Department of Computer Science & Engineering
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System Requirements Specification
CSE 4316: Senior Design I
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MosaicMovements
In/E Motion

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Revision History

Revision	Date	Author(s)	Description
0.1	07.05.2024	DP	document creation
0.2	07.08.2024	JC	section 1 draft
1.0	7.10.2024	DP, SD, AM, JC	document completed

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1 Product Concept

This section describes the purpose, use, and intended user audience for the In/E Motion system. In/E Motion is a system that captures motion data through tracking technology and generates animations projected across the performance space. Users of In/E Motion will be able to enhance their performances with dynamic, real-time visual effects, creating an immersive experience for the audience.

1.1 Purpose and Use

The purpose of the In/E Motion system is to integrate motion tracking with real-time animation projection to create an enhanced visual experience for live performances. The system captures movement data from performers using advanced motion tracking technology. This data is then processed to generate animations that are projected in real-time onto the performance area. The system is intended to be used in various performance settings, including theater, dance, and live art installations, to provide a visually engaging and interactive experience.

1.2 Intended Audience

The intended audience for the In/E Motion system includes:

- Performers: Dancers, actors, and other live performers who will have their movements tracked and visualized.
- Technicians: Individuals responsible for setting up, operating, and maintaining the system during performances.
- Audience: Viewers of the performances who will experience the enhanced visual effects created by the system.

Additionally, the system is designed to be used in a variety of performance venues, ranging from small theaters to large concert halls. It is intended for use by professional performance groups, educational institutions, and event organizers who seek to incorporate advanced visual technology into their productions.

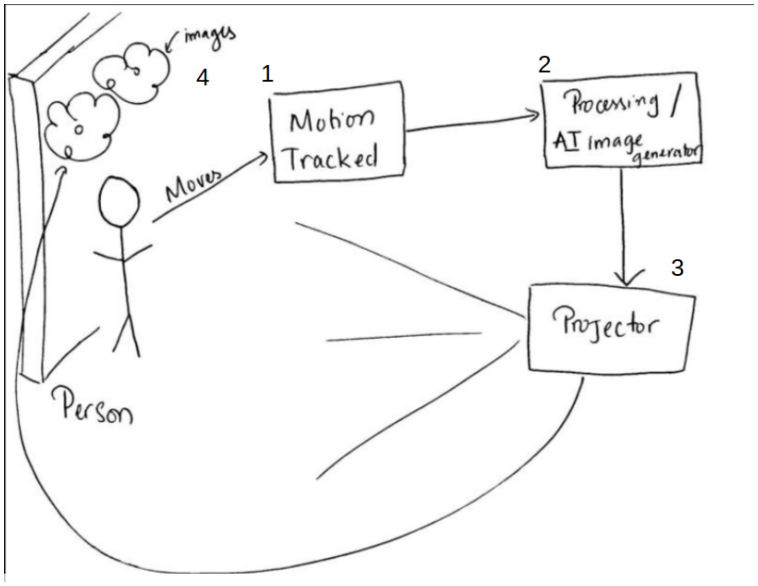

Figure 1: First Conceptual Drawing

2 Product Description

This section provides the reader with an overview of In/E Motion. The primary operational aspects of the product, from the perspective of end users, maintainers, and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces, are described in detail.

2.1 Features & Functions

In/E Motion is designed to capture motion data from performers and generate real-time animations that are projected onto the performance space. The system includes the following key features:

- Motion Tracking: Utilizes motion tracking sensors to capture the movements of performers.
- Data Processing: Processes captured motion data to generate corresponding animations.
- Real-Time Projection: Projects animations in real-time onto the performance space.
- User Interface: Provides a user-friendly interface for setup and control.

The system consists of the following primary components: High definition cameras to capture the movements of performers. A computer that processes the motion data and generates animations. Projectors that project the generated animations onto the performance space. A user interface for technicians to control the system.

Breakdown of Diagram of System Components:
(Figure 1: Conceptual Diagram of In/E Motion System)

1. Cameras for capturing data that is transmitted to a computer for processing.
2. A computer workstation is depicted as a central hub connected to the cameras for processing data and the projector for generating animations.
3. Projectors are shown positioned around the performance space, pointing towards the walls.
4. The users that are being tracked. They could be performers or audience members.

2.2 External Inputs & Outputs

This subsection describes the critical external data flows for the In/E Motion system. The table below specifies all data/information that flows into and out of the system.

Inputs/Outputs	Description	Use
Motion Data	Real-time data captured from cameras	Generate projected animations
Animation Templates	Predefined animation templates stored in the system	Used as a basis for generating visuals
Projected Animations	Real-time animations generated and projected onto performance space	Visual output for the audience
Control Commands	Inputs from the technician via the user interface	Used to control system operations
System Logs	Logs of system operations and performance	Used for maintenance and analysis

2.3 Product Interfaces

The In/E Motion system provides a user-friendly interface for technicians to set up, control, and monitor the system. The interface includes the following elements:

- Control Panel: Allows the technician to start, pause, and stop the system. Provides access to settings and configurations.
- Live Preview: Displays a real-time preview of the captured motion data and generated animations.
- Settings Menu: Provides options to adjust system settings such as sensor calibration, animation templates, and projection parameters.
- Logs and Reports: Allows access to system logs and performance reports for maintenance purposes.

3 Customer Requirements

This section outlines the customer requirements for the In/E Motion system. Customer requirements are those features and functions specified for and by the intended audience for this product. The customer requirements include:

- Real-Time Motion Capture
- Real-Time Animations
- Reliable System Performance
- User-Friendly Interface

3.1 Real-Time Motion Capture

3.1.1 Description

The system must capture and process motion data from performers in real-time, ensuring minimal latency to maintain synchronization with live performances. The motion data captured by the sensors will be used to generate animations that are projected instantaneously.

3.1.2 Source

MosaicMovements team, UTA Fine Arts Sponsors

3.1.3 Constraints

- Economic: The system must use affordable motion tracking sensors to be cost-effective for small performance groups.
- Environmental: The system should operate reliably in various indoor environments.
- Health & Safety: Sensors must be safe to use around performers, ensuring no interference with their movements.

3.1.4 Standards

IEEE 1599-2008 [4] , Vicon DataStream SDK [19]

3.1.5 Priority

Critical

3.2 Real-Time Animations

3.2.1 Description

The system must generate high-quality animations based on the captured motion data, with a smooth and visually appealing output. The animations should accurately reflect the movements of the performers and be custom based on performance requirements.

3.2.2 Source

Sponsors, Performers

3.2.3 Constraints

- Economic: Animation software and hardware must be cost-effective.
- Manufacturability: The system should be designed using readily available components to facilitate easy assembly and maintenance.

3.2.4 Standards

OpenGL [18], DirectX [17]

3.2.5 Priority

Critical

3.3 Reliable System Performance

3.3.1 Description

The system must perform reliably during live performances, with minimal downtime or technical issues. This includes robust hardware and software components that can operate continuously without failure.

3.3.2 Source

Sponsors, Technicians, Performers

3.3.3 Constraints

- Economic: Use high-quality components to ensure reliability while keeping costs reasonable.
- Sustainability: The system should be designed for easy maintenance and long-term use.

3.3.4 Standards

ISO 25010 [7]

3.3.5 Priority

Critical

3.4 User-Friendly Interface

3.4.1 Description

The system must provide a user-friendly interface for technicians to set up, control, and monitor the performance. The interface should include a control panel for starting, pausing, and stopping the system, a live preview of the motion data and animations, and settings for customization.

3.4.2 Source

Sponsors, Technicians

3.4.3 Constraints

- Social: The interface should be intuitive to use to minimize the learning curve for new technicians.
- Health & Safety: The interface should be designed to prevent eye strain and ensure comfortable long-term use.

3.4.4 Standards

ISO 9241 [12]

3.4.5 Priority

High

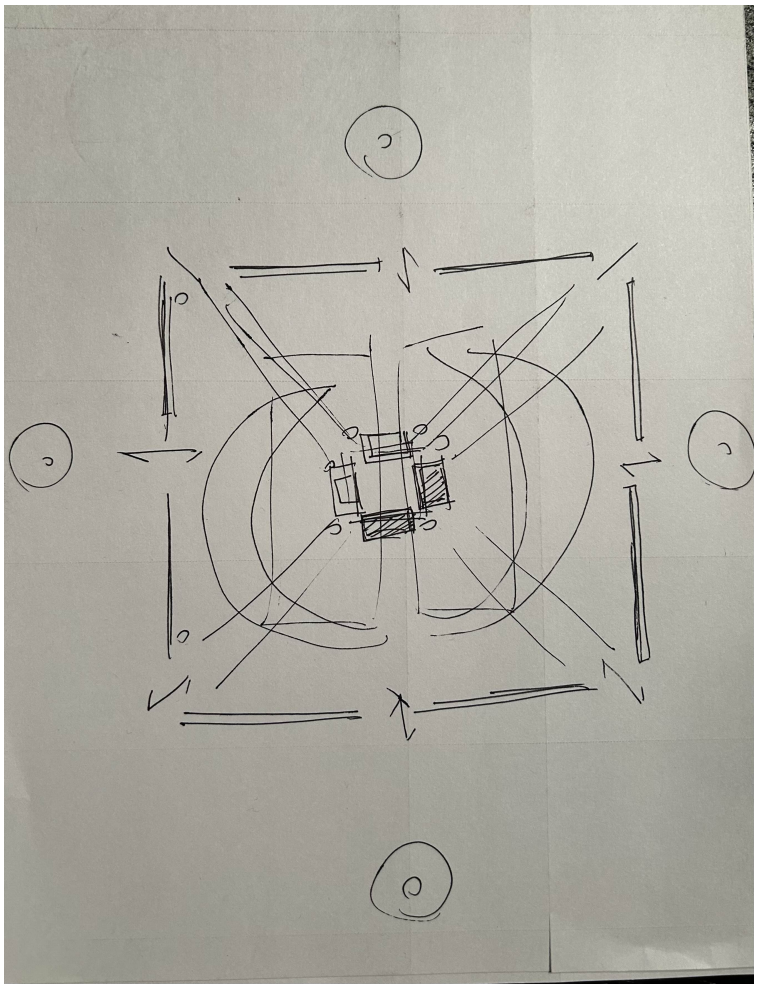

Figure 2: Sponsor Conceptual Drawing

4 Packaging Requirements

This section details the packaging requirements for the In/E Motion system, which identify how the delivered product will be packaged for delivery to the customer. The packaging requirements are:

- Software Installation
- Software Delivery
- User Documentation

4.1 Software Installation

4.1.1 Description

The software will be designed to be customer installable, with a simple, user-friendly installation wizard to guide the user through the installation process. Detailed installation instructions and a user manual will be included in the packaging, both in digital format (PDF) and as a printed booklet.

4.1.2 Source

Sponsors, Technicians

4.1.3 Constraints

- Usability: The installation process must be straightforward to minimize user frustration.
- Documentation: Comprehensive and easy-to-understand instructions must be provided.

4.1.4 Standards

ISO 9241 [12], IEEE 1063 [2]

4.1.5 Priority

Critical

4.2 Software Delivery

4.2.1 Description

The software required for the operation of the In/E Motion system will be available via secure download from the official website. A downloadable link and license key will be provided to the customer upon purchase. Alternatively, the software can also be delivered on a USB drive or DVD upon request.

4.2.2 Source

Sponsors

4.2.3 Constraints

- Economic: The cost of USB drives or DVDs should be minimal.
- Environmental: USB drives and DVDs should be made from recyclable materials where possible.

4.2.4 Standards

HTTPS, USB 2.0/3.0, DVD-ROM

4.2.5 Priority

High

4.3 User Documentation

4.3.1 Description

A comprehensive user manual will be included in both digital (PDF) and printed formats. The manual will cover installation, setup, troubleshooting, and maintenance. Quick start guides will be provided to help users get the system up and running quickly.

4.3.2 Source

Sponsors, Technicians

4.3.3 Constraints

- Usability: Documentation must be easy to understand and follow.
- Format: Must be available in both digital and printed formats.

4.3.4 Standards

ISO 9241 [12], IEEE 1063 [2]

4.3.5 Priority

High

5 Performance Requirements

This section outlines the performance requirements for the In/E Motion system. These requirements ensure that the system operates smoothly and meets the expectations of end-users, providing a seamless and immersive experience during live performances. The performance requirements include:

- Real-Time Data Processing
- System Setup Time
- System Shutdown Time

5.1 Real-Time Data Processing

5.1.1 Description

The system must process motion data in real-time with a maximum latency of 50 milliseconds from data capture to animation projection. This ensures that the animations are synchronized with the performers' movements without noticeable delay.

5.1.2 Source

Sponsors, Performers

5.1.3 Constraints

- Hardware: Requires high-performance processors and efficient motion tracking sensors.
- Software: Algorithms must be optimized for real-time processing.

5.1.4 Standards

IEEE 802.1 [5]

5.1.5 Priority

Critical

5.2 System Setup Time

5.2.1 Description

The system must be ready to use within 2 minutes of being powered on. This includes booting up the processing unit, initializing motion tracking sensors, and loading the software interface.

5.2.2 Source

Sponsors, Technicians

5.2.3 Constraints

- Hardware: Use of SSDs for faster boot times.
- Software: Efficient initialization scripts and minimal startup processes.

5.2.4 Standards

None

5.2.5 Priority

High

5.3 System Shutdown Time

5.3.1 Description

The system must complete the shutdown process within 1 minute. This includes saving any necessary data, powering down sensors, and closing the software interface.

5.3.2 Source

Sponsors, Technicians

5.3.3 Constraints

- Hardware: Efficient power management.
- Software: Quick data saving processes and minimal shutdown tasks.

5.3.4 Standards

None

5.3.5 Priority

High

6 Safety Requirements

This section outlines the safety requirements for the In/E Motion system. Safety requirements are critical to ensure that the product does not pose any harm to users, whether performers, technicians, or audience members. This includes:

- Laboratory equipment lockout/tagout (LOTO) procedures
- National Electric Code (NEC) wiring compliance
- Electrical Safety and Grounding

6.1 Laboratory equipment lockout/tagout (LOTO) procedures

6.1.1 Description

Any fabrication equipment provided used in the development of the project shall be used in accordance with OSHA standard LOTO procedures. Locks and tags are installed on all equipment items that present use hazards, and ONLY the course instructor or designated teaching assistants may remove a lock. All locks will be immediately replaced once the equipment is no longer in use.

6.1.2 Source

CSE Senior Design laboratory policy

6.1.3 Constraints

Equipment usage, due to lock removal policies, will be limited to availability of the course instructor and designed teaching assistants.

6.1.4 Standards

Occupational Safety and Health Standards 1910.147 [16]

6.1.5 Priority

Critical

6.2 National Electric Code (NEC) wiring compliance

6.2.1 Description

Any electrical wiring must be completed in compliance with all requirements specified in the National Electric Code. This includes wire runs, insulation, grounding, enclosures, over-current protection, and all other specifications.

6.2.2 Source

CSE Senior Design laboratory policy

6.2.3 Constraints

High voltage power sources, as defined in NFPA 70, will be avoided as much as possible in order to minimize potential hazards.

6.2.4 Standards

NFPA 70 [15]

6.2.5 Priority

High

6.3 Electrical Safety and Grounding

6.3.1 Description

All electrical connections in the In/E Motion system must be properly packaged and grounded to avoid any risk of electrical shock to users. This includes ensuring that all exposed wires are insulated and all electrical components are housed in secure enclosures.

6.3.2 Source

Sponsors, Technicians

6.3.3 Constraints

- Design: Secure enclosures and proper insulation of all electrical components.
- Testing: Rigorous testing for electrical safety before deployment.

6.3.4 Standards

NFPA 70 [15], IEC 60364 [14]

6.3.5 Priority

High

7 Security Requirements

This section outlines the security requirements for the In/E Motion system, specifying measures related to information security and privacy. These requirements include:

- Data Encryption
- Access Controls
- Data Privacy

7.1 Data Encryption

7.1.1 Description

All sensitive data, including motion capture data and user information, must be encrypted both in transit and at rest. This ensures that any intercepted data remains unreadable and secure.

7.1.2 Source

Sponsors, Performers

7.1.3 Constraints

- Performance: Encryption must not significantly impact system performance.
- Compatibility: Must work with existing data storage and transmission infrastructure.

7.1.4 Standards

AES-256 [1], TLS 1.3 [13]

7.1.5 Priority

Critical

7.2 Access Controls

7.2.1 Description

The system must implement access controls to restrict user access based on roles and responsibilities. This includes defining user roles, assigning permissions, and regularly reviewing access rights.

7.2.2 Source

Sponsors

7.2.3 Constraints

- Complexity: The system must manage access controls without introducing significant complexity.
- Scalability: Access control mechanisms must scale with the number of users and roles.

7.2.4 Standards

ISO/IEC 27002 [8]

7.2.5 Priority

Future

7.3 Data Privacy

7.3.1 Description

The system must ensure the privacy of all user data, including motion capture data and personal information. This includes anonymizing data where possible and providing users with control over their data.

7.3.2 Source

Sponsors

7.3.3 Constraints

- Regulations: Must comply with data privacy regulations.
- User Consent: Must obtain user consent for data collection and processing.

7.3.4 Standards

GDPR [10], CCPA [11]

7.3.5 Priority

Critical

8 Maintenance & Support Requirements

This section outlines the maintenance and support requirements for the In/E Motion system. These requirements are designed to ensure the ongoing functionality, reliability, and user satisfaction of the system after delivery. These requirements include:

- Error Correction and System Updates
- Hardware Maintenance
- Support and Troubleshooting Manuals

8.1 Error Correction and System Updates

8.1.1 Description

The system must support regular software updates and patches to correct errors, enhance features, and improve security. This includes providing a mechanism for automatic updates or notifications to users about available updates.

8.1.2 Source

Sponsors

8.1.3 Constraints

- Internet Access: Updates require a stable internet connection for download and installation.
- Compatibility: Updates must be compatible with existing system configurations and hardware.

8.1.4 Standards

ISO/IEC 14764 [3]

8.1.5 Priority

High

8.2 Hardware Maintenance

8.2.1 Description

The system must be designed for easy maintenance and repair of hardware components. This includes modular design for easy replacement of parts, availability of spare parts, and detailed hardware maintenance manuals.

8.2.2 Source

Sponsors, Technicians

8.2.3 Constraints

- Training: Technicians must be trained to perform hardware maintenance.
- Tools: Specific tools required for maintenance must be readily available.

8.2.4 Standards

ISO 55000 [9]

8.2.5 Priority

High

8.3 Support and Troubleshooting Manuals

8.3.1 Description

Comprehensive support and troubleshooting manuals must be provided, detailing common issues, diagnostic procedures, and solutions. These manuals should be available in both digital and printed formats.

8.3.2 Source

Sponsors, Technicians

8.3.3 Constraints

- Clarity: Manuals must be clear and easy to understand.
- Accessibility: Manuals must be easily accessible to all users.

8.3.4 Standards

IEEE 1063 [2]

8.3.5 Priority

Future

9 Other Requirements

This section specifies additional requirements necessary for the In/E Motion system to be deemed complete. This includes requirements related to customer setup and configuration, product architecture and design, modularity, extensibility, and portability. These requirements ensure that the system is flexible, future-proof, and easy to deploy across various platforms. These requirements include:

- Customer Setup and Configuration
- Performance Optimization
- Modularity and Extensibility

9.1 Customer Setup and Configuration

9.1.1 Description

The system must include a user-friendly setup and configuration process that allows customers to easily install and configure the system. This includes step-by-step installation wizards, configuration tools, and support for common performance environments.

9.1.2 Source

Sponsors, Technicians

9.1.3 Constraints

- Usability: Setup process must be intuitive and require minimal technical knowledge.
- Documentation: Comprehensive setup guides and configuration manuals must be provided.

9.1.4 Standards

ISO 9241 [12], IEEE 1063 [2]

9.1.5 Priority

High

9.2 Performance Optimization

9.2.1 Description

The system must be optimized for performance to ensure smooth operation during live performances. This includes optimizing the motion capture data processing, animation rendering, and system responsiveness.

9.2.2 Source

Sponsors, Performers

9.2.3 Constraints

- Hardware: Performance optimizations must be compatible with the specified hardware.
- Software: Code must be optimized for efficiency and low latency.

9.2.4 Standards

ISO/IEC 25010 [7]

9.2.5 Priority

Critical

9.3 Modularity and Extensibility

9.3.1 Description

The system architecture must be modular to allow for easy updates and extensions. This includes designing components that can be independently upgraded or replaced and providing APIs for integrating additional features.

9.3.2 Source

Sponsors

9.3.3 Constraints

- Design: System components must be loosely coupled to ensure modularity.
- Maintenance: Modular design must not complicate maintenance activities.

9.3.4 Standards

ISO 42010 [6]

9.3.5 Priority

Future

10 Future Items

In this section, these requirements are reiterated for easy-to-reference for the future iterations of the In/E Motion system. These requirements include:

- Support and Troubleshooting Manuals
- Modularity and Extensibility
- Access Controls

10.1 Support and Troubleshooting Manuals

10.1.1 Description

Comprehensive support and troubleshooting manuals must be provided, detailing common issues, diagnostic procedures, and solutions. These manuals should be available in both digital and printed formats.

10.1.2 Source

Sponsors, Technicians

10.1.3 Constraints

- Clarity: Manuals must be clear and easy to understand.
- Accessibility: Manuals must be easily accessible to all users.

10.1.4 Standards

IEEE 1063 [2]

10.1.5 Priority

Future

10.2 Modularity and Extensibility

10.2.1 Description

The system architecture must be modular to allow for easy updates and extensions. This includes designing components that can be independently upgraded or replaced and providing APIs for integrating additional features.

10.2.2 Source

Sponsors

10.2.3 Constraints

- Design: System components must be loosely coupled to ensure modularity.
- Maintenance: Modular design must not complicate maintenance activities.

10.2.4 Standards

ISO 42010 [6]

10.2.5 Priority

Future

10.3 Access Controls

10.3.1 Description

The system must implement access controls to restrict user access based on roles and responsibilities. This includes defining user roles, assigning permissions, and regularly reviewing access rights.

10.3.2 Source

Sponsors

10.3.3 Constraints

- Complexity: The system must manage access controls without introducing significant complexity.
- Scalability: Access control mechanisms must scale with the number of users and roles.

10.3.4 Standards

ISO/IEC 27002 [8]

10.3.5 Priority

Future

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