Presented by Group R26-IM-004

Immersive Multisensory VR Motion System for Embodied Navigation

A Multisensory Motion-Enabled VR Interaction System

Progress Presentation 01



TODAY’S AGENDA

PROJECT OVERVIEW

PROPOSAL FEEDBACK & PROGRESS

TECHNICAL ARCHITECTURE

INDIVIDUAL COMPONENTS

SYSTEM DEMONSTRATION

COMMERCIALIZATION & SUSTAINABILITY

Q&A SESSION

THE PROBLEM WE SOLVE

Lack of Physical Realism and Embodied Interaction in VR Navigation

↓

VR systems provide strong visual immersion, but lack physical feedback

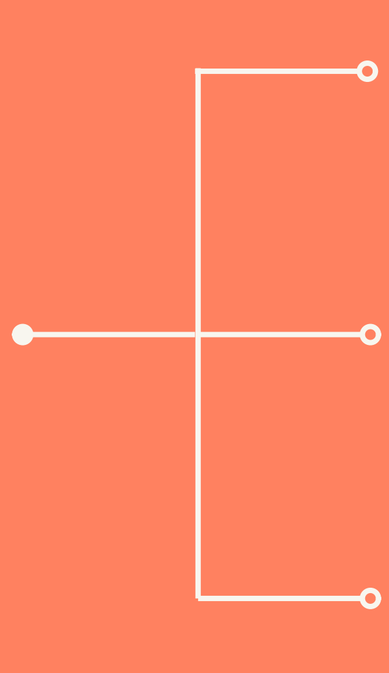
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This creates sensory mismatch, in return reducing immersion

Project ID: R26-IM-004

TO WHOM WE SOLVE

Our users and stakeholders



- **VR users (gamers, trainees, researchers)**
- **VR developers & simulation designers**
- **VR simulation institutions & companies**

COMMENTS FOR THE PROPOSAL

Comment 1: Rejection of Previous Component 3

The team restructured the project scope and introduced a new research component:

Synchronized External Visual Feedback System

NEW INDIVIDUAL COMPONENT OVERVIEW

Component 3: Synchronized External Visual Feedback System for Spectator Engagement

Creating an external LED lighting system synchronized with Herald's VR events (speed, collisions, environment) to improve the experience for spectators outside the headset.

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NEW INDIVIDUAL COMPONENT OVERVIEW

Component 3: Synchronized External Visual Feedback System for Spectator Engagement

Research Novelty:

Translates "invisible" VR experiences into real-world visual effects, creating shared immersion between the player and the audience.

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IT22082992 | Gunawardena L H

Motion Rendering and Control for Embodied VR Navigation

Specialization in Interactive Media

How the Solution Addresses the Sub-Problem?

- **Pressure-Sensitive Acceleration:** Replaced binary button inputs with an Arduino-linked pressure sensor to mimic real-world grip-to-speed mechanics.
- **Dynamic Velocity Mapping:** Implemented logic where higher sensor pressure directly correlates to increased nimbus speed in the Unity environment.
- **Physics-Based Flight:** Integrated a demo environment in Unity that responds to hardware input with realistic momentum and inertia.
- **Embodied Control Loop:** Created a functional feedback loop where physical user effort determines virtual flight intensity.

User Requirements Addressed by the Solution

- **Variable Speed Control:** Allows users to modulate flight velocity through physical grip, addressing the need for intuitive speed management.
- **Tactile Interaction:** Provides a physical sensation of "throttling" the nimbus, increasing the sense of embodied agency.
- **Reduced Latency:** Optimized the Arduino-to-Unity serial pipeline to ensure immediate visual response to physical pressure changes.
- **Spatial Realism:** The demo environment provides visual cues that align with speed changes, reducing the risk of cybersickness.

Design Excellence / Contribution

1

HARDWARE-SOFTWARE SYNERGY

Seamlessly integrated an analog pressure sensor with a digital VR environment for high-fidelity control.

2

CUSTOM EVENT LOGIC

Engineered specific Unity event listeners that interpret raw sensor data into meaningful flight parameters.

Design Excellence / Contribution

3

PROPRIOCEPTIVE ALIGNMENT

Designed the system so the physical act of "squeezing" the broom handle naturally feels like accelerating.

User Feedback on Prototype

- **Intuitive Acceleration:** Testers noted that the pressure-based speed control felt significantly more "magical" than a standard joystick.
- **Positive Sensitivity:** Feedback confirmed that the sensor mapping is sensitive enough to allow for subtle speed adjustments.
- **Enhanced Engagement:** Users reported feeling more connected to the flight process when physical grip influenced speed.



IT22119094 | Botheju W R D

Environmental Interaction and Immersion Modelling for VR Aerial Navigation

Specialization in Interactive Media

How the Solution Addresses the Sub-Problem?

- **Spatial Haptic Mapping:** Developed a system that maps Unity spatial triggers to specific haptic zones on a wearable jacket prototype.
- **Real-time Zone Triggering:** Implemented real-time vibration responses that fire as objects or environmental zones move through the virtual space.
- **Environmental Foundations:** Successfully established the core logic for simulating wind resistance, turbulence, and proximity haptics.
- **Multi-Motor Control:** Integrated three independent vibration motors to represent distinct environmental directions or intensities.

User Requirements Addressed by the Solution

- **Directional Awareness:** Uses localized haptic zones to help users perceive the direction of wind or nearby obstacles.
- **World Presence:** Enables users to "feel" the virtual world, moving beyond purely visual immersion.
- **Reduced Sensory Mismatch:** Synchronizes environmental events with tactile feedback to decrease disorientation during flight.
- **Wearable Comfort:** Designed the haptic feedback layer to be integrated into a vest for natural, hands-free interaction.

Design Excellence / Contribution

1

MODULAR FEEDBACK ARRAY

Developed a scalable motor layout that can be expanded for full-body environmental immersion.

2

PRECISION TIMING

Calibrated the response pipeline to ensure vibration triggers occur instantly upon virtual contact.

Design Excellence / Contribution



Engineered a force-mapping algorithm that translates 3D environmental vectors into localized vibration.

User Feedback on Prototype

- **Seamless Coherence:** Feedback highlighted that the vibration felt "natural" and well-synchronized with visual spheres moving in Unity.
- **Heightened Immersion:** Early evaluations confirm that localized haptics provide a stronger sense of being "inside" the environment.
- **Emotional Impact:** Testers described the turbulence simulation as adding a thrilling "weight" to the flight experience.



IT22129208 | Silva H S N

Mechanical Integration and Stability Design for the VR Motion Seat Platform

Specialization in Interactive Media

How the Solution Addresses the Sub-Problem?

- **Dynamic Fan Control:** Developed an Arduino-controlled relay system that scales fan RPM dynamically based on real-time VR velocity.
- **Wind-Force Feedback Loop:** Successfully synchronized virtual flight speed with the physical actuation of a high-power airflow system.
- **Load-Bearing Integration:** Designed the platform to maintain structural integrity while supporting both the user and the mechanical feedback hardware.
- **Modular Rig Assembly:** Constructed the primary frame and seat support to integrate mechanical actuators and fan mounts.

User Requirements Addressed by the Solution

- **Dynamic Speed Realism:** Addresses the need for physical wind cues to match the visual sensation of high-speed flight.
- **Environmental Grounding:** Enhances the user's sense of "being there" by bridging the gap between visual speed and physical atmosphere.
- **Structural Safety:** Provides a stable, ergonomic platform that ensures user security during active motion.

Design Excellence / Contribution

1

VELOCITY-TO-WIND MAPPING

Engineered a precise control algorithm that translates Unity speed parameters into physical fan intensity.

2

HARDWARE-SOFTWARE SYNCHRONIZATION

Achieved sub-perceptual latency between virtual acceleration and physical fan response.

Design Excellence / Contribution

3

MODULAR MECHANICAL ARCHITECTURE

Designed a scalable frame that allows for easy addition or replacement of flight-themed components.

User Feedback on Prototype

- **Postural Grounding:** Early testers felt that even a partially built rig provided a necessary physical base that enhanced their stability during navigation.
- **Ride Feel Potential:** Users expressed excitement for the full motion-seat integration, noting the current rig already "sets the stage" for high-fidelity flight.
- **Balance Perception:** Testers felt the current center of gravity was well-positioned, providing a solid foundation for upcoming pitch and roll actuation.



IT22191724 | Nimsara L G S K

Synchronized External Visual Feedback System for Spectator Engagement in VR Motion Platforms

Specialization in Interactive Media

How the Solution Addresses the Sub-Problem?

- **Reactive LED Integration:** Developed an external lighting system that utilizes reactive LED arrays to reflect real-time pixel data from the VR environment.
- **Visual-Environment Sync:** Successfully mapped dominant virtual colors (e.g., blue for sky, green for forest) to physical LED strips mounted around the rig.
- **Peripheral Realism:** Implements a light-tracking system that ensures the user's peripheral vision is always aligned with the virtual horizon.

User Requirements Addressed by the Solution

- **Shared Immersion:** Bridges the gap between the headset wearer and spectators by making virtual events visible in the real world.
- **Enhanced Presence:** Increases the sense of "being there" by extending virtual lighting cues into the physical room.
- **Atmospheric Consistency:** Ensures that the lighting in the physical room matches the lighting conditions of the virtual flight scenario.
- **Communication Bridge:** Facilitates better interaction between the pilot and audience during public demonstrations.

Design Excellence / Contribution

1

PIXEL-TO-LIGHT MAPPING

Engineered a custom algorithm that identifies and averages screen colors to drive LED animations dynamically.

2

SPECTATOR-CENTERED DESIGN

Introduces a new research approach focused on the audience experience in VR motion platforms.

Design Excellence / Contribution

3

DYNAMIC EVENT VISUALIZATION

Uses specific lighting patterns (e.g., red flashes for collisions) to tell the story of the flight to spectators.

User Feedback on Prototype

- **Compelling Audience Connection:** Spectators reported feeling much more "in the loop" when they could see the lighting change with the flight.
- **Reduced Isolation:** Pilots felt less "cut off" from the room when their peripheral vision captured familiar environmental light cues.
- **Enhanced Visual Comfort:** Users noted that the ambient LED glow made the transition between the headset and the room feel more natural.

IMMERSIVE MULTISENSORY VR MOTION SYSTEM FOR FULL BODY NAVIGATION

Ability of Commercialization

Viable as a location-based immersive VR attraction

Suitable for arcades, immersive
venues, and event spaces

Target Market

Fantasy/adventure fans, young gamers, and experience-seeking groups

VR arcades, gaming cafés, and immersive
entertainment providers

Value Proposition

Motion-enabled full-body VR flight with stronger realism and embodiment

Reusable modular platform for multiple ride themes

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IMMERSIVE MULTISENSORY VR MOTION SYSTEM FOR FULL BODY NAVIGATION

Cost and Pricing

Cost: hardware, fabrication, VR setup, software, and maintenance

Revenue: per-session pricing, venue packages, and repeated use

Scalability

Starts with broom-riding, expandable to dragon-riding and other fantasy flight themes

Demonstration



Thank you