# 1. Introduction

## 1.1 Purpose

This document was created by:

* Ashish Ghaskata
* Krishna Raj Bhandari
* Suraj Bhatta
* Mohammad Adnan Khan

It serves as the architecture documentation for the **FunFlip Educational Game**, a mobile memory game targeting children aged 4–6.  
This document should be read by:

* Developers and system architects
* UI/UX designers
* Quality assurance and testing teams
* Future maintainers

It is binding for anyone involved in designing, maintaining, or extending the FunFlip application.

## 1.2 Summary

This documentation outlines the architectural structure of the FunFlip Game.  
It covers:

* Functional and non-functional requirements
* System decomposition
* Interface design
* Design decisions and rationale
* Reuse of components
* Human-machine interaction modeling

**Stakeholders**: development team, testers, product owner, designers.

## 1.3 Definitions and Abbreviations

|  |  |
| --- | --- |
| **Term** | **Definition** |
| FR | Functional Requirement |
| NFR | Non-Functional Requirement |
| UX | User Experience |
| Q | Quality Attribute |
| L | Legal Requirement |
| T | Technical Design Element |
| HMI | Human-Machine Interface |

## 1.4 References, Standards, and Rules

* FunFlip Requirements Specification
* Godot Engine 4.x documentation
* JSON structure used for categories
* Usability guidelines for early childhood apps
* ISO/IEC 25010 quality standards

## 1.5 Overview

This document is structured as follows:

* Description of core architecture and its principles
* Interfaces and component responsibilities
* Design decisions and alternatives considered
* Component reuse strategy
* Human-machine interface requirements and modeling
* Summary, appendix (diagrams), and index

# 2. System Architecture

## 2.1 Functional and Non-Functional Requirements

|  |  |  |
| --- | --- | --- |
| **Requirement** | **Must/Can** | **Category** |
| Allow category selection | Must | FR, UX |
| Support 3 difficulty levels | Must | FR |
| Flip cards and match pairs | Must | FR |
| Audio on card flip | Must | FR, UX, Q |
| Unmatched cards flip back after delay | Must | FR |
| Display turn count | Must | FR |
| Happy sound on match | Must | FR, UX |
| Replay, return to menu, quit | Must | FR, UX |
| Voice feedback by category | Can | FR, Q |
| Simple, colorful UI for kids | Must | NFR, UX, Q |
| Offline operation | Must | NFR, L |
| Toggle sound/music | Can | FR, UX |
| Response within 0.5s | Must | NFR, Q |
| No personal data collection | Must | NFR, L |
| Modular Godot components | Can | T, NFR |

**List of Requirements**

## 2.2 Prioritization of Non-Functional Requirements

|  |  |  |  |
| --- | --- | --- | --- |
| **Attribute** | **Definition** | **How Achieved** | **Measured By** |
| Usability | Child-friendly and easy to navigate | Large buttons, 3-click access, no text | Game start in ≤ 3 steps |
| Accessibility | Audio feedback and inclusive design | Voice cues, mute toggle | 100% cards play sounds |
| Performance | Fast and stable response | Optimized scenes and animations | Flip time ≤ 0.5s, no crashes |

## 2.3 Architectural Principles

1. **Strict Layered Architecture** – UI → Scene Loader → Game Logic → Data → Services
2. **Separation of Concerns** – Each module has a clear role
3. **Low Coupling & High Cohesion** – Components interact via clean signals/APIs
4. **Open/Closed Principle** – Easy to add cards or features without rewriting logic
5. **KISS (Keep It Simple)** – Single Card.tscn reused, minimal dependencies
6. **Centralized Cross-Cutting Concerns** – Audio, performance, and usability handled uniformly

# 3. System Interfaces

**SceneLoader**

* Handles transitions between all major game scenes
* Exposes:
  + Show start screen
  + Show category/level/game screens
  + Show completion screen

**GameManager**

* Manages gameplay logic
* Exposes:
* Start game
* Handle card flip
* Pause/Resume
* Get score
* End game

**DataManager**

* Provides and persists card/category data
* Exposes:
  + Get categories/cards
  + Save/load game progress

**AudioPlayer**

* Manages sound effects and settings
* Exposes:
  + Play sound by name
  + Mute/unmute
  + Set volume

**UICallbacks**

* Reacts to UI input events
* Exposes:
  + Play button pressed
  + Category/level selection
  + Back navigation

# 4. System Design

## 4.1 System Decomposition

* **Presentation Layer**: Start, Category, Level, Game, Completion screens
* **App Controller**: SceneLoader (Main.gd) handles flow
* **Game Logic**: GameManager, Card.gd, ScoreManager, MatchChecker
* **Data Layer**: DataManager loads from categories.json
* **System Services**: AudioControl.gd, Godot’s FileAccess API

## 4.2 Design Decisions

* Use 5-layered architecture for modularity
* Use JSON for extensible card storage
* Use signals for UI → Logic communication
* Centralized scene control with SceneLoader
* Reuse single Card.tscn scene across all levels
* Target smooth 60 FPS
* Record decisions using ADRs (Architecture Decision Records)

## 4.3 Design Alternatives Considered

|  |  |
| --- | --- |
| **Alternative** | **Rejected Because** |
| Embed card data in logic | Violates open/closed principle |
| Let GameManager control scenes | Breaks separation of concerns |
| Load card data per level | Slower, reduces responsiveness |
| Use multiple Card scenes | Increases maintenance complexity |
| Allow UI to access DataManager | Breaks layering, tight coupling |

## 4.4 Reuse of Components

* **Card.tscn**
  + Used for all cards
  + Reduces duplication, updates propagate globally
* **AudioControl.gd**
  + Central manager for all game audio
  + Ensures consistent volume/logic
* **SceneLoader (Main.gd)**
  + Reused for all transitions
  + Decouples navigation from game logic
* **categories.json**
  + Contains all card data
  + Easy to extend without code changes

# 5. Human-Machine Interface (HMI)

## 5.1 Requirements

* Simple, age-appropriate design
* Max 3 steps to gameplay
* Large, touch-friendly buttons
* Visual/audio feedback
* High contrast, toggleable audio

## 5.2 Design Principles

* **KISS** – No clutter, only essentials shown
* **Consistency** – Uniform button styles
* **Child-friendly** – Big fonts, cheerful colors
* **Accessible** – Audio + visual feedback everywhere

## 5.3 Interaction Model

* Linear flow:  
  Start → Category → Level → Game → Completion
* Input method: Touch
* Feedback loop:  
  Tap → card flips  
  Match → visual + audio  
  Win → completion screen

Scene transitions are all handled by SceneLoader.

# 6. Summary

The FunFlip Educational Game architecture follows best practices for modularity, performance, usability, and accessibility. It ensures scalability through clean layering, reuse, and design separation.

# 7. Appendix

* Figures:
  + Figure 1: High-Level System Architecture
  + Figure 2: Activity Diagram
  + Figure 3: Domain Data Model
  + Figure 4: Interaction Modeling

A diagram of a software process

AI-generated content may be incorrect.

Figure 1 High-Level System Architecture

A diagram of a process

AI-generated content may be incorrect.

Figure 2 Activity Diagram

A diagram of a game

AI-generated content may be incorrect.

Figure 3 Domain Data Model

A diagram of a diagram

AI-generated content may be incorrect.

Figure 4 Interaction Modeling

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