

WILL SOCCER BECOME A COMPUTER GAME?

Cameras on the field already record every movement in professional soccer matches. Modern tracking systems will soon be able to gather and analyze even more data—much more data, in fact—as our look into the future reveals.



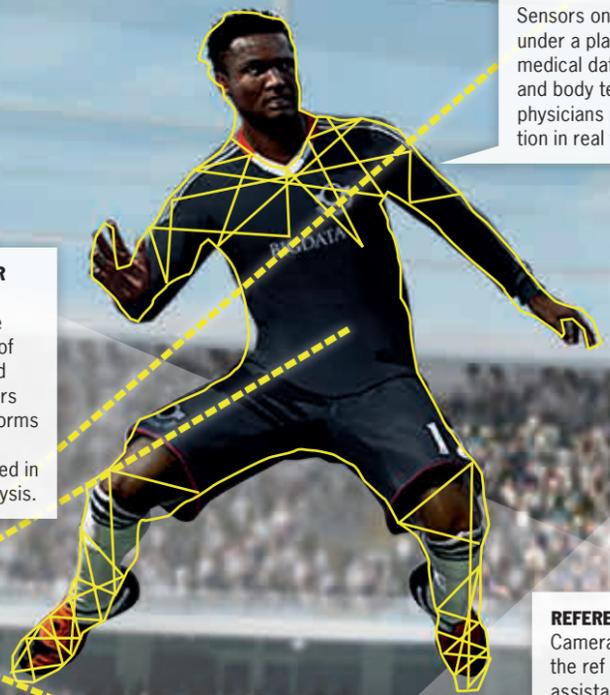
SMART BALL
A chip in the ball sends data about trajectories and shot speeds.

CAMERAS
A mobile tracking system captures every movement on the field. Contrast recognition systems automatically derive coordinates, facilitating precision analyses.

SPECTATORS
Real-time data is transmitted to spectators' smartphones. This information also flows into forecasts used for bets on the matches.

COMPRESSION SHIRT
Sensors on the shirt worn under a player's jersey gather medical data such as heart rate and body temperature. Team physicians receive the information in real time.

RADIO RECEIVER
Antennas in the stadium receive 50,000 pieces of data per second from transmitters on players' uniforms and the ball. The data is stored in a cloud for analysis.



CONTACT DATA
Cameras and microchips register the actions of each player and enable precision analyses of actions such as tackles.

MEDICAL DATA
Before the match, each player swallows a microchip that records physiological data. If this information suggests a risk of injury, coaches can make early substitutions.

REFEREE
Cameras also track the ref and his assistants. Their decisions can then be evaluated.

PRESS
Journalists use real-time data for their reports.

FIELD
Some things will always be analog. Groundkeepers are responsible for making sure the grass has the specified height of 10 to 11 inches. They check the quality right before the match.

CHIP IN THE SHOE
Offside or not? A microchip in each shoe shows every position down to mere fractions of an inch.

GOAL-LINE SYSTEMS
Did the ball cross the line? Precision tracking can make that decision for referees. GoalRef uses antennas to monitor goal lines, and GoalControl has seven cameras pointed at each goal, generating 500 images per second. UEFA (the Union of European Football Associations) has authorized goal-line systems for the 2016 European Championship.



WILL SOCCER PLAYERS HAVE TO SWALLOW MICROCHIPS?

Video analyses are a thing of the past—real-time data is the way of the future.

ANDREAS WEIHER

For each player, coaches receive real-time data on their tablets. This information supports their ongoing analyses and helps them decide on matters such as substitutions.



COACH

Technology has the potential to leave virtually no decision in soccer to chance. Millions of data from matches, players, and referees can be compiled and channeled into real-time analyses. These analyses are playing an ever greater role in lineup and tactical decisions, as well as on the transfer market. Microchips worn by the players plus all manner of digital technology are what make this possible.

A last-minute goal can mean more than just winning a match. In the Champions League, for example, reaching the next round means bonuses and television rights worth tens of millions of euros to the clubs. For third-division teams, just reaching the next round in the DFB Cup can be more lucrative than ticket sales for the entire season. It's no wonder, then, that pro soccer clubs and associations do not wish to leave anything to chance. These days, it's the

rare coach who doesn't use technical aids for practice sessions and tactics. Although video analyses were all the rage until just a few years ago, new technologies—and their millions of data—are becoming a set part of practices and games. Complex software can derive much more from this huge amount of data than can the eye alone. The technology captures every movement of each player, and their individual levels of fitness. It is almost like a “Big Brother” scenario in soccer.

The Fraunhofer Institute for Integrated Circuits (IIS) in Nuremberg is breaking new ground in data-based play in Germany. Its RedFIR radio-based tracking system is currently being used by TSG 1899 Hoffenheim and is installed in 1. FC Nürnberg's stadium. Up to 144 chips on the ball and the players' shoes and jerseys transmit 50,000 pieces of information a second to 12 receivers in the stadium. This data is processed with the help of the SAP HANA platform, which records the exact position of all the players on a 3D surface as well as game-specific information including ball possession, passes, crosses, and shots on goal. It even records real-time performance data such as the height of jumps, the number of steps, and speed. This lets coaches see the performance level of each player at all times, within an accuracy of several decimal places. The information can be used to make decisions about lineups or tactics. “Right now, our system may only be used for practice games,” says René Dünkler, technology marketing director for Fraunhofer IIS, “because regulations from international organizations like FIFA and IFAB do not allow players to wear transmitters. But changes are under discussion.”

Analyzing play is nothing new, of course. The British company Prozone has been gathering data on professional soccer since 1995. Today, the company is part of Stats, the world's leading data seller, and supplies more than 200 top-level clubs with information—including the German national team, FC Bayern München, Arsenal FC,



Antennas in the stadium track ball possession, passes, crosses, and shots on goal. They also register performance data such as the height of jumps, the number of steps, the miles run, and speed. The RedFIR system from the Fraunhofer Institute for Integrated Circuits (IIS) uses as many as twelve receivers to gather around 50,000 pieces of data per second. This data is then processed by the SAP HANA platform.

Paris Saint-Germain, and FC Barcelona. One of Prozone's core technologies is its mobile tracking system. Up to five HD cameras are used to capture an entire match. By means of contrast recognition systems—in which dark and light areas are differentiated from one another—the images are converted to coordinates. This data enables coaches to evaluate the performance of each player in terms of speed, movement patterns, ball contact, and tackles. The major advantage of this system is that it can be used in games as well as practices because it does not use transmitters and therefore does not violate current FIFA regulations.

It's valuable to have data on the game itself, but also on the physical condition of the players. The German national team has been using not only Prozone but also a solution from the Adidas sports goods manufacturer since the start of its preparations for the 2014 Football World Cup in Brazil. The miCoach Elite Team System

from Adidas uses sleeveless compression jerseys with integrated sensor technology to send physiological data to coaches' tablets in real time. These include not only speed, acceleration, and distance covered but also parameters like heart rates. The DFB team physician, Professor Tim Meyer, is not entirely in favor of this flood of information. “We can gather much more data these days than we can actually use,” he notes. “Big data only makes sense if you can actually apply the data—not simply be fascinated by it.” He does consider some information beyond purely positional data to be useful for the future, however. “I'd find it interesting to measure the core body temperature of the players during matches, for example. That could help identify exhaustion more accurately and enable better decisions about substitutions. We already have chips you can swallow that provide this information. They're still very expensive, though. And of course you'd have to make sure they don't pose any health risks.” →



PHYSICIANS

Chips that players wear on their uniforms or possibly even swallow in tablet form provide doctors with a steady stream of fitness and performance data. Physicians can detect a risk of injury early on and take preventive measures.

The flood of information in soccer is also of interest to related industries, and has developed into a sector worth billions of euros. Adidas is installing chips in balls to test how new materials in soccer shoes affect their flight properties. Computer game manufacturers like EA Sports or SEGA are using the data to make their programming even more realistic. Media outlets, online platforms, databases, and betting organizations purchase analyses to use for their own purposes. Legal sports betting organizations alone had a turnover of around 4.5 billion euros in Germany in 2014, in large part from online activity, and with soccer-related picks way out in front. The betting companies use the data to recalculate their payouts on a continuous basis during the matches. Whether a team is ahead or behind is not necessarily the most important criterion, because real-time data can provide solid forecasts on the course of play to come. Some algorithms can also be used to detect the possibility of manipulation. In addition to player and team performance, the technology also records what the referees do. Certain patterns of movement by the players and refs can yield at least the suggestion that something is deviating from the norm.

SAP project director Jens Wittkopf says the greatest advantage of this data lies in the search for talent. A software specialist, he observes that “the use of big data is having a revolutionary effect on talent scouting. Above a certain level, you can find comprehensive data on

young players from national teams worldwide. At the leading clubs, just a few of these up-and-coming players will make it onto their pro teams. This data will make it easier for clubs to find the right striker, let’s say, including candidates from other countries.” But even the managing director of Prozone, Jens Urlbauer, doesn’t think computers will ever take over the job of determining lineups. “What’s important in all of this technology is the individual who analyzes the huge amounts of data it generates. And for that

HD stadium cameras such as those in the Prozone company’s mobile tracking system follow all 22 players on the field plus the ball and refs. Visual data from these moving elements is converted into coordinates for further processing. This allows the match to be shown in three dimensions and viewed from all sides.

you need experience and a deep understanding of soccer.”

In theory, machines could even replace highly paid professional human players at some point. But that is still a number of years away. According to Professor Jürgen Schmidhuber, co-director of the Swiss Institute for Artificial Intelligence Research (IDSIA), “No robot is anywhere near the level of good human players right now. But that will not always be the case.” ←



CAMERA

SOCCER REPORTER SABINE TÖPPERWIEN:

“SOME DATA WOULD BE PRICELESS”



Sabine Töpperwien, a German sports journalist born in 1960, played table tennis in the 2nd Bundesliga in her youth. Her brother, ZDF soccer reporter Rolf Töpperwien, introduced her to sports journalism while she was pursuing a degree in sociology. Töpperwien joined the WDR broadcasting company in 1989 and is now its sports director. She is the first woman to report regularly on ARD’s live Bundesliga radio broadcasts.

Will Big Data turn soccer at stadiums into computer games?

Sabine Töpperwien: The essence of soccer is its spontaneity and individuality. If electronic analyses standardize, objectify, and verify absolutely everything, I would find that excessive. In that case we could also just get rid of the referees. But as far as training goes, digitization is enormously important. The data enables coaches to analyze the strengths and weaknesses of each player.

How will more technology on the field change the experience for spectators?

TV viewers can choose different camera perspectives, follow their favorite reporters, and customize how they experience the atmosphere in the stadium—for example, by selecting the sounds that are transmitted. But none of this can substitute for actually being in the stadium. That will remain a unique experience.

Do you think digital technology could take the excitement out of soccer?

Yes, it could take away some of the excitement—and especially the fascination. If you have 50,000 pieces of data being evaluated every second, there might not be anything to talk about after the game is over. It’s OK if we use data to benefit from it. But we shouldn’t become dependent on it. Otherwise, Big Data will end up dominating our world.

But as a reporter you surely wouldn’t mind having access to a little real-time data ...

Some data would be priceless. The seats for reporters are about 30 to 50 meters from the action, and we don’t see every detail precisely. One example would be the World Cup final in Rio de Janeiro. When Christoph

Kramer lost his bearings after that major three-way collision, no one really realized what had happened to him. The effects only became clear after the match. It would also be helpful to have information on oxygen levels in the blood, because then we’d know for certain whether players still have juice or are running on empty. And of course we also need goal-line systems as soon as possible. If a team shoots a goal that clearly crosses the line but isn’t seen and counted, that’s extremely unfair. The action takes place so quickly these days that the refs and their assistants can’t keep an eye on everything. But I could do without some of the other information, like the distance tallies for individual players. That really doesn’t tell us much about whether a team will win or not.

TV and radio fans will certainly be happy to hear what the players and coaches are saying to each other. This is already happening in the Formula One with the help of on-board radio systems.

That is appealing, of course; I’ve already enjoyed it myself with the Formula One. But all the same... I wouldn’t want that in soccer. That type of information could be abused by people with harmful intentions. Coaches are already holding their hands in front of their mouths when they give instructions on the sidelines to prevent the possibility of lip reading.

So a little of the mystery should remain?

A little nostalgia in soccer has never hurt. The sport even lives in part from its past. That being said, I’m in favor of technological advances in our multimedia world, but in moderation. I would never call for players to swallow a chip so we can have a live feed on their medical data. That’s going too far.