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Energy Consumption of a Hexspider Robot-o as Function of Footwear and Underground - Experimental Investigations

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Content

Introduction

Background:

- Cyber Physical Systems (CPS) → microcontroller → Arduino platform.
- IoT systems as robots - e.g. Hexspider or Spiderino → swarm robots or robot-os
- according to Orgiton theory → cybernetic elements of mass, energy, information units.

Goal:

- Determine energy consumption as a function of friction-pairs - feet and floor

→ energy optimisation of robotic applications, robot-os.

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Background-Robot-o I

Position:

We can influence Energy consumption of a Robot-o by friction pairs.

Background:

- spiderin-o$^{a}_{b}$ $\rightarrow$
  - a as the type of footwear, and
  - b to the type of ground.
- Intermission of a "wear", changes the relation of a system to its environment.

$$E(\mu_{a,b}) \stackrel{!}{=} opt \tag{1}$$

Energy Consumption of a Spiderin-o I

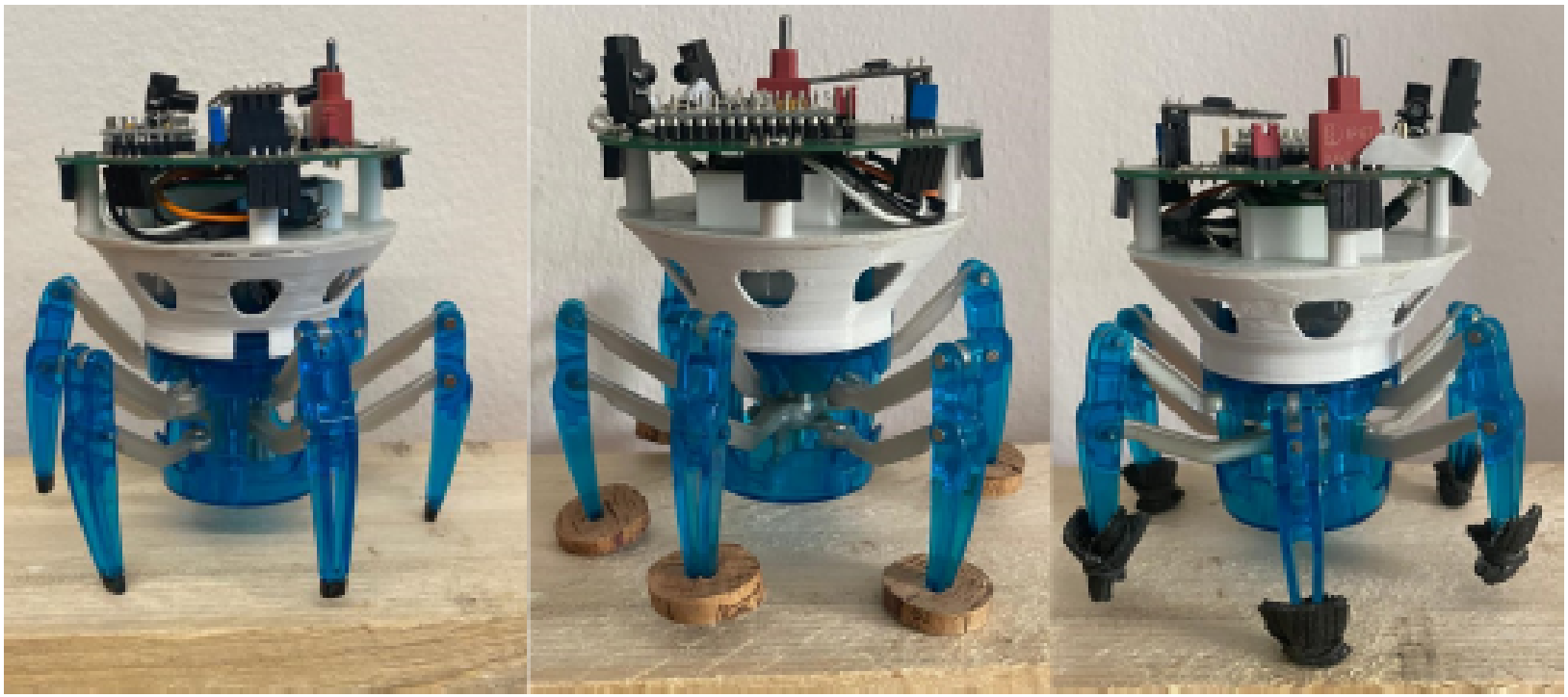

Figure 1: Robot-o with standard, cork, and rubber footwear from left to right according to Koren 2021.

Energy Consumption of a Spiderin-o II

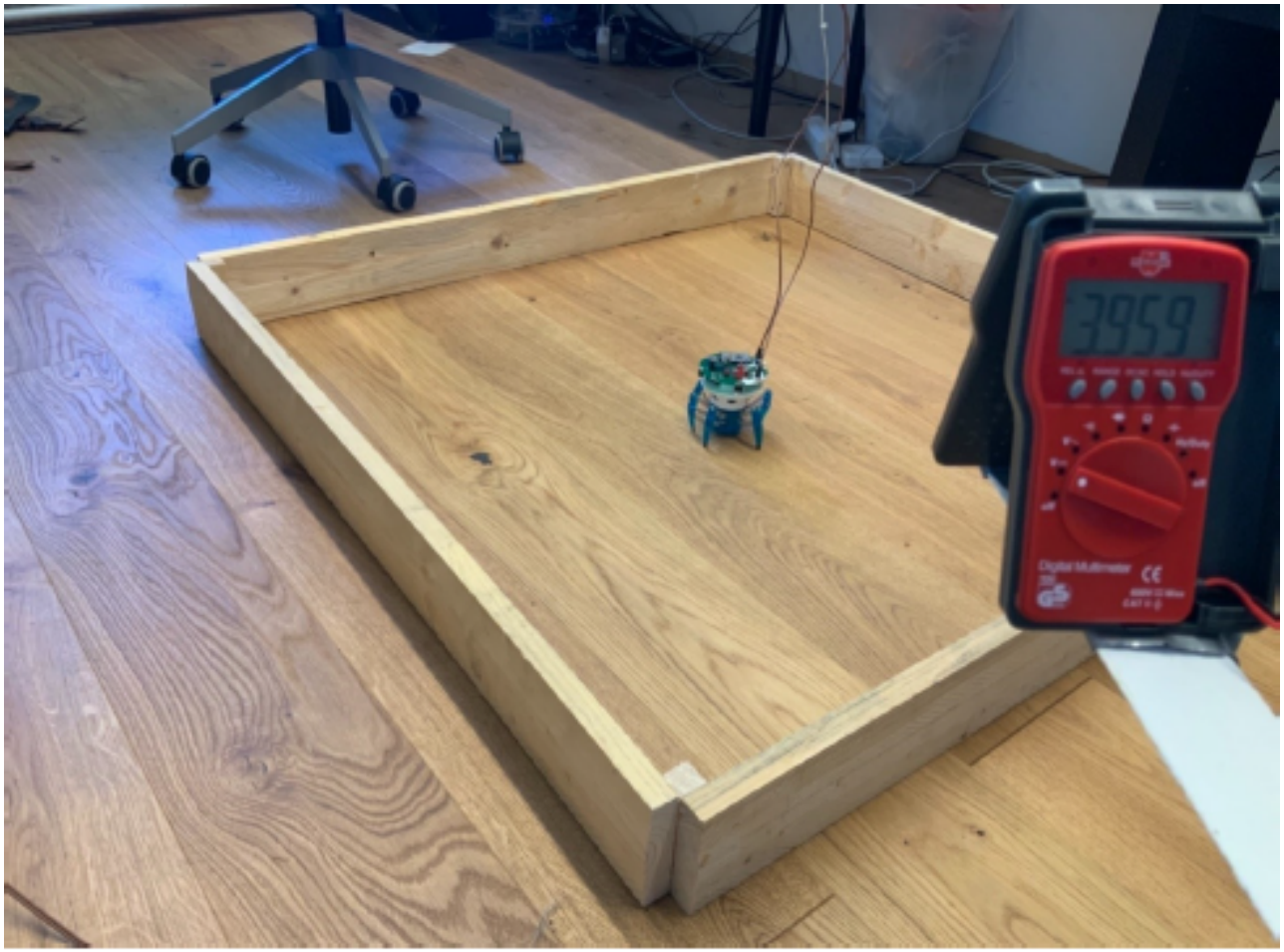

Figure 2: Robot-o platform and measurement according to Koren 2021.

Energy Consumption of a Spiderin-o III

With height (h) of movement:

$$h \sim t \rightarrow E \sim t \tag{2}$$

Now when we assume E to be the potential energy

$$E = E_{pot} + E_x = m \cdot g \cdot (h + x) \tag{3}$$

then it follows

$$\frac{E}{m \cdot g} \sim t \sim (h + x) \tag{4}$$

Energy Consumption of a Spiderin-o IV

Now having two robot-os with different mass m_1, m_2, due to their footwear as in the experiments, and also different Energies E_1, E_2, we get the relation at the same time:

$$\frac{E_1}{E_2} \sim \frac{m_1}{m_2} \tag{5}$$

When we take 1 for standard and 2 for rubber or cork: m_1=119 g and $m_2 = 120$ g then

$$E_2 \sim \frac{m_2}{m_1} \cdot E_1 \tag{6}$$

$$E_2 = \gamma \cdot \frac{m_2}{m_1} \cdot E_1 = \gamma^* \cdot E_1 \tag{7}$$

from the experiments $\rightarrow$ γ^*=1.0005

Energy Consumption of a Spiderin-o V

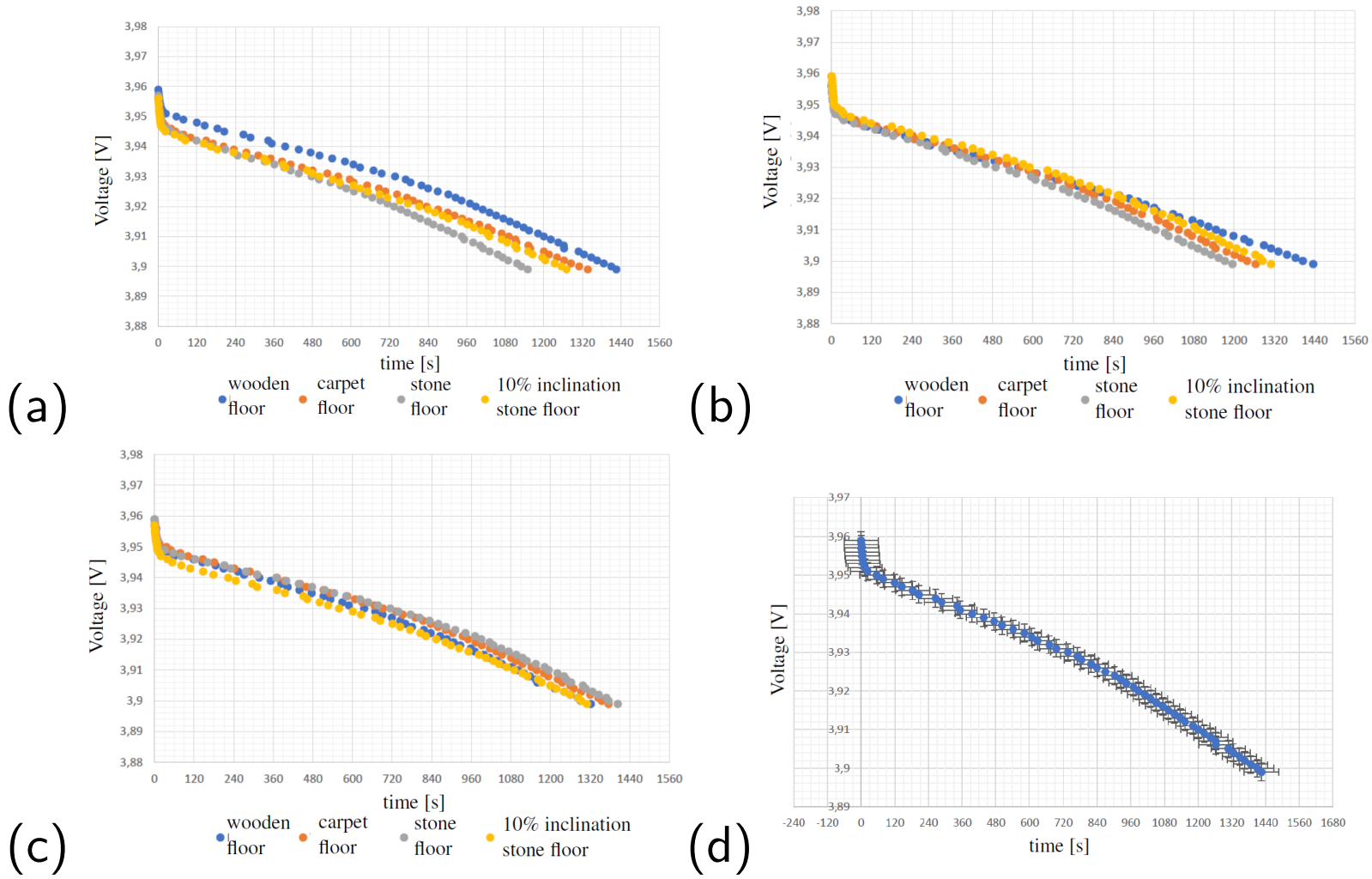

Figure 3: (a) standard feet / (b) cork feet / (c) rubber feet / (d) measurement error

Logistics Application I

- Industrial and Private Purposes:
  - Transport assistant tasks;
  - Private mobility assistance;
  - Good energy performance on the stone $\rightarrow$ Potential applicable for transport operations in mining industry
  - Application for stair climbing $\rightarrow$ decrease of energy consumption needed

Conclusions and Outlook I

Summary and Conclusions:

- Spiderin-o Robot-o investigated for friction pairs:
  - Feet: standard (plastic) / cork / rubber and
  - Floor: wood, stone, carpet, stone-10% inclination
- homogenisation or domination effect of
  (a) Inclination
  (b) Rubber

Outlook:

- More, more accurate, and position measurements
- Automated measurements
- Explicit friction pair measurements for used materials

Thank you cordially for your attention!

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PS.: The presentation can later also be found at:

http://www.dr-heiden.com/Vortraege.htm

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