



# Player Analysis Technology Approval report

## BigBow Camera System

**Test code:** PAT-14-006

**Serial no:** n/a

**Software versions:**

BigBow Manager 4.0.27

BigBow Admin 2.0.1

BigBow Client 2.0.1

**Firmware version:** n/a

**Issue date:** 4 January 2016



**Objective:** To test and evaluate the BigBow Camera System Player Analysis Technology according to Rule 31 of the 2014 Rules of Tennis.

**Result:** Approved

### SUMMARY

Multiple smart cameras fixed around the court are used to capture images of play. The cameras are wired or wirelessly (Wi-Fi®) networked. Software, on the network, is used to reconstruct the ball trajectories and player movements in three dimensions from the two-dimensional camera images and a virtual model of the court. The system is controlled by an experienced operator.

Coaching information, including instantaneous ball position and player location, in addition to derived data, is available to auxiliary devices with wireless connectivity, e.g. a laptop, and (potentially) the smart cameras themselves.

Restrictions on the access by a player to the BigBow Camera System components during periods when coaching is and is not allowed are as follows:

COMPONENT	NO COACHING	COACHING
Smart cameras	Not permitted	Permitted
Auxiliary device (e.g. laptop)	Not permitted	Permitted

## MAIN COMPONENTS

The main components of the system are described in table 1 and depicted in figure 1.

COMPONENT	FUNCTION(S)
Smart cameras	Capture images of play, store, process, transmit and (may) communicate data
Personal computer (PC)	Start/stop data capture
Camera server	Transmit data
BigBow Manager software	Process data
Cloud server	Store and transmit data
BigBow Admin software	Store data
BigBow Client software	Display data to the operator
Auxiliary device (e.g. laptop)	Communicate data

Table 1. Description of the components of the BigBow Camera System.



Figure 1. Components of the BigBow Camera System: smart camera (left) and auxiliary device (laptop).

## DATA CAPTURE AND PROCESSING

Multiple (typically four) smart cameras are mounted at fixed locations around the court. The cameras are networked via a wired or wireless (Wi-Fi<sup>®</sup>) connection to a server. Images captured by the cameras are processed 'on-board', i.e. objects of interest such as the ball and players are identified using software running on the smart camera's internal computer. The two-dimensional (pixel) co-ordinates of objects of interest are sent from the cameras to a server using encryption.

The smart cameras can also operate 'offline': storing the processed data locally and subsequently uploading to the server.

A 'control' personal computer (PC) connected to the server (wired or wirelessly) is used to: (a) control whether the cameras are 'on' or 'off' and (b) reconstruct the trajectory (in three dimensions) of the ball and the movements of the players relative to the court using BigBow Manager software. The control PC is run by an experienced operator.

Data output by BigBow Manager includes time histories of: position of the ball and players in three dimensions; instantaneous speeds of the ball; identification of ball impacts (with the racket and the court).

## COMMENTS

The system functions independently of the players (does not require any player input). It is typically run by a single operator.

Wireless transmission of data between components is encrypted, limiting susceptibility to hacking.

## DATA COMMUNICATION

Data are stored on a cloud server and managed using BigBow Admin software. Visualisation of the three dimensional ball trajectories can be viewed on an auxiliary device, e.g. a laptop, using BigBow Client software.

In addition, the smart cameras have the capacity to communicate data generated by the BigBow Camera System, or indeed a third-party system, since they have wireless connectivity, sufficient computing power and an LCD screen (user-interface).

## COMMENTS

Coaching information is available on the auxiliary device, and (potentially) the smart cameras. Therefore, players must not have access to the auxiliary devices, e.g. laptop, or smart cameras when coaching is prohibited.

## ADDITIONAL INFORMATION

**Client:**

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**Date received:** 8 July 2014

**Report prepared by:** Jamie Capel-Davies

**Report authorised by:** Stuart Miller

**Revision number:** 0

**Please note:**

Approval does not attempt to, nor does it in fact, establish the accuracy or reliability of data or fidelity of its transmission.