Use of the e-puck accelerometer to detect earthquakes

Laura Pasero, Gabriel Kathari, Loïc Brouet
Presentation summary

➢ Introduction

➢ Methods & Experiments

➢ Results

➢ Conclusion
Introduction

- Earthquakes
  - result of release of energy in the earth crust
  - creates 2 types of waves: body & surface waves
    (b) Primary
    (c) Secondary
    (e) Love
    (d) Rayleigh
  - frequencies from 5 to 40 Hz
  - to simulate it: use of phone vibrator (about 25Hz)
Introduction

- **E-puck accelerometer**: detection tool

  - measure the changes in acceleration: rate of change of velocity (along 3 axis)
  - linked to voltage measurement
  - gravity = $g = 9.81\text{m/s}^2 = 744$ units of acceleration on E-puck (0 to 4096 units)

<table>
<thead>
<tr>
<th>Acceleration range</th>
<th>± 2g</th>
<th>± 19.6m/s$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min amplitude detectable</td>
<td>± 15 units</td>
<td>± 0.02g</td>
</tr>
<tr>
<td>Max amplitude detectable</td>
<td>4096 units</td>
<td>± 2.75g</td>
</tr>
</tbody>
</table>
Introduction

• Goal of the project:
  - Detect earthquake (e.g. phone vibration) with the 3-axis accelerometer of the e-puck and show it in real time

• Questions to answer:
  - Is the e-puck able to detect earthquakes waves and with which accuracy?
  - What are the factors limiting the accuracy of the detection?
Methods & Experiments

Use of Fourier Transform

- useful to get **frequencies and corresponding amplitudes** of a signal
- in order to distinguish different signals

Description of a signal in time and frequency domain
Webots simulation to get prepared

➔ one e-puck to simulate earthquakes with stepper motor
➔ another to get accelerometer values

matlab analysis to find main frequencies of receiving signal
Phone vibrations to simulate earthquakes

main frequency here: 25 Hz

frequency range chosen: 22 to 32 Hz
Hand shaking

=> low frequencies = easy to ignore
C-Code implementation

FFT done for each axis
every 256 data collected

if i: [a:b] & magnitude > c → earthquake detected

(i indice corresponds to frequency)

Sampling frequency calibrated on 90 Hz
⇒ [a:b] = [60:90]

Fig. : architecture of the C code
C-Code implementation

magnitude c defined by experimentation
Limitations

When we drop e-puck on the table,
we get same frequencies and high amplitude
→ complicated to filtrate this signal
➢ Results

- Strong results with FFT
- Drop the e-puck on the table is the only problem.
- With the FFT hand shaking are never detected

If the e-puck is already on the support it will detect the earthquake signal every time without any trouble.
Démonstration en vidéo :

![Image of demonstration](image-url)
➢ **Conclusion**
Is the e-puck able to detect earthquakes?
- Only with fake experiment.
- Only with phone vibration as reference.
Conclusion

Is the e-puck able to detect earthquakes?

- No real test in large scale