Prospective control of free-throw in basketball: Validation of a virtual setup and de-correlation methodology

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Introduction

Previous basketball studies are unclear on whether free-throws are pre-programmed (Vickers, 1996) or regulated online (de Oliveira, Huys, Oudejans, van de Langenberg, & Beek, 2007). In line with the law of control framework (Warren, 1988), we are in favor the second solution. This would imply that visual information concerning the sufficiency of the current movement to score a basket should be available within the players' perceptual flow and used online during the entire propelling phase so as to correct the movement pattern if necessary. While eye-tracking measurements or visual occlusion methodology have provided strong evidences in favor of the online hypothesis, biasing visual perception by mean of virtual reality should ultimately settle the issue.

For this sake, our agenda intended to first validate a basketball free-throw simulator and second setup an experimental protocol to study how basketball players respond to online manipulation of the visual appearance of a virtual free-throw scene. In case we identified the use of any perceptual variable used for expert online control, such a simulator would become useful as a learning accelerator to guide novice toward an expert perceptual-coupling.

Apparatus

Our simulator (Figure 1) involves that players throw an instrumented ball – the *e*-ball – as naturally as possible onto a virtual basket back-projected on a large screen (3.75 m wide × 2.81 m height) with stereo images (F35 ASF, Barco). The screen height and position relative to the player were optimized in order to allow both tall players to see the whole virtual backboard and short players to throw the *e*-ball over the screen with a large enough safety margin. Players wear active stereo glasses (3D Edge FR, Volfoni) equipped with a set of 4 active markers (Codamotion) used to enslave the virtual scene to their point of view. A specific and original element of this simulator is the *e*-ball, a real basketball equipped with 8 active markers (Codamotion) flushing its surface. These markers are used by a host computer to measure in real-time the trajectory of the *e*-ball so as to extend it on the screen through a virtual ball while it goes behind the screen and then fall onto a net. The *e*-ball diameter (Ø = 0.24 m), weight (621 g) and texture conformed to the FIBA regulation.

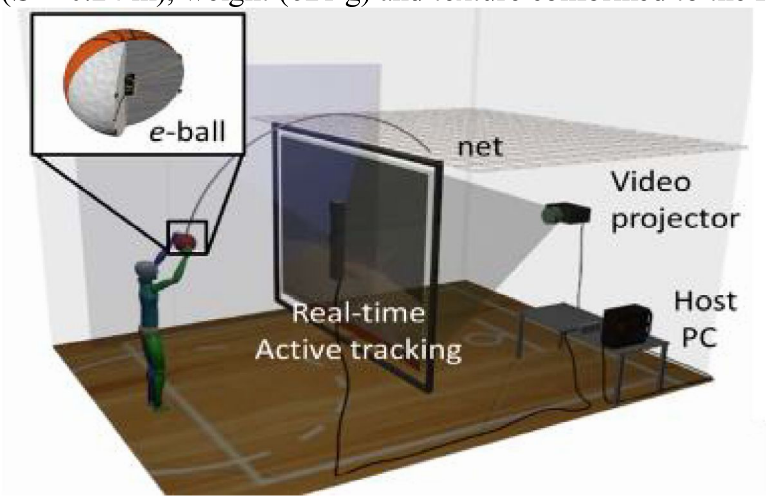

Figure 1. Overview of the basketball simulator.

Validation study

We first intended to evaluate the performances, the content validity (e.g., fidelity in players' behavior) and the subjective validity (e.g., players' feelings) of our setup. Simulator's performances were benchmarked through time-delays measurements and study of ball-rim or ball-backboard bounces realism. Content validity was evaluated through comparison of expert players' free-throw in our simulator with reference to a real environment. We especially feared that the players might be sensitive to a "wall-effect" due to presence of the screen and scrutinized its influence on the ball trajectory. Finally, subjective validity was evaluated through a custom-made form filled by expert players concerning their feelings about the *e*-ball and the simulator. We notably studied how the players' feel not to be allowed to bounce the *e*-ball as a pre-shoot routine.

Scientific study

We secondly aimed at evidencing that free-throws are regulated prospectively and to identify the visual information used. The methodology consisted in biaising the visual appearance of the rim or/and the backboard during the arm motion while keeping constant the location of the center of the rim. Indeed, changes in the ratio between the large and small axes of the rim's ellipsoidal appearance and changes in the ratio between the visual height and width of the backboard are assumed to specify online the players about their relative distance and height to the virtual basketball. De-correlating these visual cues from the actual distance and height of the virtual basketball would thus lead players to modify their movements, evidencing thus not only the use of online regulation process but also the perceptual variable(s) used.

Conclusion

Both the validation and scientific studies are still under progress. Preliminary results nevertheless confirm that our simulator is a promising tool in helping novices to learn regulating online their free-throw as the use of virtual reality setup has already proven its efficiency in learning real-life tasks such as regulating walking speed while approaching moving doors (Camachon, 2007), in transport when regulating the landing approach of an airplane (Huet, Jacobs, Camachon, Goulon, & Montagne, 2009), or in sport task such as basketball (Covaci, Olivier, & Multon, 2014).

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