

## Development for Environmentally-Relevant Educational Scenarios with Arduino Kits

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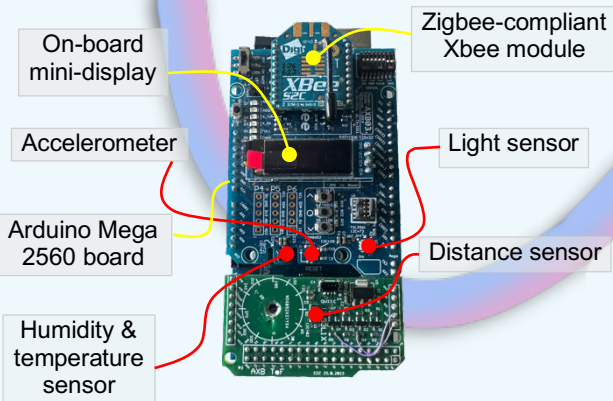
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### Objectives

This project aims to create an end-of-semester exercise for the **Signals, Instruments and Systems** course (BA5) taught by Professor Martinoli. **Embedded systems** are vital for environmental monitoring due to their efficiency, autonomy and adaptability. The aim of this project is to build a heatmap of the environment by holding an **Arduino board** while walking. By combining the indoor localization method, it allows an automatic calculation of the measurement with measurement position. To localize the board with limited sensors in an indoor environment, distance sensor and step counter are used, and a Kalman filter is used to fuse the data from these two sources. The system used here is an **Arduino kit** developed by the DISAL laboratory.

### Material



### Method

#### Kalman filter

The distance covered is predicted by the number of steps taken. The step counter error accumulates as a function of the number of steps.

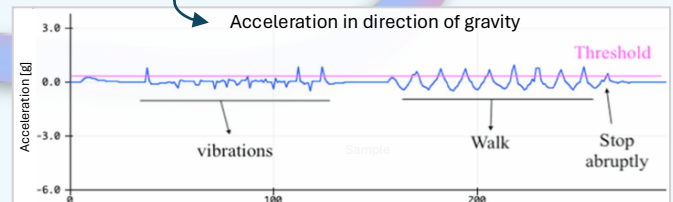
When the distance sensor is available, the filter merges the two values according to their respective errors and the new statistically optimal prediction is obtained.

#### Step counter

It uses an accelerometer fitted with various filters to obtain acceleration in direction of gravity. A threshold and other conditions are applied to count the correct number of steps.

#### Distance sensor

It provides another estimate of position from 2,5 meters from the wall.



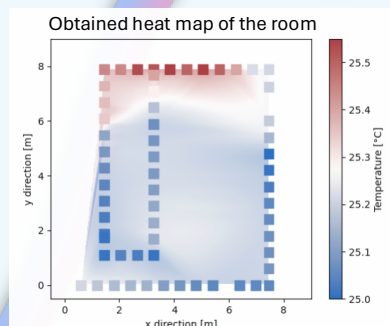
### Results

Using the temperature and light data collected during positioning, **maps of the room** can be created by associating the values with their position.

This project gives students insight into the various ways in which embedded systems can be used for the environment. It combines the fun aspect of walking around a room to collect data, the fact of using several sensors to take measurements and different aspects seen during the course. Instructions and hints are provided to help the students create this project in the right direction, while allowing them certain freedoms.

### Limitations

- The lack of a gyroscope makes it impossible to know the board's position in space and therefore use the buttons when **changing direction**.
- Distance sensor values quickly become unusable above **2,5 meters** and depend on the type of surface.



### Variance

The variance is important and practical for embedded systems and particularly for the Kalman filter, which uses them for its estimate.

