Proposal for centimeter accuracy tracking of volleyball players

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General questions to be answered:

- What resolution and type of camera is sufficient to attain centimeter accuracy?
- Can we find centimeter accurate heights based on a fixed frame video?
- Can we accurately track players and volleyballs in an active play scenario?
    - How do we model the trajectory of the player and ball?
- Can we calculate player statistics based on a fixed frame video?
    - How high did the player jump?
    - How fast did the player hit the ball?

Requirements:

To start, we would like the following preliminary restrictions. First, a fixed camera position. Second, only one player doing action (no game video). Third, short video clips will be easier to test algorithms. Finally, we will start with a single lens camera (for testing the most practical camera scenario) and if requirements fail for a single lens, we will explore other camera options.

1. Fixed-Frame distance algorithm
    1.1. Manual (by hand) height calculation of single lens fixed-frame camera
    1.2. Script or function for calculations of a single frame
2. Fixed-Frame object detection
    2.1. Single frame object identification: ball, player, pole
        2.1.1. Box and label object -- OpenCV work with object detection
        2.1.2. Optimal dimension locking -- object box ends where player ends
    2.2. Dimensional classification
        2.2.1. Pixel-length identifiers -- Understanding how wide and tall an object is in pixels.
        2.2.2. Determine “center of mass” -- geometric middle of object

2.2.3. From (Req. 1): Real-world 3D distance -- Using fixed frame distance algorithm and pixel information to figure out actual distances

3. Short video clip distance and object detection
   3.1. Clip processing -- of a single hit (length 3-4 seconds max)
      3.1.1. Get video attributes -- dimensions and frames/second
      3.1.2. Split video into individual frames
      3.1.3. Applying Reqs. 1 and 2 to sequence of frames
   3.2. Create a standard data structure of the clip for further processing simplicity

4. "Tracking Statistics" from short video clip processing
   4.1. Follow objects in clip data structure
      4.1.1. Identify the object movements
      4.1.2. Follow through the frame
      4.1.3. Create a path of the player moving through the clip
   4.2. Calculate real-world speed and trajectory
   4.3. Plot findings in a visual way
      4.3.1. Create x, y, z coordinates of player and ball "center", then use that to plot positions in a 3D manor.

5. Upload/Submit/Database/Download -- a database for coaches use

   -or-

5. Longer length clip processing -- taking game video and breaking it down

   -> Series of hits of a single player or expansion for a court with multiple players

Additional questions:

- What angles of video can be used?
  - What angles of video will output optimal results from our processing
- If "fixed frame" distances aren't possible, what other method would be better (IR Detection, stereoscopic camera, etc)?
  - What are the attributes necessary for a camera to be used for 3D modeling of volleyball?

- What would it take to create a 3D model of a play?
- How can we link different ball trajectories in a useful manor?
- How can we track players through multiple clips or longer videos?

General Weekly Calendar:

WEEK	NOTABLE	OBJECTIVE	STATUS
June 4-8	Proposal mtg. Fri. 1pm	• Project Write-up • research, reading, OpenCV	Done
June 11-15	(s) Bball camp	• (Req. 1) Hand calculation fixed frame viability • (Req. 1) *if nec.* Reconsider distance calculation • (Req. 2) OpenCV Edge detection	
June 18-22		• (Req. 2) OpenCV object detection and initial “boxing” • (Req. 2) Optimization of object boxing • (Req. 2) dimensional classification in pixel units	
June 25-29	(s) Bball camp		
July 2-6	July 4th	• (Req 1) and (Req 2) complete	
July 9-13			
July 16-20		• (Req 3) and (Req 4) “live”	
July 23-27	(s) Presentation practice	• Package up “live version” for presentation	
July 30-31	(s) Presentations		