# Intelligent Digital Twin for Hyper Automation Deployment in Smart Factories


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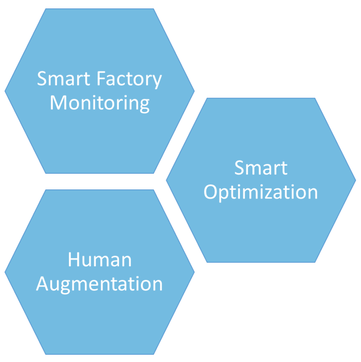
## Introduction:

Considering the promises of the Fourth Industrial Revolution (Industry 4.0) as increased flexibility, productivity and performance a necessity of data-oriented interactions as presented itself., nonetheless a flexible and versatile system showed hard to appear mainly due to until recently machinery and equipment manufacturers were reluctant on the utilization of open protocols or publicly dispense products designs for a better interconnections between components from rival companies. A Digital Twin (DT) is virtual representation of a physical asset enabled through data and simulations for real time monitoring, control and prediction [1,2]. The firsts practical utilizations of DTs comes from NASA due to the lack of access of the physical entity they needed another method to control, monitor and predict the states of their assets in outer space[3], for multiple years this concept has singular to the aerospace area nonetheless in recent years its expanding to other like Industry, automobile, etc. This systems can further be used in doting humans with the resources to augment themselves into a more efficient asset in factories giving them tools to perform tasks in a more efficient approach[4].

## Objectives:

This PhD project proposal targets the exploration of a digital twin framework for the advanced integration of hyper automation concepts with human collaborators in factory environment, to this, the following research questions arise:



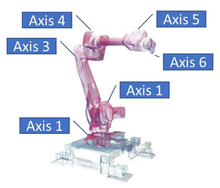

- How to reproduce a functional DT 3D model from real environments?
- How to extract relevant data from Industrial Environment?
- What are the limits of optimizations with DT?
- Can human workers be enhanced by intelligent digital twins?

## Methodology:

In this context, several key enabling module must be developed to enhance and evaluate the adoption of DT and Hyper Automation:

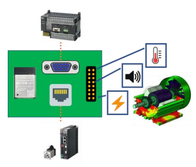
### 3D Point Cloud Semantic Segmentation for automatic industrial labeling

- Evaluate 3D point cloud acquisitions systems in key aspects such as portability, precision and practicability.
- Study different algorithms to automatically identify and classify different machines and their key components from scanned data.
- Obtain datasets from industrial machines and components.



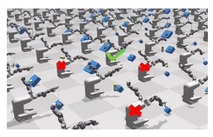

### Real time data acquisition with edge-Ai enabled capabilities

- Development of a modular low power edge Ai embedded system capable of communication with multiple devices (MODBUS, Ethernet, etc.) and connection with multiple sensors (vibration, temperature, etc.) for use in predictive maintenance.



### Data fusion for DT optimization with reinforce learning

- Development of a modular framework for Digital Twin capable of connect all data, run simulated cases using physics and AI models.
- Development of reinforce learning strategy for fully automated DT optimization.

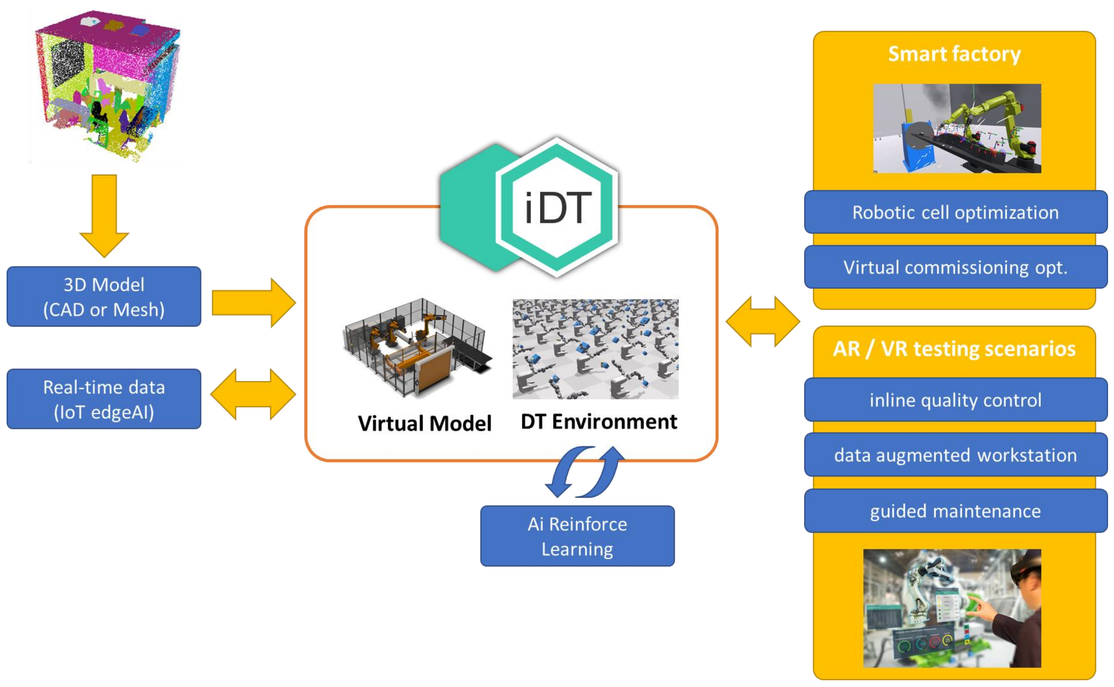


### Digital twin and hyper automation for human augmentation

- Develop a user interface in VR/AR to visualize, monitor, and interact with DTs in real time also simulate case studies in order to optimize processes.
- Interface will also run training simulations for new workers, shows maintenance suggestions and help works in their daily operations

## Expected Results:

- Obtain a 3D reconstruction algorithm with automatic feature recognition.
- A dataset of segmented industrial parts and equipment's.
- An AI algorithm for DT continuous update and learning.
- An 3D application with data fusion from IoT sensors for DT.
- A modular embedded acquisition system with edgeAi/tinyMl for predictive analytics.
- An reinforce learning (RL) method for robotic cell optimization from DTs.
- An VR/AR applications for industrial operations with intelligent DT and improved human training.
- Increased worker satisfaction and knowledge in monitoring and maintenance interventions.




## Conclusions:

- In the end this project, one aims to increase industrial performance by creating a tool that helps to digitalize and optimize processes, complemented with reinforce learning for automatic process improvement by analyzing data and suggesting changes.
- The DT also aims to expand the human interaction and knowledge in a production environment, ensuring precision, quality and flexibility to reduce defects of new employees in learning periods besides, helping more experiment ones complete their regular tasks in a more efficient matter, increasing their value in the production line.

## References: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