



MOTION Started with AI-Driven Biomechanical Motion Capture



Aiden Ma
West Brook High School

Advisor: Wenhao Yang
Department of Industrial Engineering, Lamar University

1. Introduction

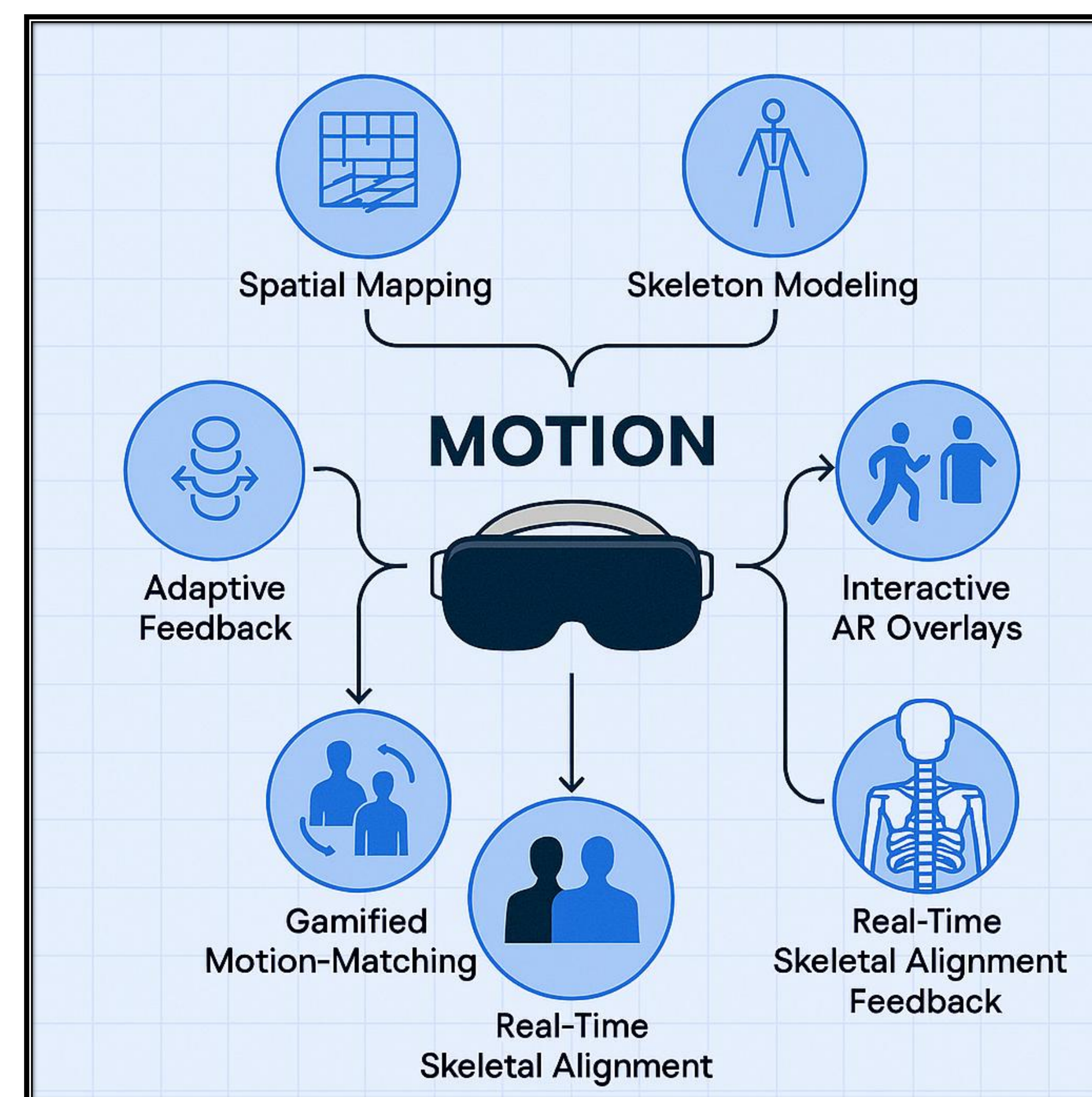
- Chronic musculoskeletal disorders affect more than 1.7 billion people in the world. The leading causes of long-term disability and loss of functional mobility.
- The treatment of these conditions requires regular exercise and supervision by a clinician, which can be very labor intensive and constrained.

2. Related Works

- An AR-based rehab program led to higher recovery scores, less pain, and quicker return to activity compared to traditional therapy, showing strong potential. [1]
- A review of 11 studies found AR enhances balance and mobility as a supplement to conventional therapy, though larger, standardized trials are still needed. [2]
- Across 13 trials, VR/AR and exergaming significantly reduced pain and improved function and quality of life. [3]

3. Research Focus

- MOTION focuses on treating chronic degenerative musculoskeletal diseases
- Its scalable architecture allows for potential integration with home-based therapy and into clinical environments to have remote monitoring and data-driven insights.



4. MOTION

- Developed in Unity, MOTION (Musculoskeletal Therapy through Immersive Orthopedic Navigation) brings together spatial mapping, skeleton modeling, and depth sensing to capture accurate full-body kinematics.
- Leveraging Meta's Movement SDK and mapping techniques, the system accurately maps the user's physical body on their avatar in the AR space.
- Interactive AR overlay project dynamic exercise targets and visual cues directly into the user's environment via an AR headset while also employing an adaptive feedback algorithm.

5. Conclusion and Future Prospects

- The MOTION system redefines the implementation of musculoskeletal rehabilitation.
- A gamified "motion-matching" mechanic prompts users to align their body with an optimal silhouette, supported by immediate skeletal alignment feedback.
- A multiplayer-enabled rehabilitation session, allows specialists or physical therapists to join users in a shared AR environment and provide direct guidance remotely.

6. References

- [1] Theodora Plavoukou, Pantelis Staktopoulos, Georgios Papagiannis, Dimitrios Stasinopoulos, & George Georgoudis. *Virtual and Augmented Reality for Chronic Musculoskeletal Rehabilitation: A Systematic Review and Exploratory Meta-Analysis*, 2025.
- [2] Maria Jesus Vinolo Gil, Gloria Gonzalez-Medina, David Lucena-Anton, Veronica Perez-Cabezas, María Del Carmen Ruiz-Molinero, Rocío Martín-Valero. *Augmented Reality in Physical Therapy: Systematic Review and Meta-analysis*, 2021.
- [3] Lingfeng Li. *Effect of Remote Control Augmented Reality Multimedia Technology for Postoperative Rehabilitation of Knee Joint Injury*. 2022.