Solution Showcase

![NVIDIA logo]

Understanding the AI Techniques Behind Real-Time Graphics With RT Software and NVIDIA

Today we see self-driving cars identifying potential hazards using advanced video analysis. Similar approaches that use machine learning are also being deployed by leaders in media technology to push beyond the limits of traditional human processes. These techniques deliver results more quickly than comparable manual efforts by using AI to accelerate functions, while simultaneously improving the accuracy of graphics positioned on screen.

This whitepaper sheds light on how RT Software delivers ground-breaking graphics products by leveraging the full set of capabilities in an **NVIDIA RTX™ GPU**. Today's GPUs offer much more than simply graphics rendering. RT Software is unusual in making full use of the entire range of GPU accelerations in a single application:

> Tensor Cores for accelerated AI

> RT Cores for rendering

> CUDA® Cores for graphics and compute

> NVENC for video encoding

Sports Analysis Graphics

We explore how AI technology provides benefits for one of RT Software's products, Tactic Pro. Tactic Pro is a sports analysis graphics package (also known as telestration) used to add a graphic overlay to videos of players to help explain their performance on the pitch. We'll look at how machine learning and computer vision techniques have been developed to enhance the functionality and usability of the product.

Tactic Pro supports all sports, but as it is most often used for football (soccer) we are going to use that as our example here.

Two markets benefit from Tactic Pro, broadcast (TV) sports shows, and professional sports organizations. In both cases, there's an audience eager to better understand the performance and tactics of players and teams. Both types of users work under pressure to deliver insightful analysis. For broadcasters this often means time pressure—for example, having to provide a sequence ready for a half-time discussion. Whereas coaches will select from clips of practice sessions that need to be discussed with the players to highlight how they performed.

![RT Software logo]

RT Software provides professional graphics systems to the broadcast and professional sports markets. Products are used to provide insightful graphical analysis for sports or add high quality graphical elements over live broadcast video.

Industry

> Broadcast / Sports Media

Solution

> Tactic

Benefits

> Users can produce more insightful analysis sequences

> Limited available time is spent on higher value tasks

> Quality of analysis is less likely to vary between different users of varying skill levels

> Accuracy of graphics attached to running players is greatly improved

Let's explore some of the features that are used in these analysis sequences. The features in Tactic Pro we'll explore are:

> AI Pitch Calibration

> AI Player Detection

> AI Camera Tracking

> AI Player Drag

These features are simple to explain and easy to use, but they mask considerable complexity in computer vision and machine learning techniques.


Tactic edit screen, showing analysis sequence being created

Objective 1: Attaching Graphics to Moving Players

When we attach graphics to single or groups of players, we want them to stay together and move as a single item. The challenge here is how to ensure the graphics match the perspective of the pitch as seen through the cameras. We must also identify what a 'player' looks like so we can automatically track them as they move around the pitch.
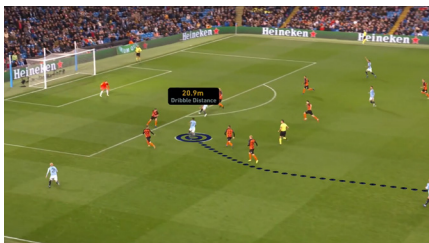
Single highlighted player with a trail showing the sprint
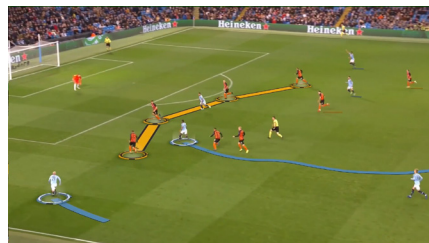
Multiple players in orange linked to illustrate how they perform as a group

How To: Perspective Graphics Using AI Pitch Calibration

The first step in attaching convincing graphics to players is ensuring we use the correct perspective. If we take as an example, a simple arrow graphic that we want to add to the sequence, we could do it in two ways. The first image shows a simple arrow overlayed on the image of the pitch. It doesn't convince anyone that the arrow inhabits the same 3D space as the players. The second image is convincing for viewers, and lets the presenter explain player tactics in a much more engaging way.

NVIDIA Products Used

> RTX A6000

> RTX A4000

> BlueField DPU

> Rivermax SDK

> DOCA FireFly

> NVENC

> CUDA

About RT Software

RT Software is a leading worldwide provider of real-time graphics solutions. Its products span CG, template-driven graphic overlays, election and newsroom graphics, specialist sports graphics and virtual studios. From its beginnings as an offshoot of the BBC 3D Graphics Department in 2004, it now has broadcast installations from Iceland to New Zealand, and its growing customer base includes the BBC, Sky Sports, Fox Sports, BT Sport and many other Tier 1 broadcasters.

Our products for the professional sports market have evolved from broadcast analysis tools to focus on providing powerful data visualization solutions for recruitment and team management. We're proud to have worked alongside some of the biggest names in the professional sports world.

The way this is achieved is with Tactic Pro's AI Pitch Calibration feature. It uses an AI model that RT Software has created in-house. The model was trained with an NVIDIA RTX A6000 using dozens of videos of soccer pitches to recognize the lines and markings (We are showing soccer here, but it's also trained on US NFL and Australian AFL with other pitch types being added over time).

When a user selects Pitch Calibration, the AI knows what a pitch should look like and applies its model to the new unique video it's been given. The process is instantaneous, and the result is shown to the user with the model's blue lines overlaying the white lines of the real pitches, so the user has confidence the applied model is accurate. Tactic Pro now understands the field's coordinates in 3-dimensional space.

Tactic Pro will draw all graphics with a perspective that matches the way the camera shows the pitch and maintains the correct perspective even as the camera moves to track the action in 3D space.

> For competing systems that don't use AI to calibrate the pitch, the user might have to manually select lines and corners on the pitch. This will typically use a pure CPU computational process called Least Square Estimate, which can be laborious. In comparison, Tactic's AI will achieve results in milliseconds.

> The benefit of AI for pitch calibration is that the user can spend more time on higher value activities instead of manually calibrating the system. By providing more insightful match analysis, the result is more engagement from viewers.

Arrow without perspective
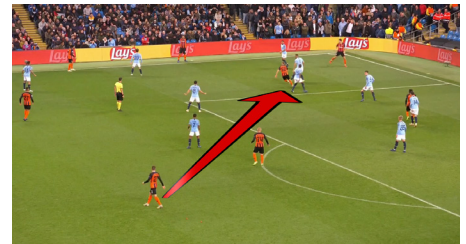

Arrow adjusted to match camera perspective

Tactic overlaying the blue lines of its model against the white lines of the pitch in the video.

Tactic Pro runs through the video, identifies players, and automatically tracks their movements.

It's then a simple process to attach graphics to the paths of individual players or to link multiple players with dynamically adjusting graphics.

> For competing systems that don't use AI, manually setting the keyframes fo the player's movements means clicking on the positions on screen, so the system can map that click into 3D space. If the click is inaccurate, the position will be inaccurate, which then requires manual fixing, which is all very labor intensive and prone to error.
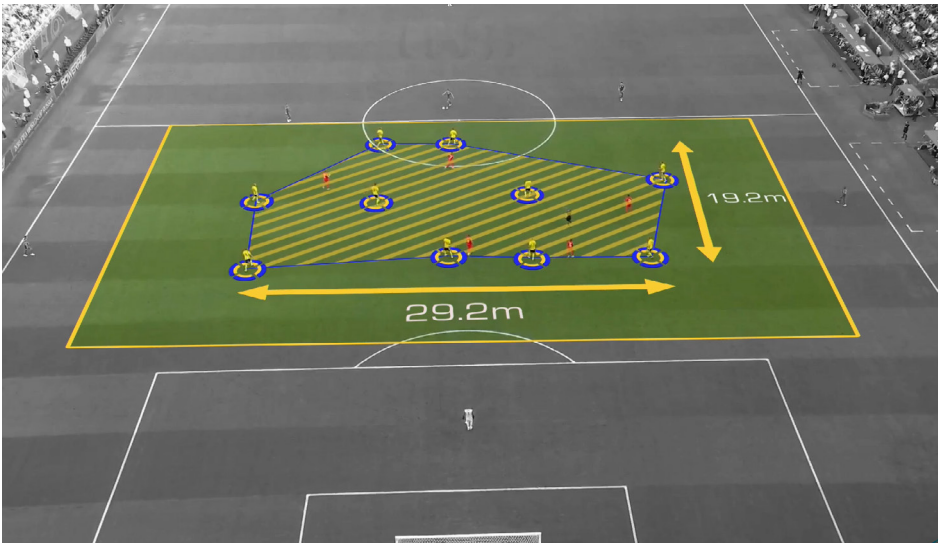
Tactic edit screen showing players automatically detected and their motion path trails shown

Player with name and team logo attached

Multiple players showing attached lines and areas

The combination of AI Pitch Calibration and AI Player Detect brings together two capabilities to allow users to deliver results very quickly, with minimal errors, and improved accuracy. The real benefit is the time savings that can now be used to create more insightful sequences. Time savings will vary, but typical values are:

	Manual	AI	Saving with AI
Pitch Calibration	Approximately 30 seconds	200 milliseconds	150x faster
Player Key Framing	30 seconds per player	500 milliseconds per player	60x faster
(Example clip with 10 players in view)	Total 5 minutes	Total 5 seconds	

Objective 2: Fix Graphics to the Pitch Even as the Camera Moves

A key challenge with adding graphics to video sequences is ensuring that any graphics that are attached to the pitch (as opposed to attaching to moving players). There are many moving items in the video sequence that the software could become confused by and mistakenly lock to. For example, the advertising boards at the edge of the pitch often have moving video graphics.

How To: AI Camera Tracking

This is where another AI feature is used — AI Camera Tracking. This process is much more robust than traditional methods which are at risk of drifting. AI Camera Tracking uses a dataset looking for specific types of intersections found in the images. By weighting the results, the AI can make more accurate decisions, leading to rock-solid graphics attached to the pitch.
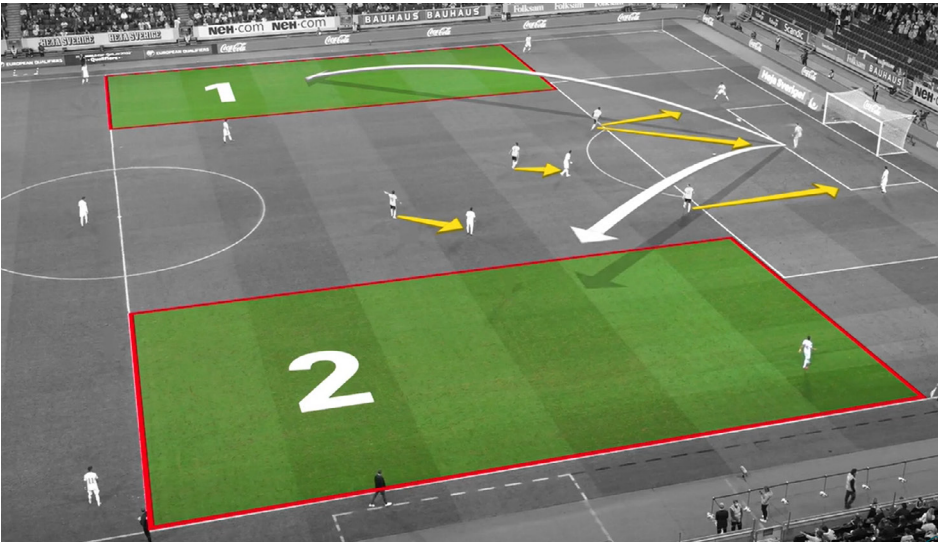
Graphics fixed to the pitch to illustrate areas of interest

Objective 3: Dragging a Player Across the Pitch, and Automatically Filling the Space

Picking up and dragging a player to a new position on the pitch lets the presenter illustrate how they could have been better positioned to attack or block. The challenge here is to fill in the missing pitch cleanly where the player was originally positioned.

How to: 'Infilling'

The technique is called 'Infilling' and uses an AI neural network to reconstruct missing pixels that accurately represent the space where the player used to be before they were dragged/moved. It not only has to deal with green grass, but also any white lines that may be passing through the space.

NVIDIA Compute and the Video Processing Pipeline

The machine learning models are developed in-house at RT Software, and built on computer vision technologies, including neural networks and long-short term memory architectures.

However, the computational power needed to achieve a satisfying user experience relies heavily on NVIDIA RTX GPUs which RT Software frequently supplies as part of a turnkey system.

NVIDIA's modern GPU cards offer a lot of discrete specialized functionality. RT Software utilizes these to implement a complete processing pipeline for its products.

The pipeline starts with source video frames in their original state, and after the separate software functions have completed their tasks, the final composited video frames are output and viewed by the audience. The diagram below shows how AI, CUDA, rendering, and video encode/decode elements are brought together to produce the final video sequence.
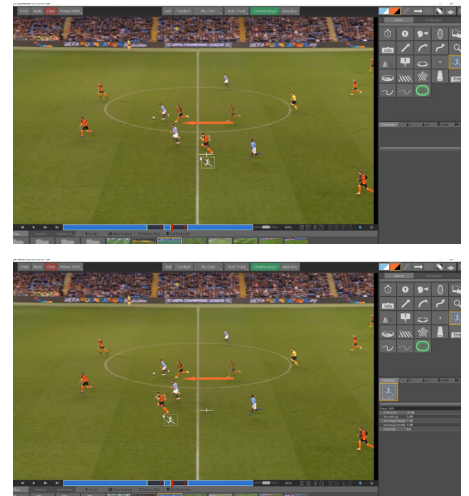
These two images show a before and after as a player is dragged across the pitch, and their original position is filled in with an accurate version of the surrounding ground.

Regarding the source live video input and final output video stream, the diagram shows two approaches — SDI and ST 2110.
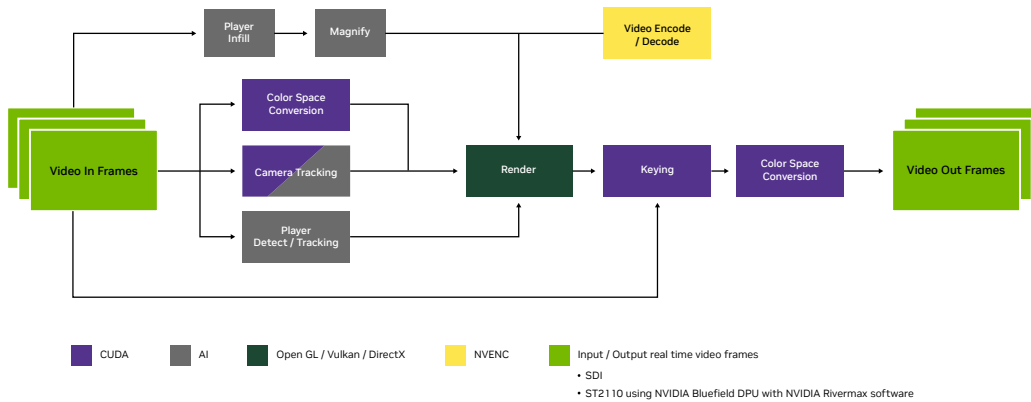
The broadcast world has traditionally used industry standard transport SDI, but this is now being displaced by SMPTE's uncompressed video over IP protocol ST 2110. RT Software has built in support for NVIDIA's BlueField DPU, DOCA-Firefly (Time service), and NVIDIA Rivermax software to support these very high bandwidth signals. For example, a single 1080i video signal might be around 1.5Gb/s and must be achieved with zero dropped or delayed frames, so requires very high precision timing software and hardware.

What's next?

RT Software's success with developing AI models, powered by NVIDIA RTX GPU and NVIDIA Networking technology has created a solid foundation for further work. Some exciting new AI feature developments from the roadmap are coming soon. Watch this space!

Ready to Get Started?

To learn more about NVIDIA-accelerated broadcast infrastructure, visit: **nvidia.com/professional-broadcast**