Golf Club Head Tracking

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Motivation

• Reconstruct golf swing from video
• To enable applications in swing analysis, instruction, entertainment
• We focus on the club head path

Assumptions

• High frame rate (synthetically made)
• Fixed camera
• Stationary background
Our approach is based largely on [Gehrig BMVC 03].
We explore some different methods for generating club head hypotheses and estimating trajectory.
Motion Detection
The moving pixels in frame $i$ are isolated.
Segment Detection

- Canny Edge
- Hough Transform
  - Strict threshold
  - Loose threshold
Segment Detection

- In general, the strict threshold has low accept and false positive rates
- The loose threshold has high rates
- We use both to make a club shaft hypothesis $s_i$ in frame $i$:
  - If 1 GOOD segment, keep it
  - If 2 GOOD segments, merge and keep
  - Else, choose the BAD segment that minimizes an error function $f(s_{i-1})$
Club Head Detection

- For each $s_i$, we need to choose the club head end
- Pick the one farther from a central reference
- Many club head guesses $h_i$ are wrong
- But that’s okay!
Trajectory Estimation

• Consider upswing and downswing separately
• Procedure to identify transition frame is not yet robust
• Instead, ask the user to supply it
Downswing Simplification

- Club head hypotheses towards the end of the downswing tend to be inaccurate.
- Also, need to offset angles when club passes $2\pi$.
- For simplification, we analyze only until $2\pi$.
- Again, ask the user for this info.
RANSAC Fitting

- RANSAC least squares routine to estimate polar curves
- Quality of results varies a lot from video to video
- Need to improve hypotheses or fitting technique
Guided RANSAC

• In our (small) test suite, extreme $h_i$ in each direction is always good
• Instead of sampling points at random, guide RANSAC to these
• Not always enough though...
Superdelegates

- Count the vote of extreme “super points” more than other points
- Overruling the popular vote of RANSAC can backfire (overfitting)
- But shows promise
Time Estimation

• Given the space model from the guided RANSAC, the inliers are used to estimate a time model
• Ordinary RANSAC to estimate angle as a function of time works fairly well

• [demo]
Future Work

- Improve segment detection
- Improve transition identification
- Accurately offset angles as needed
- Guide RANSAC in “safer” ways

For example, making use of the boundary of the motion history:
Future Work

• Obtain larger test corpus
• Consider down-line and up-line angles to reconstruct 3D trajectory
• Tolerance for lower frame rate video
• Tolerance for unstable cameras and backgrounds

• Play more golf