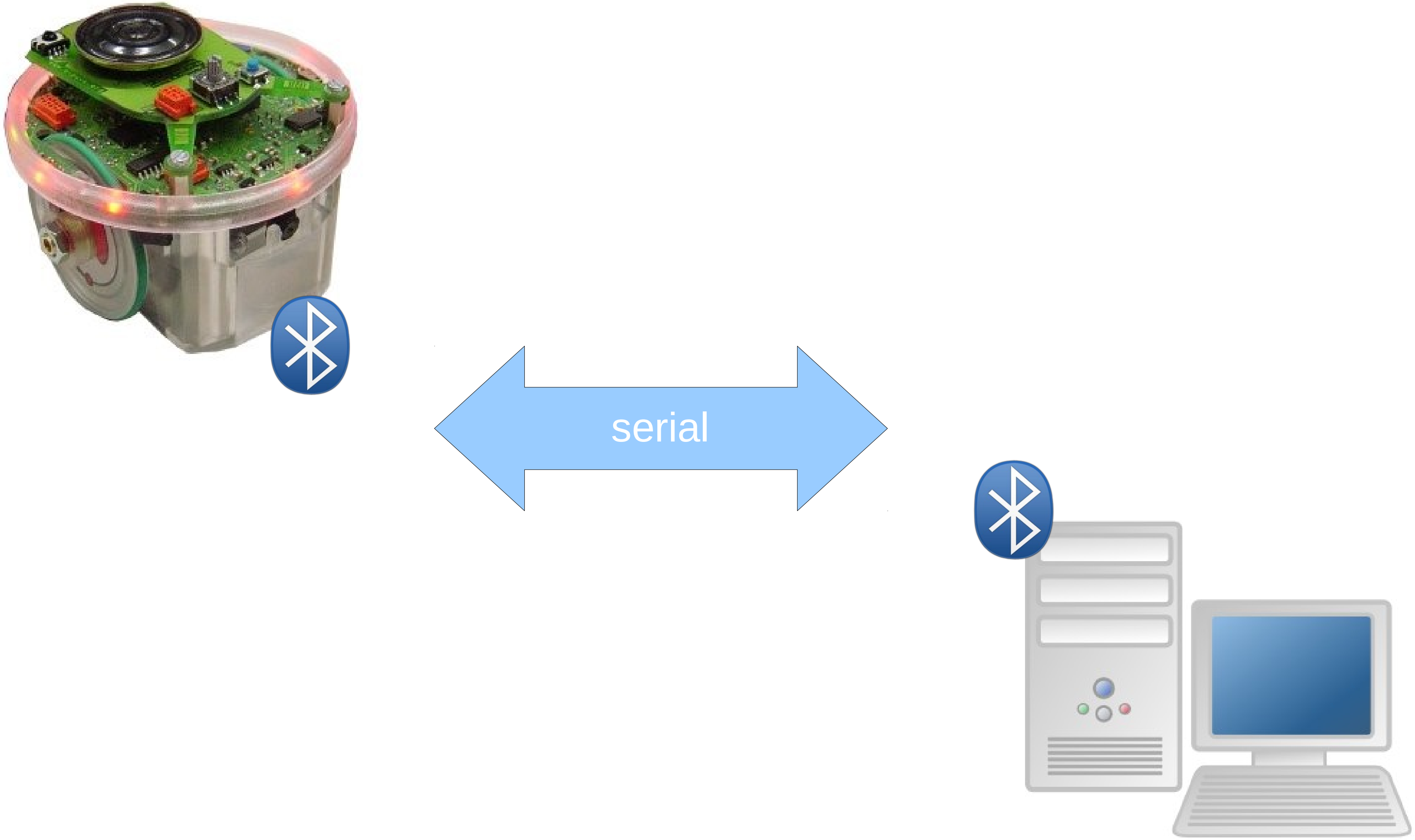
Surrounding lights

Body light

Introducing the E-Puck

On-board camera is mainly useless!

Communication



Communication in MATLAB

- Get handle with **kOpenPort**
  - you get a confirmation message
  - on Windows: insert proper COM port first
- Only on Linux: store handle in variable
- Close serial port with **kClose**

OR

- Use initialization scripts
  - setupEPuckRobot.m, closeEPuckRobot.m

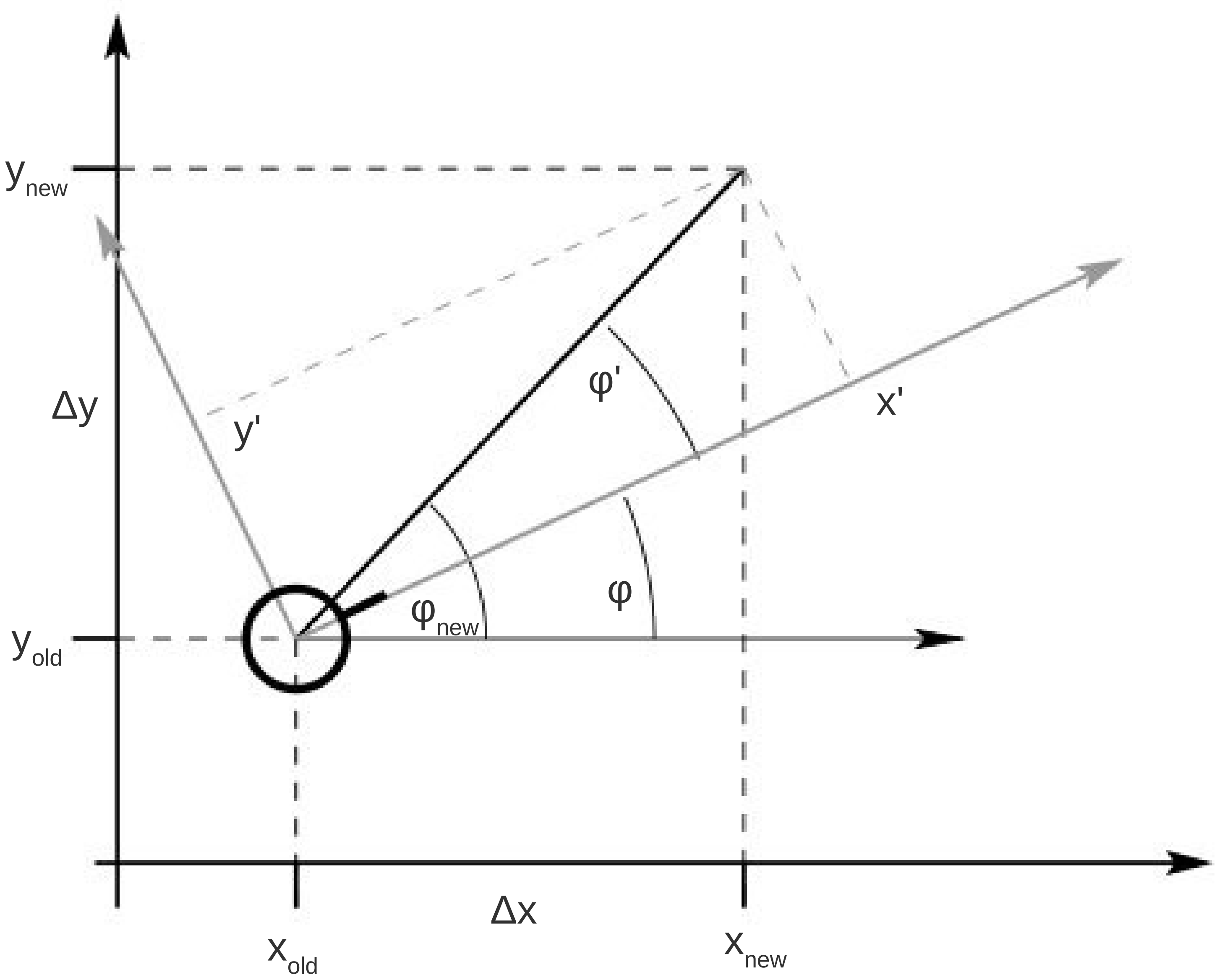
Motors

- Two separately controllable motors
- Encoders on both wheels
- Unit of velocity and distance: encoder pulses
- For E-Puck: 0.13 mm per pulse
- That's 7.692307692 pulses per mm
- Velocity is specified as pulses per second

Motors in MATLAB

- **kGetSpeed**, **kSetSpeed**
  - Get or set the robot's velocity
  - No timing parameter, executed ad infinitum
- **kGetEncoders**, **kSetEncoders** (Linux only)
  - Get or set the robot's integrated encoder values
  - Should be resetted once in a while
- **kStop**
  - Never forget to set the robot's velocity back to zero!

Motors and odometry



Motors and odometry

$$
\begin{aligned}
\Delta x &= x' \cdot \cos(\phi) - y' \cdot \sin(\phi) \\
\Delta y &= x' \cdot \sin(\phi) + y' \cdot \cos(\phi) \\
\phi_{\text{new}} &= \phi + \phi'
\end{aligned}
$$

Motors and odometry in MATLAB

- Call **integrateForwardKinematics** with
  - Travelled distance for both wheels
  - Last position and heading returned by this function
  - Wheel distance in mm
- Return value contains
  - New x,y coordinates
  - New heading direction

Sensors

- 8 infrared sensors
  - All around the robot's body
  - Passive mode: measure ambient light
  - Active mode: measure reflected infrared light
- 3 microphones
  - At -90, 90, and 180 degrees
- PAL camera
  - Maximum resolution of 720 x 576
  - External battery, not part of e-puck

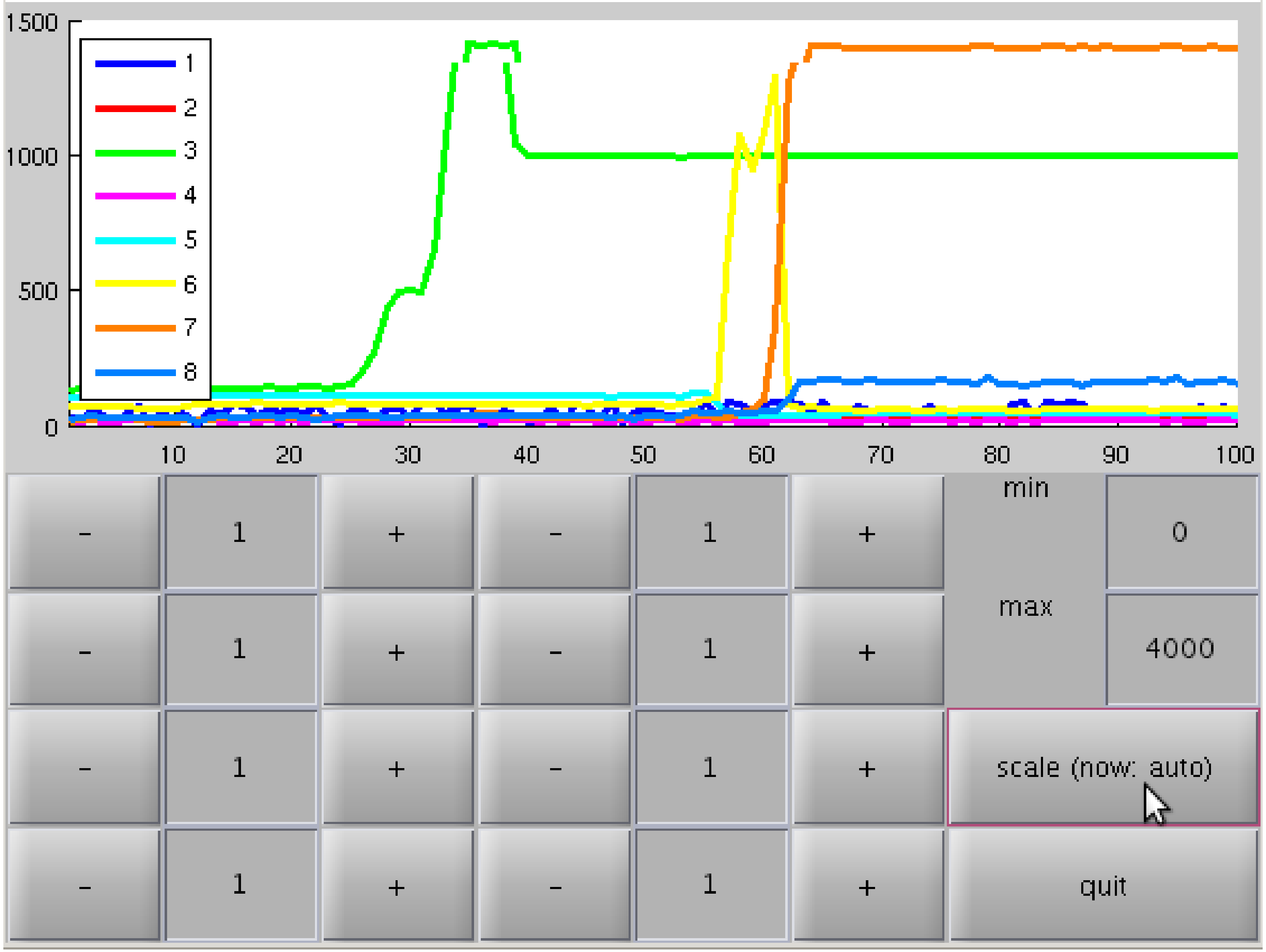
Sensors in MATLAB

- **kProximity**, **kAmbient**
  - Active and passive mode of IR sensors
  - All eight sensors are returned for each call
- **kGetMicrophones**
  - All three microphone amplitudes are returned
- Image acquisition toolbox (Windows only)
  - vid = videoinput('winvideo', 1, 'YUY2_640x480');
  - Initialization...
  - trigger(vid); getdata(vid);

Sensor Calibration

- IR sensors are not identical
  - Manufactoring errors
  - Vertical alignment
- We provide a simple solution
  - Determine weights for all sensors with GUI
  - Weaken or strengthen specific sensors

Sensor Calibration in MATLAB

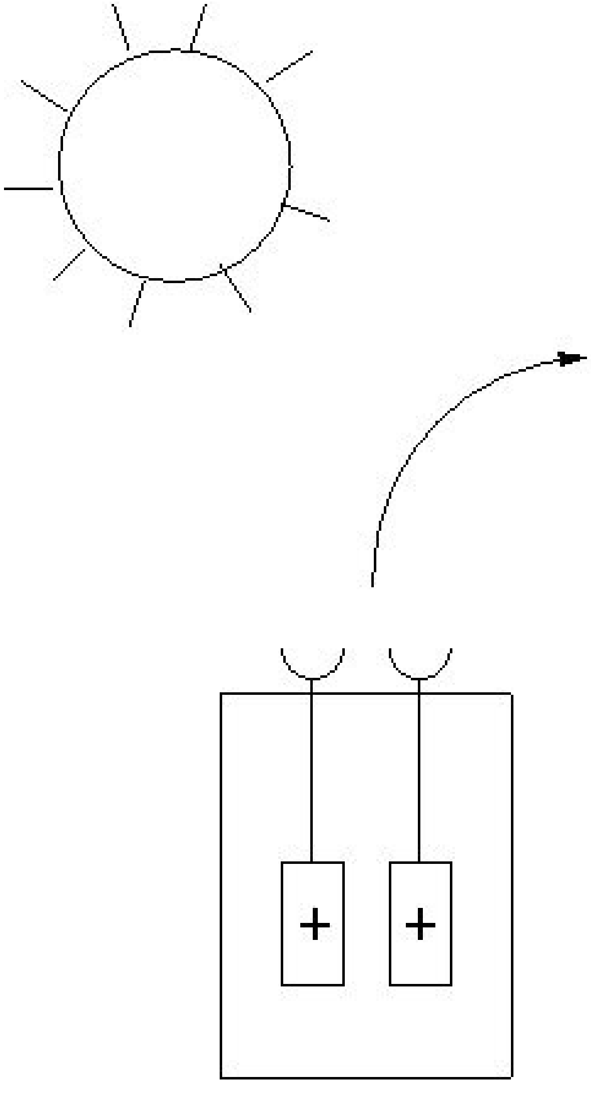


min 0

max 4000

scale (now: auto)

Case Study Braitenberg



Braitenberg 1986

Case Study Braitenberg

- Open communication
- In a loop
  - Call **kGetAmbient** to receive current sensor values
  - Take only the front sensors (e.g. 1 and 8)
  - Translate from sensor signal to motor strength
  - Call **kSetSpeed** to set a new velocity for each wheel
  - Insert a pause
- Close communication

The Wrapup

- Learning by doing
- We provide you with
  - Cheat sheet for constants
  - Cheat sheet for functions
  - Templates
    - Odometry
    - Sensor calibration
    - Getting camera images
- If you experience any difficulties, just ask!