

## Development of a Smart Multimedia Application for Sustainable Environments and Cultural Heritage Preservation

**Objectives:** Conceive and specify a networked multimedia application that leverages sensor data, machine learning, and multimedia content to contribute to sustainable environments or cultural heritage preservation and dissemination.

This assignment intends to offer the opportunity to the student to jointly apply creativity with technological knowledge for designing and specifying an interactive multimedia application. Students should adopt good practices for user-centred design when conceiving their application in relation to the UI and follow an iterative process. A formal methodology for conceiving the software system should be adopted, going from a phase of identification of user requirements, through developing use cases, to more advanced formal tools, namely, collaboration and class diagrams. At the end of the semester, students should have a full formal functional specification of their application and a high-fidelity prototype.

### 1. Introduction

The objective of this work is for you to conceive from scratch and develop the formal functional specification of a multimedia application. Preferably, the student should create a socially useful application i.e. that helps your friends, family, or community in some way. Your project proposal should address the social usefulness of your app/program within the context of sustainable environments or cultural heritage preservation and dissemination.

### 2. Project components

#### a) Sensor Data Collection:

Integrate various sensors such as sound, temperature, GPS, accelerometer, gyroscope, and camera to collect real-time data.

Design modules to ensure continuous and reliable data collection.

Foresee error handling and data quality control mechanisms (**extra**).

#### b) Data Processing and Machine Learning:

Create a data preprocessing pipeline to clean and prepare sensor data.

Identify machine learning models/tools to analyze the sensor data and make decisions.

Example: Use sound data to detect wildlife activity or environmental sounds, temperature data to monitor climate conditions, and GPS coordinates for location-based insights.

#### c) Multimedia Content Generation:

Based on the machine learning decisions, define modules to dynamically generate or retrieve multimedia content such as images, videos, audio clips, or text.

Use multimedia content that aligns with the sustainable environment or cultural heritage preservation theme.

Define techniques possible to apply, like computer vision, natural language processing, or audio processing, to generate relevant content.

**d) User Interface:**

Design an intuitive user interface (UI) that allows users to interact with the application.

Display sensor data in a user-friendly manner.

Provide options for users to explore multimedia content and insights.

**e) Network Communication:**

Specify modules to establish secure communication using protocols to connect to a remote server or cloud service.

Enable real-time or scheduled data uploads and downloads.

Devise forms for ensuring data encryption and authentication for data transmission (**extra**).

**f) Server Side Backend:**

Specify a server-side backend to receive and store sensor data, as well as multimedia content.

Devise a database system to manage data storage efficiently.

Create APIs for the application to interact with the server.

**g) Data Visualisation and Reporting:**

Conceive data visualisation tools to present sensor data trends, machine learning insights, and multimedia content.

Generate reports or alerts for users or administrators.

Devise advanced forms of presentation, namely, AR (**extra**)

**h) Application Testing and Validation:**

Develop a non-functional prototype demonstrating its use for selected use cases or application scenarios

**i) Documentation:**

Prepare documentation that includes design, formal specification, and usage instructions.

### **3. Minimum requirements (up to 16 values)**

The application must fully comply with the definition of multimedia:

- digital format
- more than one type of media
  - at least one of them must be continuous
  - some kind of interaction/coordination must exist between at least two such media
    - temporal or spatial

Focus on the user interactivity

- User-centred design
- More than one modality
- Adaptability and context-awareness

Conception steps

- Conceiving the idea
  - identifying problem(s) to solve
  - alternative solutions
  - Picking up the IDEA

The different phases of the UI iterative process should be defined and adopted

- User Requirements; User and tasks analysis; refining user requirements and tasks
- Conceptual modeling
- Formal use cases
- Sketching the UI
- Prototyping
  - Making at least two prototypes (a low fidelity prototype and a high fidelity with all intended functionality)
  - Presenting the prototypes to at least one user and collecting feedback

Formal specification of the software system

- Adopting the UML
  - From user requirements to Use cases
  - Component diagram (high-level system architecture)
  - Collaboration diagrams

#### **4. Valorisation aspects (up to more 4 values)**

- Explore the use of audio signals and audio analysis techniques to offer and adapt interactivity
- Sensor error handling and data quality control mechanisms
- Data encryption and authentication for data transmission
- Advanced forms of presentation, namely, AR
- More than two prototypes
- Larger number of users testing the prototypes
- UML class diagrams

#### **5. General methodology to apply**

- Identify a problem to solve or a challenge to overcome

- many times this goes by speaking with friends, and users, making questionnaires
- think of ideas, even the most unrealistic ones, that may help solve the problem
  - do not try to think whether they are feasible/practical or not; give space to your imagination (“think in the shower”) and write down your ideas until you have a sufficiently large pool of ideas
- go through that pool of ideas and select the ONE
- elaborate a list of (formal) requirements and functionality
  - what should the application offer to their users? what actions should it perform? what are the expected results?
    - ex., the application should allow the user to register, build a profile and visualize and change personal data
- identify use cases, and elaborate a narrative description of them
- draw a sketch/diagram of the user interface and user interactions
- draw a block diagram illustrating the different components identifying interactions
- build a mock-up/prototype

## 6. Tools

### 6.1. Prototyping

- wireframe.cc
- Balsamic: <https://balsamiq.com/>
- Figma: <https://www.figma.com/prototyping/>
- Adobe XD: <https://www.adobe.com/products/xd.html#>
- Axure: <https://www.axure.com/>
- Proto.io: <https://proto.io/>
- Fluid: <https://www.fluidui.com/>
- Marvel - <https://marvelapp.com/>
- Invision: <https://projects.invisionapp.com/>
- Framer: <https://framer.com/>
- Sketch: <https://www.sketchapp.com/>

### 6.2. UML

- Lucid Chart <<https://www.lucidchart.com/>>
- Creately <<https://app.creately.com/>>

## 7. Project presentation

Each group must present their application by making a short video (no more than 10 minutes long) presenting the outcomes of each design and specification step to be submitted by date TBD.

Evaluation criteria include:

- Informative -- how well did the presentation represent the project?
- Clarity -- was the presentation clear and understandable?
- Completeness -- did the presentation cover all the minimum requirements for the work?

Prepare the presentation/demonstration taking these evaluation criteria into consideration and trying to address the following points:

- [name of the application] is ... [kind of thing it is]
- for [the people who would use it] it offers/allows ... [what it offers/does]
- unlike [the major alternatives], ... [shortcoming/differences from alternatives]
- [the people who would use it] can interact through [voice, text, gestures, etc.] using [the mouse, keyboard, touchscreen, etc.]

## 8. Submission Procedure

A short report must be submitted in Moodle together with the video. Different files addressing different steps of the project should be uploaded as a single compressed archive.

The report should:

- describe the goal/purpose of the application; what the user can do with it;
- Indicate the different modalities used to establish interactivity;
- explain how adaptability and/or context-awareness is achieved;
- clearly indicate whether use has been made of audio analysis techniques;
- How many prototypes were developed;
- How many users tested the application;
- include the functional specification;
- provide an indication of the tools used for developing the prototypes;
- include indications on how to use the prototype application;
- If you developed a working mockup, clearly indicate if there were significant changes between it and the initial prototype;
- provide a short discussion of your experience in developing the project (what issues did you run into? How did you solve them? )

Proofread your report before submitting it.

Submission deadline: TBD.