

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
 - 4.2. Calculate real-world speed and trajectory
 - 4.3. Plot findings in a visual way
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	<ul style="list-style-type: none"> • Project Write-up • research, reading, OpenCV 	Done
June 11-15	(s) Bball camp	<ul style="list-style-type: none"> • (Req. 1) Hand calculation fixed frame viability • (Req. 1) <i>if nec.</i> Reconsider distance calculation • (Req. 2) OpenCV Edge detection 	
June 18-22		<ul style="list-style-type: none"> • (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	<ul style="list-style-type: none"> • (Req 1) and (Req 2) complete 	
July 9-13			
July 16-20		<ul style="list-style-type: none"> • (Req 3) and (Req 4) "live" 	
July 23-27	(s) Presentation practice	<ul style="list-style-type: none"> • Package up "live version" for presentation 	
July 30-31	(s) Presentations		