AUTOMATIC DETECTION AND ANALISYS OF DEFECTS BASED ON ARTIFICIAL INTELLIGENCE: **SKYAI ENGINE**

The SkyAI System, developed by Skypersonic, is adopted to accelerate the detection of defects during inspections and it is based on a neural AI technology for industrial applications.

INTRODUCTION TO TECHNOLOGY

The technology used, precisely SkyAI, is grafted into the DroneBox, a proprietary software platform of Skypersonic and Red Cat dedicated to the control and remote piloting of drones, in particular, the Skycopter Cobra. Developed by Skypersonic Inc. for the research and field application phases, it is now in use for the automatic detection of plant defects in the United States.

SYSTEM ARCHITECTURE

The System consists of three main components:

HARDWARE: The hardware necessary to carry out the inspection and then to acquire all the data necessary to define the dataset on which the neural network identified for automatic detection will be trained and will operate.

SOFTWARE: The software is represented by the implementation of the neural network that detects and identifies the class of a possible defect during the inspection process, hosted on a server (located on-field or on a cloud service platform) and whose results are served and accessible through an API.

ENGINEERING PROCESS (PIPELINE): The process of training, validation and deployment of the network is automated through a pipeline, consisting of a series of algorithms whose purpose is to ensure a correct and efficient functioning of the neural model and at the same time make it adaptable both to the variation of the requirements and the operating context.

The system is schematically described by the following blocks (A, B, C):

A

HARDWARE AI ONBOARD THE DRONE

System for acquiring and sending the captured data to the remote control-platform (**DroneBox**)

B

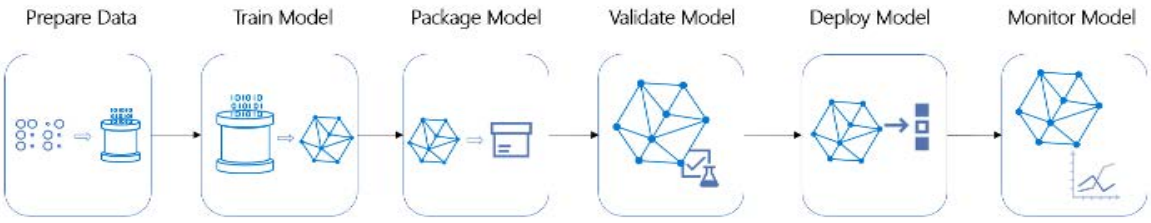
AI SOFTWARE ON THE FIELD OR ON CLOUD SERVER

Industrial neural network and related access and interfacing portal (**SkyAI**) that operates on the data acquired by the drone.

C

MACHINE LEARNING PIPELINE

Pipeline dedicated to data ingestion, training, and validation and deployment of the neural network illustrated in the previous point.



Block A: Specific hardware onboard the drone

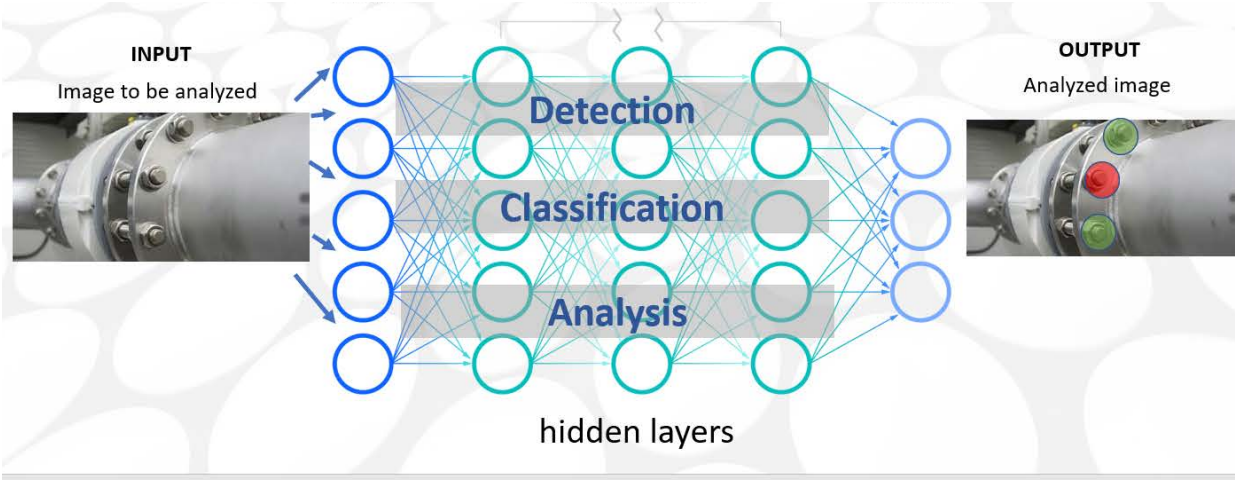
The Skycopter drone (block A), produced by Skypersonic Inc., mounts an original video-inspection system onboard that transfers data, through a technology called DroneBox, directly to a remote Server with very low latency times (soft real-time) in the order of 50-90 milliseconds.

The Remote Server (which could also be a station in the field) hosts a neural network developed by Skypersonic (block B) that detects and classifies the defects present during the inspection and allows their display on the interface of the remote-control software.

The hardware system of block A is, then, required to transfer the input data needed by the neural network to perform the analysis.

The data detected by the drone in video format is sent directly to the AI software installed on a specific server or on an on-field computer that is able to perform the following functions:

1. IDENTIFICATION of components or inspection areas
2. CLASSIFICATION of the types of components and subsystems subject to inspection
3. ANALYSIS (i.e., detection) of possible defects
4. Upon completion of the inspection process, the software will report the results of the analysis in tabular form



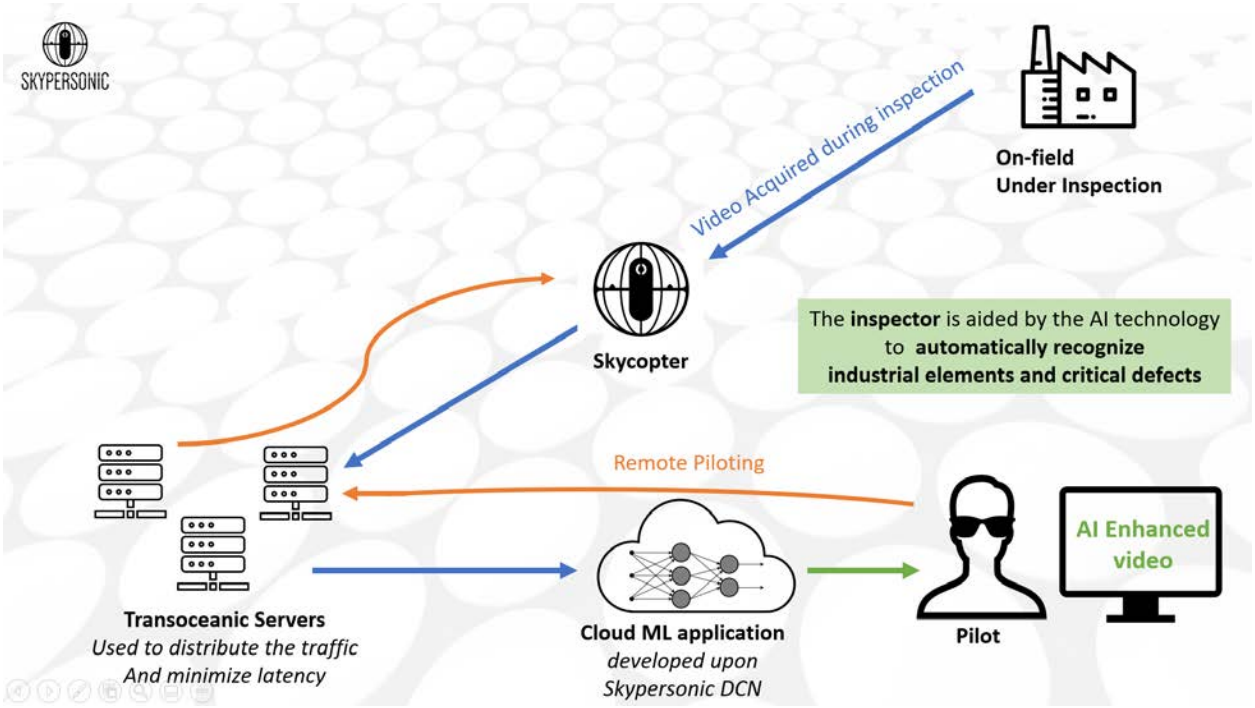
Schematic representation of the operation of the SkyAI neural network

To ensure proper operation of the SkyAI software it is necessary to follow a rigorous process of training and validation of neural technology. If this process is not performed correctly by specialized operators capable of labeling and preparing the dataset necessary for the neural network training and validation process, the results of the analysis process will be unreliable.

Over the years, Skypersonic has collected significant amounts of data and a level of experience to achieve the know-how necessary for the development for both companies in the following phases:

1. Acquisition and preparation of the dataset in collaboration with the developers and engineers necessary for the neural network training phase
2. Preparation of the neural architecture appropriate to the context of automatic analysis
3. Development of the data ingestion phase and training of the neural model
4. Deployment of the neural model and access point (API)
5. Validation of the functioning of the neural model in the case of application
6. System activation (regime

The fully operational system is schematically summarized in the following image:



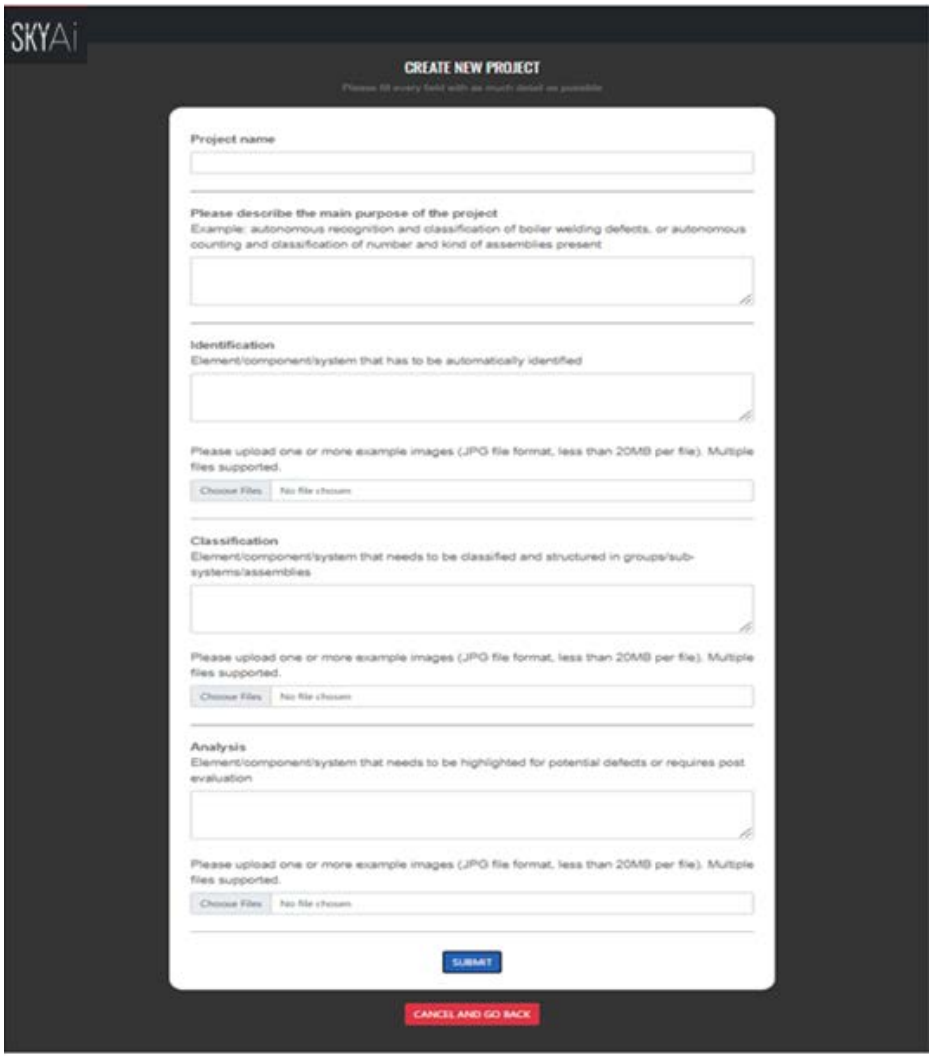
Points 2 to 5 of the process described above are implemented and automated through the pipeline introduced in block C of the software system.

The steps necessary for the inspection cycle will now be explained in more detail.

DEVELOPMENT AND APPLICATION METHODOLOGIES

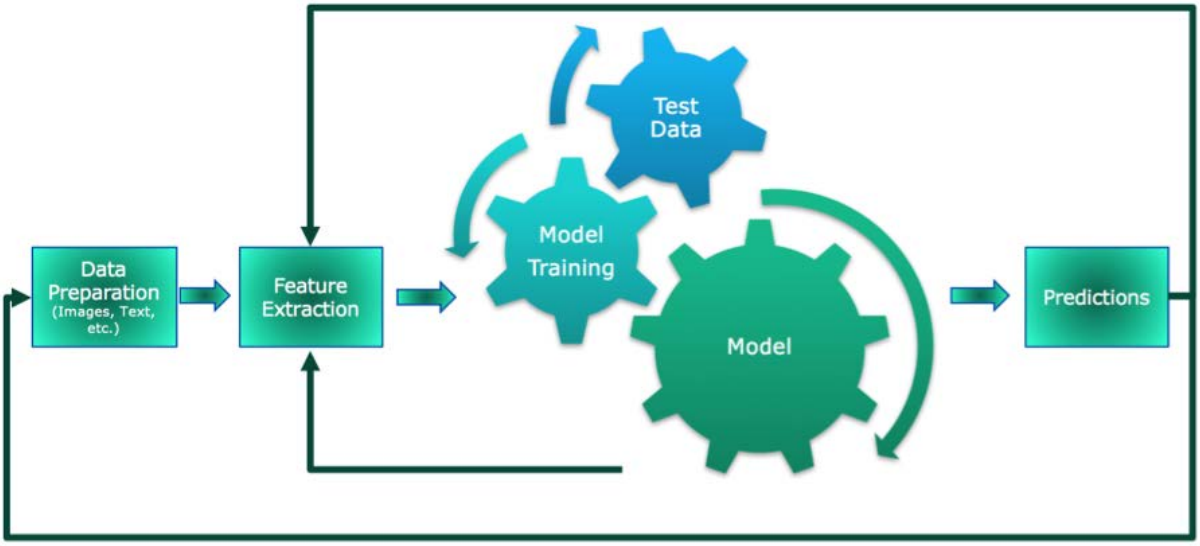
1. Architectural design phase: Choice of the neural model and implementation of the architecture (pipeline) necessary for the correct functioning of the automatic inspection process.

2. Dataset acquisition phase: Acquisition of the dataset necessary for the preliminary training of the neural network. During this phase, specialized operators who can identify and label the defects that must be identified, classified, and analyzed by the neural model must intervene. The know-how acquired from the experience in the context of industrial inspections is fundamental for the correct preparation of the dataset.



Interface for entering data required for network training (SkyAI access portal)

Training and validation phase of the neural model: through the pipeline and the dataset prepared in the previous point, the network is trained, validated, and effectively implemented. The network obtained after the first iteration of this phase can be considered a "zero network": it is the starting point when a neural system is applied for the first time to a context not yet well identified. A process of tuning and refining the neural model is necessary, through successive iterations of the pipeline, which allows the system to reach full capacity.

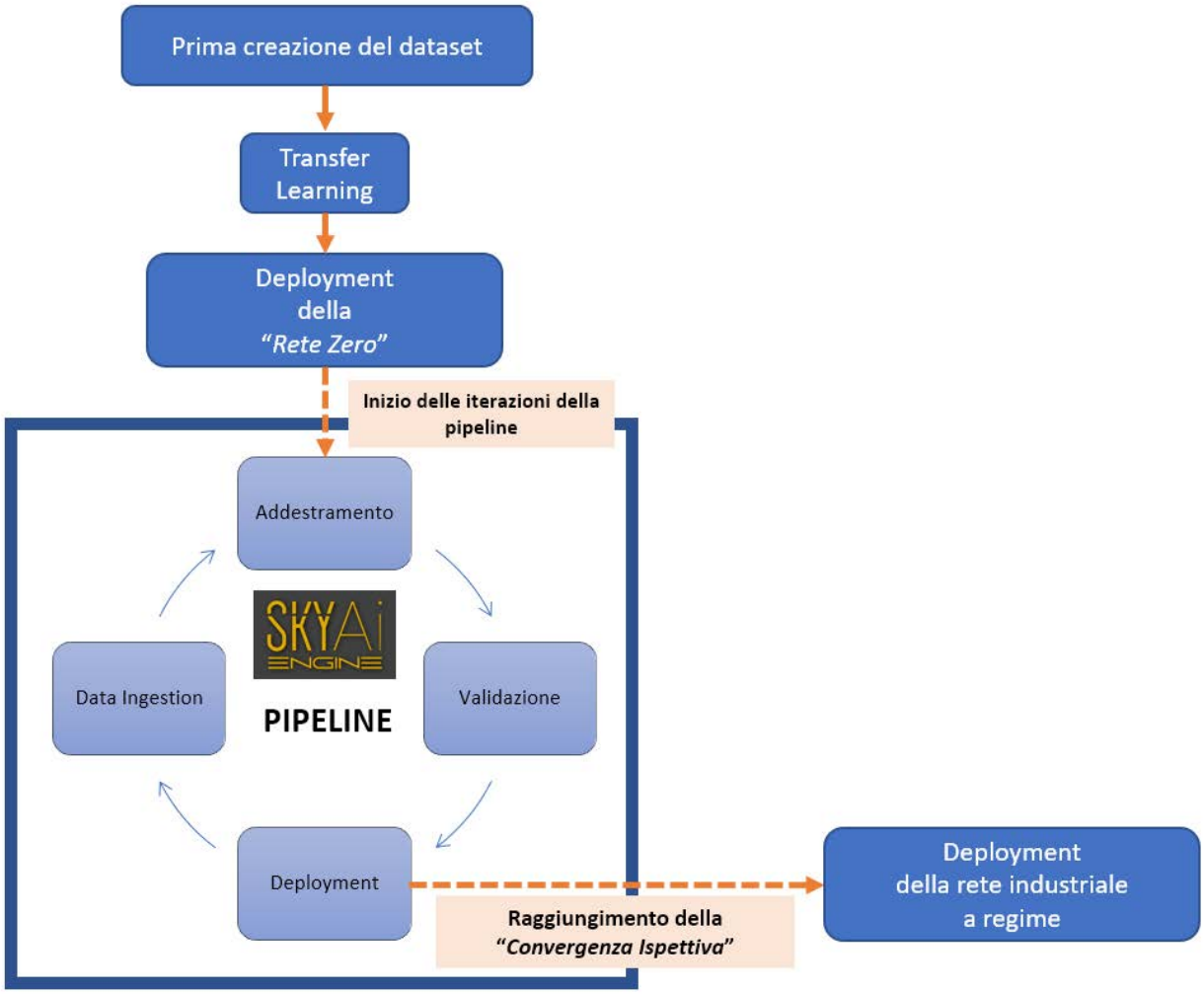


Example of the iterative workflow through the various components of the pipeline to obtain a neural network at full capacity

1. Neural model serving phase: Establishment of the access point (API) from which it is possible to obtain the processed data output from the neural model

2. Transition phase from manual to automatic analysis method: in the development of the tender in question there is a pilot period in which the reporting and analysis of the inspection will be carried out in a traditional (or "manual") way in parallel with the automatic system resulting from the application of the "zero network". During this phase of comparison and continuous training of the automatic system, a point called inspection convergence will be reached. The moment of inspection convergence represents a pivotal moment of the process, determining the validation of the industrial neural network that can then be used without the need for traditional methods. At this point, the system can be considered fully operational

This last phase is schematically summarized in the following diagram:



Summary diagram of the achievement of the automatic system at full capacity using the network development methodology created through the SkyAI software

BENEFITS OF THE AUTOMATIC INSPECTION SYSTEM

The use of an automatic defect inspection system brings several relevant benefits. By way of example these can be:

1. Homogeneity and precision of the survey: traditional methods, based on analyses carried out by a human operator, may be subject to errors and inaccuracies. The automatic system at full speed provides homogeneous and reliable results

2. Detection speed: the automatic system, if able to operate in real time and with low latency times, can analyze a large number of images more quickly and is scalable according to the hardware resources available on the server on which the neural model is hosted. In the case of very high processing power, it is possible to significantly speed up the inspection process

3. Flexibility: In case of similar operational contexts, the management of the neural model through the pipeline allows the generation, training, and implementation of a new model quickly. This allows you to have an automatic system available at full speed in a short time

4. Cost reduction: the automatic system at full capacity can operate in complete autonomy and with an upkeep time very close to 100%. By not requiring constant human supervision (e.g., in case of automatic inspections with fixed chambers), it can reduce the use of personnel and the associated costs

5. Reduction of risks for human operators: an automatic inspection, by means of a drone, can replace the intervention of a human operator in hostile and dangerous environments, minimizing the risk of accidents and injuries on the job

ROLES AND SKILLS OF SKYPERSONIC/RED CAT PARTNERS IN ITALY/EU: EUROSET

Euroset's technical staff has always supported Skypersonic in the testing phases of technologies in the industrial field, proving to be an effective and prepared partner.

Euroset oversees supporting Skypersonic developers and engineers for the training phases of the SkyAI neural model, particularly in new application areas.

Euroset pilots and engineers have several years of experience in the use of the Skycopter drone and its detection and reporting systems (e.g., Skyloc Telemetry Gateway, a self-reporting system developed by Skypersonic and implemented by Euroset during sewer inspections carried out by drone).

APPLICATION

The SkyAI system can be applied to any industrial inspection activity, the only requirement is to build a good data set for the training of Network 0.

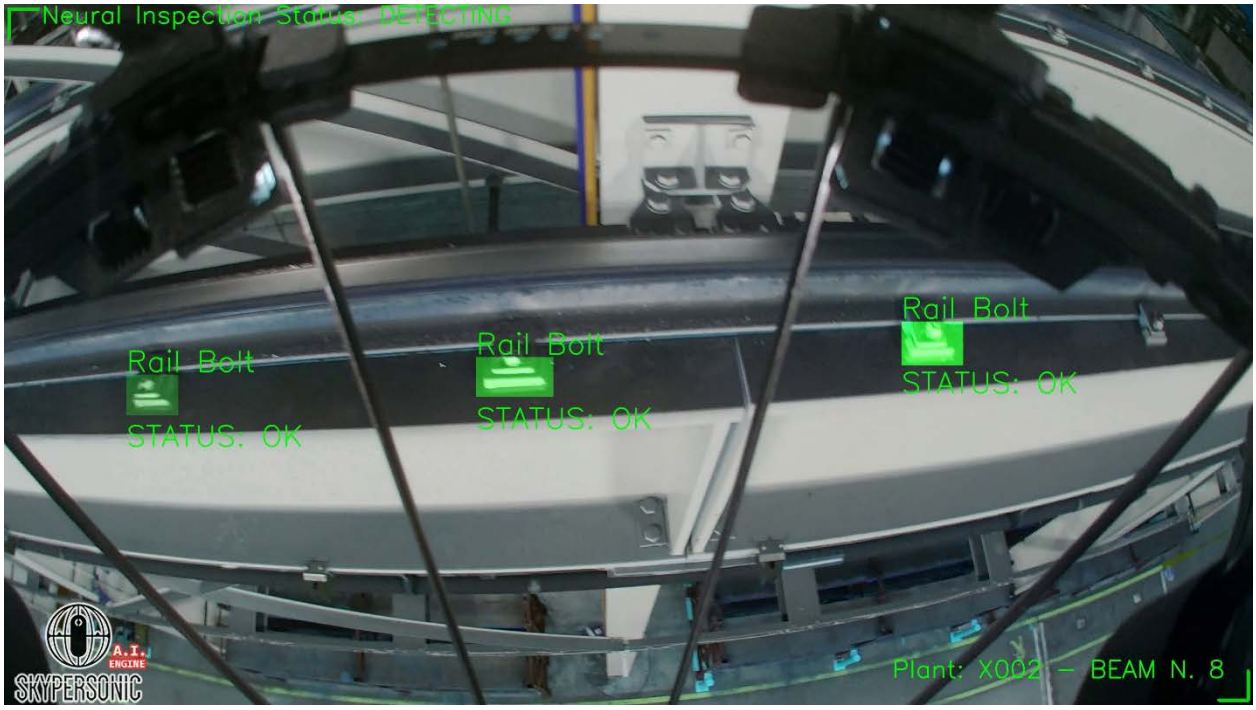
Some examples of fields of use are the automatic detection of defects in critical infrastructures such as bridges, railways, and viaducts; nuclear power plant survey or decommissioning activities; automatic inspections in confined spaces such as tanks, boilers, chimneys, tunnels, sewage systems, pipes, naval plants, Oil and Gas and refinery plants.

Application example of the SkyAI system for automatic detection and analysis of overhead crane systems at the General Motors plants in Detroit

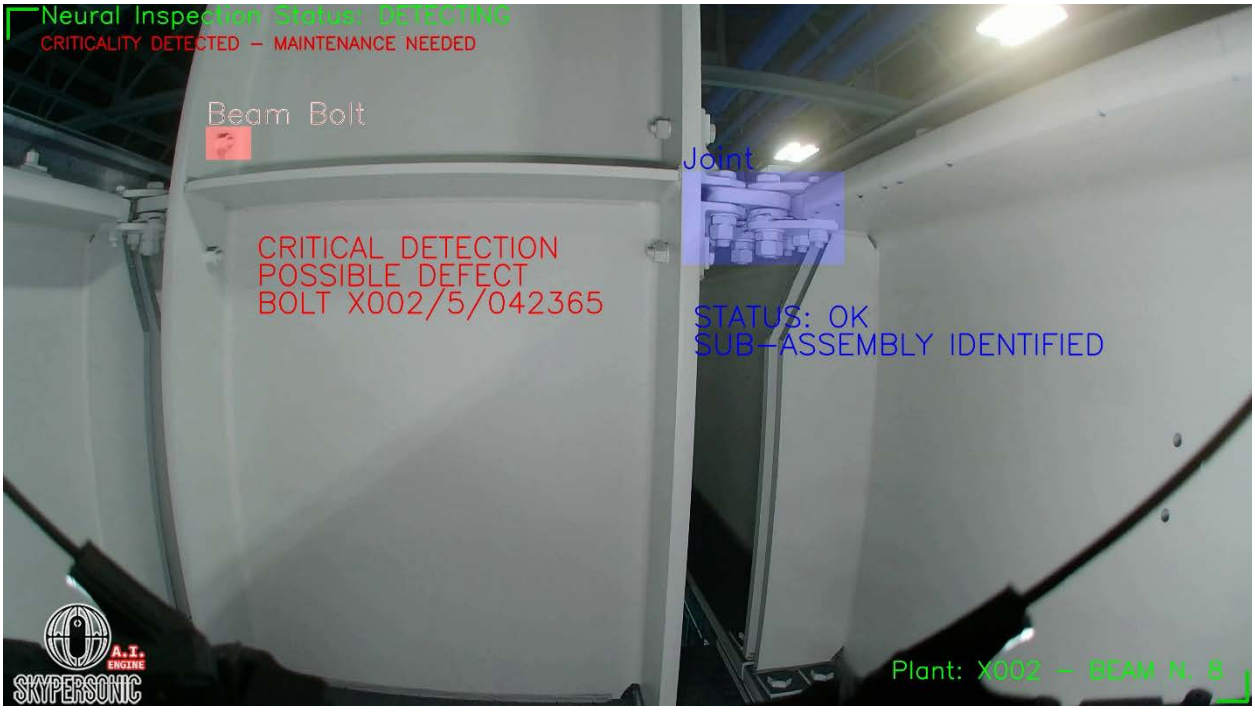
General Motors is currently using Skycopter drones, produced by Skypersonic, with the DroneBox remote piloting system for the completion of inspection procedures.

In the images: application examples of the SkyAI artificial intelligence system for the automatic analysis of the mechanical defectiveness of the bolts used for fixing hoists on bridge cranes.

View from the Skycopter camera – You can see the bolts that will be inspected on the overhead crane



View from the Skycopter camera – The bolts of the previous image are analyzed by the SkyAI artificial intelligence software, and the state of maintenance is shown



View from the Skycopter's camera – SkyAI artificial intelligence software has identified and classified two mechanical components: a beam bolt and a joint. In the first case the element was classified as possibly defective.