DEPARTMENT OF COMPUTER SCIENCE
NORTH CAROLINA A&T STATE UNIVERSITY

ARCHITECTURAL DESIGN SPECIFICATION

COMP 496: SENIOR DESIGN II

STACK UNDERFLOW

LUMI

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1 INTRODUCTION

Mental health has become a global concern, with millions of individuals lacking consistent and accessible support tools for emotional well-being. Lumi is an innovative solution that leverages modern technologies, such as Natural Language Processing (NLP), Augmented Reality (AR), and sentiment analysis, to deliver a web-based mental health companion that promotes mindfulness, emotional regulation, and user reflection.

The primary concept behind Lumi is to create an interactive environment where users can engage in daily check-ins, mood tracking, journaling, and guided coping exercises that adapt based on emotional input. By analyzing journal entries and user-reported data, Lumi intelligently responds with personalized feedback, motivational support, or crisis intervention resources if concerning patterns are detected.

2 System Overview

Lumi's architecture, an AR mental health companion, is organized into three distinct layers that reflect its core functional domains. Each architectural layer encapsulates a unique responsibility and interacts with others via well-defined interfaces. This modular approach supports scalability, maintainability, and a clear separation of concerns.

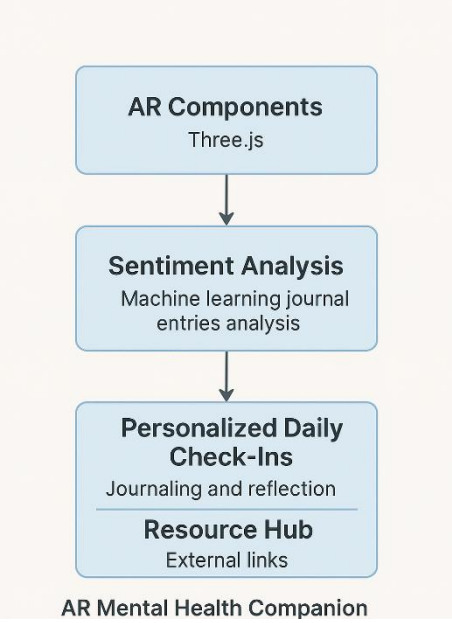

Figure 1: Architectural Layer Diagram of Lumi

2.1 Layer X Description

This top-most layer serves as the immersive interface for user interaction using augmented reality. Built with Three.js, this layer presents guided exercises such as breathing routines and walking meditation visually and interactively through AR. It focuses on enhancing user engagement by blending mental health guidance with spatial, visual feedback.

Features & Services Provided:

- Renders interactive 3D/AR content (breathing animations, calming visuals).
- Accepts user input through gesture, voice, or screen interaction.
- Host AR-enabled activities to complement journaling and reflection.

Interfaces & Interactions:

- Sends collected user input (e.g., mood selection) to the Sentiment Analysis Layer.
- Receives feedback and prompts (e.g., next activity suggestions) based on emotional context.
- Interfaces with device sensors and AR rendering engines through Three.js and WebXR.

Naming Conventions & Structure:

- Modules are stored under /lumi/ar/ and follow the format ARComponent_[Function].js.
- Interfaces with sentiment services via REST API or in-app message passing.
- Follows MVVM pattern to keep AR rendering logic and data handling separated.

2.2 Layer Y Description

This middle layer powers the emotional intelligence of Lumi. It analyzes user journal entries, check-in responses, and behavioral patterns using natural language processing and machine learning models to determine emotional states and suggest appropriate next steps.

Features & Services Provided:

- Processes journal text and user feedback using sentiment classification.
- Identifies trends in mood and provides tailored responses.
- Supports a recommendation engine for AR exercises or resources based on emotional state.

Interfaces & Interactions:

- Receives journal data and user interaction feedback from the AR Layer and Check-in Layer.
- Sends processed sentiment results (positive, neutral, negative) to the other layers for action.
- Optionally interacts with external ML services or local inference models.

Naming Conventions & Structure:

- NLP modules follow the naming format Sentiment_[ModelType].py.
- Communication follows RESTful API protocols, returning JSON-encoded sentiment scores and tags.
- Sentiment tags (e.g., stress, joy, anxiety) are mapped to AR or resource responses in a configuration file.

2.3 Layer Z Description

This foundational layer supports Lumi's goal of daily self-reflection and growth. It provides mechanisms for journaling, emotional check-ins, and access to curated mental health resources. It anchors the system by offering consistent, structured interactions that feed data upward to the intelligence and AR layers.

Features & Services Provided:

- Daily check-in prompts and emotion selection UI.
- Structured and free-form journaling.
- Resource hub with curated articles, videos, and helpline links.

Interfaces & Interactions:

- Sends user data (mood ratings, journal entries) to the Sentiment Analysis Layer.
- Receives emotion-informed suggestions and feedback from sentiment services.
- Interfaces with cloud-based storage for journaling history and with external APIs for up-to-date resources.

Naming Conventions & Structure:

- Resource links are stored in a JSON feed (resources.json) that can be updated without app redeployment.
- It uses localStorage or a secure backend database to store journal content and mood logs.

3 SUBSYSTEM DEFINITIONS & DATA FLOW

The following diagram illustrates the logical breakdown of Lumi's architecture into individual subsystems, organized across three primary layers: the User Interface (Layer X), Sentiment Analysis & Recommendation Engine (Layer Y), and Core Logic & Data Services (Layer Z). These subsystems collaborate to deliver a seamless user experience, ensuring emotional insights are processed and visual feedback or coping tools are delivered effectively.

Figure 2: System Data Flow Diagram Across Lumi's Three Core Layers

4 X LAYER SUBSYSTEMS

4.1 SUBSYSTEM 1

The visual components include different exercises created using AR/VR/2D visuals as well as actual environments. It is responsible for rendering visual elements and creating the user experience. It provides calming visuals, appropriate environments, and mindfulness cues like breathing animations.

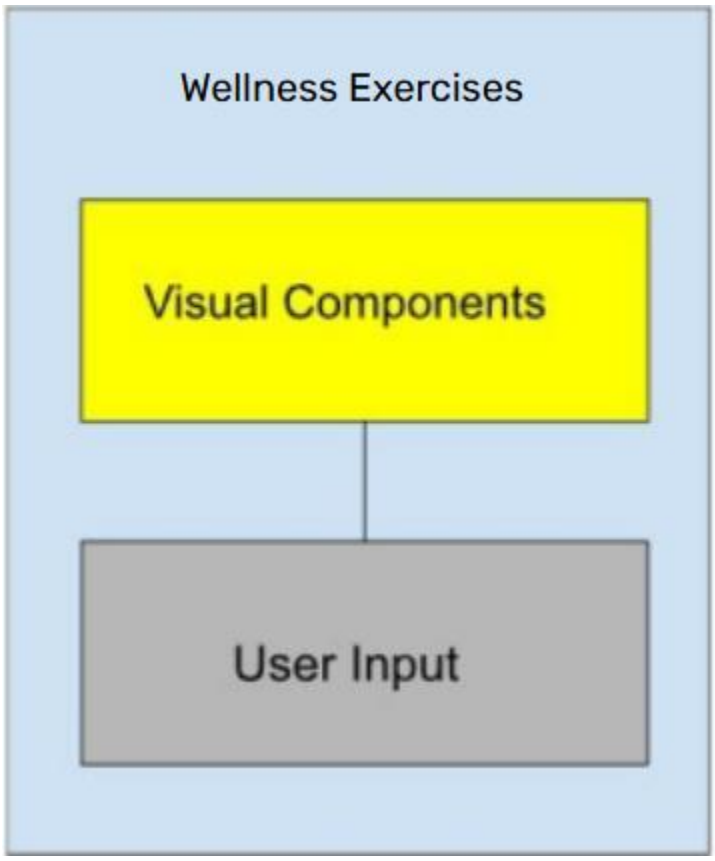

Figure 3: Visual Components Subsystem Diagram (Layer X)

4.1.1 ASSUMPTIONS

The system assumes that the user's device is able to render theappropriate components such as AR components to display appropriate objects.

4.1.2 RESPONSIBILITIES

The visual components subsystem is responsible for rendering and managing the display of all visual assets.

4.1.3 SUBSYSTEM INTERFACES

Table 2: Visual Components Subsystem Interfaces (Layer X)

ID	Description	Inputs	Outputs
V01	Visual Interface	Signal from UI	Specific AR exercise
V02	Asset Loader	Content for visuals	Loaded AR visual

4.2 SUBSYSTEM 2

The User Input Handling subsystem manages interactions within the AR system. Interactions may include starting and stopping the activities, advancing through specific exercises, and exploring an environment. Any interactive AR elements are part of the UI layer and the User Input Handling responds to those element's triggers or state changes.

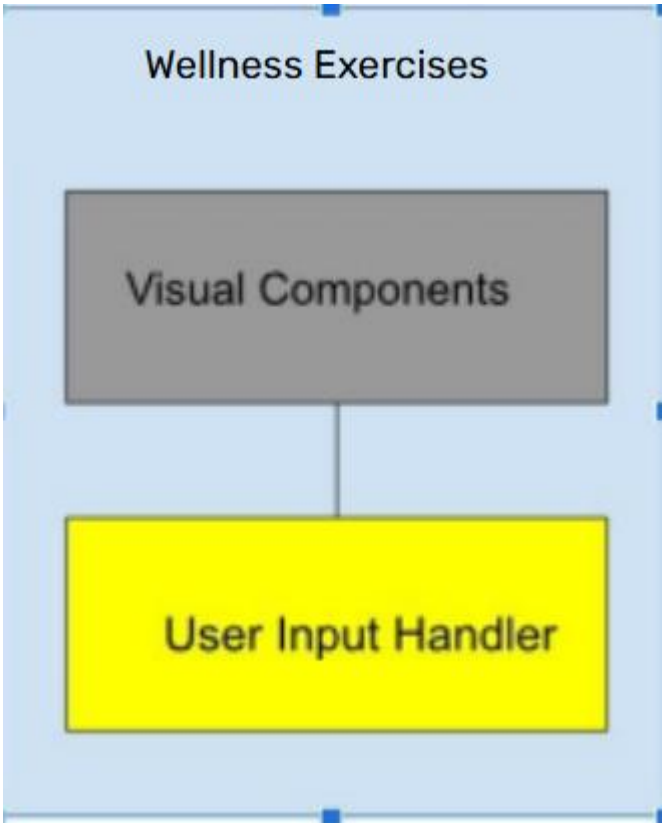

Figure 4: User Input Handling Subsystem Diagram (Layer X)

4.2.1 ASSUMPTIONS

It is assumed that all user interaction occurs through screen input and there are interactive elements that the Input Handler can listen to.

4.2.2 RESPONSIBILITIES

The User Input Handler subsystem captures user actions and communicates with the Visual Components

subsystem to show visuals as requested. The Input Handler must also close the exercise as triggered by the user.

4.2.3 SUBSYSTEM INTERFACES

ID	Description	Inputs	Outputs
U01	User Input Listener	Button presses, selections	Trigger AR visuals
U02	Close Action	User exits exercise	Hides visuals and returns to main application

Table 3: User Input Handling Subsystem Interfaces (Layer X)

5 Y Layer Subsystems

5.1 Subsystem 1

This subsystem is responsible for analyzing the user's journal entries and extracting emotional tone, sentiment score, and identifying any harmful or concerning language using pretrained machine learning models.

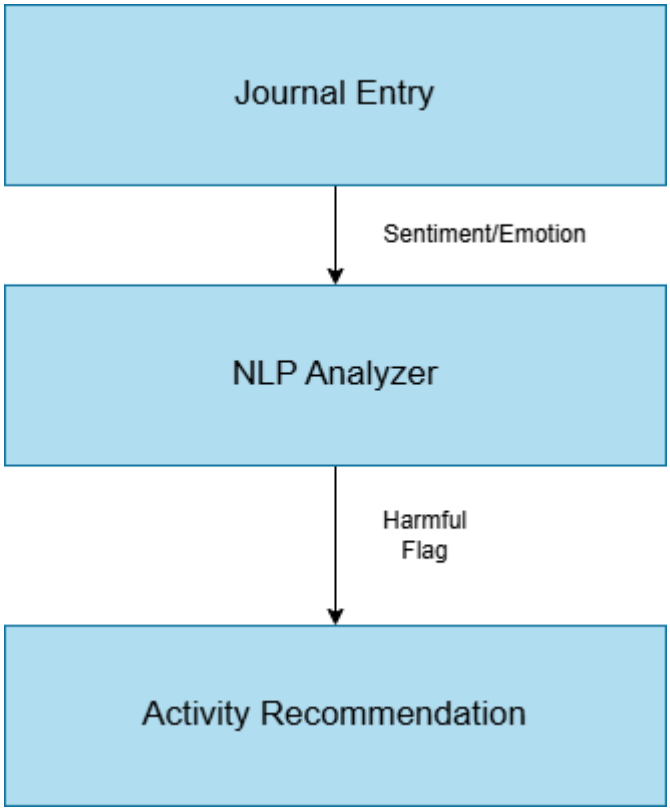

Figure 5: Sentiment & Emotion Analysis Subsystem Diagram (Layer Y)

5.1.1 Assumptions

- Any Input text is sanitized and free of formatting issues before analysis.
- Pretrained models are correctly installed and operational.

5.1.2 Responsibilities

- Classify overall sentiment (positive, neutral, negative) from journal entries.
- Identify the top emotional tone (e.g., sadness, joy, fear).
- Detect key phrases or patterns associated with harmful intentions or distress.
- Log flagged entries for escalation or intervention.

5.1.3 Subsystem Interfaces

Table 4: Sentiment Analysis Subsystem Interfaces (Layer Y)

ID	Description	Inputs	Outputs
Y1-01	Journal text analyzer	Raw journal entry text	Sentiment tag Emotion Classification
Y2-02	Harmful Language Detector	Entry Text Keyword Patterns	Alert Flag Logged concern entry

5.2 SUBSYSTEM 2

This subsystem takes emotional data from the NLP analyzer and produces real-time, user-facing feedback based on emotional state, including motivational comments or emergency resources.

5.2.1 ASSUMPTIONS

- Sentiment input is formatted and tagged correctly by the NLP Analyzer.
- Recommendation logic maps specific emotions to appropriate responses

5.2.2 RESPONSIBILITIES

- Provide motivational feedback if sentiment is positive or encouraging.
- Suggest journaling prompts or coping tips for negative or neutral states.
- Trigger helpline links and alerts if harmful intent is detected.

5.2.3 SUBSYSTEM INTERFACES

Table 5: Sentiment-Based Feedback Subsystem Interfaces (Layer Y)

ID	Description	Inputs	Outputs
Y1-03	Sentiment-Based Response Selector	Sentiment/emotion tags, harmful flag	Feedback message, journaling tip, or support suggestion
Y2-04	Emergency Routing Output	Harmful flag = TRUE	Helpline contact info and crisis warning

6 Z Layer Subsystems

This section describes the foundational Z Layer of Lumi, which supports daily self-reflection, emotional journaling, and access to mental health resources. These subsystems facilitate structured input, data logging, and personalized feedback routing. Each subsystem plays a role in ensuring user input is stored securely, analyzed appropriately, and results for personalized support.

6.1 Subsystem 1

This subsystem handles internal data routing within the Z Layer and communicates with both the Sentiment Analysis Layer and the User Interface Layer. It processes check-in and journal inputs, delegates them to the appropriate subsystems (Journaling Engine, Resource Hub, Data Logger), and relays sentiment-driven responses from the Y Layer.

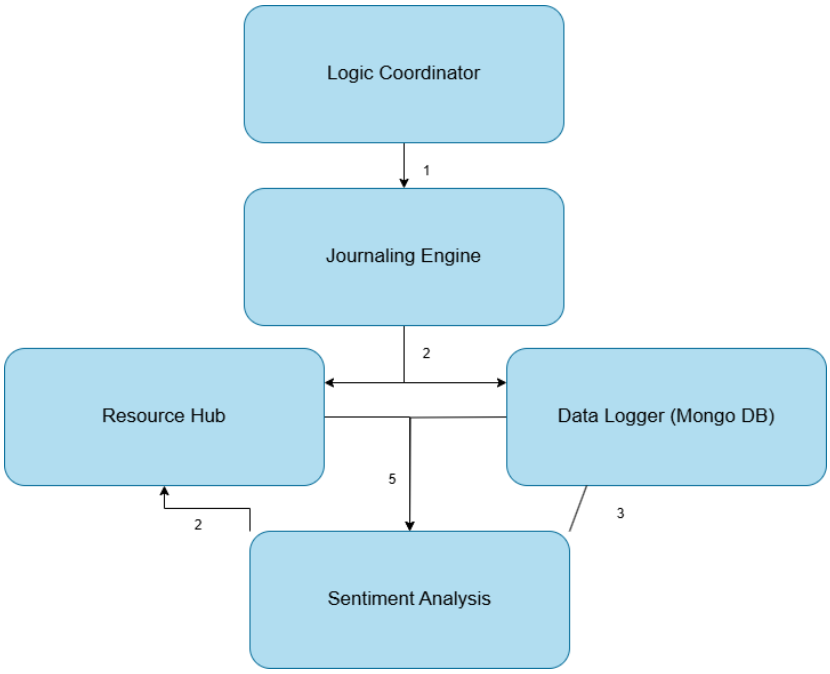

Figure 6: Data Routing & Feedback Coordination Subsystem Diagram (Layer Z)

6.1.1 Assumptions

- This subsystem assumes journal and check-in data arrive in standardized formats like JSON.
- Communication with the NLP layer (Layer Y) occurs over a secure API.
- It is assumed that other Z Layer subsystems are available and functioning for proper data flow.

6.1.2 Responsibilities

- Receive user inputs from Layer X and route to Z2 (Journaling), Z3 (Resource Hub), or Z4 (Database).
- Receive emotion classifications from Layer Y and determine appropriate actions (e.g., suggest resources, trigger AR).
- Manage internal flow between check-ins, feedback, and saved entries

6.1.3 Subsystem Interfaces

Table 6:Data Routing and Feedback Coordination Interfaces (Layer Z)

ID	Description	Inputs	Outputs
Z1-01	Journal/check in routing	Journal Entry Mood rating from UI	Routed data to Journaling/DB/NLP
Z1- 02	Sentiment response handler	Emotion tags and insights from layer Y	Response directives to UI or AR system
Z1-03	Resource suggestion trigger	Flagged Moods or Keywords	Resource Links or feedback routes

6.2 SUBSYSTEM 2 -JOURNALING ENGINE

6.2.1 ASSUMPTIONS

- Data from the UI is pre-validated before entering this subsystem.
- Time stamps and user IDs are included in each journaling submission.

6.2.2 RESPONSIBILITIES

- Accept and process free-text journal entries.
- Structure check-in responses into a consistent format.
- Forward data to the database for long-term storage.

6.2.3 SUBSYSTEM INTERFACES

Table 7: Journaling Engine Subsystem Interfaces (Layer Z)

ID	Description	Inputs	Outputs
Z2-01	Receive Journal Entry	Text from UI from Logic Coordinator	Journal Object
Z2- 02	Log Check-in data	Emotion tags, ratings	Journal and Mood record sent to database

6.3 SUBSYSTEM 3 – RESOURCE HUB

6.3.1 ASSUMPTIONS

- All resources are kept up to date.
- Sentiment tags are used to match emotional states with suggested resources.

6.3.2 RESPONSIBILITIES

- Present content based on user sentiment or journaling flags.
- Interface with emergency services if triggered.
- Provide general mental health content regardless of mood input.

6.3.3 SUBSYSTEM INTERFACES

Table 8: Resource Hub Subsystem Interfaces (Layer Z)

ID	Description	Inputs	Outputs
Z3-01	Load recommended resources	Emotion tag from layer Y	JSON data to UI
Z3- 02	Emergency Trigger Handler	Keyword flags from journal	Resource Hub display

References