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A “smart” multimedia guide for indoor contextual navigation in Cultural Heritage applications

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Outline

- DATABENC District Project
- Goals and Motivating Example
- System Architecture
- The Multimedia Smart Guide
- A Case of Study

DATABENC Project

- DATABENC Project
  - It is a High Technology District for Cultural Heritage management recently funded by Regione Campania, Italy.
  - Starting from the city of Naples, it will envolve during the next 3 years the whole Campania enabling and promoting cultural tourism and a new concept of living, exploiting and taking care of cultural resources.
  - As short term goal it aims at building the “Talking Museum” metaphora.

Goals and motivating example of the paper contribution

- As part of the DATABENC project:
  - it aims at exploiting several location-based services technologies to realize a **smart guide** able to detect users' position and make objects of a museum exhibition able to **"talk"** during tourists' visit and capable of automatically telling their story using multimedia facilities.
- Maschio Angioino Castle Exibitions:
  - Francesco Jerace sculptures collection

System Architecture

Main components:

- A wireless sensor network (WSN)
- The Gateway Server (GS)
- The Multimedia Content Server (MCS)
- The Multimedia Guide App

System Architecture(2)

WSN Component

- It is constituted of a set of wireless sensors, each one deployed near a museum artefact.
- It employed **Libelium** devices:
  - the **Waspmote** nodes, as sensing nodes placed on the artworks basement;
  - the **Meshlium** base station
- Bluetooth devices of Class 1 and 2

Network working principle

- Each sensing node placed on an artwork (e.g. a sculpture) communicates through:
  - the **Zigbee** protocol with the base station.
  - the **Bluetooth** protocol with the users' devices detected in the surrounding area of the artwork.
- When a new device is detected the related MAC Address is sent to the Base Station communicating with the GS.

Indoor localization task

- Waspmote and Meshlium nodes are employed to detect users location.
  - we don’t need the precise user’s location but to know which is the closest artwork and his Mac address to log and deliver tailored contents
- To detect users’ device position Meshlium devices adopt the called **Adaptive Frequency Hopping (AFH)** algorithm
- **It** improves the common algorithm used by Bluetooth (FHSS) detecting channel in use by Zigbee and Wi-Fi devices and so avoiding collisions.

The Gateway Server (GS)

- It hosts a set of daemon processes able to filter and gather information coming from the WSN: each process manages the communication with a given sensor.
- When information about the presence of a user device near an object is notified on the related stream, the GS a send request for contents to the Multimedia Content Server.
- All information about communication between users and artefacts are properly stored in dedicated logs.

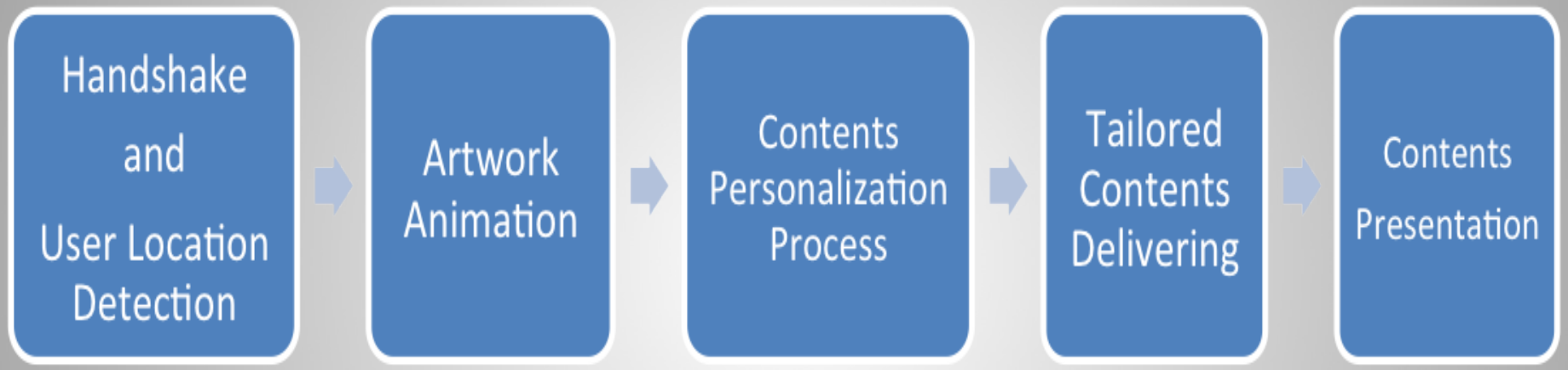
The Multimedia Content Server (MCS)

- **Accepts a request for contents** from the GS;
- Builds a **multimedia story** in according to user preferences and delivers all the information to the related user mobile App.
- Manages a **multimedia repository** and exploits proper multimedia delivery techniques to propose to users other object of interest arranged in the shape of multimedia stories.

The Multimedia Guide App

- It allows the **fruition of multimedia contents**.
- Users download the App and a questionnaire is preliminarily submitted in order to capture the his/her profile (e.g. favourite artworks, artists, subjects, and kind of multimedia) and the device features.
- When a user starts a visit within the museum, a registration phase is also necessary to map the device MAC address with the related IP address.

Overall Animation Process



Contents personalization process

Data and retrieval model:

- Is composed of a database of:
  - **m** multimedia objects O_i (images, textual description, videos;
  - **n** resources R_j (the list of artworks in the exhibition);
  - **k** features F_j related to each multimedia object O_i (color region, texture, pixelation);
  - P users' profile P_j

Data and retrieval model(1)

- Each multimedia object o_i is described as its set or subset of the features $\{f_i \ldots\ldots f_k\}$
- As for the retrieval model:
  - given a query object **Q ={Q_i…..Q_n}** composed of n elements, a **distance function d** is computed between each query element and each set of available multimedia object features.

Data and retrieval model(2)

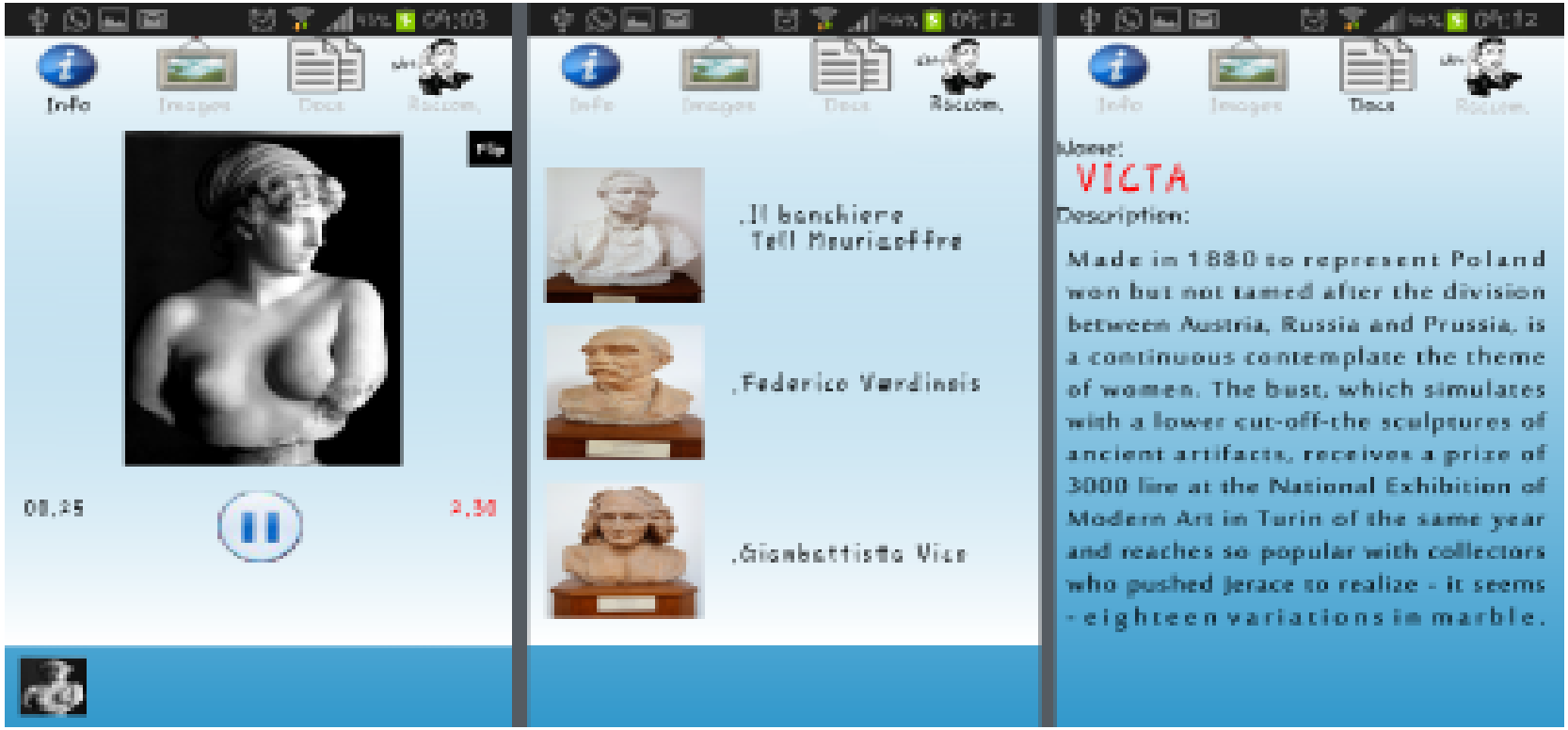
- ***distance function d*** measures the ***dissimilarity*** of a given pair of elements (using their features);
- we want to determine the top - k objects in O that are the most similar with respect to Q.
- Similarity between objects is numerically assessed by way of a object ***distance function d*** that combines together the single element distances into an overall value.
- Consequently, resource O_a is considered better than O_b for the query Qi if $d(Q, O_a) < d(Q; O_b)$ holds.

Contents tailoring strategy

- **Prefiltering stage**:
  - After the recommendation step, the list of selected objects is compared to the users' profile features applying the same distance function.
  - **Users are associated to clusters**.
- **Post-filtering stage**:
  - The filtered objects list is so arranged in the most suitable visit path for the user.

Smart Guide App Prototype

- Android Platform App Prototype
- Java Technology employed in Back-end application
- PostgreSQL DBMS



A Case of Study

- A multimedia collection of 4500 images, texts and audio files about Francesco Jereace Sculptures
- Maschio Angioino Castle Exhibition, Naples.
- User device: Samsung Galaxy S3 Android phone

Task Class	Strategy	t_a (min)	n_r
Q1	Without any help	6	4
Q1	Our System	4	2
Q2	Without any help	8	5
Q2	Our System	6	3
Q3	Without any help	16	6
Q4	Our System	10	4

Conclusions and further steps

- Complete the development of the prototypal application.
- Test the effectiveness of the suggested approach in different anfid larger context.
- Refining the localization step.

DATABENC references

- **DATABENC Project**, http://www.databenc.it
- **DATABENC Lab**, http://www.databenclab.unina.it
- **DIETI UniNA**, http://www.dieti.unina.it