Classroom Attention Monitoring

Pervasive Systems
2015
Sapienza University of Rome

Scenario

This project is intended to provide a contribution in the area of the so called

“Learning Analytics”

Learning Analytics 1

“Learning analytics is the use of intelligent data, learner-produced data, and analysis models to discover information and social connections, and to predict and advise on learning”([1])

Learning Analytics 2

- Learning Analytics is aimed at providing a feedback about the learning of the students: this information is useful for the education system to correct or improve the teaching methods

Learning Analytics 3

- Learning Analytics is made of five steps:
  1. Capture Data
  2. Report Data
  3. Predict
  4. Act
  5. Refine

The goal of the project

- The aim of the project is to provide a support to the first phase of Learning Analytics, namely capturing data
- This support consists in a system capable of collecting data about the “degree of attention” of the students while they attend a lecture
- This gives an indication to the lecturer about the quality of his/her lecture

Related works 1

- Given the importance of a successful learning by students, some attempts have already been made to find an effective way to measure the attention of the students ([2][3][4])
- All of them try to convey a measure of the attention by correlating it with the motion of the body of the students

Related works 2

- More precisely, in all these works the motion is tracked using video analysis: during the lecture students are observed by means of cameras
- Analyzing the collected video frames, conclusions about the attention of the students are drawn by focusing on two aspects of their motion
  1. Gaze orientation of each student
  2. Coordinated motion of all the students

Gaze Orientation

Three main orientations are considered:

1 Lecturer/blackboard

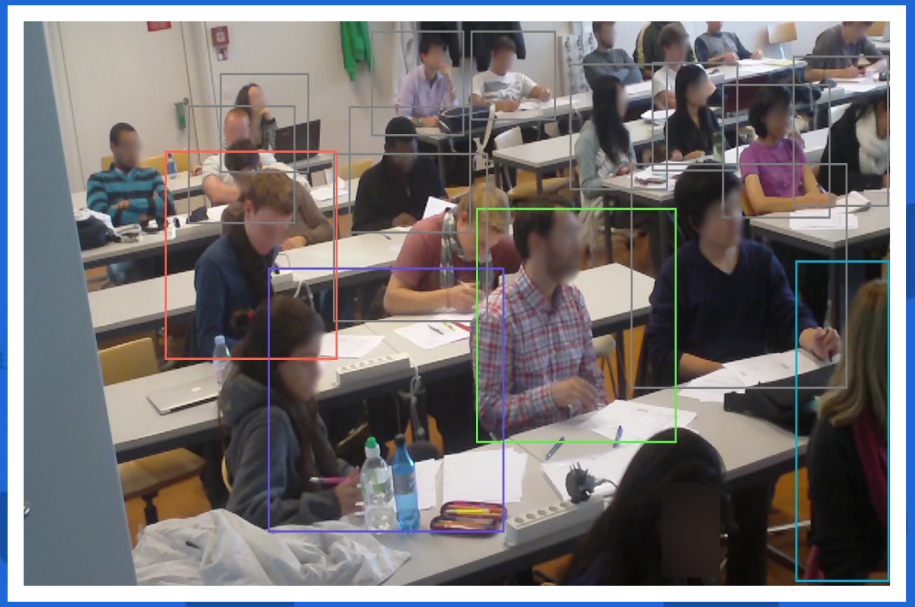
2 Notebook

3 Other directions

The first two positions are considered as a sign of attention, unlike the third one

Coordinated Motion

Students paying attention tend to react at the same time to inputs (e.g. question posed by the lecturer), while the others tend to move in an uncorrelated manner.



Related works 3

- The common approach of these works is trying to give more significance to data gathered by giving a questionnaire to students: they're asked to self-evaluate their attention during the lecture
- In this way it's possible to confirm the correctness of the results obtained with the video analysis. In other words, the number of students declaring themselves to be distracted must be coherent with results from the video analysis

Overview of the project

- This project tries to develop a system capable to evaluate the attention of students again by monitoring their motion but...
- ...unlike previous works, the analysis of the motion is carried out using sensors installed on the chairs where the students are sitting

Architecture of the system

- The system consists in a **wireless sensors network (WNS)**: its nodes are the sensors installed on the chairs of the classroom
- Nodes collect data about the motion of chairs caused by the movements of the students and send them to a **central base station (BS)**
- The base station gather data from all the nodes and provide an estimate of the attention of the students

The nodes

Each sensor node is usually referred to as **mote**. Their most important feature is the low energy consumption: the less energy they waste, the longer they can keep collecting data. Since WNSs are designed to last as long as possible without human intervention, motes are very often deployed in this kind of networks.

Anatomy of a mote

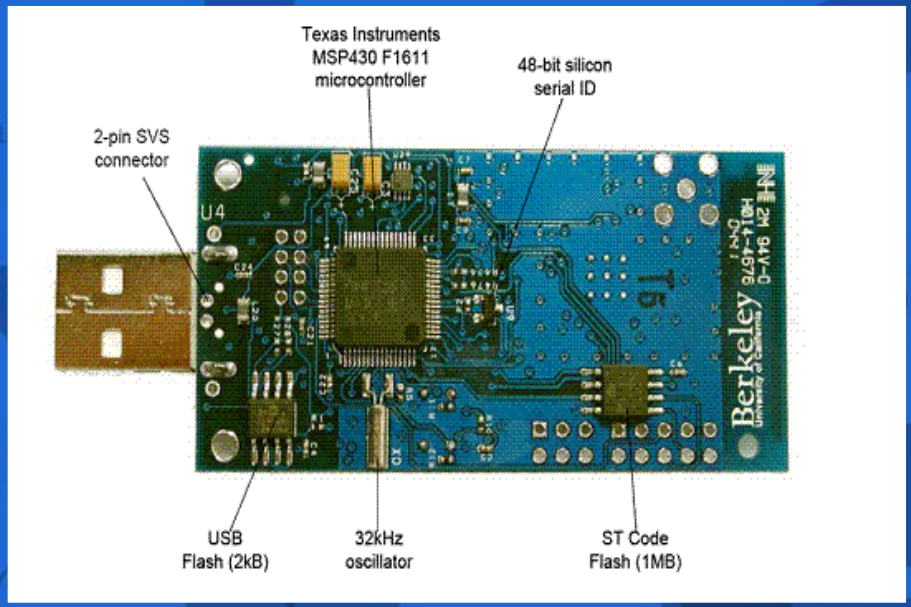
A mote is a small device consisting in a few components:

1. 8-16 bits microcontroller; runs at 1-10 Mhz and comprises a few kilobytes RAM
2. Transceiver: low-power radio transmitter and receiver (10-300 kbps)
3. Power source
4. Sensors: an A/D converter that sends digital data to the microcontroller

Deployed motes:TelosB

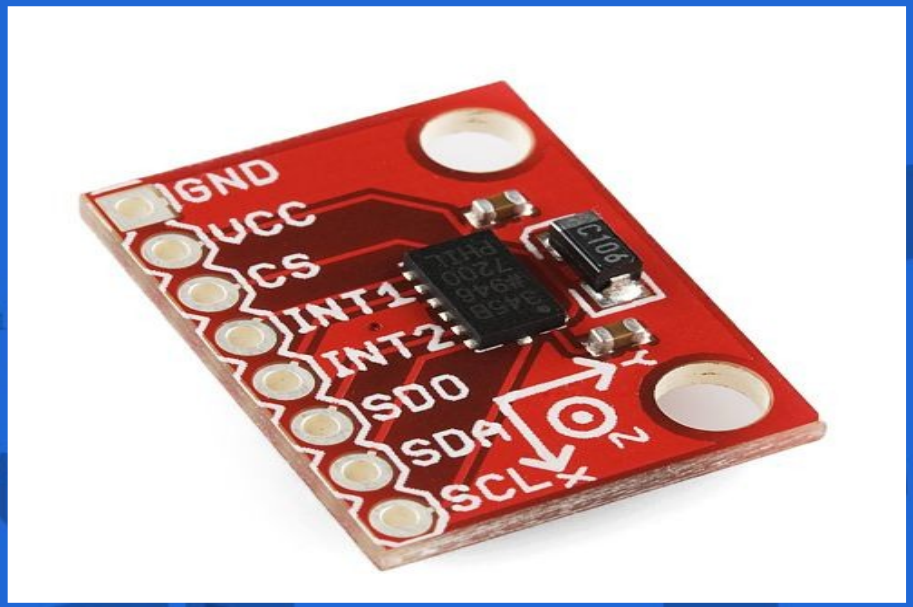
Here's the main features of the motes deployed in the system:

- TI MSP430 Microcontroller with 10KB RAM
- 250 kbps, High Data Rate Radio
- Integrated Onboard Antenna
- IEEE 802.15.4 Compliant



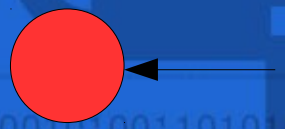
Motion detection:accelerometer

To monitor the motion of chairs, each mote is connected to the 3-axis accelerometer ADXL345. It has a 13 bits resolution and is very accurate (3.9 mg/LSB). It's possible to set a custom threshold to detect motion or inactivity.

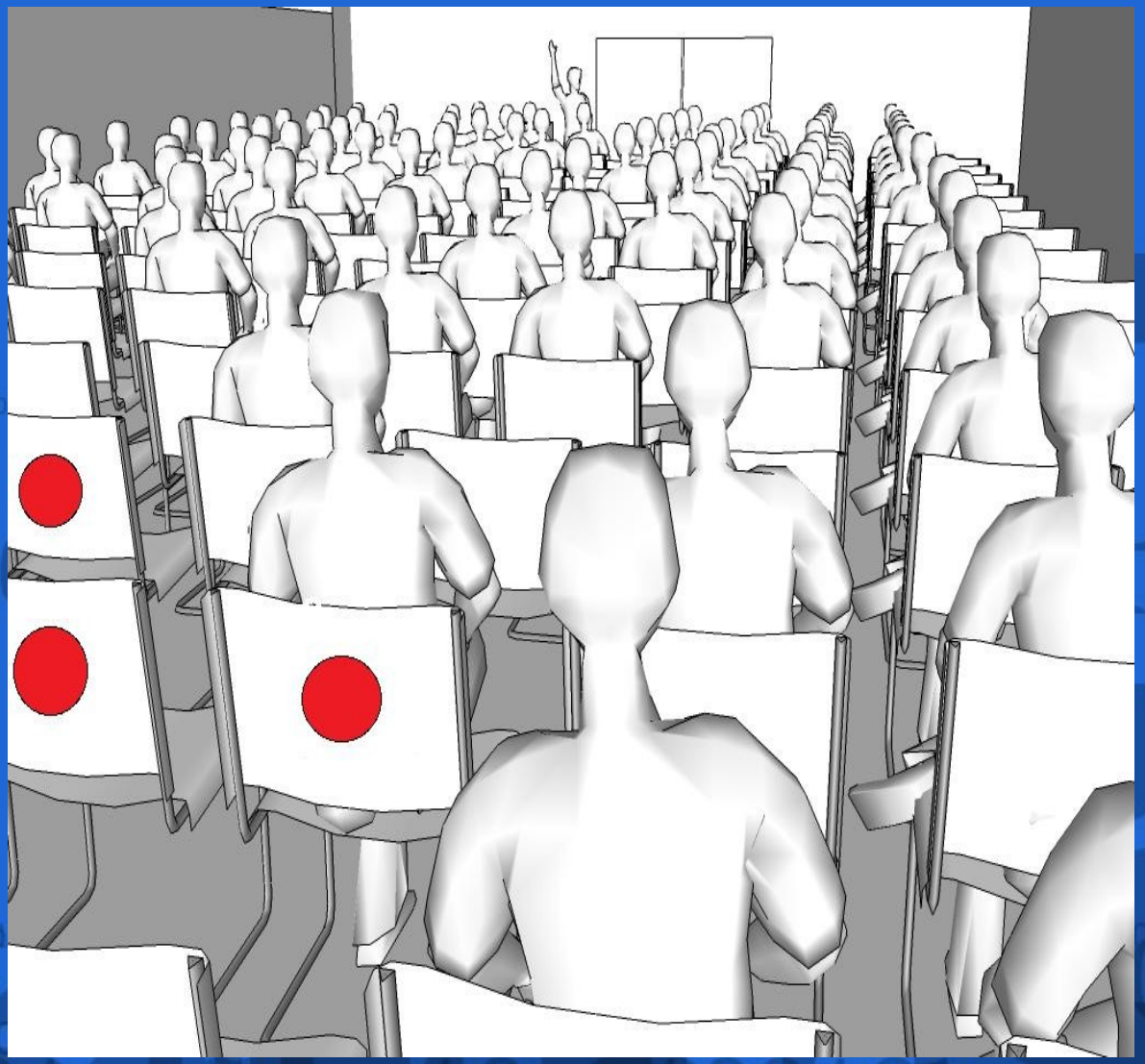


Data collection

Nodes behind or under the chairs collect data about the motion of students during the lecture



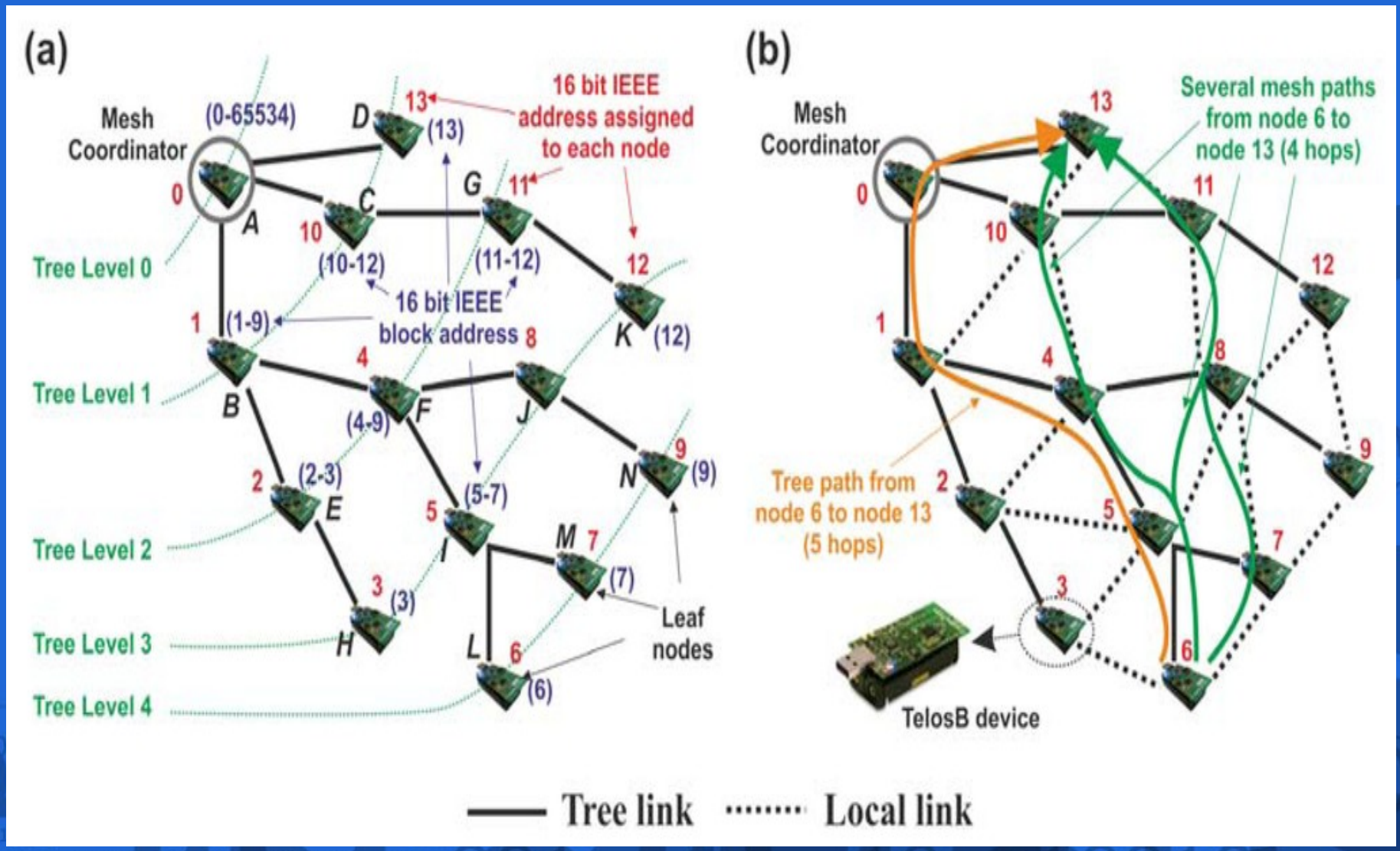
Node=TelosB+accelerometer



Multi-hop networking 1

- Because of the limited radio range of the motes, motes that are further from the BS can't send packets directly to it.
- That's why the communication protocol adopted is the **tree-collection**: motes organize themselves in a routing tree whose root node is represented by the BS. In this way messages flow from the furthest motes to the BS thanks to the motes in the middle

Multi-hop networking 2



Main challenges 1

- Finding a suitable threshold for the detection of the motion of chairs: a too high value would imply scarcity of data, while a too low value would cause a huge amount of data (accurate calibration required)
- Writing a high-performance code for the motes in order to save as much energy as possible (motes stay in “sleep mode/low-power consume” mode most of the time)

Main challenges 2

- Choosing a suitable metrics to measure the attention of the students
- Dealing with “interferences” and “noise” while collecting data from the accelerometer: since in the classroom chairs are all connected, the motion of one student may cause a wrong motion detection by the sensor related to another student.

Issues to solve

- Uploading data collected by the base station on Parse (using Parse Embedded C SDK???)
- Defining the interface for the connection between the accelerometer and the motes
- Checking availability of sensors at Sapienza

References

[1] “Academic Analytics”, John P. Campbell and Diana G. Oblinger, October 2007

[2] “System for Assessing Classroom Attention”, Mirko Raca and Pierre Dillenbourg

[3] “Student motion and it’s potential as a classroom performance metric”,Mirko Raca, Roland Tormey, Pierre Dillenbourg

[4] “Sleepers’ lag - study on motion and attention”,Mirko Raca, Roland Tormey, Pierre Dillenbourg