ShuttleSpeed

High-speed real-time video processing in badminton

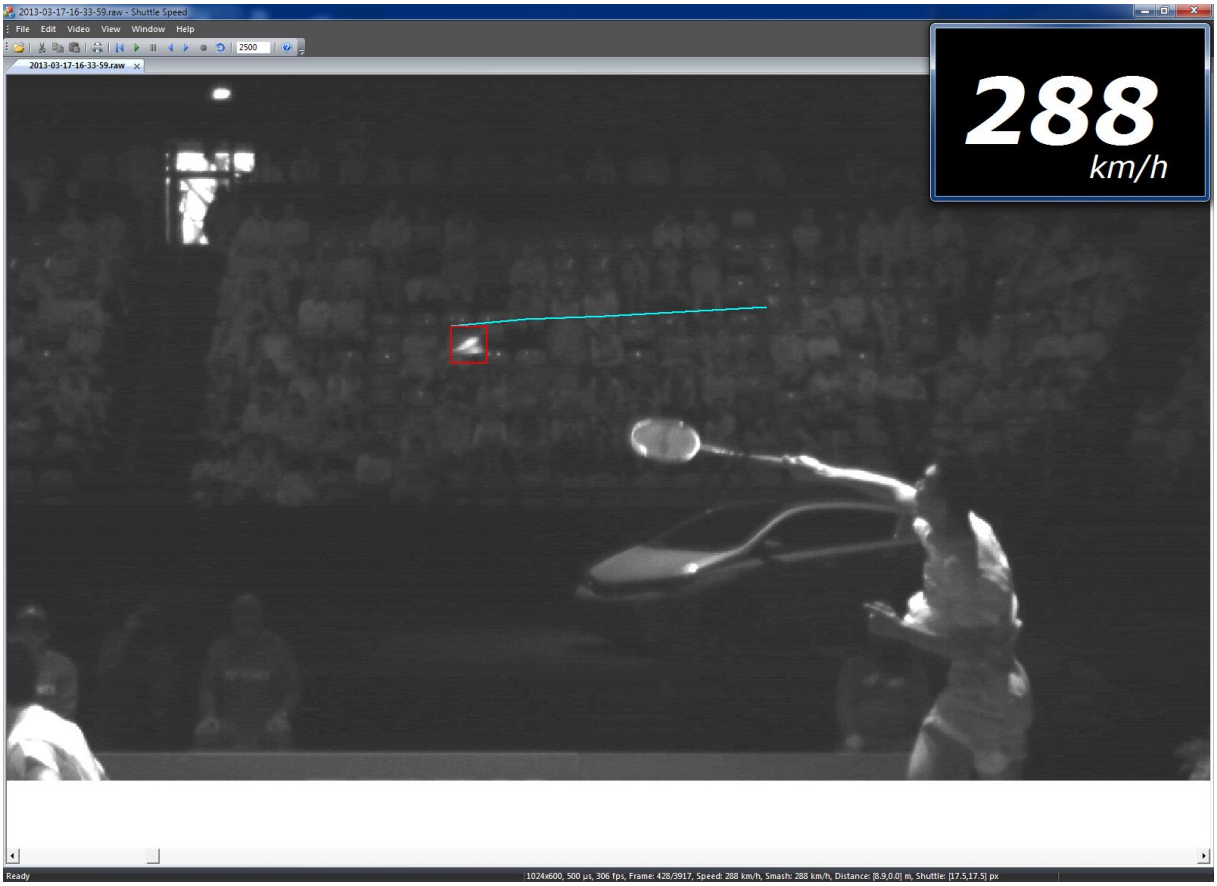

Figure 1: Badminton jump smash in the men's double final at the Badminton Swiss Open 2013 in Basel. Real-time speed measuring with *ShuttleSpeed* provides speed information to the audience.

In contrast to international tennis tournaments, where measuring service speed is standard since many years, there are no comparable speed measurements with corresponding badminton tournaments. Tennis or badminton speed measurements are primarily intended as enrichment for the audience, but indeed, they can be very helpful for players, coaches and outfitters, too.

ShuttleSpeed is a novel badminton speed measuring system. It consists of an AOS high-speed camera system PROMON and a real-time software system developed at the University of Applied Sciences Northwestern Switzerland. *ShuttleSpeed* has been tested at the Badminton Swiss Open 2013 in Basel (Fig. 1).

Figure 2: Badminton jump smash in the men's double final at the Badminton Swiss Open 2013 in Basel

Famous international badminton tournaments attract many visitors and show the very fast and dynamic sport of his most impressive side. For more than 20 years the Badminton Swiss Open takes place in a great arena in Basel. The Swiss Open belongs to the very best badminton tournaments around the world. In 2008 and 2009, for example, 25 television stations with 250 million potential consumers reported of this major event. However, the sophistication and performance required in badminton reveals itself often inadequately to broader audience, especially when quick and highly precise rallies dominate a game. Even photographers and television companies are usually not able to capture the very high dynamics. Hence follows that tournament organizers are required to provide the impressive images with expert presentations and to use the short breaks between rallies with attractiveness-enhancing additional information, such as super slow motions of high speed cameras (Fig. 2) or speed information (Fig. 1).

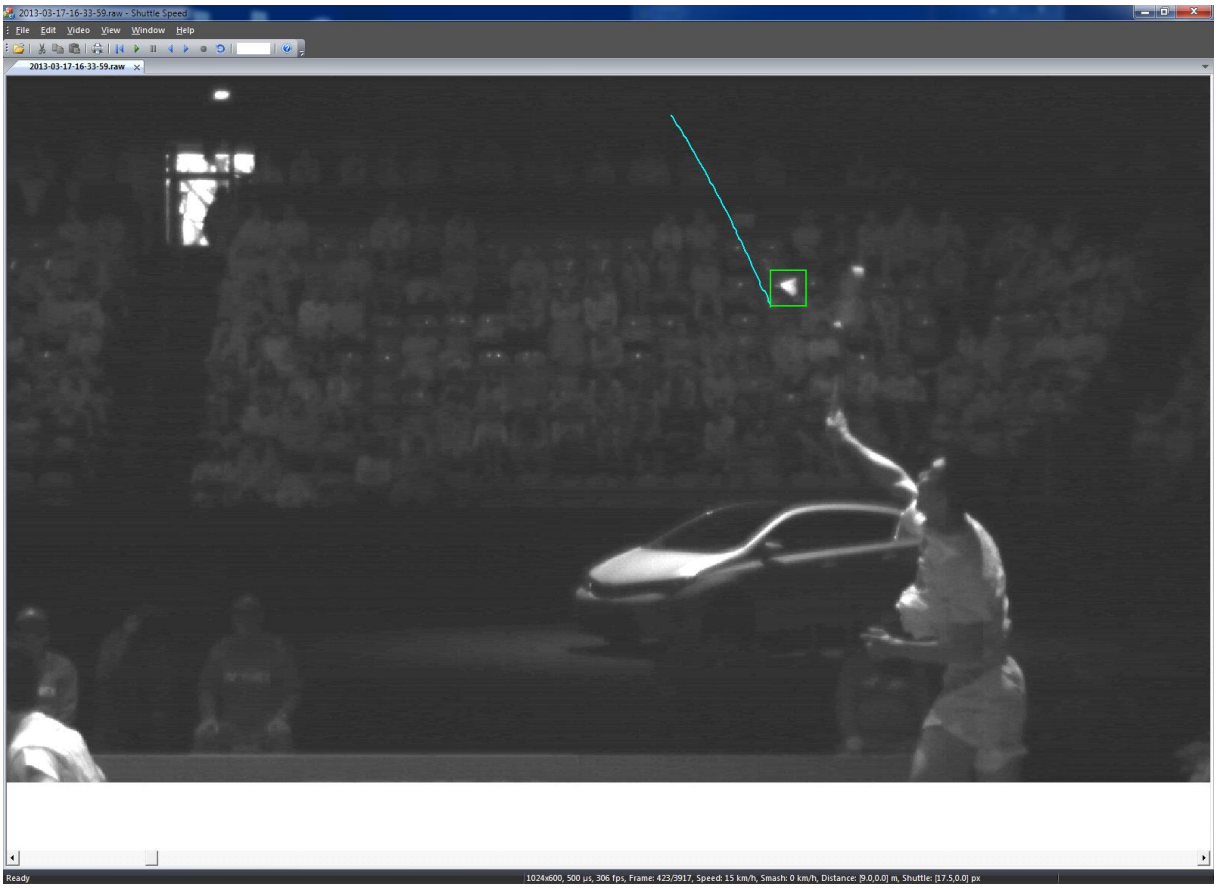

Figure 3: The green box shows the tracked shuttlecock just one frame before the player will hit it. The blue line depicts the trace of the lower left corner of the green box. The current speed is 15 km/h.

The speed measurement of a shuttlecock during a running game is confronted with various difficulties: the smash can occur almost everywhere, it can be played in different directions and in very different game situations. Therefore, in an ongoing badminton rally neither the hitting position nor the heading is known in advance. In addition, the small and lightweight (5 g) shuttlecock has to align its cone with an extremely fast transverse rotation to the new direction of flight. This approximation can be seen as a rapidly decaying transverse wave motion in Figure 2.

In the first few meters after the stroke the average flight speed of the shuttlecock is very often 100 km/h and more (Fig. 3 and 4), but then decreases rapidly. Smashing speeds of top players of 250 km/h are not uncommon. The current speed record is 332 km/h and comes from a Chinese badminton player[1] in 2005. In comparison, the current official speed record in tennis[2] is 263 km/h. Badminton racket manufacturers already have measured speeds of 421 km/h in laboratory conditions, but not in running games.

For these reasons, a spontaneous, exactly and precisely timed radar based speed measuring in a distance of 15 meters in a running badminton game is impracticable.

[1] Fu Haifeng: http://de.wikipedia.org/wiki/Fu_Haifeng

[2] ATP: http://www.atpworldtour.com/News/Tennis/2012/05/Features/Groth-Fast-Serve.aspx

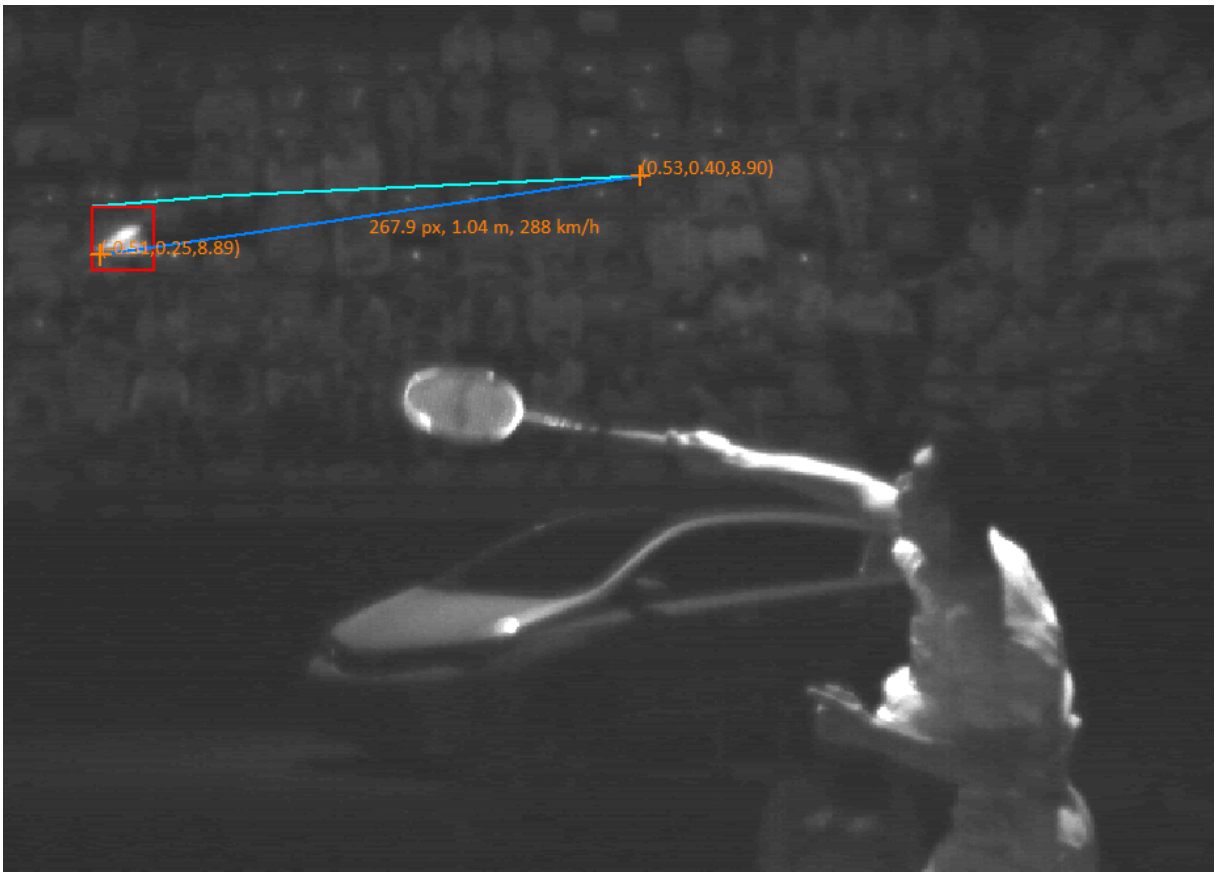

Figure 4: The red box shows the tracked shuttlecock just one meter after the stroke. The light blue line depicts the trace of the top left corner of the red tracking box. The blue line is an interactive measuring tool, which can be used for recorded video sequences. The measured average speed is 288 km/h.

High-speed video recordings with real-time streaming are a practical alternative to radar. Today, high-speed digital cameras are able to produce 1000 frames per second at VGA resolution and even tens of thousands of images at lower resolutions. For the fastest strokes in badminton frame rates of 300 to 500 fps are enough, therefore, better video resolutions can be used to be very close to the badminton court. In addition to the high frame rate a very short exposure time is necessary in order to prevent motion blur, which would unnecessarily complicate the distance and speed measurement. Very short exposure times (0.1 to 0.5 ms) can be achieved with fast lenses and good badminton court illumination due to the white shuttlecocks against the dark background.

Gigabit Ethernet data line technology allows real-time streaming of the high-speed images to a commercially available high-performance personal computer where our *ShuttleSpeed* software analyzes the video images and computes the shuttlecock speed in real-time.

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