

## Bachelor's Thesis, Term Project

# Digital Twin for the Industrial Automation 4.0 on the Hydraulic Cylinder Test Rig)

**Main Advisor(s):** (Assoc. Prof. Dr. Eng. Amir Roushdy)

**Co-Advisor(s):** (Eng. Malek Mahmoud)

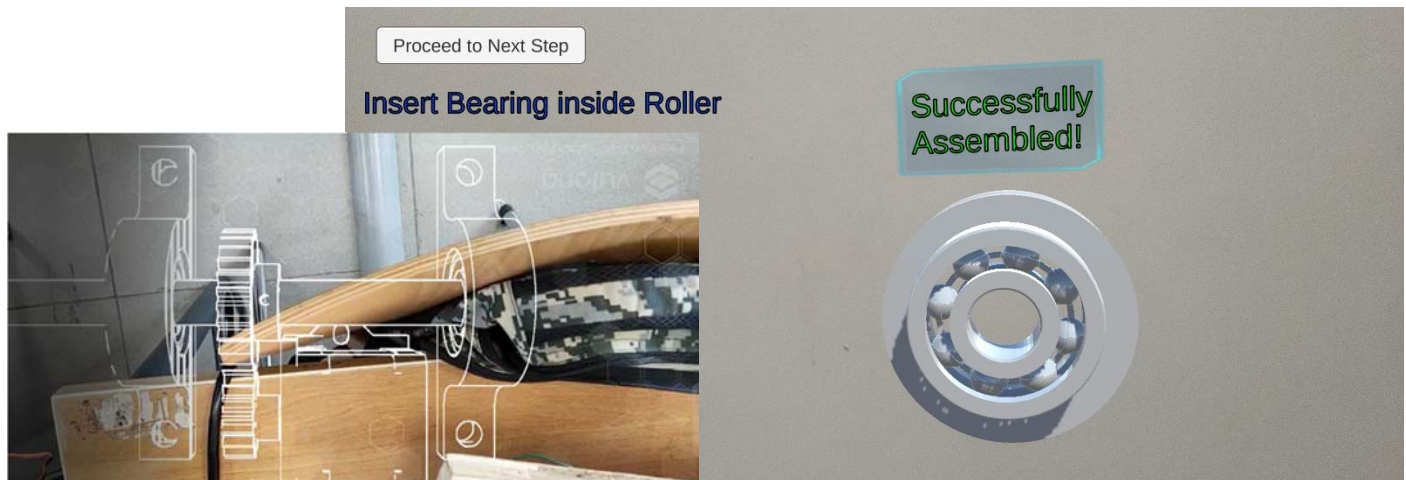
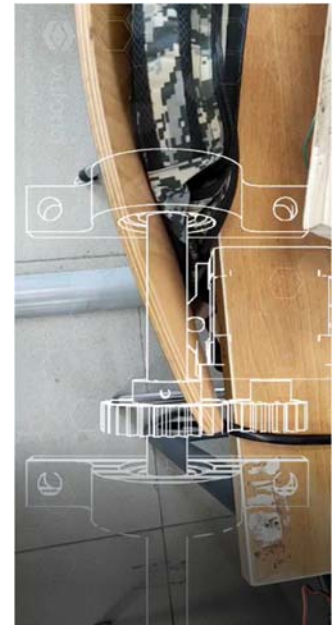
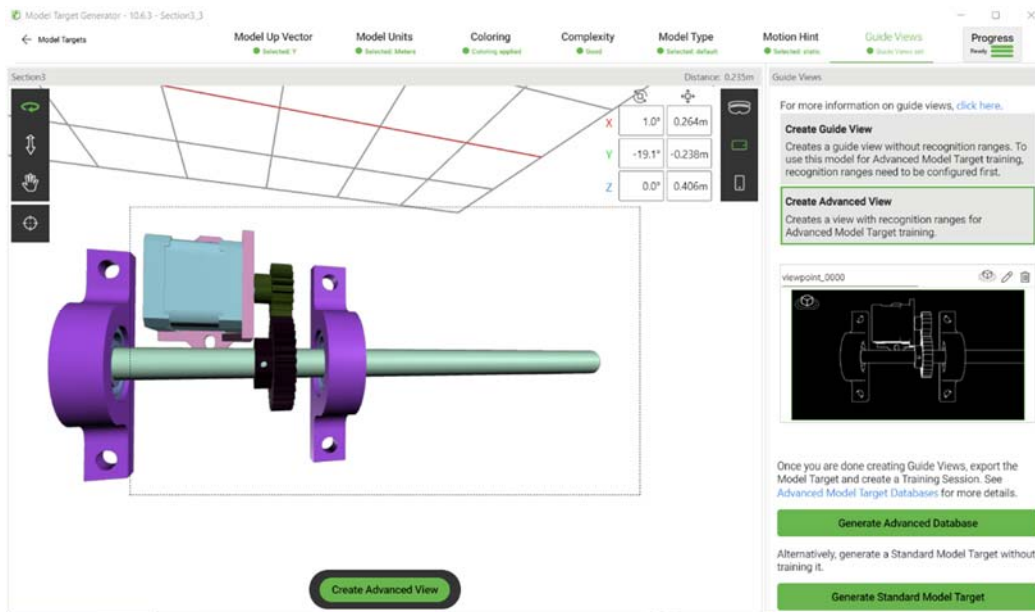
A digital twin is a virtual representation that serves as the real-time digital counterpart of a physical object or process. Though the concept originated earlier the first practical definition of digital twin originated from NASA in an attempt to improve physical model simulation of spacecraft in 2010. In this project, you will have to work in the existing Hydraulic Cylinder Test Rig in the ARATronics Lab as Mechatronics System that we need to build a digital twin for it and also we are looking to build an Augmented Reality for the Machine (AR) to help in the maintenance and assembly process. **There is a Master's student from Mechatronics Engineering Department, Senior Researchers from ARATronics also available to help and advice and The Lab Engineer from ARATronics, guiding and directing the student with Assoc. Prof. Dr. Eng. Amir Roushdy.**



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For more details please contact:

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**Fig.:** Hydraulic Cylinder Test Rig with Mechatronics Twin at the ARATRONICS Research Center

### **Project description and objective:**

Smart production systems conforming the Industry 4.0 vision are based on subsystems that are integrated in a way that supports high flexibility and re-configurability. Specific components and devices, such as industrial and mobile robots or transport systems, now pose full-blown systems, and the entire Industry 4.0 production system constitutes a system-of-systems. Testing, fine-tuning, and production planning are important tasks in the entire engineering production system life-cycle. All these steps can be significantly supported and improved by digital twins, which are digitalized replicas of physical systems that are synchronized with the real systems at



runtime. However, the design and implementation of digital twins for such integrated, yet partly stand-alone, industrial sub-systems can represent challenging and significantly time-consuming engineering tasks. In this article, the problem of the digital twin design for discrete-event production systems is addressed. This project also proposes to utilize a formal description of production resources and related production operations that the resources can perform. An executable version of such formalization can be automatically derived into a form of a digital twin. Such a derived digital twin can be enhanced with operation duration times that are obtained with process mining methods, leading to more realistic simulations for the entire production system. The proposed solution was successfully tested and validated in the Industry 4.0 Testbed, equipped with four robots and a transport system, which is utilized as a use-case in this project.

#### **Research focus of this project:**

- Literature review on the project should be studied properly.
- Not only, creating a software control system for the project but also the hardware.
- Experiments using the gadget and control system should be built properly.
- The outcomes must be documented.

#### **Requirements:**

- Passionate to learn more about, VR, 3D Printing design, Robotics and control.
- Prior mechatronic design expertise is desired like “SolidWork and Arduino”.
- Enthusiasm for completing actual practical work with 3D printing staff (design fabrication and construction).
- A method of working that is both structured and self-contained.

#### **General tasks of the project:**

- The complete methodology is already available in the ARATRONICS Lab, so we will discuss it from the first day to start the automation process for it
- Fabricate the robot/system using 3D printer/CNC machine (small parts).
- Assembly all parts of the proposed Machine.
- Changing the working variables and see the effect on the Machine

#### **Other notes:**

- A weekly meeting with the advisors will be required for this project, as well as weekly progress updates (*The meeting could be more than once during the week based on your progress and based on your achievements*).
- You should to be in the Lab two days per week (*It could be more than two days based on your progress and based on your achievements*).
- All reports must be prepared in the style of a research paper.



**ARAtronics Research Center for  
Opto-Mechatronics Engineering**

ARAtronics Research Center,  
Mechatronics Engineering Department,  
Faculty of Engineering and Material Sciences (EMS),  
The German University in Cairo (GUC)

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- The outcome of this research will be published in one of the coming international Conferences and ,  
or Journal

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