

## EMPOWER AN IOT MACHINE'S MONITORING PLATFORMS WITH AUGMENTED REALITY

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### ABSTRACT:

*NOWADAYS ALL MODERN PRODUCTION SYSTEMS INCLUDE ONLINE MACHINE MONITORING SYSTEMS. AS IOT (OR INDUSTRY 4.0) TOOLS ARE EVOLVING THEY REPRESENT A GOOD ALTERNATIVE FOR TRADITIONAL MONITORING PLATFORMS. EVEN FOR A SMALL PRODUCTION PLANT A COMPLETE MONITORING SYSTEMS HELD A LOT OF DATA WHICH USUALLY IS DIFFICULT TO HANDLE.*

*IN THIS PAPER, WE PRESENT A METHOD OF USING AUGMENTED REALITY TO EASILY DISPLAY ONLY RELEVANT INFORMATION ABOUT EACH MACHINE IN A USER-FRIENDLY INTERFACE. AUGMENTED REALITY CAN COMBINE REAL WORD DATA WITH COMPUTER GENERATED IMAGES OR DATA. THE INTERFACE CONTENT IS SELECTED BASE ON THE USER TYPE AND THE MACHINE ID FROM AN IOT THINGWORX MONITORING PLATFORM. THINGWORX STUDIO WILL BE USED TO AUGMENT DATA VALUES ON THE MACHINE (ONSITE) FOR OPERATORS, OR TO SHOW A SERVICE SEQUENCE FOR A MAINTENANCE TECHNICIAN OR EVEN TO AUGMENT THE 3D MODEL OF THE MACHINE OFFSITE WITH THE SENSOR VALUES LIVE FROM THE REAL MACHINE FOR A SUPERVISOR.*

*TO IMPROVE THE INDUSTRIAL MONITORING SYSTEM FURTHERMORE CONTROL CAPABILITIES CAN BE ADDED SO THAT ENGINEER, OPERATORS, AND SUPERVISOR CAN TAKE RESPONSIVE ACTIONS OFF SITE BASED ON MONITORING DATA.*

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**KEY WORDS:** AUGMENTED REALITY, IOT, MACHINE MONITORING

### INTRODUCTION

In industrial environments, the use of monitoring systems of the machines is becoming the best method to enhance the plant productivity. Current industrial monitoring systems gather a lot of data about equipment usage but usually only a small percent of this data is processed for predictive maintenance purposes.

Working with a big amount of data can be sometimes difficult as not every piece of information collected is relevant for everyone. To solve this problem usually dashboards are used to process and display data for each role in a company. The main drawback of this method is that for larger plants it is a hard job to navigate through all available dashboards to identify a faulty machine. In this case augmented reality can be used to display only relevant information for each machine that is monitored.

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## AUGMENTED REALITY IN ENGINEERING

Modern monitoring systems are used nowadays to collect working data from machines, to store and to process information to prevent downtimes and to schedule repair periods as accurate as possible.

The IoT platforms provide a good support for predictive maintenance as it can integrate information from different machines and manufacturing systems and support a lot of predefined code programs that can be used to facilitate some routine operations like sending alerts by SMS or email.

Augmented reality usually represents a mix of real world physical objects and computer-generated elements, usually sounds and graphics. The augmented data is related with different objects by using markers that are place over the physical objects. In industrial application AR is used mainly for training, quality inspection or repair operations [X1, X2].

As both virtual reality and augmented reality are now considered mature technologies increasingly more industrial application are developed and implemented. In this context, we developed a system that can enrich a preventive maintenance system with graphical representation of data to ease operation, supervise and maintenance of the industrial equipment.

## CASE STUDY

For this case study, we've used a smart monitoring system based on the ThingWorx platform. ThingWorx is a dedicated IoT platform that support a great variety of protocols and programming languages like Representational state transfer (REST) API or Java protocols. The platform is used to store all the functional parameters of the machines that are monitored.

For this case study, a new thing called "Test\_stand" was defined. The thing includes four properties, one for each key parameter that needs to be measured by the monitoring system (Figure 1). The thing includes also numerical properties for the alarm threshold levels and the alarm state for each sensor. For this case study two different threshold were implemented: one at 32 °C and one at 35°C. If the temperature reaches the first critical value an alarm is displayed on the operator screen and a text message is send to the supervisor. If the second alarm level is trigged an emergency stop command is issued and the machine stops.

Name	Type	Alerts	Additional Info	Default Value	Value	DataChange
# Left_pillow_block		0 Alerts			23.0	Set VALUE: 0
# Right_pillow_block		0 Alerts			25.0	Set VALUE: 0
# Ball_nut_left		0 Alerts			30.0	Set VALUE: 0
# Ball_nut_right		0 Alerts			21.8	Set VALUE: 0
# Left_pillow_block_alarm		0 Alerts			true	Set VALUE
# Left_pillow_block_ts1		0 Alerts			32.0	Set VALUE: 0
# Left_pillow_block_ts2		0 Alerts			35.0	Set VALUE: 0
# Estop		0 Alerts			true	Set VALUE
# Right_pillow_block_ala...		0 Alerts			true	Set VALUE
# Right_pillow_block_ts1		0 Alerts			32.0	Set VALUE: 0
# Right_pillow_block_ts2		0 Alerts			35.0	Set VALUE: 0
# Ball_nut_left_alarm		0 Alerts			true	Set VALUE
# Ball_nut_left_ts1		0 Alerts			32.0	Set VALUE: 0

Fig. 1 Key functional parameters for the screw ball stand

The data acquisition system includes a process computer and one NI cDAQ-9191 WiFi DAQ device for each machine being monitored (Figure 2). Sensor values are transferred from the LabView environment and converted to numbers with a service defined within the IoT platform.

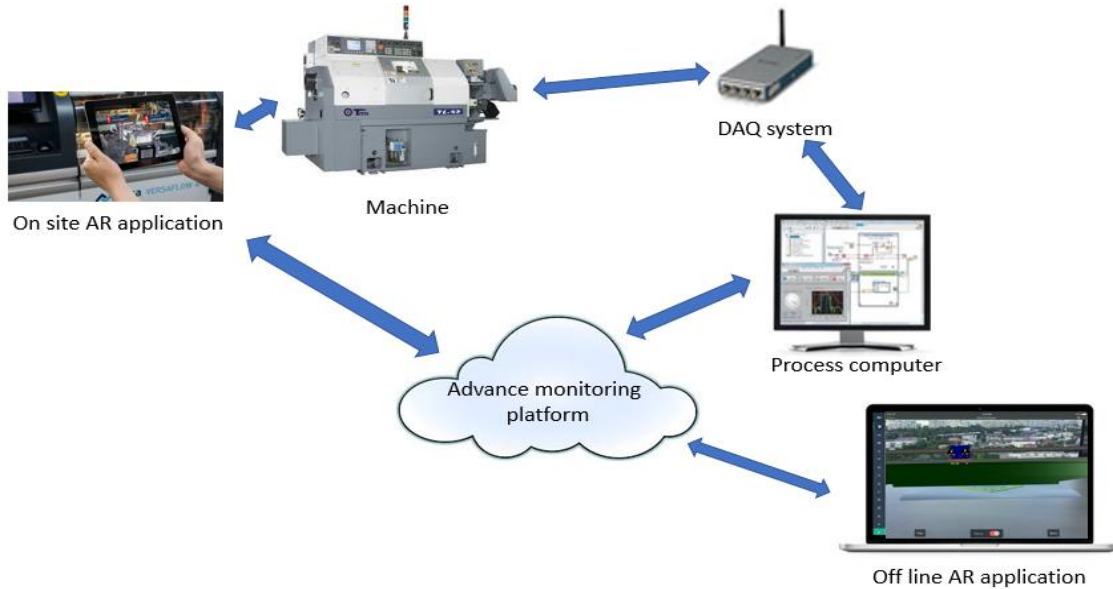


Fig. 2 Advanced monitoring system architecture

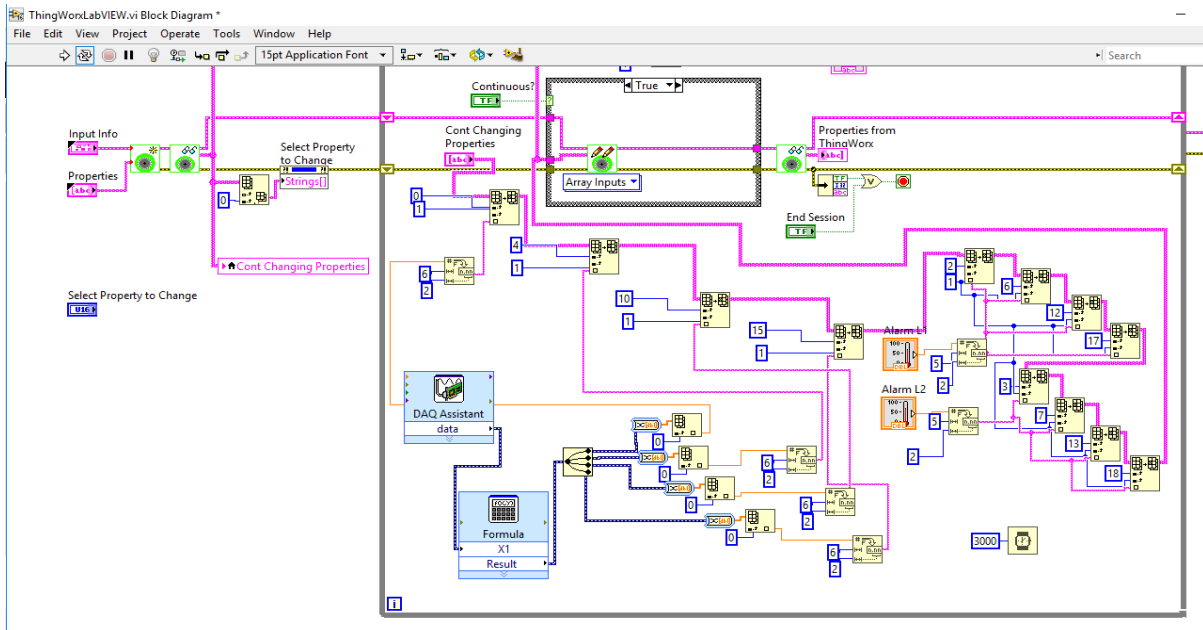


Fig. 3 Labview backend diagram for data acquisition

The UpdateValues service is accessed from LabView using a REST call. Every time a new value is changed the service check if the value is smaller than the alarm value and if this is true an alarm is triggered.

Augmented reality can combine real time data with computer generated representation of machine systems so engineer can easily identify where are the key parameters measured, what are the normal values for each parameter and if are any alarms activated.

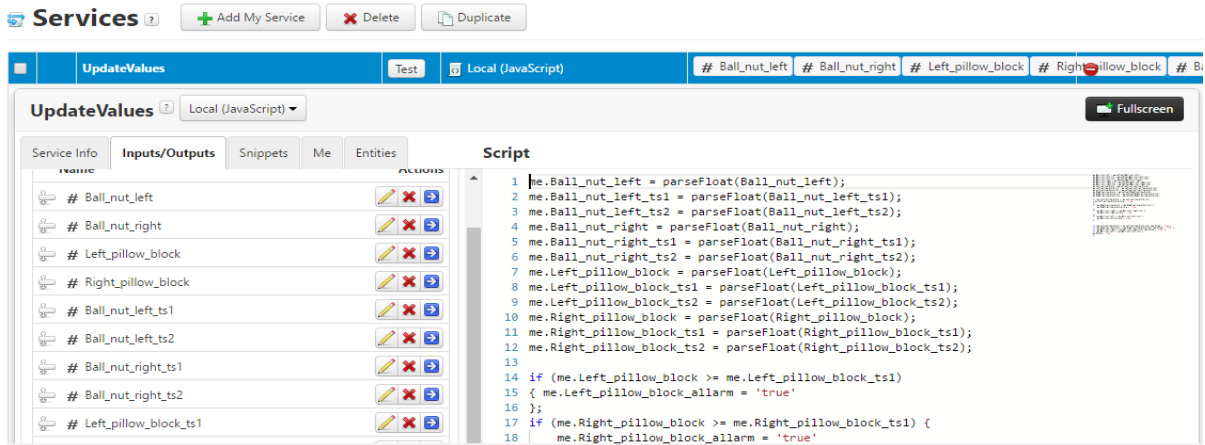


Fig. 4 Service used to transfer and convert monitored parameters from the LabView Programming environment

The augmented reality application, created in ThingWorx Studio (figure 5), has components one that can be used on site to monitor the temperature values and one that can be used off site, to augment the machine anywhere and show the parameters and their limit values. The last is used to map sensor data on a virtual model of the machine.

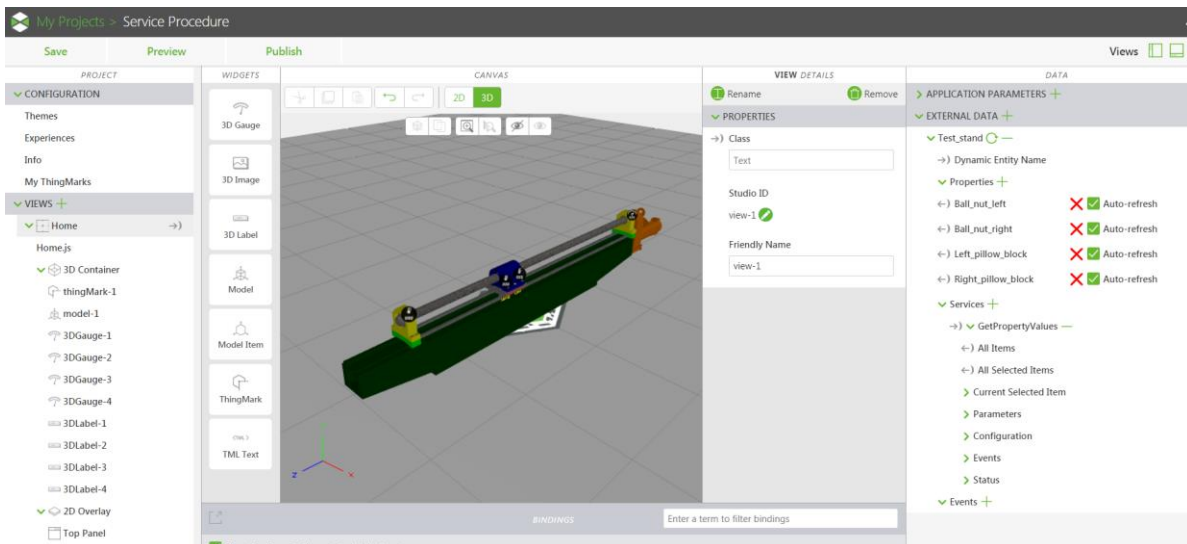


Fig.5 ThingWorx Studio project that gets the parameters from ThingWorx

In figure 6 we can see the supervisor screen for our monitoring platform, in this case only working parameters and alarms are visible, augmented on the CAD model of the machine. In this AR experience, the supervisor can also see a disassembly sequence (for training a technician) that shows how to replace the screw or nut or a faulty sensor. The sequence was created in Creo Illustrate (Figure 7) and published in the ThingWorx Studio experience. The sequence is in the same application and the animation can be started by pressing the play button.

The onsite module is used to map parameters value directly on physical equipment (Figure 6) so that engineers will be able to see sensor values and working parameters directly on the machine. If several parameters of the same type are monitored the values are represented regarding the sensor position, in case of an alarm the operator can easily identify the faulty area. Without using the augmented reality in case of an alarm the operator should

look for the name of the sensor and search more information about sensor position in the technical documentation.



Fig.6 Supervisor augmented view of a monitored machine – off site

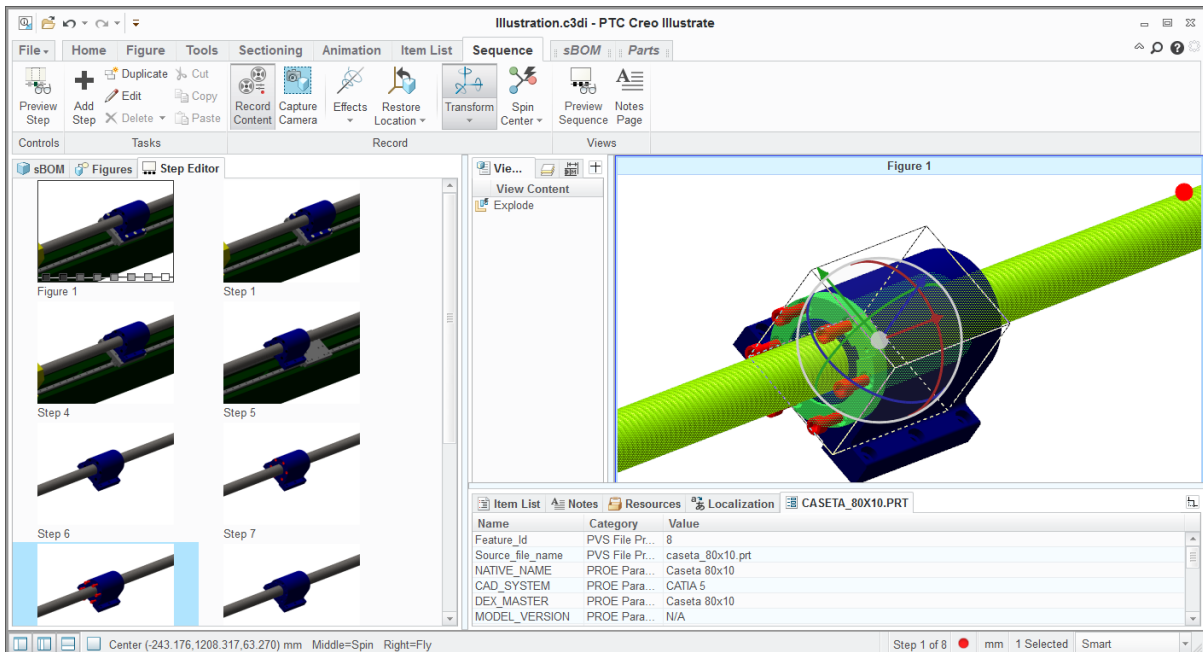


Fig 7 Creo Illustrate disassembly process animation

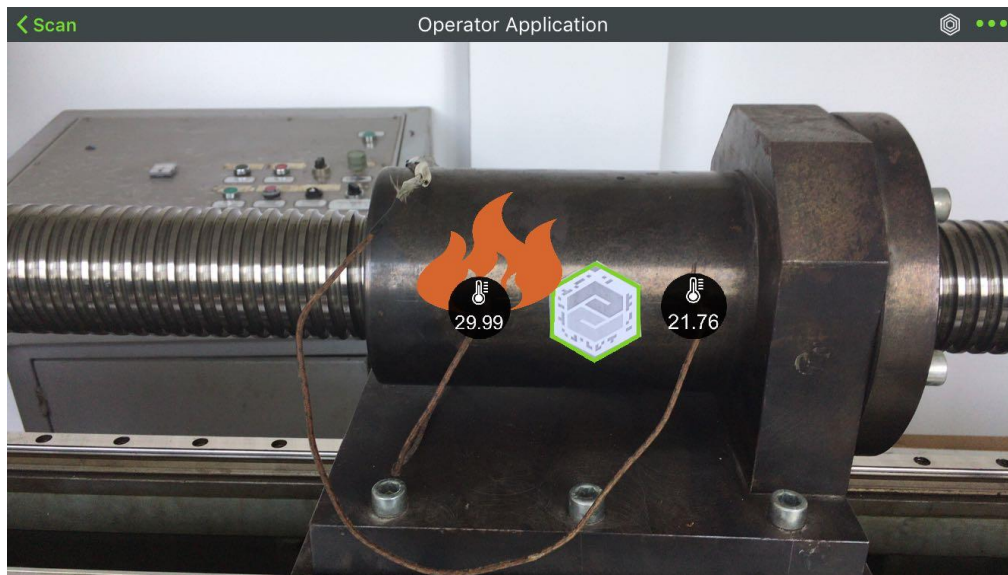


Fig. 7 Operator augmented view of a monitored machine – on site application

## CONCLUSION

By using augmented reality on machines monitoring platforms user can easily filter relevant information based on their role. Maintenance engineers can see maintenance data, operators are able to check functional parameters directly on site by using a mobile device like a phone or a tablet pc.

By measuring key parameters maintenance stops can be better scheduled using ThingWorx machine learning module. This Module will predict failure based on learning the normal behaviour and understanding the nominal values of each parameter. Using predictive analytics and machine learning operators and supervisors may schedule the maintenance processes before a failure occurs, saving time (they will know the parts that need to be changed and procure them) and money (the machine downtime will be scheduled).

Maintenance operations are also simplified by displaying visual representation of the parts that are malfunctioning. Also for known defects detailed repair instruction can be displayed for each machine.

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