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Asset Management & Digital Twins: It's all about As-builts and Tags

How Cintoo's Asset Tagging & Display tools powered by Cintoo's AI Engine is key for managing asset-intensive worlds

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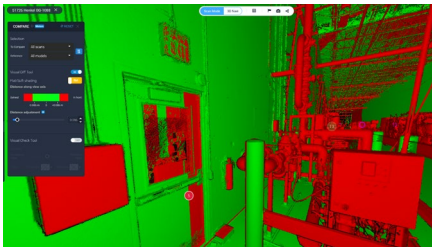
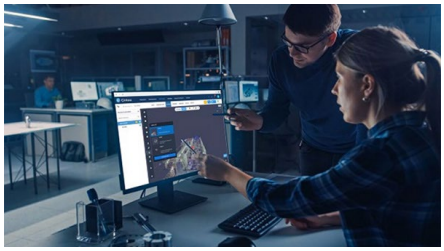
Contents





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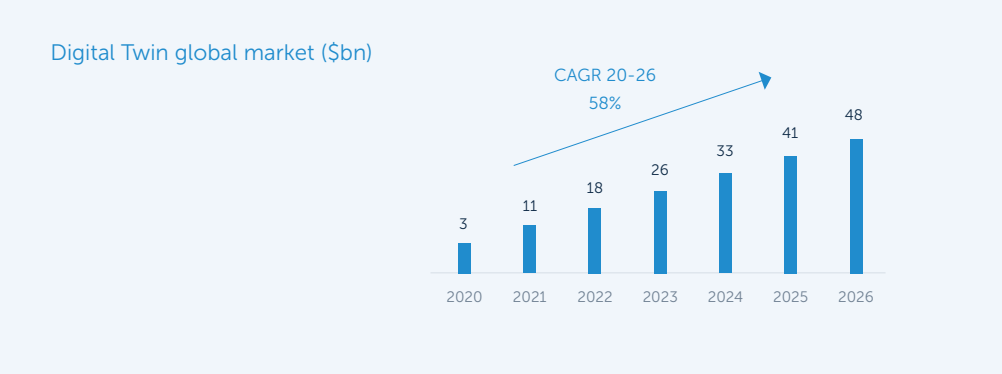
Digital Twins for Asset Management

A Digital Twin is a virtual representation that serves as the real-time digital counterpart of a physical space (factory, plant, infrastructure, sub-station, oil rig...), a manufactured object (car, robot, aircraft...) or a process (supply chain...). In various industries, Digital Twins of physical spaces are used to optimize the operation and maintenance of physical assets and systems. Digital Twins can do more than just serve as a connector to the physical world as it is often used today. It can help improve the design of new spaces or sites, optimize the understanding of existing assets, run 'what if' simulations, forecast the potential outcomes of workflow decisions and compare various scenarios. Digital Twins allow users to create digital simulation models that update and change as their physical counterparts do. Furthermore, they are a formative technology for the Industrial Internet of Things (IoT), where physical equipment can live and interact virtually with other machines for predictive maintenance.



The present capabilities of Digital Twins as well as their promise for future intelligence and applications has helped push the Digital Twin market into the billions — analysts presently value the market at around $8.6 billion USD (Fortune Business) and it's projected to reach $183 billion USD by 2030 (Meticulous Research, April 2023). And although various analysts may disagree on the exact forecasted value, they all anticipate significant growth and the importance of the Digital Twin for design, construction and operation of built spaces or infrastructure.

Digital Twins are a must-have for all types of Industry 4.0 businesses, including:

- Pharmaceutical
- Oil & gas
- Automotive
- Energy
- Food and beverage
- Water treatment
- Utilities
- Shipbuilding

Today's Asset Managers are faced with the unenviable task of realizing value and achieving organizational objectives in a world that is increasingly complex, siloed, disrupted, and uncertain. In this context, the clarity and foresight provided by an optimized Digital Twin program can be invaluable for managing assets making decisions more accurate and effective. In fact, a comprehensive and connected Digital Twin platform is now a must-have for all 4.0 industries including car manufacturing, construction, and energy, to name a few. Digital Twins give organizations the insight to help them catalogue, manage and understand their asset performance, right down to the individual parts for each piece of equipment, making Digital Twins an invaluable tool for business operations and Asset Preventive Maintenance (APM).

A Digital Twin can be made up of different best of breed platforms connected for decisive asset intelligence. Each company can assemble their twin differently. An open approach does work. Replacing a brick for a legal/IT or other reason must be possible. The key for Digital Twins is interoperability between platforms and separation between software and data.

The key element for Asset Management is all about tagging your equipment in your Digital Twins. Users can then connect their tagged equipment to other platforms so you can easily access all kinds of information related to this equipment. A tag identifies a unique piece of equipment with its ID, geolocation, volume (bounding box) and other metadata such as its class, description, function, etc. A 'tag' is not useful until it is associated and linked to other 1D, 2D, or 3D information such as documentation, maintenance logs, business data, and work orders to name a few, i.e. all the information required to maintain or operate this equipment.

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Your As-builts; Essential Elements for Digital Twins & Asset Management

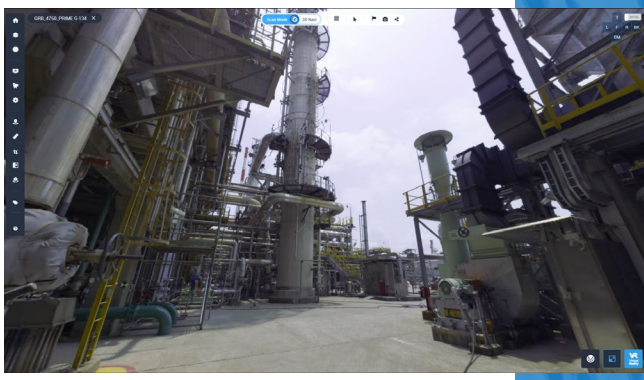
However, the ability to capitalize on the Digital Twin's advantages begins with the two most primary essential pieces.

1

Getting to know your exact as-built conditions through Reality Capture

There is generally a huge gap between the physical world, made of complex shapes that change very often during operations, and its virtual representation made of a 3D CAD or BIM model that may not have been updated for some time.

Reality Capture technologies such as 3D laser scanning is essential to provide a foundational layer for capturing spaces and objects that make up Digital Twins.
Modern 3D scanners (terrestrial or mobile laser scanners), or drones can now acquire up to hundreds of millions of data points (point clouds) in a single capture, providing comprehensive data-rich 3D point clouds of each and every object visible in the scanner's view.



But those large 3D point clouds can also be a challenge for asset-intensive or equipment-intensive industries when the smallest valve to the largest pipe network needs to be located, scanned, and identified.

2

Getting to know how many pieces of equipment each asset is made up of in their current condition, where they are located in space, and tagging them to create those necessary links with your other data platforms.

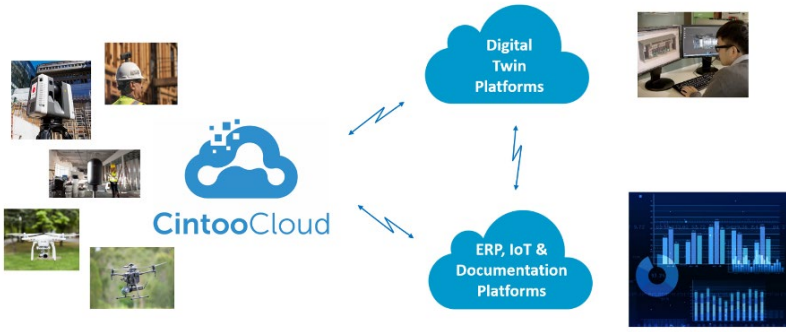
An essential part of Digital Twin workflows for Asset Management is utilizing the scanned as-builts rather than just the CAD models that may not be up to date. This allows users to link physical equipment or parts to their digital counterpart, and in combination with other business data, make decisions which optimize the process and performance. The Reality Capture data also provides the context, which the CAD model does not. What is going on around a machine or equipment in the built environment may affect accessibility when repairs or replacement must happen. This context from the Reality Capture data also validates that the model or twin is accurate, and therefore reliable, or not. When built on top of reality data, Asset Management's decision-making process is greatly improved by increasing the organization's efficiency, effectiveness and safety as well as reducing rework and downtime.

Cintoo Cloud for Digital Twins & Asset Management

The ultimate source of truth for Asset Management ecosystems

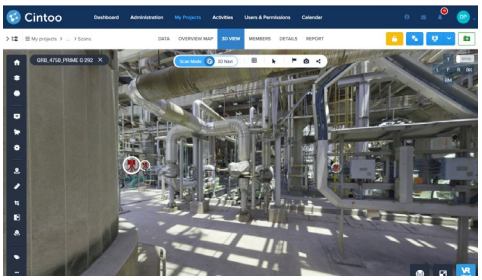
Cintoo's core technology effortlessly converts massive point clouds into high-resolution, high-fidelity 3D surfaces or meshes with no decimation or loss of information. This mesh-based reality data can be streamed from the cloud into a web browser at the same resolution of the source scanner, which is much easier to view, navigate and interpret by experts or non-experts alike. This mesh-based representation of your scan data at the same resolution of your source scanner has made Cintoo Cloud an overwhelming success, which is now being used by more than 400 corporations in more than 40 countries worldwide.

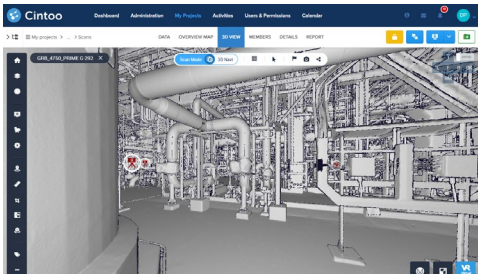
This mesh-based scan data is also the ultimate source of truth for Asset Management ecosystems.



Asset Management leveraging as-builts in Cintoo Cloud

To provide the greatest value to Asset Management in Digital Twin workflows, Cintoo provides a set of Asset Tagging and Display (ATD) tools which includes a Tag Explorer and three ways to tag your assets; manual tagging, tagging from a CAD model, and automated tag geolocation and classification using Cintoo's AI Engine.





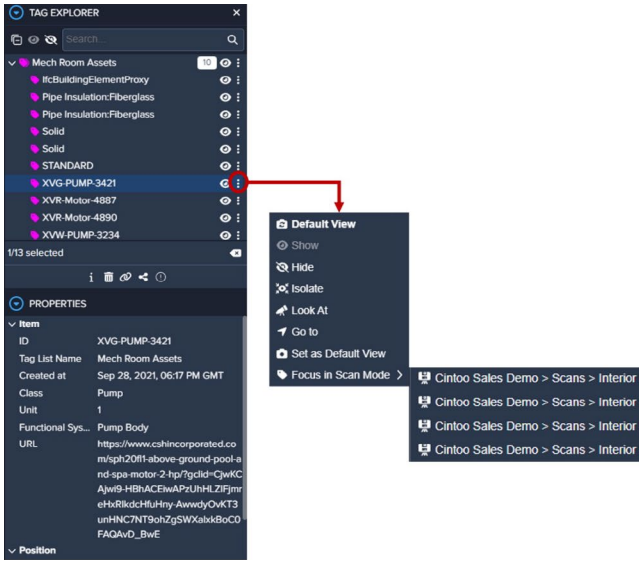
1. The Tag Data Model

Cintoo Cloud's set of ATD tools leverage an open tag data model that can be tailored to each company's needs:

- You can create lists of tags with up to 20 custom metadata for each tag.
- Metadata can be of any kind, including hyperlinks to your Digital Twin, ERP and EAM platforms.
- Lists of tags and individual tags can be updated programmatically using Cintoo Cloud APIs.
- Tags can be seen from one or many scan positions.

2. The Tag Explorer

The Tag Explorer is your access to your tag lists and individual tags in each list in Cintoo Cloud. Each tag has its properties (ID + metadata) listed and accessible. There are several actions possible (hide, isolate, go to...) for each one of them, including the possibility to select the scan vantage points that best display this selected tag (default: closest scan automatically computed by Cintoo Cloud).



Tags and display options in Cintoo Cloud

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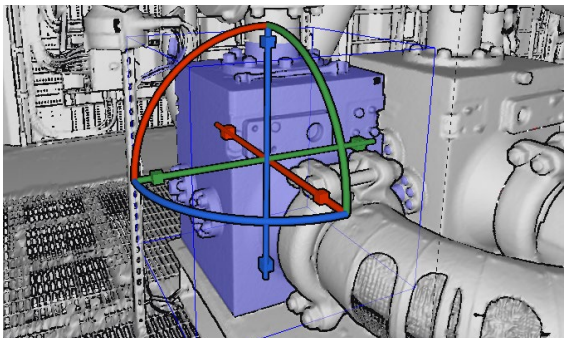
3. Manual tagging

Manual tagging using Cintoo Cloud consists in using our new bounding box tool to demarcate the equipment and in setting the tag ID and metadata manually.



Manual 3D Cropping Tool

4. Tagging from a Digital Twin or a CAD model

You may also get a list of tags from your Digital Twin or from your Revit or Navisworks model via a simple CSV file that contains the ID of each piece of equipment, their location and various other metadata.

ID	X	Y	Z	Class	Unit	Functional System	Description	URL to CAD model	URL to ERP

Example Tag Data Model from CAD

These lists of tags from your Digital Twin or CAD model will then be displayed as bounding boxes overlaid to the scans, with the possibility to edit each box to match the reality, or to edit the list to add more metadata.

5. Automatic tag geolocation and classification

Cintoo's AI Engine replaces the cumbersome manual tag search in your scan data with an automated, faster, easier, and more accurate approach. Based on a Deep Neural Network engine and modern computer vision algorithms, Cintoo's AI Engine allows users to automatically geolocate and classify tags in their 3D scans.

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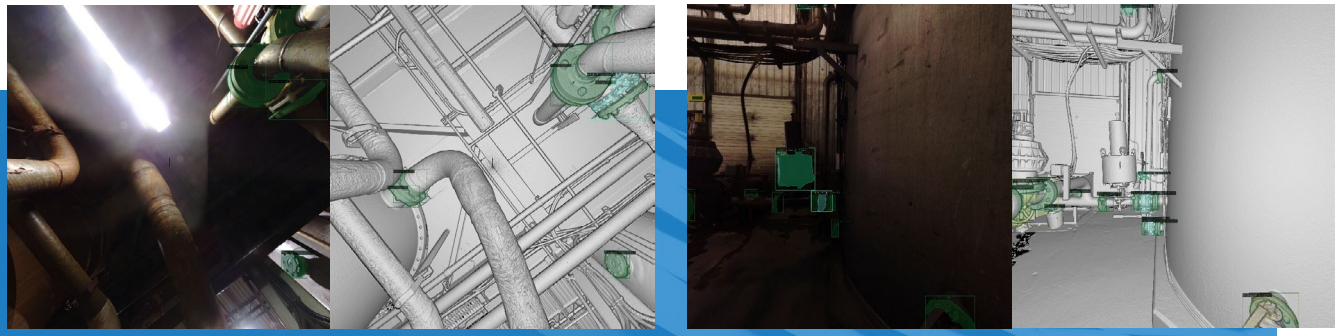
Cintoo AI Engine for Asset Tagging

Unlike general AI models that focus on common objects found in indoor spaces (table, chairs, etc.), the Cintoo AI Engine is tailored to the typical Cintoo customers' requirements and the important objects they need to identify for their specific applications. For example, the Cintoo AI Engine can readily detect common Industry 4.0 objects such as valves, flanges, electric motors, electric devices, etc. The Cintoo AI Library contains a large set of real use-case content that has been manually annotated and includes at least seven different categories of tags. This customized list of assets is continuously enhanced and updated according to customer requirements.

Example of categories of tags. From left to right: electric motor, valve, electric device, flange, manometer.

Cintoo's unique point cloud-to-surface technology converts cumbersome point clouds into a 3D surface mesh, which retains the original point cloud's accuracy but is 10 to 20 times smaller in size than the source scans. This 3D surface display not only makes data management easier, but its precision can also reveal obscured objects not readily noticeable in the original scan or visible in a typical point cloud viewer. Cintoo AI Engine leverages this surface data, so that our technology can distinguish equipment that is unclear or dark in RGB panoramic images, increasing the accuracy of object detection. See below how a tag can be detected even though it is not visible in the RGB image.



The use of the surface in the AI engine allows the detection of objects that are not easily visible in RGB panoramic images due to illumination conditions.

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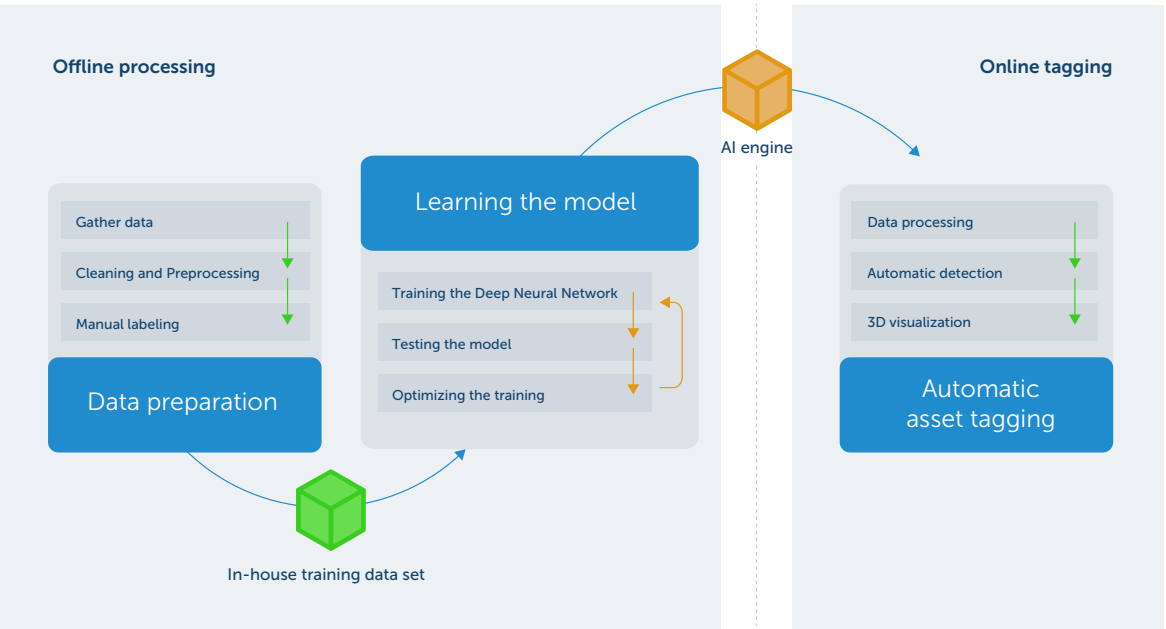
General workflow for Cintoo AI Engine

The Cintoo AI Engine uses deep-learning algorithms optimized on 2D/3D data and has been trained on in-house, high-quality databases. The offline optimization work Cintoo completed— dataset preparation and AI engine training — enables customers to automate their asset tagging using Cintoo's AI engine.

Our AI engine, which automatically detects complex objects and locates them in the 3D coordinate system in a precise way, is the result of 3 years of research by a team of doctorates and engineers specializing in machine learning and computer vision. Throughout this journey, they encountered challenges such as complex tag requirements and noisy input data coming from different modalities like static scanners or indoor mobile devices. To address these obstacles, we adopted a crucial feature of our AI solution: gathering a lot of diverse, real-world data and meticulously annotating it at Cintoo thus ensuring the creation of high-quality and rich training datasets. Additionally, the inherent multimodality of our AI solution, combining 3D surface and panoramic images, played a pivotal role in overcoming these challenges. Furthermore, the continuous training and optimization of our tailored AI engine has been instrumental in achieving success in the face of these difficulties.

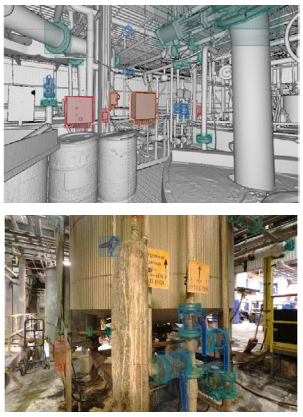


Cintoo AI Engine

In-house dataset preparation (offline process by Cintoo's AI Team)

With more than 400 Digital Twin customers across varied industries such as energy, construction, utilities, automotive, aerospace, and architecture, Cintoo is well-versed in what asset information and asset management means for these dynamic industrial environments. That knowledge contributed to the development of our data acquisition process, training data, and tag identification categories.

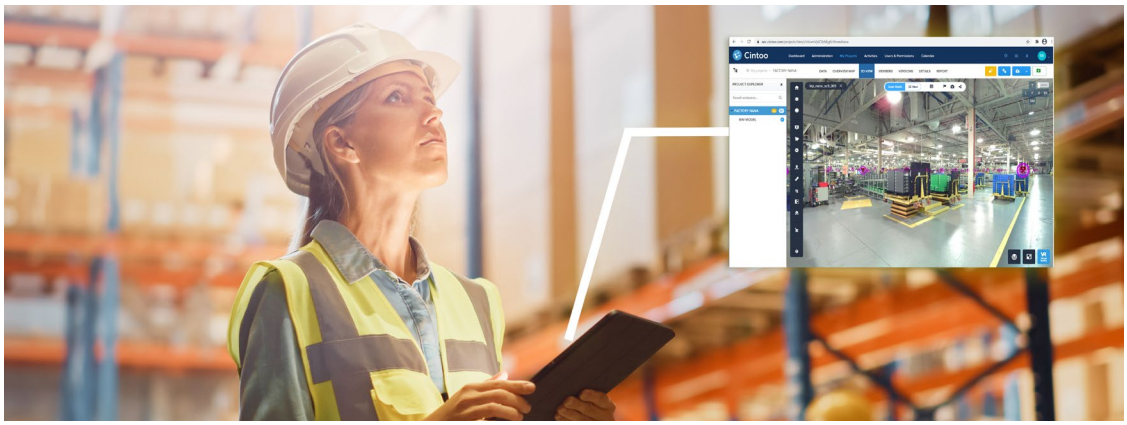
- Cintoo's AI Team used high-resolution multimodal data combining both RGB and surface information to train robust object detection models.
- Through reality capture, we built a large-labeled in-house image dataset to train the deep-learning algorithms. The dataset is created from extremely complex real 3D scenes that include several different asset tag categories, and each asset is tagged manually in each image. Some images may contain a very high density of tags — up to 30 tags or more for a single image. The annotation process has resulted in a level of unequaled precision.
- Cintoo's AI Team developed a scalable dataset, in which each new object has been annotated manually on at least 500 instances. The data is stored locally on our secured machines or secured cloud resources (SOC2 certified) and reverse engineering is impossible.



The dataset is built from extremely complex real 3D scenes including several different tag categories.

Training of AI engines (offline process by Cintoo's AI Team)

Cintoo AI Engine is designed for vertical business (manufacturing, AEC, energy...). It is based on a deep-learning algorithm optimized for instance segmentation. The engine is trained on Cintoo's in-house, high-quality labeled datasets containing over 50,000 manually annotated objects and uses high-performance computing servers. Our AI Engine is continuously maintained, optimized and updated regularly with the introduction of new labeled data, new tag types and technologies. The AI Engine is tested and validated on independent datasets to guarantee the reproducibility of the performance.



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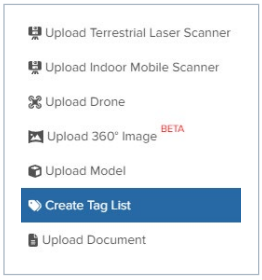
The Cintoo AI Engine has undergone rigorous testing on various internal projects, showcasing its outstanding performance and delivering remarkable accuracy. When it comes to average precision, our engine achieves up to 90%, affirming its reliability and effectiveness. For the specific task of detecting valves with handle actuators, the engine achieves an impressive precision rate of up to 97%. Similarly, when detecting flanges, the precision rate reaches up to 94%. Even when faced with the increased complexity and variability of electric devices, our engine maintains a commendable precision rate of 83%. Additionally, the false positive rate remains exceptionally low at just 11% underscoring the engine's ability to minimize erroneous detections. These results demonstrate the robustness and reliability of the Cintoo AI Engine in accurately identifying and localizing tags.

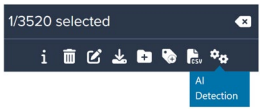
Running the AI-based tag detection in Cintoo Cloud (online process by customers)

Users can run the AI engine online to automatically detect tags in their scans directly from their Cintoo Cloud workspace. To apply automatic asset tag detection for any given project, users simply:

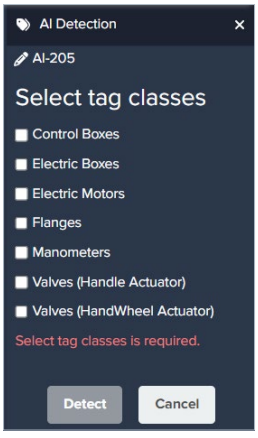
1. Create a tag list and set your metadata for each tag.



2. Select your tag list and choose to run the AI Detection for this list.



3. Select the tag classes to be detected.



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4. Run the detection job.

The online detection process benefits from bidirectional translation between 3D point clouds and 2D modes (RGB, surface map, intensity map). It is mainly composed of five automatic steps as illustrated in the following figure. Using cloud computing, the online detection process runs very fast, around 45 seconds for a 40-million-pixel scan (tests performed on a machine with Ryzon 7 CPU (8 cores – 16 threads), 128 GB of RAM, and a Nvidia RTX 3090 GPU).

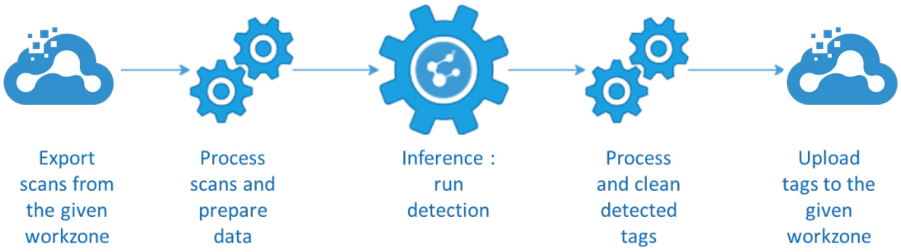

Illustration of the Cintoo Cloud automatic tagging workflow.

Users are notified at the end of the detection process by receiving an email. Through the Tag Explorer, they can then visualize the detected tags. Tags are localized in the 3D scene and listed according to their category, identifier, confidence rate, etc. With the set of Asset Tagging & Display tools, users can easily navigate through the list of tags, and have the options to export tags, crop them, modify them, add metadata or link them to any Digital Twin, ERP and EAM platform.

Cintoo AI Engine key features and benefits

The main advantages of Cintoo's AI Engine are:

- ✓ Use of high-resolution multimodal data combining both RGB and geometric 3D information (surface mesh) to train robust object detection models.
- ✓ Large-labeled in-house image dataset built from reality capture (to train deep learning algorithms).
- ✓ AI Engine designed for vertical industrial businesses (manufacturing, AEC, energy).
- ✓ A rich list of classes, which is continuously enhanced and updated according to customer requirements.
- ✓ Bidirectional translation between 3D and 2D modes (RGB, surface map, intensity map).

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Cintoo Asset Tagging and Display for Digital Twin Asset Management

Digital Twins offer organizations a transformative tool to provide greater insight, helping them improve operational efficiencies, information accuracy, safety, quality control and predictability. However, for Digital Twins to be truly effective, they need to be built on accurate as-built asset information.

As digital replicas of real-world infrastructure, Digital Twins can bring greater accuracy, control and predictability to a range of complex challenges in the physical world. As they grow in maturity, Digital Twins can move from descriptive duties — collecting and visualizing data — to real-time monitoring and prediction including prescriptive and transformative roles where they propose interventions and communicate machine to machine to achieve the best result.

But no matter how sophisticated a Digital Twin is, its sum effectiveness will always be dictated by its conformity to the existing, as-built conditions and its asset management practices. Cintoo's Asset Tagging & Display tools help ensure asset information is complete and accurate the first time and every time, giving users an AI based automated solution to build their asset-intensive Digital Twins and help shape the physical world dictated by its conformity to the existing, as-built conditions, and its asset management practices.

Cintoo Asset Tagging & Display tools features/benefits include:

- Creating tag lists with custom metadata.
- Easily creating and editing tags in the 3D space.
- Easily importing tags from Digital Twin models.
- Automatically geolocating and classifying equipment using an online AI engine tailored for industrial use cases.
- Inherently cataloguing and displaying assets and equipment in their existing conditions, connecting them to relevant documentation, Digital Twin platforms or live-streamed IoT data.

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The Future of Asset Management is in AI

Using AI to automatically geolocate and classify your tags is just the beginning! There are many other possible applications of AI technology in the Digital Twin Asset Management arena:

1. **Asset identification:** With Cintoo AI engine, equipment can now be accurately classified and localized in Reality Capture data. Leveraging a comprehensive database of CAD models, the goal is now to automatically identify the precise equipment's model and ID and to link it to the right data base or IoT sensor with limited human intervention. The automatic identification of the equipment will play a crucial role in asset tagging efficiency, improving inventory management and prompt maintenance operations.

2. **Predictive maintenance:** AI-powered equipment monitoring can help identify potential maintenance issues before they become serious problems. By monitoring the performance of equipment and identifying patterns that indicate potential failures, the technology can alert maintenance personnel to take corrective action before a breakdown occurs. This can prevent costly downtime and reduce the need for emergency repairs.

3. **Inventory management:** In a large industrial site, keeping track of inventory can be a challenge. AI-based tag detection technology can help automate inventory management by identifying and tracking items as they move throughout the site. This can reduce the risk of lost or misplaced items and help ensure that the site has the necessary supplies and equipment to operate efficiently. It also effectively and easily provides a digital catalogue of all assets and their history.

4. **Safety monitoring:** In many industrial settings, safety is a top concern. AI-powered tag identification can help improve safety by monitoring equipment and alerting personnel to potential safety hazards. For example, the technology can detect when equipment is operating outside of normal parameters or when workers are in potentially hazardous areas.

5. **Quality control:** AI tag detection technology can also be used to improve quality control by monitoring equipment and products as they move through the production process. By identifying defects or anomalies, the technology can help ensure that only high-quality products leave the site.

By employing leading edge solutions such as Cintoo Cloud Asset Tagging and Display, enterprise users can achieve the maximum return on their Digital Twin and Reality Capture investments with many new and profitable applications in the near future. Stay tuned for Cintoo's next developments in this area!

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