



The Use of AI in TRACAB
Data Processing and Analysis

TRACAB

OPTICAL TRACKING

WHITE PAPER

Live Video & Data

GEN5 TRACKING

TRACAB Optical Tracking



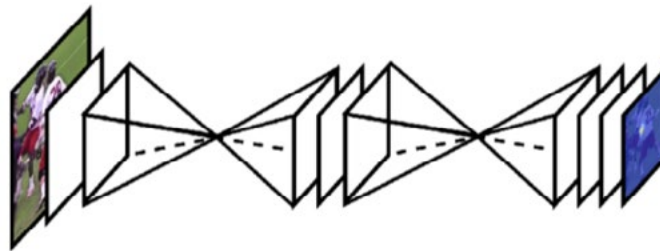
INTRODUCTION

Sports leagues from every corner of the globe are actively investigating, and in many cases, deploying artificial intelligence (AI) and machine learning to improve performance, gain competitive advantage, and enhance fan engagement.

The concept of AI isn't new. John McCarthy, who was both a Computer Scientist and a Cognitive Scientist, first coined the term "AI", during an academic conference in 1956. Over the subsequent decades, AI and machine learning have penetrated a wide variety of industries,

including technology, healthcare, manufacturing, telecommunications, and automotive, to name just a few.

With its rich history of innovation, ChyronHego (as Hego Group) pioneered the use of AI within the world of sport as far back as 2003. Today, through its Emmy® Award winning TRACAB® Optical and Wearable Player Tracking solution, ChyronHego is recognized as the preeminent leader in real-time positional tracking solutions, offering the world of sports, the most accurate performance tracking and datasets.



THE USE OF AI IN TRACAB DATA PROCESSING AND ANALYSIS

ChyronHego's sports performance technologies are specifically engineered for competitive and data-intensive sports environments. Whereas some tracking solutions' capture systems are limited to standard broadcast camera video, and therefore more limited datasets, TRACAB's purpose-built optical computer vision cameras provide real-time, in-game tracking data accuracy.

The question is, how do you make sense of, and therefore make practical use of, the immense amount of geospatial and time-based data captured during a typical sports game? After all, what good is all of this data if you are precluded from turning raw data into actionable, and where the use case allows profitable, insights?

This is where ChyronHego data scientists apply AI and Machine Learning techniques, using algorithms that are designed to process massive amounts of raw data to track player and ball movements within sports. Exactly how much raw data are we talking about?

Let's take a look at the following figures (next page) for a 90-minute soccer game, as it relates on a comparison basis to ChyronHego's TRACAB Gen 4 and Gen 5 Optical Player Tracking solutions.

TRACAB GEN4	TRACAB GEN5
TRACAB Gen 4 captures and processes 3.4 TB of raw video data captured over a 90-minute match	TRACAB Gen 5 captures and processes 5 TB of raw video data captured over a 90-minute match
These figures are based on the amount of pixels ingested and are computed as follows:	
TRACAB Gen 4: $16\text{-bits/pixel} * (1920 \times 1080)$ $\text{pixels/camera} * 6 \text{ cameras} * 25$ $\text{frames/sec} * 90 \text{ minutes} * 60$ $\text{sec/minute} * 1/8 \text{ bytes/bit} =$ $3.3592\text{e}+012 \text{ bytes} = 3.4 \text{ TB}$	TRACAB Gen 5: $8\text{-bits/pixel} * (1936 \times 1216)$ $\text{pixels/camera} * 16 \text{ cameras} *$ $25 \text{ frames/sec} * 90 \text{ minutes} *$ $60 \text{ sec/minute} * 1/8 \text{ bytes/bit}$ $= 5.0850\text{e}+012 \text{ bytes} = 5 \text{ TB}$

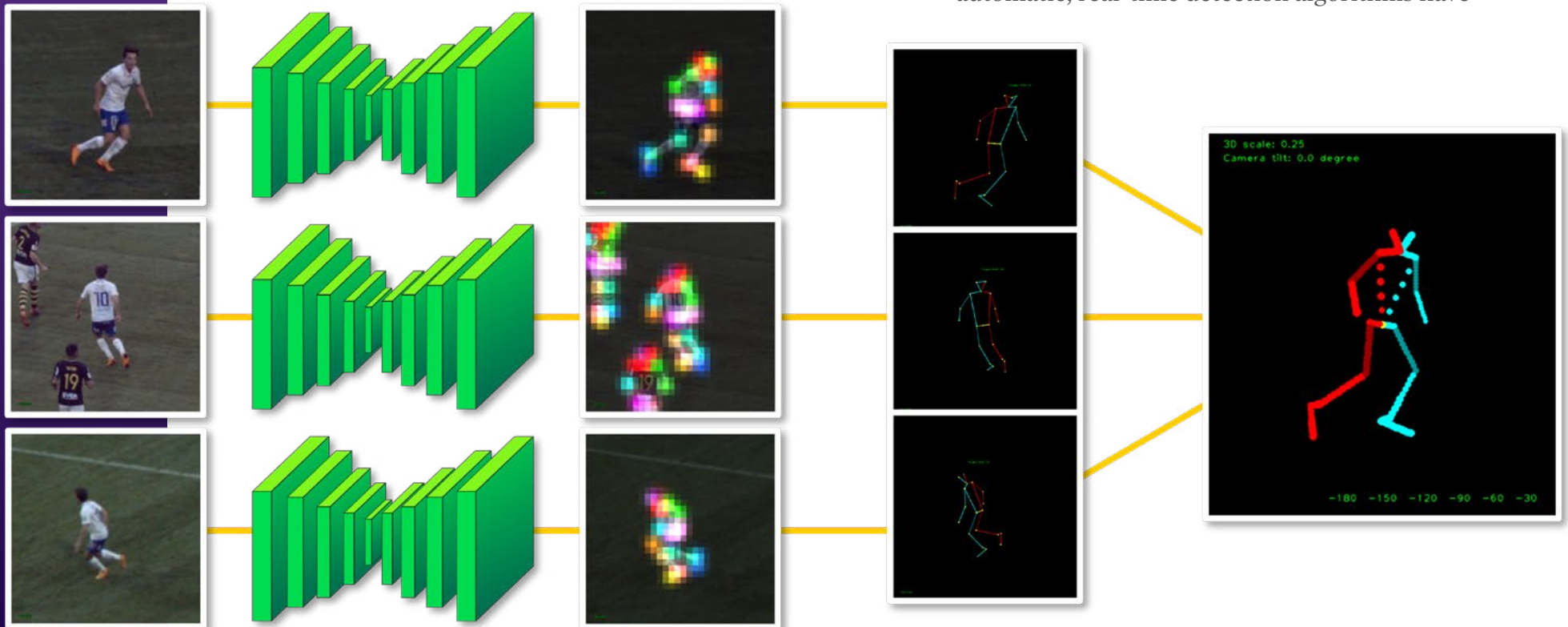
ChyronHego's implementation of AI and Machine Learning within TRACAB is a differentiating technique because the player and ball movement data, in its most raw and unprocessed form is completely unstructured and lacking any context.

Context is critical, and it is realized by leveraging TRACAB's industry leading advancements in multi-dimensional computer vision.

PLAYER RE-IDENTIFICATION AND DETECTION

As the preeminent Artificial Intelligence pioneer in sport, ChyronHego has earned a rich history of client success and boasts a massive deployment of well over 30,000 matches across multiple sports.

TRACAB's unique AI capabilities learn to recognize players and objects on the field. Its automatic, real-time detection algorithms have



been independently tested* and verified to be the most accurate within professional sports.

ChyronHego continues to push the 21st century boundaries of AI. Today, TRACAB automatically assigns targets based on a shirt colour and number. However, the very nature of live sport brings with it an environment of unpredictability. Some tracking solutions may be challenged to correctly identify a given player, such as when multiple players converge on a single area of the pitch or field, forming a “mass” of temporarily unrecognized targets. This all too common situation has the potential to confuse most player tracking solutions. Not so with TRACAB.

TRACAB is endowed with deep learning and neural network-based capabilities, which recognize patterns within images, as well as letters and numbers.

As a result, TRACAB can re-identify players that could ordinarily swap assignment targets in clustered scenarios. This is similar to how airport security cameras are able to identify, track, and then re-identify one person from among many as they travel between ticketing and their assigned gate.

And in the very near future, users will further benefit from TRACAB’s neural network-powered deep learning skills, where TRACAB comprehends the multi-dimensional position of a player’s body,

including their individual appendages such as arms, hands, legs, and feet to derive data points in 3D space.

This capability flows directly from ChyronHego’s in-house development of 3D Pose Estimation methodology, which provides benefits over and above those offered through licensed third-party solutions, such as Open Pose.

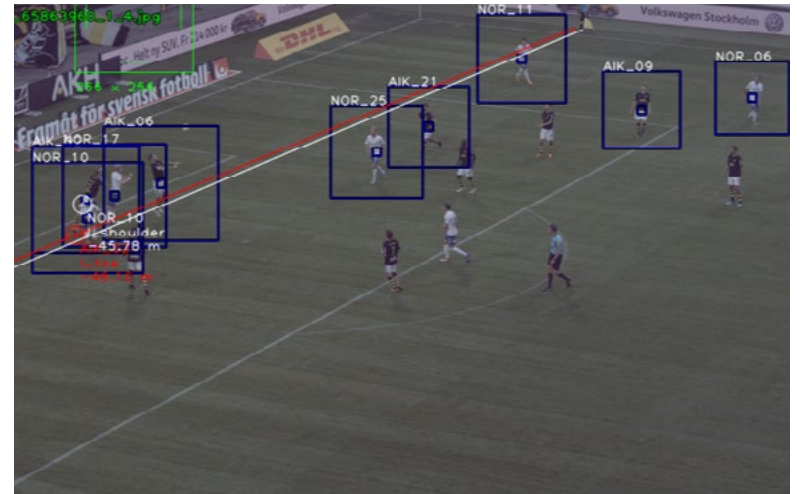


3D Pose Estimation provides body part detection through AI and deep learning using convolutional neural networks. Currently providing twenty-one body landmarks, including heels and toes, are made visible. These learned, associated vector fields between body parts aid in grouping key connecting points into recognizable features. For example a right knee connects to a right ankle, and a left elbow connects to left wrist. TRACAB's Automatic Skeleton Detection feature transforms the 2D camera image into a 3D skeletal image.

This type of ground-breaking AI experience allows for the tracking of player skeletal movements to analyze body-pose attributes, and leads to new advancements in offside calling through pinpoint player positioning that until now hasn't been possible.

AI, machine learning, deep learning, and the application of neural networks have been and will continue to be integral to the development of ChyronHego's TRACAB Player Tracking solution. The goal is to support the needs of sports data stakeholders; from leagues, to officials, teams, broadcasters and media analysts with objectively derived insights based on captured real-time positional tracking data.

Ultimately, it is the quality, reliability, experience and credibility of creating and utilizing that data that defines TRACAB's effectiveness as the sports industry's leading tracking technology.



ABOUT CHYRONHEGO

ChyronHego, a portfolio company of Vector Capital, is a global leader in products, services, and solutions for the broadcast and sports industries. Specializing in live television, news, and sports production, ChyronHego offers some of the industry's most widely deployed solutions — including Lyric®, the world's most popular broadcast graphics creation and playout offering; the all-new CAMIO® Universe newsroom workflow; and TRACAB® Optical Tracking, the global leader in optical sports tracking systems as well as Click Effects, the most proven and versatile stadium broadcast family of graphics products. Headquartered in Melville, New York, ChyronHego also has offices in the Czech Republic, Denmark, Finland, Germany, Mexico, the Netherlands, Norway, Singapore, Slovak Republic, Sweden, and the United Kingdom.

For more information on ChyronHego, visit www.chyronhego.com.

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