Hawk-Eye in Tennis

Officiating | Broadcast Enhancement | Live Production
Experiential | Digital | Coaching

hawkeyeinnovations.com | pulselive.com
Hawk-Eye in Tennis

Hawk-Eye has been an integral part of tennis since 2002 and continues to deliver innovative solutions for tournaments, broadcasters, federations, sponsors and academies that truly enhances the game for fans and players.

“Hawk-Eye not only dismantles a tennis controversy in a matter of seconds, but spectators get to watch replays right along with the players. It’s fun, lightning-quick and decisive, absolutely clearing the air for the ensuing point.”

Sports Illustrated

SERVICES

Officiating
Broadcast
Tournament
Coaching
Digital
## HOW WE HELP

| **Tournaments** | By delivering officiating and broadcast solutions that raise the exposure of the event and fan engagement solutions that add value to sponsors. |
| **Broadcasters** | By delivering broadcast enhancement products that help tell stories and drive viewer engagement. |
| **Federations** | By providing solutions that make the game fairer, more engaging and more accessible. |
| **Sponsors** | By providing solutions that integrate sponsors into the fabric of the sport and get them closer to tennis fans. |
| **Academies** | By providing coaching services that deliver unique insights that can make the difference between winning and losing. |
Hawk-Eye’s experience at managing officiating services within the live event environment has enabled the development of a number of solutions that enhance the in-stadia experience for fans and players.

### Big Screen Production

Hawk-Eye delivers engaging Big Screen Production solutions that make the live event experience for fans as exciting and interactive as possible. The delivery of the big screen production can encompass: live scores, virtual reality replays, challenges, sponsors messages, live social polling results and much more.

### Serve Speed & Shot Clock Display

Hawk-Eye’s ball-tracking solution enables the accurate capture of serve speed which can be activated via digital LED boards around the court and also on the big screen. In addition, Hawk-Eye’s Shot Clock adds another element of drama by displaying the time taken between shots to ensure there are no lengthy stoppages.

### SMART Vote

Taking fan participation to the next level, by using high visibility branded voting cards and vision processing, to automatically calculate polling results. This provides a natural sponsorship extension and encourages fan interaction during breaks in play. Hawk-Eye’s SMART Vote is easy and cost effective to set up with only six CCTV cameras required.

### Tennis Simulator

Hawk-Eye’s Tennis Simulator gives fans a taste of the action through a unique immersive, interactive, game play environment. The Tennis Simulator also provides an excellent experiential extension to event sponsors and a great opportunity to capture participant data.
Hawk-Eye’s Electronic Line Calling service is now used by over 80 global tournaments every year and has become a must for all major tennis tournaments, making the game fairer for players and acting as an exciting broadcast enhancement feature.

**HOW IT WORKS:**

**Camera setup**
Up to ten cameras set up around the court to capture live images.

**2D (x,y)**
Vision processing is used to identify the centre of the ball.

**3D (x,y,z)**
System triangulates information from each calibrated camera to provide 3D position of ball.

**4D (x,y,z,t)**
Process repeated for each frame so that 3D positions of ball can be combined to produce single trajectory of flight of the ball.

**Bounce Mark**
Trajectory is then used to calculate exact contact area ball made with court during the bounce phase.

**Virtual Reality**
Data is quickly and clearly shown via intelligent virtual reality software.
**Ultra-Motion**

Recently approved by the ATP, Hawk-Eye’s Ultra-Motion cameras transform the officiating replay by working at a frame rate of 340 fps to render the trajectory and bounce mark of the ball onto real video footage – making decisions more believable.

**Virtual Reality Replay Sponsorship**

The exposure and interest of the Hawk-Eye Virtual Reality replays provide a fantastic opportunity for a sponsor to engage with a captivated audience.
Hawk-Eye has developed a number of innovative broadcast solutions ranging from an HD quality, low cost live production service to insightful augmented reality graphics that drives fan engagement.

**SMART Production**

Hawk-Eye, in collaboration with SONY, has developed a new broadcast technology that allows tennis to increase the number of broadcast courts at an event for a fraction of the cost of traditional approaches.

The SMART Production solution uses up to six cameras on remote heads, which automatically track both the players and court lines to recreate the angles and shots you would expect to see from a cameraman. The images are then fed into a central server which acts as vision mixer, provides replays, and produces in game score graphics in the style of the event, allowing a traditional five man broadcast operation to be run by a single person.

**HOW IT WORKS:**

- Between four & six remote HD player-tracking cameras on remote heads set up around court.
- Virtual Director oversees all cameras and can take manual control at any time.
- Replays can be played out at any speed, controlled by a jog wheel.
- Clip lists, graphics, audio can be integrated into live pictures instantaneously.
- Live HD pictures can be distributed across broadcast, big screen at venue and transcoded and streamed online.
### BROADCAST ENHANCEMENTS

**Green Screen**

It is now possible to use Green Screen technology to take analysis to the next level. Whether it is the broadcaster’s talent facing up to different serves or discussing shot placement, it can now happen within the virtual world adding a new element to analysis and the way it is presented.

**Augmented Reality Analysis**

By optimising a deep understanding of data analysis and visualisation in tennis, Hawk-Eye is able to develop augmented reality graphics that help presenters and analysts tell insightful and engaging stories.

**Ultra-Motion**

Hawk-Eye’s Ultra-Motion cameras capture up to 340 fps and significantly enhance the viewing experience. The footage from the cameras can be used for analytical pieces as either as full frame inserts, split-screens, or combined with Hawk-Eye’s tracking data. This opens up the opportunity for ground breaking biomechanical analysis of player technique that hasn’t been possible previously.

**TennisTable**

All of the stats that would normally be presented within the virtual world can now be displayed on top of a table giving talent the opportunity to interact and tell stories in a new and innovative way.

“Yet another terrific step forward for tennis, something that will benefit players and spectators and bring more intrigue into the game.”

Jim Courier
Hawk-Eye’s digital division, Pulselive has a unique set of capabilities that can bring tennis to life through digital and social media - making the game more interactive, engaging and accessible for fans.

**Web & Mobile**
Pulselive has developed a number of web and mobile applications for some of the world’s largest sports events and has taken this expertise to tennis, working with federations, broadcasters, tournaments and sponsors to develop exciting digital and social solutions.

**Social Media**
Pulselive is an official partner of both Twitter and Facebook and is uniquely positioned to capitalise on both mobile, web and broadcast media to develop interactive social media solutions that drive interaction across all platforms and connect sports fans with the sport more effectively than ever before.

**Content**
As the digital division of Hawk-Eye, Pulselive has taken this expertise in data visualisation and augmented reality and brought this to life in the digital world.

**Second Screen**
Second screen is fast becoming a must have for the live sports experience, adding an additional layer of engagement and insight to the TV pictures and offering an additional sponsor touch point. Pulselive are already working with broadcasters such as ESPN to create second screen experiences that truly complement live TV coverage.
“Pulselive are a company of action. The brains behind the dynamic CourtCast application, Pulselive spearheaded a phenomenal tennis tool, unique to the world of ESPN.”

Matt Wilansky, Tennis Editor, ESPN Inc.
**TENNIS COACHING SYSTEM**

Hawk-Eye’s understanding of officiating and broadcast technology in combination with extensive experience in working alongside top athletes has enabled the development of a coaching system that show players and coaches not only what happened but also why.

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**Example of Coaching Data Points**

<table>
<thead>
<tr>
<th>SHOT ANALYSIS</th>
<th>PLAYER ANALYSIS</th>
<th>BALL SPEED ANALYSIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accuracy of shots</td>
<td>Player distance covered</td>
<td>Min/Average/Max ball speeds</td>
</tr>
<tr>
<td>Statistics on shots bouncing in areas defined by the coach</td>
<td>Average and maximum player speeds by the coach</td>
<td>Speed of ball at contact point</td>
</tr>
<tr>
<td>Spin Classification of shot (Slice/Flat/Topspin)</td>
<td>Average and maximum player accelerations</td>
<td>Speed of ball at net</td>
</tr>
<tr>
<td>Accurate spin rate value</td>
<td>Heat map of player movement</td>
<td>Speed of ball into/out of bounce</td>
</tr>
<tr>
<td>Shot Classification (Forehand/Backhand)</td>
<td>Heart rate and lactate information</td>
<td>Speed of ball at baseline</td>
</tr>
<tr>
<td>X,Y,Z position data at contact point, net, bounce, apex and at baseline</td>
<td></td>
<td>Speed of ball at apex point</td>
</tr>
<tr>
<td>Distinction of whether ball is rising/dropping as it crosses the baseline</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Virtual 3D trajectory of each shot</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DATA & VIDEO INTEGRATION

Hawk-Eye’s Tennis Coaching System combines data visualisation and broadcast quality video that enables top athletes and coaches to biomechanically analyse technique and investigate on-court performance through ball tracking data.

COACHING & MATCH SYSTEM

Hawk-Eye is the only company in the world to collect player and ball tracking data at all Grand Slam events and approximately 80% of elite events below that tier. Subject to data rights, this allows users of the coaching system to easily compare and evaluate their data and video to that of current, past and future professional players.
FEBRUARY 2002
Hawk-Eye is first used in tennis as part of the BBC’s Davis Cup coverage.

SEPTEMBER 2003
Hawk-Eye wins an Emmy for Outstanding Innovative Technical Achievement.

JANUARY 2003
Hawk-Eye makes its Grand Slam television debut at the Australian Open.

NOVEMBER 2004
Hawk-Eye wins The BCS Technology Award for Enhancement to Television Production.

MARCH 2006
Hawk-Eye is used officially at the Nasdaq-100 Open in Miami, the first Tour event to adopt the system.

OCTOBER 2005
Hawk-Eye passes stringent ITF electronic line calling testing, at the Arthur Ashe Stadium in New York. This enabled Tour events to utilise the officiating aid for the very first time.

DECEMBER 2005
The Hawk-Eye Official Review Tennis system makes its debut in the Champions Tour at the Royal Albert Hall.

JANUARY 2007
The Rod Laver Arena boasts new video boards as Hawk-Eye is used officially at the Australian Open. Players are allowed two incorrect challenges per set, with the benefit of an additional challenge if the set goes to a tie-break.

JANUARY 2008
Hawk-Eye is used officially at the Wimbledon Championships, the third Grand Slam event to implement the technology. Players on Centre Court and Court Number One are allowed three incorrect challenges per set, with an additional challenge if the set goes to a tie-break.

JULY 2008
Two tennis line calling systems used at the London 2012 Olympic Games.

JUNE 2009
The French Open uses Hawk-Eye’s SMART Production across 12 courts.

MARCH 2010
Ultra Motion line calling used for the first time at a Grand Slam, at the Australian Open. SMART Production covers 6 courts.

DECEMBER 2010
The first tennis event where players call their own lines, and the opponent challenges these calls via electronic line calling during the PowerSHARES Series, USA.

FEBRUARY 2011
The Indian Wells Masters 1000 series event in California become the first event to boast Hawk-Eye on all 8 match courts.

MARCH 2013
Hawk-Eye’s digital division, Pulselive, deliver mobile application for SAP to activate sponsorship of the Sony Open.

JUNE 2014
Hawk-Eye is used officially at the Wimbledon Championships, the third Grand Slam event to implement the technology. Players on Centre Court and Court Number One are allowed three incorrect challenges per set, with an additional challenge if the set goes to a tie-break.

JANUARY 2016
The Australian Open Tennis extend the use of Hawk-Eye onto 3 of its main match courts.

SUMMER 2016
Hawk-Eye is used officially at the 10 US Open Series events and at World Team Tennis throughout the United States. The company’s four units culminate in the first Official Challenge system to be used at a Grand Slam tennis event at the US Open.
August 2008
Hawk-Eye's sister company, Pulselive, makes its debut at the 2008 US Open. Pulselive provides fans with a live and truly interactive experience of the tournament by giving users the opportunity to express their opinion, track player and tournament progress, improve their tennis knowledge and best of all predict the game-by-game outcome of the match.

January 2012
The Australian Open Tennis extend the use of Hawk-Eye onto 3 of its main match courts.

February 2013
Hawk-Eye's new SMART Production solution first used at the SAP San Jose Open.

January 2015
The French Open uses Hawk-Eye's SMART Production across 12 courts.

March 2011
The Indian Wells Masters 1000 series event in California become the first event to boast Hawk-Eye on all 8 match courts.

March 2012
Tennis player and ball tracking data is used as a coaching aid at the Miami Masters 1000 and The SAP Open events.

February 2014
Hawk-Eye's digital division, Pulselive, deliver mobile application for SAP to activate sponsorship of the Sony Open.

March 2015
The first tennis event where players call their own lines, and the opponent challenges these calls via electronic line calling during the PowerSHARES Series, USA.

June 2011
The All England Championships, Wimbledon become the first Grand Slam to use the electronic line calling system across 4 courts.

July 2012
Two tennis line calling systems used at the London 2012 Olympic Games.