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Light reflection-based system for spin measurement of table tennis balls

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INTRODUCTION:
Mastering spin is crucial to win a match in table tennis. Spin is one of the keys performance indicators for a player, alongside with placement, ball speed, technique and precision. Therefore, it is crucial to measure performance.
However, spin measurement is hard to perform in real match conditions because the speed is high (+/-800 rad/s)[1], unless using a high-speed cameras and using image processing algorithms.[2]–[5]
We proposed a new low-cost tool for spin measurement based on observation of light reflection on balls. The proposed system is also able to measure linear speed from a moving object in its field of view (FOV).
METHODS:
To calibrate accurately our system, comparisons are made with a high-speed camera Miro C210 from Phantom.
First experiment is the measure in controlled conditions. The system is used to measure a spinning ball mounted on a motor with constant speed (to ensure the measurement quality of the device).
Second experiment is the observation of the spin on real strokes. Strokes were performed by an experienced senior player. Services and hits were realized several times with increasing spin given by the player. Balls were delivered by a ball thrower robot (Amicus Expert from Butterfly).
Spin estimation with camera is obtained through frame by frame analysis, while our system is expressing spin by frequency and waveform analysis.
RESULTS:
Experiment 1 shows a measured spin at 468,7 rad/s (+/-18,8 rad/s).
Experiment 2 shows various spin measures, for strokes and services. Services observed spin range goes from 174 rad/s to 329.23 rad/s.
Strokes performed for topspin forehand shots range goes from 391.75 rad/s to 808.6 rad/s.
Strokes performed for topspin backhand shots range goes from 569.8 rad/s to 769 rad/s. Linear speed measured on forehand & backhand shots is really close from the one measured by camera (+/3.46%).Estimated error between High speed camera and our system is +/-5.6%.
CONCLUSION:
Although results are consistent with high-speed camera, we observe that the system is light-sensitive. It would not be able to detect in a fully lightened or a fully dark environment or at least with a larger error.
We are using bicolored balls which won't be allowed in real match conditions. Traditional match balls, with their natural brands are not reflective enough to get a meaningful output.
Nonetheless, the presented system, shows strong results in accordance with a high-speed camera for both measuring linear and rotational speed.
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