Table of Contents

Introduction 3
Presentation 3
Motivation 3
Problem 3
Objectives 3
Requirements 4
Tests 5
Report Structure 8

Introduction

Presentation

This project, a collaborative effort by six European students, focuses on enhancing child well-being during the pre-visit phase. By blending engineering and creative design, we aim to transform the waiting experience through interactive digital art. As illustrated in Table 1, this multidisciplinary strategy ensures our intervention is inclusive, comforting, and tailored to the emotional needs of young users.

Table 1: Team members of the Healing Cocoon project

Name	**Country**	**Studies**
Ronja Kruse	Germany	Dental Technology
Hanna Kaczmarek	Poland	Industrial Biotechnology
Anouc Daindu Goedhart	Netherlands	Industrial Design Engineering
Daniel Aagaard Pérez	Spain	Informatics Engineering
Julie Bonnet	France	Packaging Engineering
Kemal Yilmaz	Belgium	Electronics - ICT

Motivation

Hospitals and waiting rooms can be stressful and uncomfortable for many patients, especially for children or people who need to stay for a longer period of time. Clinical healthcare environments are often designed mainly for medical efficiency rather than emotional comfort.

Research shows that the surrounding environment can influence patient well-being and recovery. Calming visual elements or familiar environments can help reduce stress and improve emotional comfort.

This project is motivated by the idea that technology can be used to create more comforting and supportive healthcare environments without requiring major physical changes. Immersive visual technologies offer new ways to improve patient experiences during the waiting time for a medical appointment or hospitalization.

Problem

Medical environments are often designed for medical efficiency rather than patient comfort, which can make them feel cold and impersonal. This can increase stress and anxiety for patients, especially due to unfamiliar surroundings and medical procedures. Research shows that calming visual environments or natural elements can help reduce stress and support recovery. However, many medical areas still lack accessible solutions to create more comforting and engaging environments for patients.

Objectives

The main objective of this project is to explore how immersive projection technology can improve the

emotional experience of patients (especially children) in medical environments.

The specific objectives of the project are:

- To investigate how medical and hospital environments influence patient stress and recovery
- To explore existing technologies such as projection systems, immersive environments, and digital distraction therapy
- To develop a concept that transforms hospital or waiting rooms into calming and personalized spaces
- To reduce stress and anxiety for patients during hospitalization/waiting time
- To improve the overall patient experience through design and technology

The overall goal of the project is to design a concept that can create a more comforting and supportive hospital environment, particularly for children and long-term patients.

Requirements

The proposed solution must meet the following requirements:

User & Experience Requirements:

- The system must reduce patient stress and anxiety during waiting or treatment periods.
- The system must create a calming and comfortable environment using visual and sensory elements.
- The system must be suitable for children and adaptable to different age groups.
- The system must provide a sense of safety and personal space for the user.

Healthcare Environment Requirements:

- The system must be suitable for use in hospital or waiting room environments.
- The system must not interfere with medical equipment or workflows.
- The system must comply with hygiene standards for shared healthcare environments.
- The system must be easy to clean and maintain.

Functional Requirements:

- The system must provide immersive visual content (e.g. projection or display).
- The system must integrate at least two sensory elements (e.g. visual, audio, scent, or movement).
- The system must be easy to operate by healthcare staff.
- The system must allow quick setup and minimal preparation time.

Accessibility Requirements:

- The system must be accessible for users with reduced mobility (e.g. wheelchair users).
- The system must allow safe entry and exit.

Technical & Design Requirements:

- The system must be safe for use in indoor healthcare environments.
- The system must operate with low noise levels.
- The system must be energy-efficient.

- The system must have a compact footprint suitable for limited spaces.

These requirements are derived from user needs, healthcare constraints, and insights from the state-of-the-art analysis

Tests

Hardware Stress Testing

Functionality Tests

(FT-GY01) Baseline Calibration Read: Compare the GY-21 sensor's temperature and humidity output against a calibrated commercial environmental meter in a stable room environment to verify initial accuracy.

(FT-GY02) Thermal Responsiveness: Apply a localized heat source (e.g., physical contact) to the GY-21 sensor casing. Monitor the serial output to ensure a linear temperature increase is registered by the software.

(FT-GY03) Humidity Saturation: Expose the GY-21 sensor to concentrated moisture (e.g., direct exhalation) to force a rapid humidity spike, verifying the software registers the sudden change without integer overflow.

(FT-BH01) Lux Range Verification: Expose the BH1750 sensor to controlled lighting states ranging from total darkness (0 lx) to direct high-intensity LED light (> 10,000 lx) and log the output.

(FT-BH02) Shadow Transient Detection: Pass an opaque object over the BH1750 sensor at a constant speed to verify the system logs the temporary lux drop in real-time.

(FT-MQ01) Analog Voltage Baseline: Monitor the raw ADC output of the MQ-135 sensor in a ventilated environment to establish the “Clean Air” baseline after the initial thermal warm-up phase is complete.

(FT-MQ02) VOC Spike Detection: Introduce a controlled concentration of isopropyl alcohol vapor within 2 cm of the MQ-135 sensor mesh. Verify the analog output crosses the predefined software threshold for contamination.

(FT-WA01) Digital State Actuation: Toggle the microcontroller's GPIO pin to HIGH and LOW states to verify the immediate start and stop of ultrasonic mist production from the Grove Water Atomizer.

(FT-WA02) Capillary Wicking Action: Place the atomizer disk on a saturated absorbent material to verify continuous water delivery to the piezoelectric mesh without full submersion causing acoustic failure.

(FT-SYS01) I2C Address Multiplexing: Sequentially poll the GY-21 (0x40) and BH1750 (0x23) on the same physical I2C bus to ensure no data collisions or library conflicts occur during simultaneous operation.

Performance Tests

(PT-GY01) Environmental Recovery Rate: Measure the time required (in seconds) for the GY-21 humidity readings to return to the baseline ambient level after a forced saturation event.

(PT-GY02) I2C Polling Stress: Query the GY-21 sensor at a high frequency (every 50 ms) for 5 continuous minutes to verify data integrity and the absence of I2C bus lockups.

(PT-BH01) Continuous Light Exposure: Expose the BH1750 sensor to a constant 1,000 lx light source for 1 hour to verify reading stability and confirm the absence of sensor drift over time.

(PT-BH02) High-Frequency Illuminance Transitions: Toggle a light source at 10 Hz and monitor the BH1750 sensor's ability to track the fluctuating lux values without data freezing or communication failure.

(PT-MQ01) Thermal Burn-in Stabilization: Power the MQ-135 sensor continuously for 48 hours. Log the baseline drift to ensure the internal heating element stabilizes and analog variation does not exceed a ±3 % margin.

(PT-MQ02) Dissipation Latency: Remove the VOC source and measure the time required (in minutes) for the MQ-135 analog signal to dissipate and return to the previously established “Clean Air” baseline.

(PT-WA01) Duty Cycle Endurance: Operate the Grove Water Atomizer on a predefined loop (4 seconds ON, 3 seconds OFF) for 1,000 cycles to evaluate hardware durability and check for mesh calcification.

(PT-WA02) Driver Board Thermal Load: Run the Grove Water Atomizer continuously for 60 minutes. Measure the surface temperature of the NE555 timer component on the driver board using an infrared thermometer to ensure it remains below 55 °C.

(PT-SYS01) Rail Voltage Stability: Measure the ESP32's 3.3 V and VBUS rails with a digital oscilloscope during the atomizer's peak activation surge. Verify that the voltage drop remains < 0.2 V to prevent microcontroller resets.

(PT-SYS02) End-to-End Latency: Measure the total time elapsed between the MQ-135 detecting a VOC spike and the ESP32 successfully triggering the Water Atomizer actuator to respond to the event.

Web Application Stress Testing

To test the stability and response time of the web application, a simple performance test was conducted using k6. The application ran in a Docker-based environment, with Docker Compose used to manage the services and to run the k6 test runner.

The test simulated 5 virtual users continuously using the application for 2 minutes. The k6 script sent HTTP requests to the backend/API endpoints and checked if the responses returned the expected status codes, such as 200, 201, or 401.

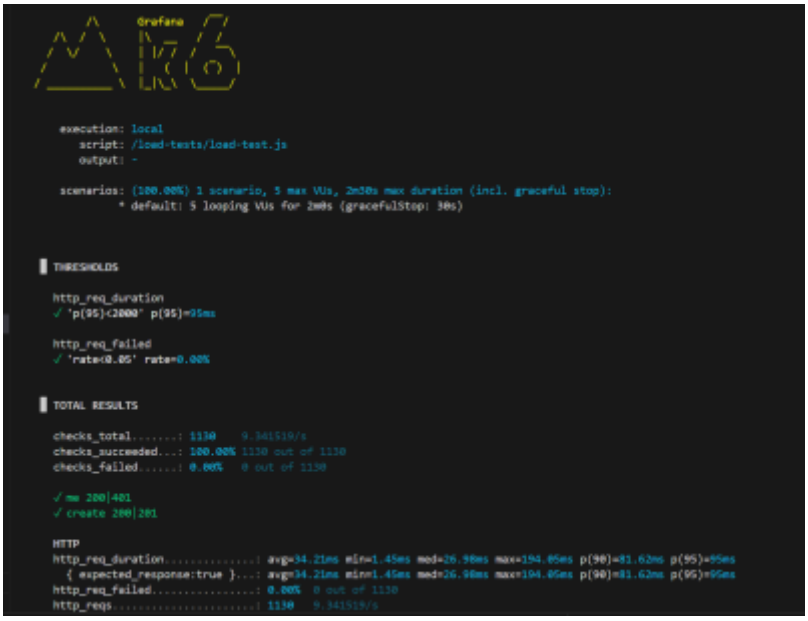

Figure 1: k6 load test results for the web application

As shown in Figure 1, the application processed 1,130 HTTP requests with a failure rate of 0.00 %. All checks were completed successfully: 1,130 out of 1,130 checks were completed. The average response time was 34.21 ms, and the response time at the 95th percentile was 95 ms, which is well below the set limit of 2,000 ms.

These results demonstrate that the web application remained stable and responsive under the tested load. Since the test was limited to 5 virtual users, it should be considered an initial performance test rather than a full-scale stress test.

Usability Testing

In addition to the technical tests, a small usability test was also done to get early feedback on the Healing Cocoon web application. While the stress tests focused on technical stability and performance, the usability test focused on how clear, understandable, and user-friendly the prototype felt to potential users.

The usability test was designed as an online survey. Participants were asked about their first impression of the application, the clarity of the layout, the ease of use of the main features, and whether the design seemed suitable for children aged 6 to 13.

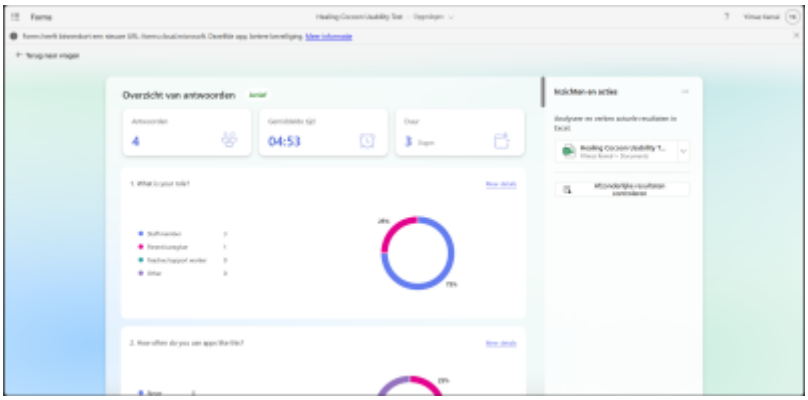

Figure 2: Overview of the responses to the Healing Cocoon usability test.

The Figure 2 shows that the survey was completed by 4 participants, and the average completion

time was 4 minutes and 53 seconds. Given the limited number of participants, the results should be viewed as early feedback and not as final validation.

Overall, the feedback was positive. Participants generally found the layout clear and the main functions user-friendly, such as choosing a world, starting a session, and understanding the sound and scent settings. The breathing exercise was also found to be helpful by the participants. The open-ended feedback revealed that users appreciated the soothing colors, the simple layout, and the various themes, such as “Forest” and “Space.” Several potential improvements were also mentioned, such as making the “Start” button more visible and adding more options for programs, scents, visualizations, or music.

Based on this small-scale user test, the prototype appears to be intuitive and user-friendly, but further research with more participants is needed to make more definitive conclusions.

Report Structure

Chapter	Description
1 Introduction	Introduction of the team, the topic, the problem and the objectives within the project
2 Background and related work	Existing research and studies
3 Project Management	Overview of the methods used within the team for project management
4 Marketing Plan	Market analysis, identification of the competitors, and market strategy
5 Eco-efficiency Measures for Sustainability	Measures to minimize the ecological footprint of the project and the most important aspects of sustainable development and eco-efficiency
6 Ethical and Deontological Concerns	Analysis of ethical considerations to be taken
7 Project Development	Development of the product from concept to prototype
8 Conclusions	Discussion of everything that has been achieved with the project
9 Acknowledgements	Bibliography of sources and articles used

From:
https://www.eps2026-wiki6.dee.isep.ipp.pt/ - **EPS@ISEP**

Permanent link:
https://www.eps2026-wiki6.dee.isep.ipp.pt/doku.php?id=report:intro

Last update: **2026/06/03 15:01**