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Real-Time Emotion Assessment System in Smart Classrooms Using Wearable Bracelets

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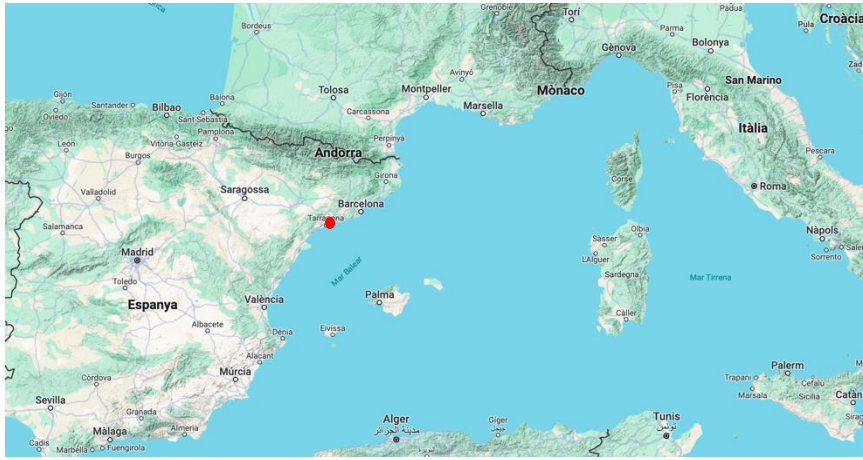

12 K graduate students
3.5 K postgraduate
1.5 K PhD
1.2 K professors

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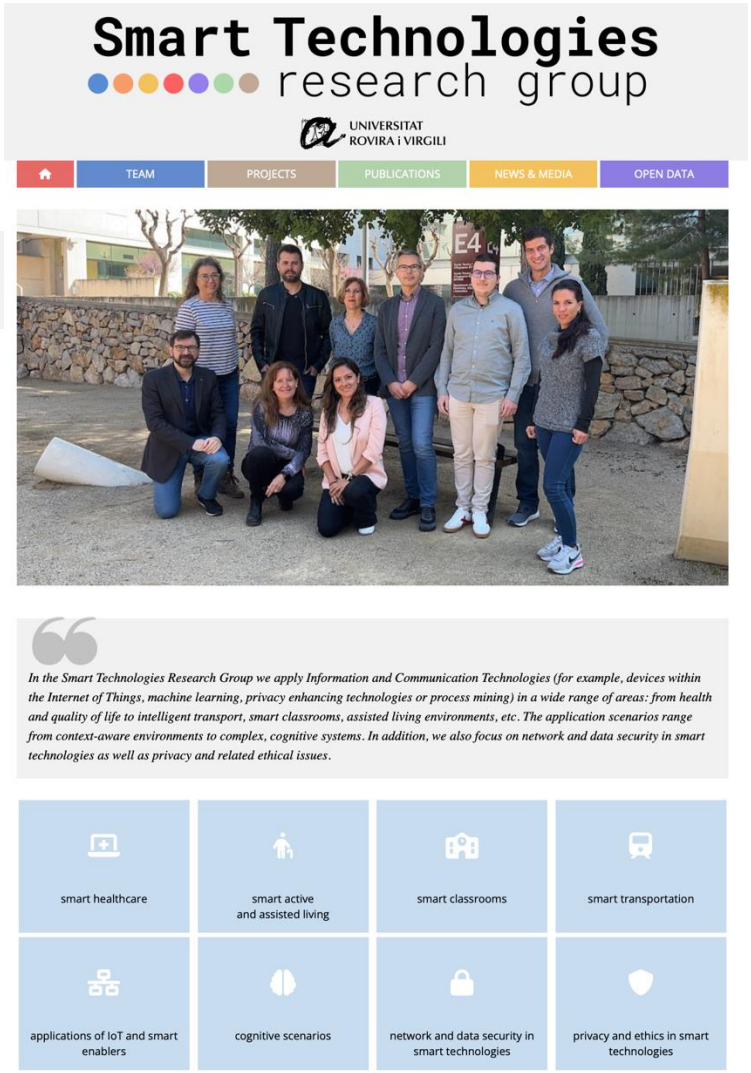
smart classrooms



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Content

- Introduction: Smart Classrooms, learning and emotions
- Components and functionalities
- Development
- Testing
- Conclusions and future work

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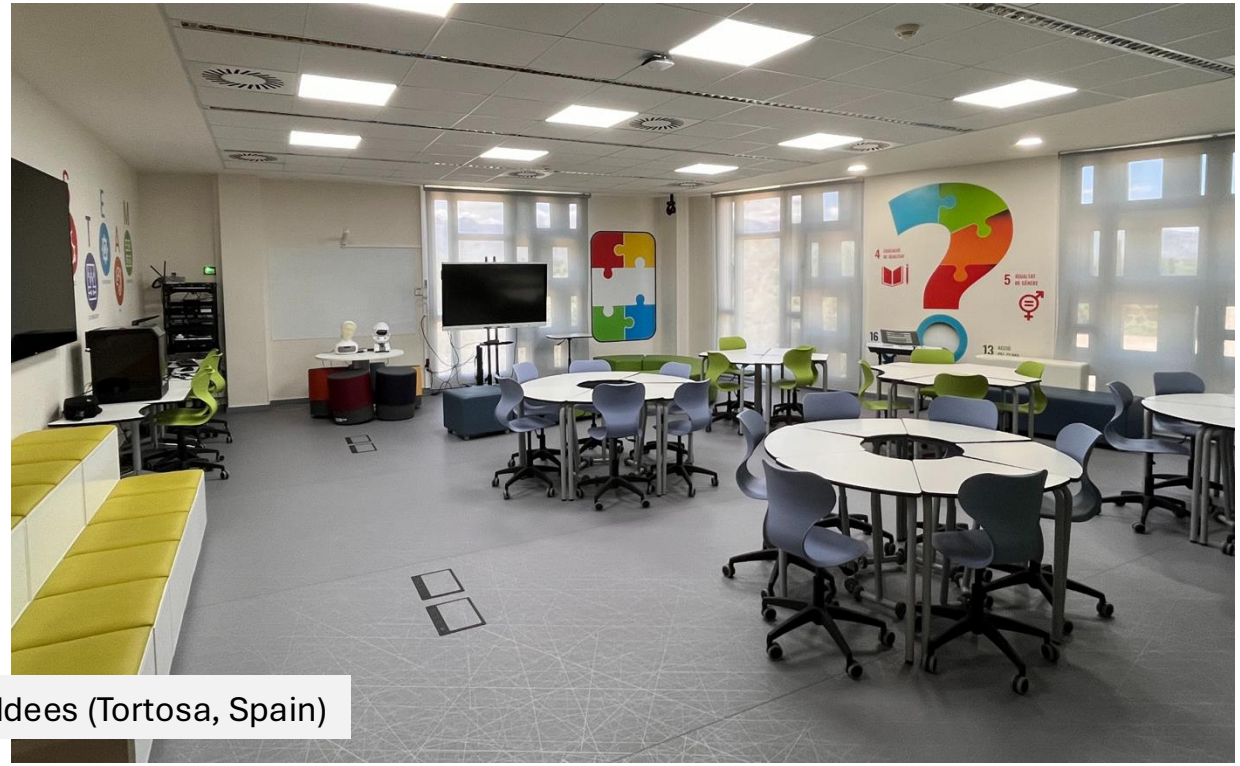

Aula Idees (Tortosa, Spain)

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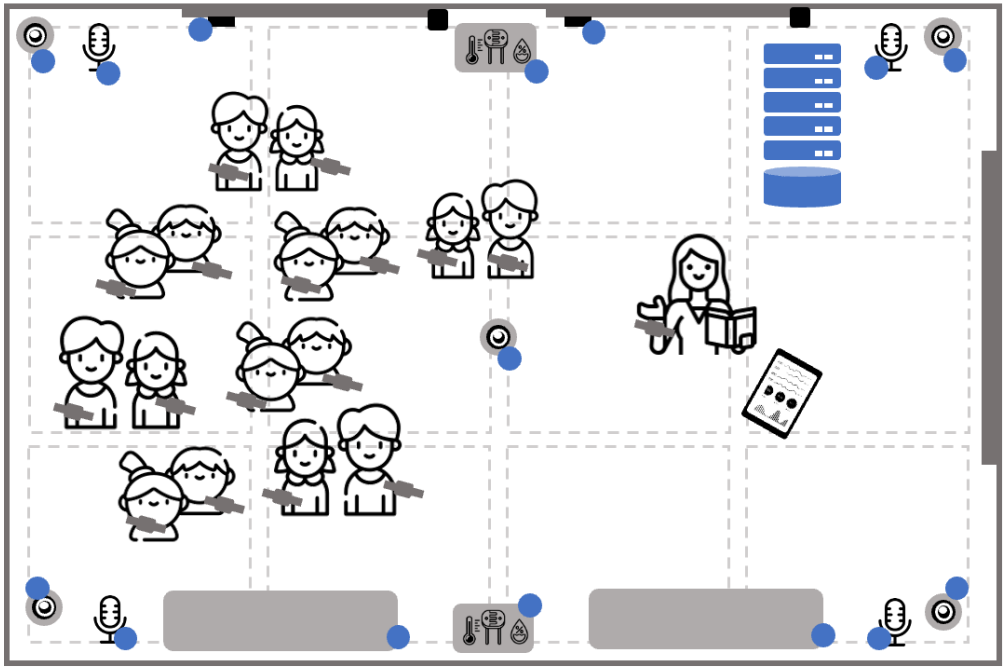

Air quality, temperature and humidity unit
Noise perception unit
Movement and presence perception unit
Emotions perception unit
Window perception unit
HVAC system
Lighting device
Blinds automation
Sensor agent
Aggregator + aggregator agent
Information System + classroom agent
Smart Classroom Teacher Assistant

A. Martínez-Ballesté, E. Batista, E. Figueroa, G. Fretes Torruella, C. Llurba, J. Quiles-Rodríguez, O. Unciti, and R. Palau, "A Proposal for the Smart Classroom Infrastructure using IoT and Artificial Intelligence", 48th Annual Computers, Software, and Applications Conference (COMPSAC), pp. 109-114, Osaka, Japan, IEEE, 2024. ISBN: 979-8-3503-7696-8.

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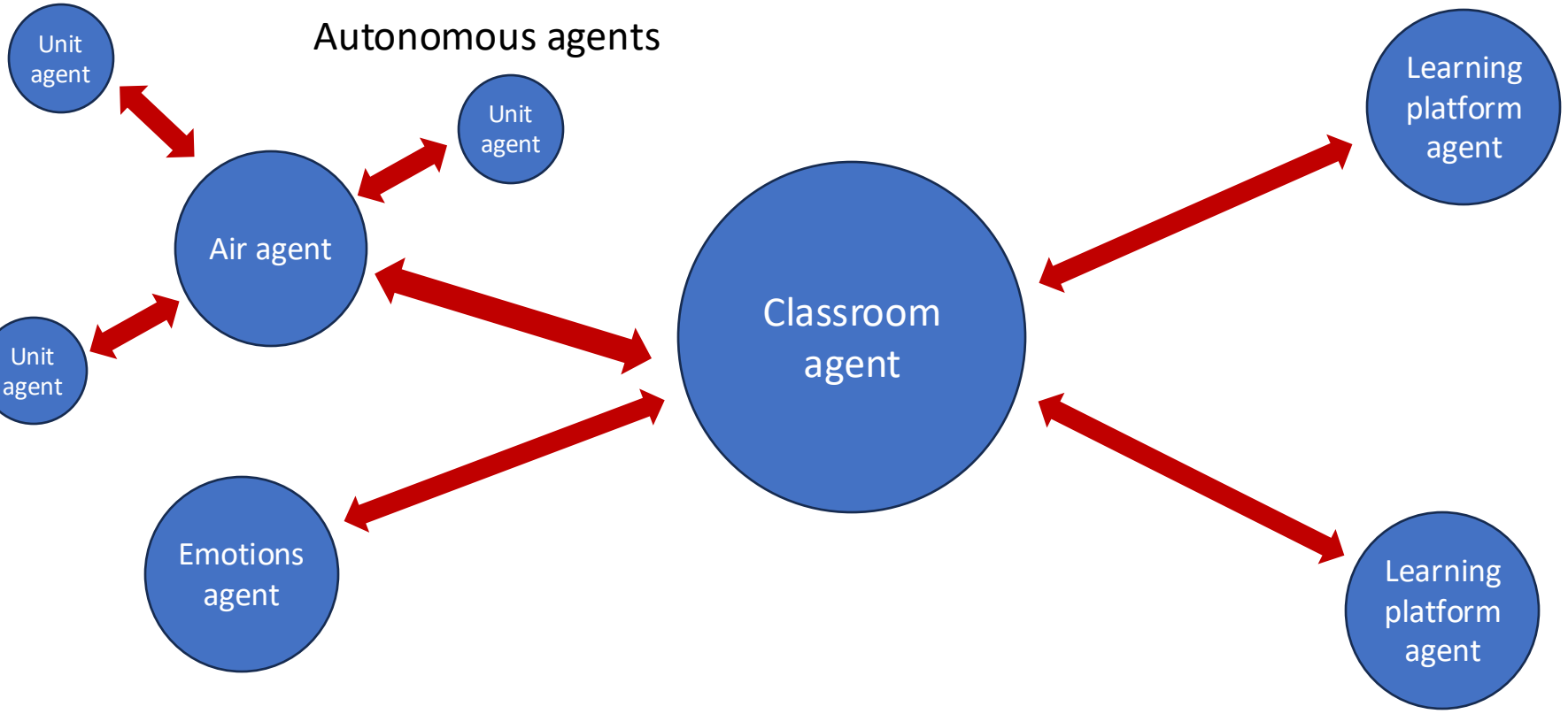

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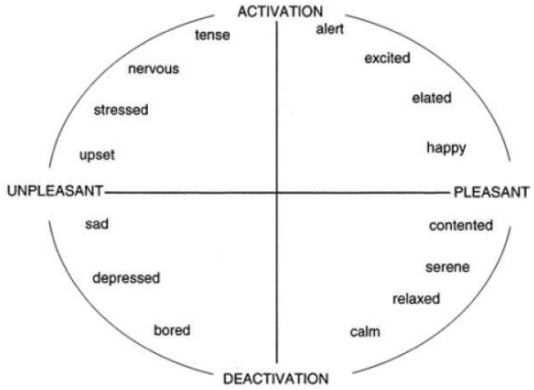
Learning and emotions

- **Understanding emotions** can foster a positive emotional climate in the classroom that results in improved academic performance.
- Affective states can be detected to track the overall mood of students and teachers.

Ekman's emotions

https://en.wikipedia.org/wiki/Inside_Out_(2015_film)



The circumplex model of affect (Posner, Russell & Peterson, 2005)

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Learning and emotions

- Most proposals for detecting emotions rely on **video analysis.**
- Video-based solutions might be limited by lighting conditions, occlusions, or even individual differences in expressing emotions. Moreover, these require robust privacy-preserving techniques.
- Video analysis alone **is not sufficient** to accurately detect the mood and engagement of students. **Alternative sources?**

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Capturing physiological factors

- Electrodermal Activity (EDA), Heart Rate Variability (HRV), skin temperature (SK) are related to emotions and stress.
- **Bracelets are able to collect such data in real-time.**
- Proprietary applications, off-line access to data, expensive products...

Empatica

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So...

- We present a first ~~approach~~ attempt to a real-time emotion assessment system for both students and teachers within smart classrooms.
- Our proposal involves real-time data collection gathered from EmotiBit devices.
- Capabilities to interact with other distributed systems within the smart classroom ecosystem.

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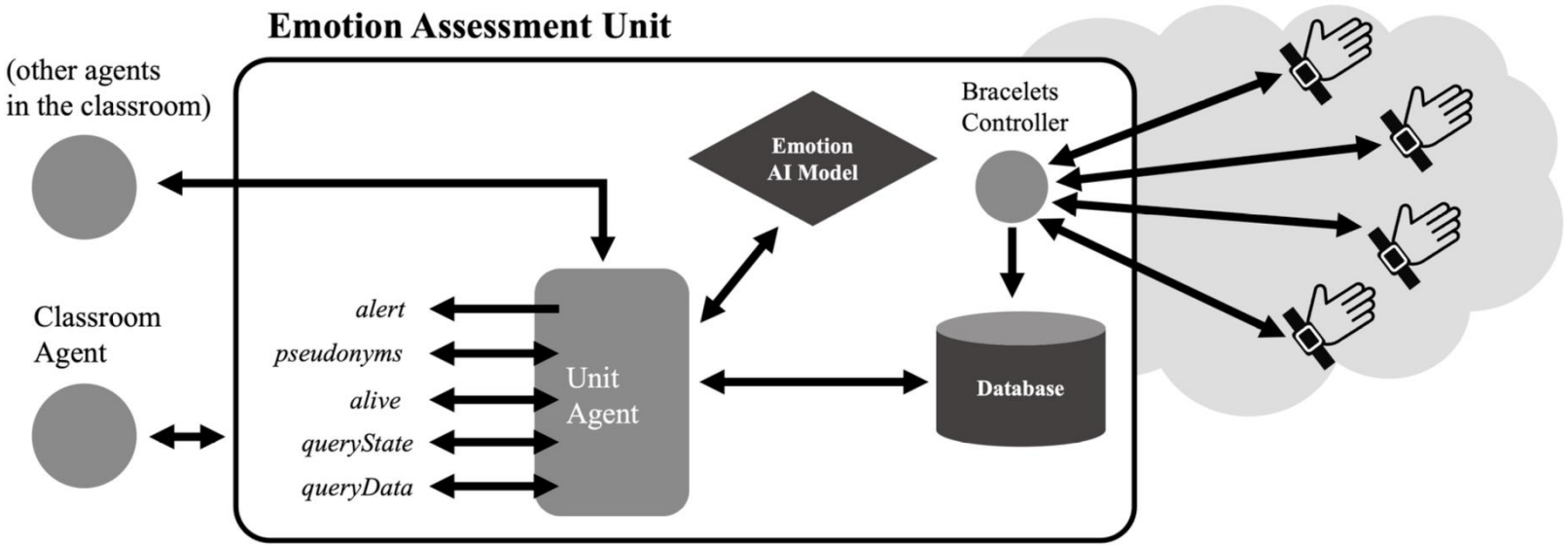
Components



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Functionalities

- **Bracelet operation**

  Bracelets discovery
  Bracelet assignment
  Start/stop monitoring

- **Classroom agent coordination**

  alive
  pseudonyms
  queryState
  queryData

- **Proactive**

  Emotion update
  Battery alert
  Database reduction

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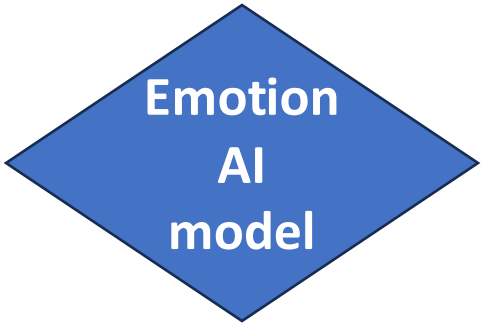
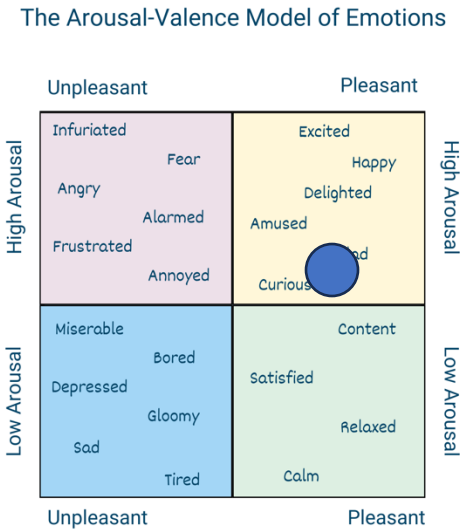
Functionalities

- **AI Model**

EDA
SK
HRV





Stress
?

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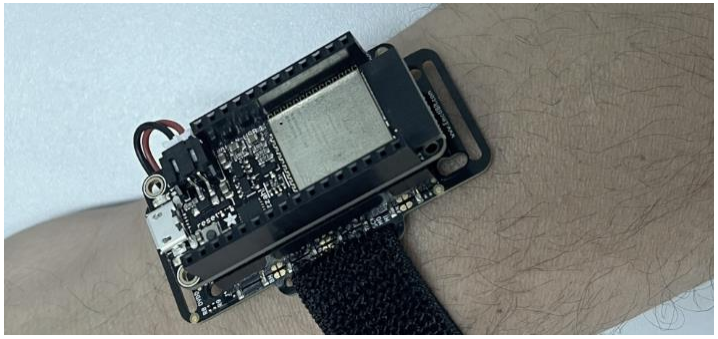
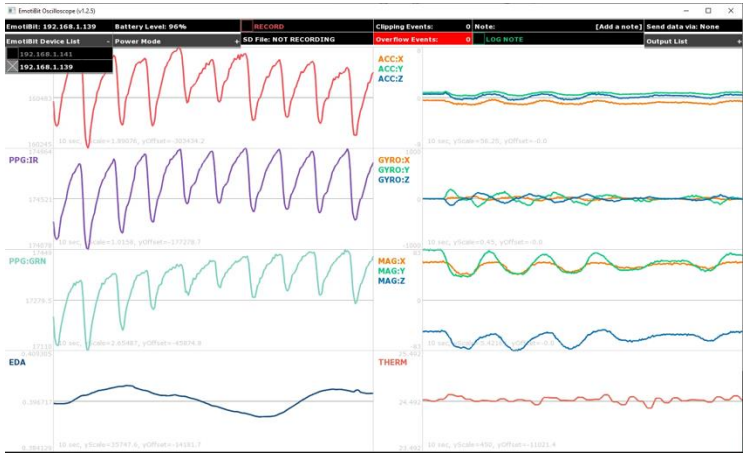
Development

- **EmotiBit sensor**
  - The gadget is open-source and, moreover, its cost is significantly lower compared to other products.
  - Collects up to 16 physiological parameters.
  - Bracelets connect to Wi-Fi and are controlled by the **Oscilloscope** software.





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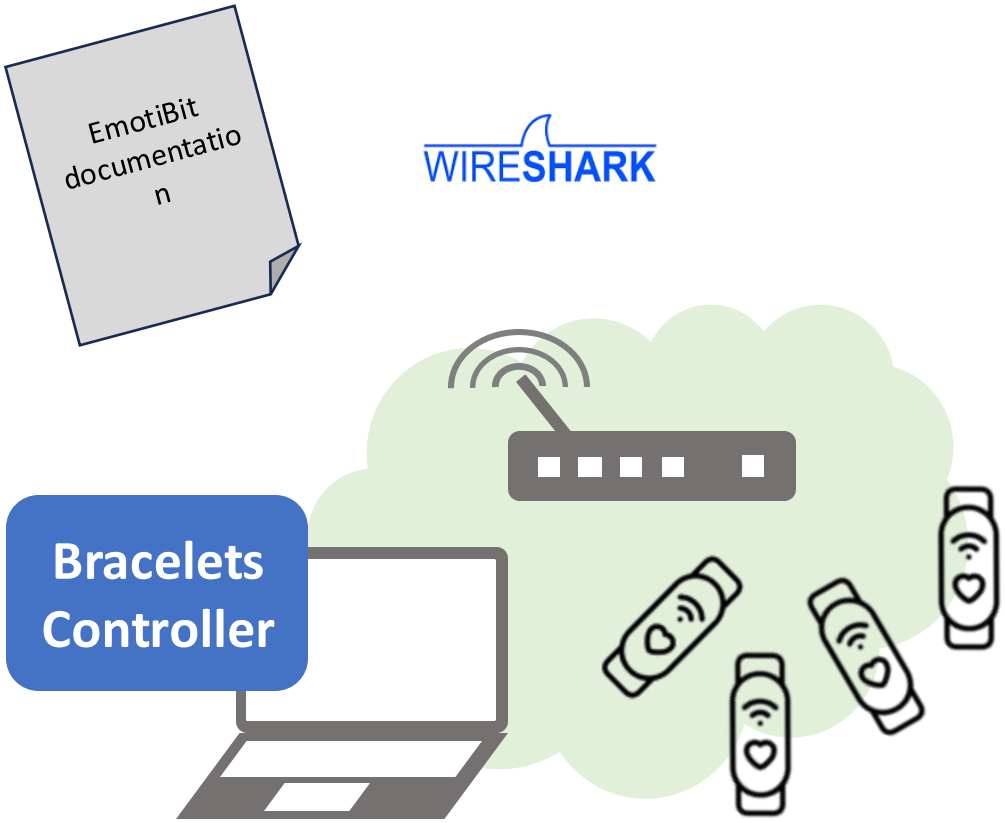
Development

- Oscilloscope can only capture data from a single EmotiBit... our goal is to process data from multiple devices.



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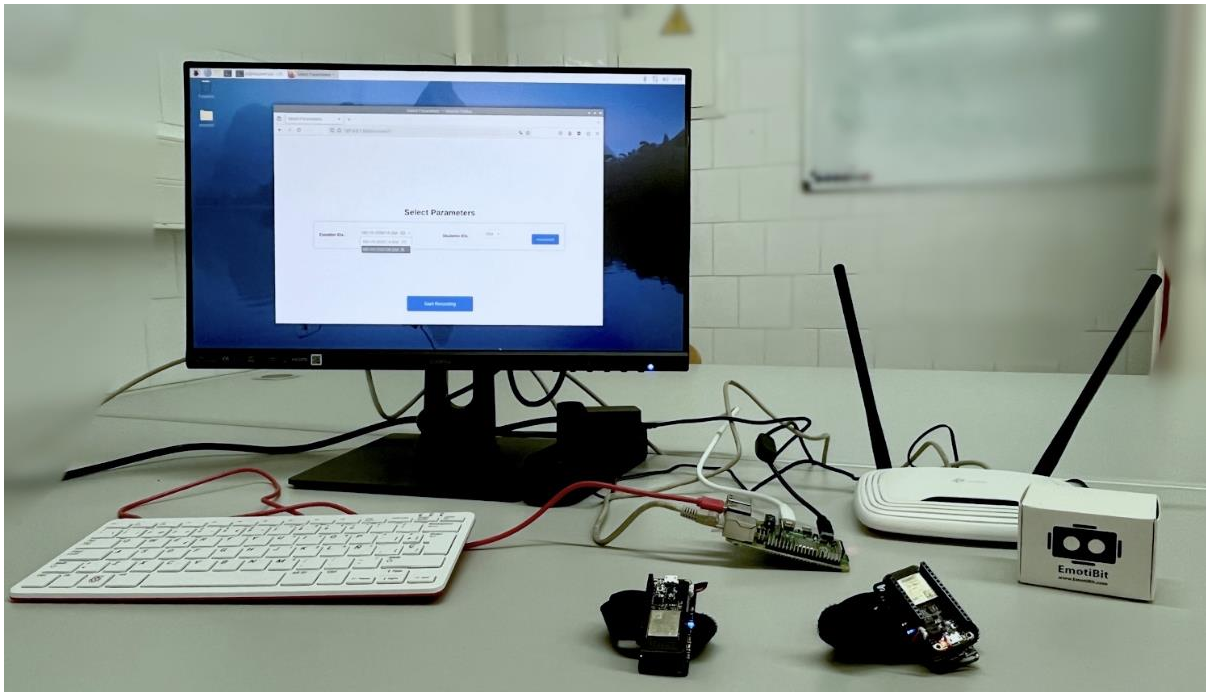
Testing



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Testing

- The prototype operates smoothly.
- Collecting all 16 values from a single EmotiBit per hour results 25 MB of data.
  - If only EDA, HR, and SKT are stored, the storage requirement decreases significantly to approximately 4 MB per hour.

Considering the application of EmotiBits in a typical primary school in Catalonia, where the average student-to-teacher ratio is 20 students per class and each student wears an EmotiBit device for 5 hours per day, the storage requirement for the entire class is around 0.4 GB per day.

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Testing

- Battery life, operational modes
  - Normal mode, where the device operates at full capacity, using all its sensors and transmitting data wirelessly in real-time. Data are acquired at 15 Hz frequency.
  - Low-power mode with no transmission but storage on an SD card.

In normal mode, the device's battery lasts approximately 3.25 hours, which can be impractical for a typical school day.

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Testing

- Emotion AI model:
  - Increase / decrease / evolution of physiological parameters.
  - Medical literature on stress and HRV, EDA and emotions...
  - Lack of training data (kids, valid for Machine Learning?)

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Conclusions and future work

- **Feasibility:** We can develop an Emotion Detection Unit that gathers data in real time about emotions and can interact with other systems within the smart classroom.
- **Data volume:** Decrease data by storing them at a given frequency or only when significant changes occur. + Database reduction.
- **Battery life:** Optimise firmware to decrease frequency of data acquisition.
- **Security:** Data is nor encrypted or authenticated! We need to add an authentication layer between devices and controller.
- **Training data:** obtain feasible data in a controlled primary school setting.

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Moltes gràcies!