Dynamic Diorama: Narrative-Driven Orientation Modeling and Object Placement for VR

Furkan Çelen, Meral Kuyucu, Bora Şenceylan, Gökhan İnce

Presenter: Furkan Çelen | Computer Engineering Dept. | celen23f@itu.edu.tr

May 2026

Who am I

- Computer Engineering master student at Istanbul Technical University.
- Software Developer & Researcher specialized in immersive environments and AI integration.
- Research Interests:
  - Intelligent Virtual Environments & Immersive Media.
  - Human-Centered AI & Spatial Reasoning in XR.
  - Software Engineering for Real-time Systems.

Overview

- Motivation
- Problem Statement
- Dynamic Diorama Framework
- Placement Strategies
- Experimental Design
- Results & Evaluation
- Conclusion & Future Work

Motivation

- Spatial Arrangement as a Narrative Medium
- Limitations of Geometry-First Layout Tools
- The "Emotional Gap" in Immersive Scenes
- Need for Emotion-Aware Spatial Design

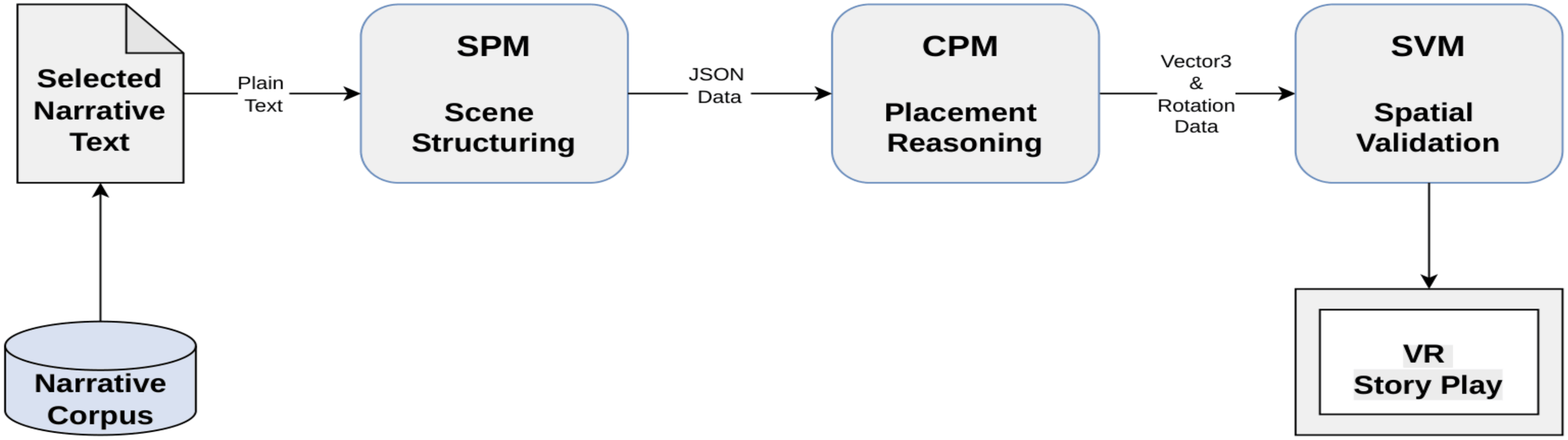
Problem Statement

- Semantic interpretation beyond pure physics

- RQ1 (Perception): Impact on Coherence & Emotional Alignment
- RQ2 (Attention): Influence on Gaze & Visual Patterns
- RQ3 (Validity): Semantic Reasoning vs. Physical Collisions

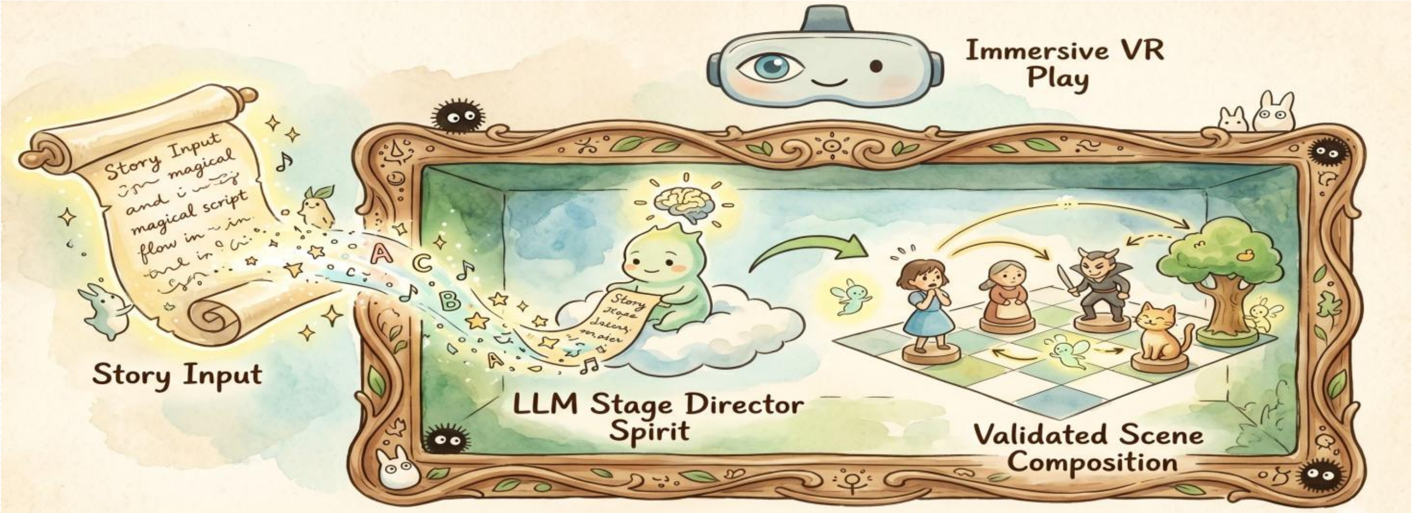
Dynamic Diorama Framework

- Controlled VR Testbed
- Standardized Evaluation
- Three-Stage Pipeline: SPM → CPM → SVM



Dynamic Diorama Framework

- SPM (Scene Parsing Module):
  Raw Text → Structured JSON Data
- CPM (Contextual Placement Module):
  JSON → Spatial Parameters (Vector3 & Rotation)
- SVM (Spatial Validation Module):
  Game Engine → Collision & Support Verification



LLM-Informed Placement Approach

- Core Engine: LLM Model API
- Zero-Shot Prompting Pipeline (Structured JSON Output)
- Affect-Driven Parameters:
  - Proximity, Character Gaze, & Orientation

Baseline Placement Approaches

- Random Strategy: Arbitrary positioning with basic collision checks
- Heuristic Strategy: Predefined, rigid spatial rules via static JSON configs
- The Core Limitation: Physically stable but entirely blind to emotional context

Experimental Design & Methodology

- Participant Cohort: 20 Volunteers (predominantly Engineering backgrounds)

HTC Vive
Focus Headset

- Hardware: HTC Vive Focus Vision Headset
- Physiological Tracking: Real-time Gaze Vector Logging via OpenXR
- Procedure: Randomized, Neutral Labeling (Scene A, B, C) to Eliminate Bias

Visual Comparisons

Random Approach

Heuristic Approach

LLM-Informed Approach

- The Fear scenario evaluates how placement strategies handle narrative priority and visual occlusion.
- Random Approach: The character gazes aimlessly into the forest, failing to acknowledge the threat.
- Heuristic Approach: The strict gaze rule is applied, but the antagonist remains completely obstructed by a tree.
- LLM Approach: The layout is semantically restructured to reveal the antagonist, with posture aligned to portray genuine fear.

Visual Comparisons

Random Approach

Heuristic Approach

LLM-Informed Approach

- The Sadness scenario tests the system's ability to model human proxemics and non-verbal emotional cues.
- Random Approach: The character stands in the background facing away from the focal memento
- Heuristic Approach: The agent looks at the target, but its rigid distance and posture fail to evoke intimacy
- LLM Approach: The agent embodies mourning by stepping intimately close to the object and applying a downward head tilt.

Quantitative Results

PERCEPTION SCORES ACROSS PLACEMENT APPROACHES (N=20).

Metric	**Random**	**Heuristic**	**LLM-based**
Narrative Coherence	3.0 ± 1.7	5.1 ± 1.3	$\mathbf{5.7 \pm 0.9}$
Emotional Alignment	3.2 ± 1.5	4.4 ± 1.3	$\mathbf{5.4 \pm 0.9}$
Sense of Presence	4.4 ± 1.1	$\mathbf{5.1 \pm 0.8}$	5.0 ± 0.8

Quantitative Results

GAZE-BASED ATTENTION RESULTS ACROSS PLACEMENT APPROACHES.

Metric	Random	Heuristic	LLM-based
Time to First Fixation (s)	4.8 ± 1.2	3.6 ± 1.0	**2.1 ± 0.7**
Dwell Time (s)	2.3 ± 0.9	3.1 ± 1.1	**5.4 ± 1.3**

Qualitative Results & Physical Validity

PHYSICAL VALIDITY AND SYSTEM PERFORMANCE METRICS.

Metric	Random	Heuristic	LLM-based
Initial Collision Rate (%)	11.2	2.1	3.8
Validation Rejection Rate (%)	14.5	1.5	2.4
Avg. Generation Retries	1.8	0.2	0.8
Final Invalid Placements (Count)	**7**	**1**	**2**

*Refers to minor artifacts visible across all 20 experimental sessions.

Qualitative Results & Physical Validity

USER PREFERENCES ACROSS PLACEMENT APPROACHES (N=20).

Preferred Scene Version	**Percentage (%)**
Random	5.0
Heuristic	35.0
LLM-based	**60.0**

Conclusion & Future Work

- Spatial Layout as a Powerful Narrative Medium
- LLM Placement Significantly Enhances Affective Resonance
- Validation Layers Successfully Mitigate Collision Risks
- Inverse Kinematics & Procedural Mesh Deformation
- Evaluating with a Larger and More Diverse Participant Sample

THANK YOU