Human Motion Reconstruction using Wearable Accelerometers

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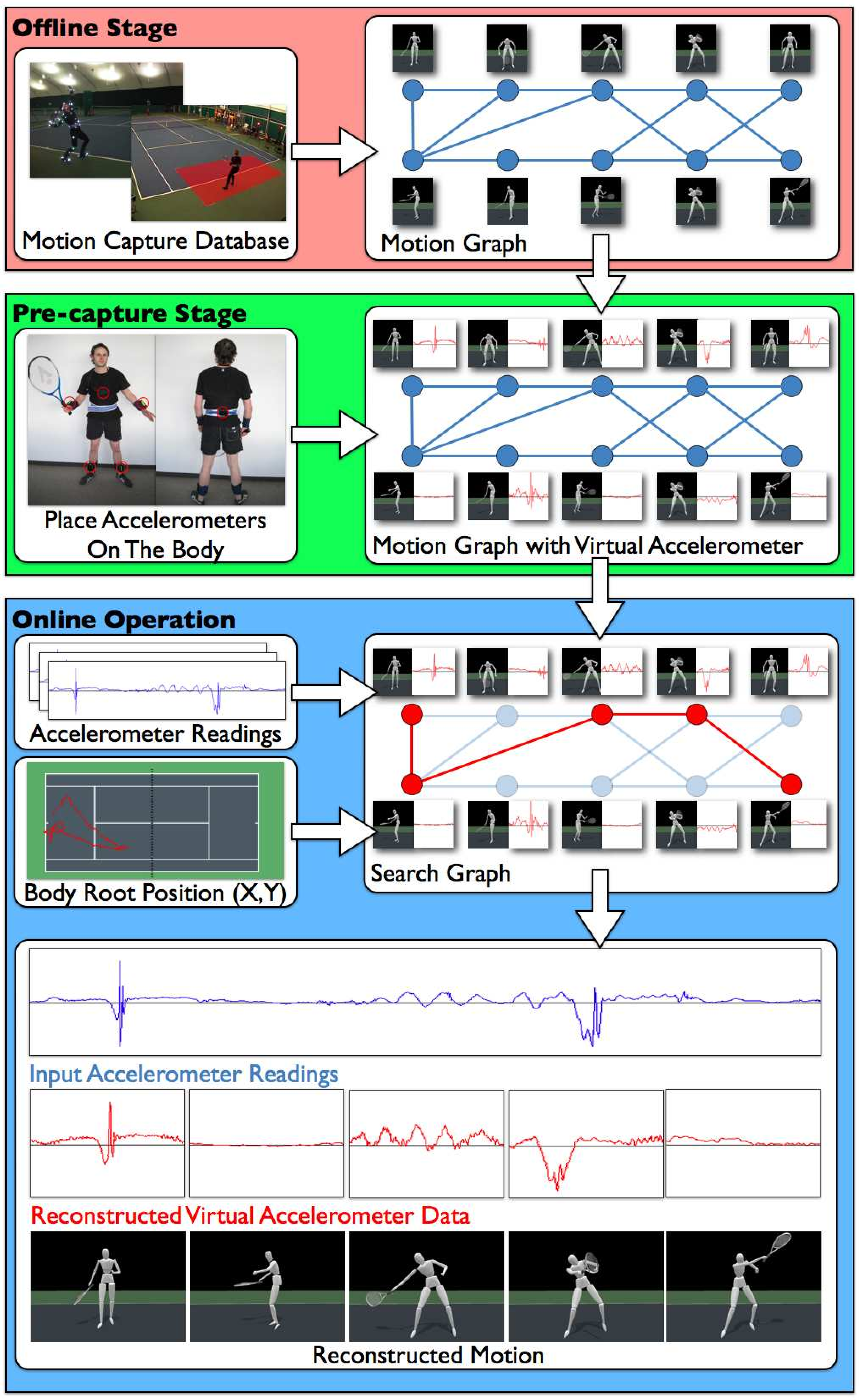
Introduction

- Focus on the specific application of visualisation of athlete performance in sports broadcasting scenarios
- Currently several days manual work required for 3D reconstruction of a play in ESPN's Virtual Playbook
- Optical motion capture systems – traditional approach for providing precise athlete performance data
  - Although very accurate, can be are cumbersome/impractical in some scenarios
    - Large spatial volumes; Areas with uncontrolled lighting; Time-critical applications; Manual correction of artifacts may be necessary due when incorrect tracking/occlusion of markers occurs.
- IMU based systems
  - Can suffer from motion drift; Size of units would impair the performance of high level athletes;
  - Speed of movement may result in poor motion reconstruction for the most critical movements.
- We focus on placing only accelerometers on the body, as they can be unobtrusively sown into clothing
- Our goal is to produce a cheap, unobtrusive and portable motion capture system that can
  - Operate in large sporting areas, such as outdoor arenas;
  - Obtain reconstructed motion to as high a degree of accuracy as possible;
  - Be used in time-critical applications, such as instant replays in sports broadcasting.



Overview

- The proposed system has three main stages;

1. Offline stage
   - Motion capture database is created
     - Database contains a sample set of the types of motions that we expect to be performed at capture time
   - Motion graph constructed using database
     - Graph encodes how captured database clips may be reassembled in different ways
2. Pre-capture stage
   - Tailors the motion graph to different placements of accelerometers on players
   - Uses *virtual accelerometers* to generate accelerometer data for each node in the motion graph
3. Online motion reconstruction stage
   - Reproduces novel motions by finding paths in the motion graph that would produce similar acceleration readings to those measured at capture time
   - Dynamic Programming (DP) search strategy
     - Finds the optimal path through the graph
     - Results in a sequence of poses whose accelerations closely match the recorded accelerometer values
   - DP/A* search strategy
     - Incorporates root position and orientation into the search strategy
     - Positional information can be obtained from any external source
     - Segments a capture session into *action* and *non-action* segments
       - DP solution reconstructs motion during *action* segments
       - A* search strategy corrects the position and orientation drift of the actor during *non-action* times

Experimental Results

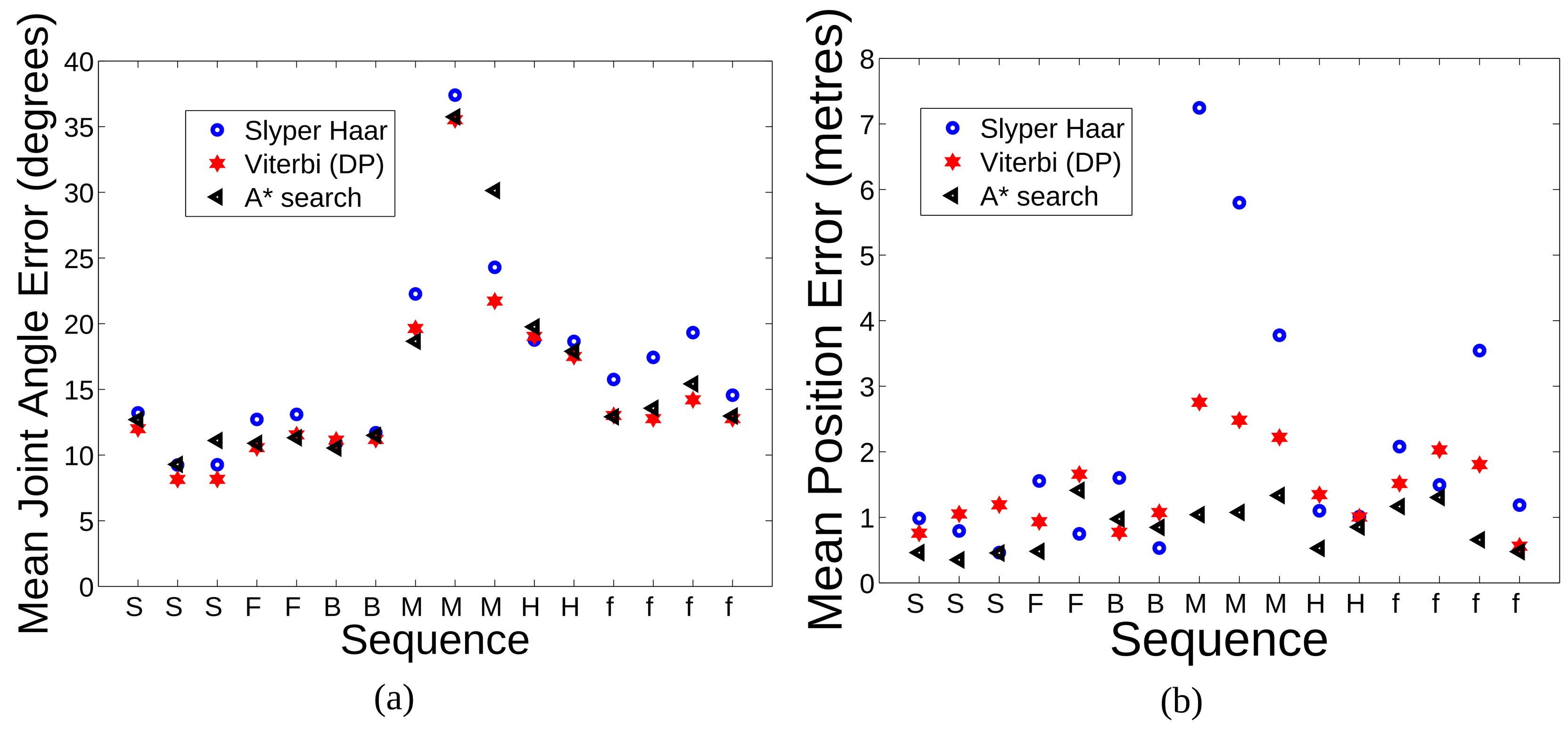


Figure 1: Joint angle error and positional error comparison.

- Quantitative evaluation using 16 tennis motion sequences of 6 different types – see Figure 1
  - S=Serve, F=Forehand, B=Backhand, M=Motion, H=move and Hit, f=Freestyle
  - Slyper Haar: Prior work in action capture using accelerometers [1]
  - DP / A* Search: The two search strategies outlined in this work
  - Groundtruth motion data captured via optical capture system
- DP approach outperforms [1] in almost all cases (or is very close)
- A* search keeps a relatively low error, while also improving upon the positional error of both DP and [1]

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References

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