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. Fourth, we will start with a single lens camera to test the most practical camera scenario. Finally, we propose that the most optimal video angle is from behind the court (baseline).

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. Background/Foreground separation
    2.1. Single image with the background
    2.2. Video with the foreground extracted
3. Object identification
    3.1. Train TensorFlow API to identify a volleyball
    3.2. Optimally identify the ball in all frames of a clip
    3.3. Dimensional classification

3.3.1. Pixel-length identifiers -- Understanding how wide and tall an object is in pixels.
3.3.2. Determine “center of mass” -- geometric middle of object
3.3.3. From (Req. 1): Real-world 3D distance -- Using fixed frame distance algorithm and pixel information to figure out actual distances

4. Vanishing points:
   4.1. Background image:
      4.1.1. Edge detection
      4.1.2. Equation of lines on edges
      4.1.3. Intersection points made from UPGMA ranked clusters
   4.2. Transfer to all frames in a clip -- for distance processing

5. “Tracking Statistics” from short video clip processing
   5.1. Follow objects in clip data structure
      5.1.1. Identify the object movements
      5.1.2. Follow through the frame
      5.1.3. Create a path of the player moving through the clip
   5.2. Calculate real-world speed and trajectory
   5.3. Plot findings in a visual way
      5.3.1. Create x, y, z coordinates of player and ball “center”, then use that to plot positions in a 3D manor.

--- FUTURE REQUIREMENTS ---

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

   -or-

7. 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. 2) Background/Foreground separation	Done
June 18-22		● (Req. 1) and (Req. 2) complete	Functional and not optimal
June 25-29	(s) Bball camp		
July 2-6	July 4th	● Start work on (Req. 3) and (Req. 4)	
July 9-13		*vacation for both Scott & Crossland, Limited hours	
July 16-20		● (Req 3) and (Req 4) “live”	
July 23-27	(s) Presentation practice	● Package up “live version” for presentation (working demonstration) ● July 26 (Thurs)	
July 30-31	(s) Presentations	● Final presentation July 31st	
Aug. 1-3	Finish hours	Package up functional module	