



SPIRIT



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EMPATHI

Emotion-Responsive Avatars for Personalized Cultural Heritage Interaction

1. Introduction and motivation

Cultural Heritage institutions seek technologies creating meaningful connections with historical content. Traditional static presentations often fail to engage diverse audiences, especially younger generations expecting interactive experiences.

EMPATHI develops an emotionally intelligent avatar system adapting to visitor responses in real-time. Building on SPIRIT's telepresence platform, it extends the Real-Time Avatar Animation use case through emotion recognition for natural interactions.

The project features a photorealistic 3D avatar of Ludovico Ariosto, the Renaissance writer, guiding visitors through "Atelier Furiose Interazioni" at Maurizio Villa in Reggio Emilia, Italy, adding emotional dimension to the Orlando Furioso exhibit experience.

2. System Architecture and Innovation

EMPATHI introduces a bidirectional emotional feedback system with key innovations.

I. Emotion Recognition Module:

CNN-Based system using VGG13 architecture [1]; processes video at 10-15 FPS; analysing facial expressions to classify emotions according to Ekman's [2] six basic categories (joy, surprise, sadness, anger, fear, disgust) plus neutral; computes engagement score (0-100) and valence (-100 to 100).

II. Bidirectional Feedback System:

EMPATHI implements a novel two-way emotional feedback loop through carefully designed interfaces (Figure 1).

Producer side: real-time emotion capture influences avatar expressions-Emotional GUI visualizes the producer's emotional state through dynamic auras changing colours [3], contextual emoticons, and particle effects.

Consumer side: Visitors provide intuitive like/dislike responses via touch-friendly SEF GUI; the Consumer SEF GUI is designed following human-centered design principles

III. Historical Avatar Reconstruction

Ludovico Ariosto's 3D avatar (Figure 2) is

crafted based on iconographic research[4], primarily referencing Titian's masterful portraits, and is 3D modeled in Blender, optimized for Unity3D rendering.

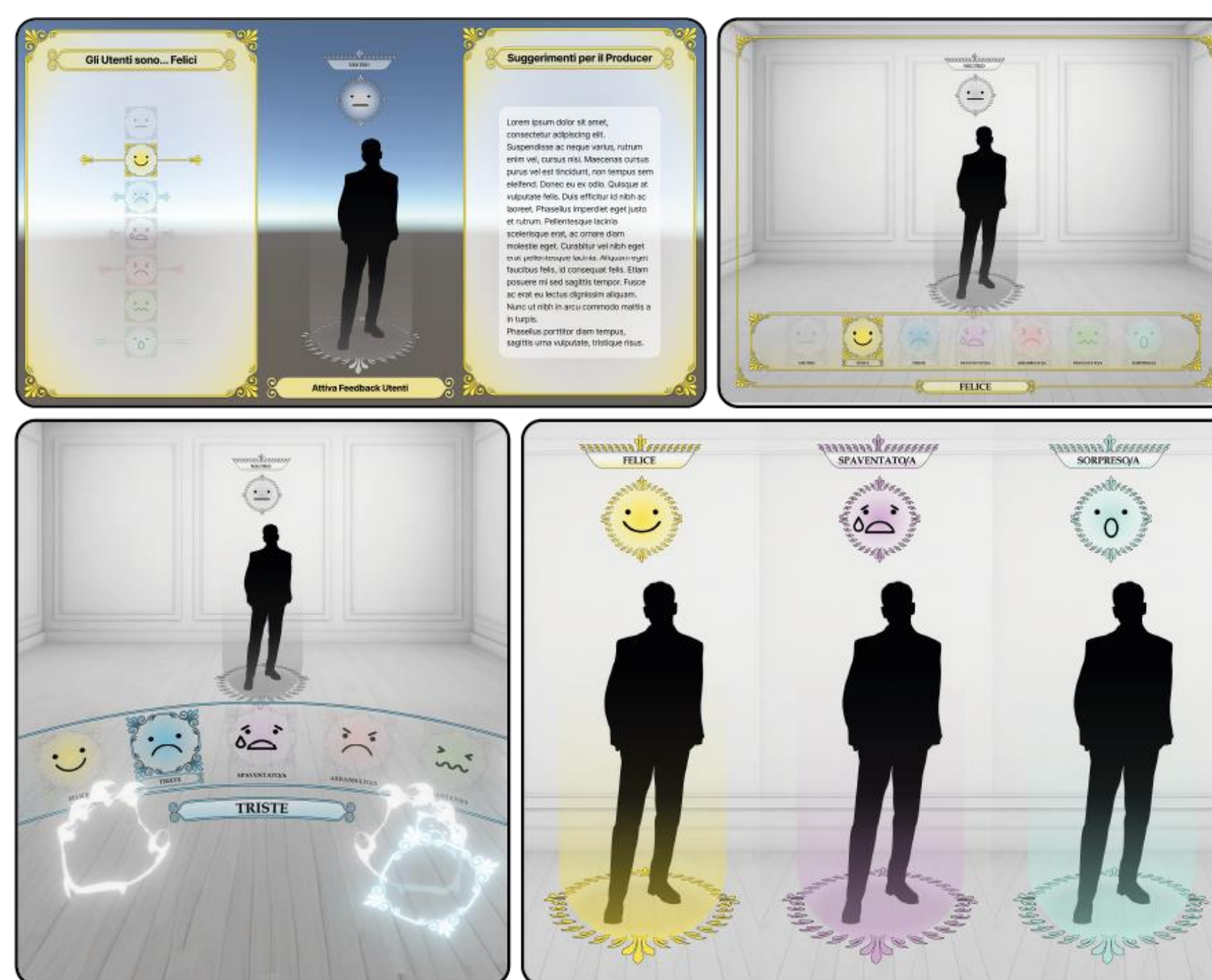


Fig. 1: UX/UI moodboard of Producer and Consumer SEF GUI



Fig. 2: Ludovico Ariosto 3D Avatar

3. Technical Implementation

EMPATHI extends SPIRIT's Kubernetes-orchestrated infrastructure with three specialized Docker containers operating in isolation for enhanced security and maintainability (Figure 3).

Emotion Recognition Service: CNN-based analysis with temporal filtering
Audio Animation Server: Viseme extraction for lip-sync.

Streaming Server: Synthesizes data into real-time 3D animations

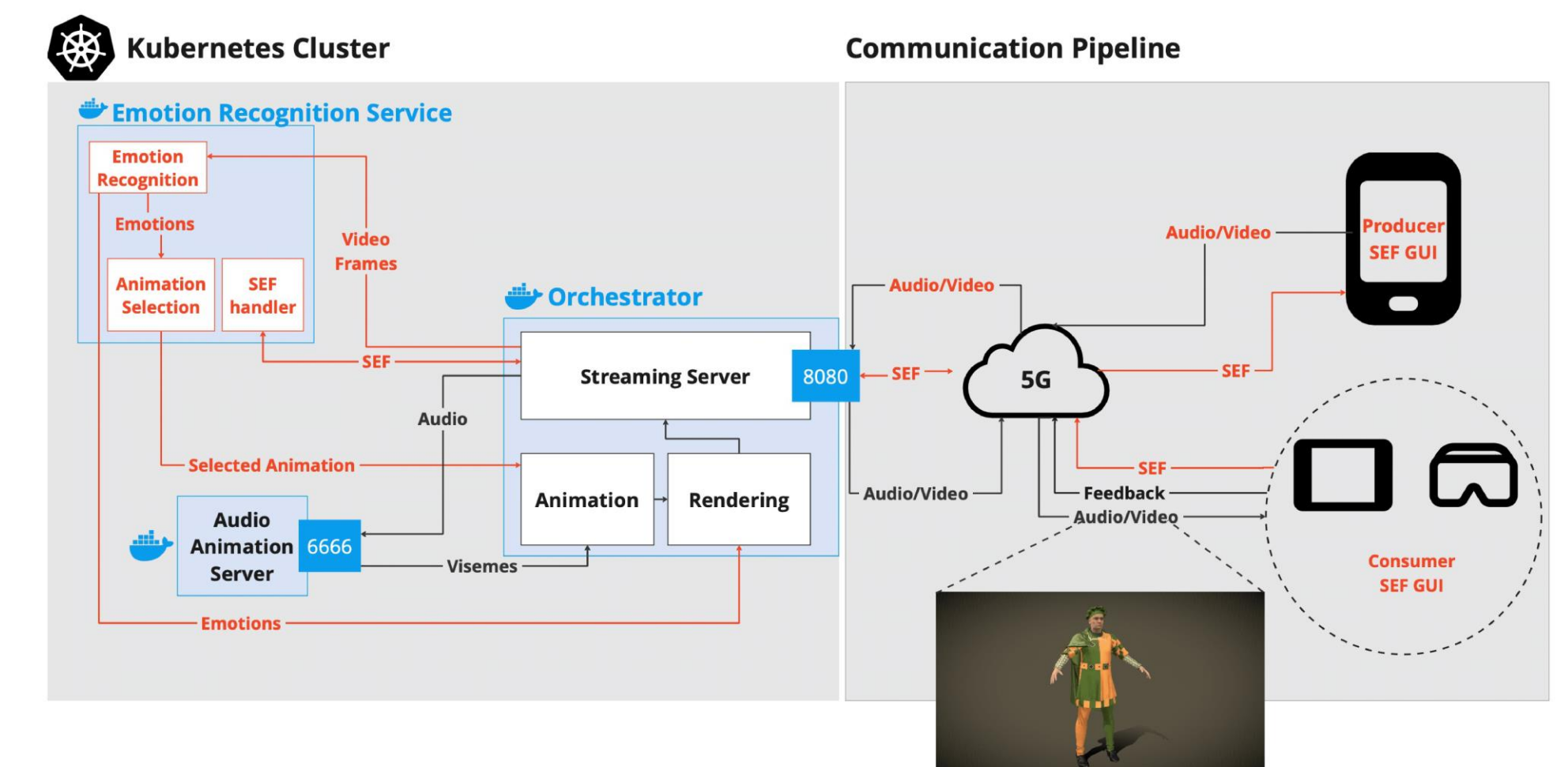


Fig. 3: The high-level proposed pipeline

The system maintains sub-100ms latency via LAN/5G networks, demonstrating successful AI integration within SPIRIT's streaming infrastructure.

4. Methodology for user testing

The EMPATHI system will undergo comparative evaluation through two experimental conditions.

Condition A: Traditional linear storytelling
Condition B: Emotionally adaptive Ariosto avatar

Each 30-minute single user sessions across four age cohorts (5-6, 7-12, 13-17, 18-60) measure: Engagement levels, Comprehension, Emotional response, Interpretive plurality.

5. Expected impact and applications

EMPATHI significantly extends SPIRIT's capabilities:

- Introduces emotion recognition and enhanced avatar animation to platform library.
- Validates SPIRIT's extensibility through real-world deployment.
- Opens applications in cultural heritage, education, and tourism.

Post-project, EMPATHI modules join SPIRIT's open component library, demonstrating how domain-specific innovations enrich the telepresence ecosystem for immersive educational experiences.

Contact

Annalisa Mombelli (RE:LAB srl)
annalisa.mombelli@re-lab.it
Thomas Agostinelli (UnivPM)
t.agostinelli@pm.univpm.it
Marco Luciani (EMOJ)
m.luciani@emojlab.com

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www.spirit-project.eu