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TARGETED AUGMENTED REALITY SYSTEM – ASSISTING OPERATORS IN FIXING FREQUENT FAULTS DETECTED AT TEST STANDS

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Abstract: *The main theme of the project is to eliminate common failures in halls equipped with specific bearing test equipment.*
The subject, which is being set up and carried out in partnership with a production plant in Romania, is to design a comprehensive project to help detect and repair damage to the test benches at the company's test centre in Brasov. Internally, the machines on which tests are carried out are called test stands, so the work relates to test stands with faults such as oil leaks. The underlying problems that hamper the testing process are oil leaks due to possible cracks in the hoses that supply the test stands with lubricating oil or oil that serves as a test medium for the bearings. Once damage is detected, the aim is to repair it quickly and efficiently. From this point of view, the work helps non-technical staff, so the application is to develop an augmented reality system to help operators troubleshoot using the equipment available - in particular the HoloLens glasses that are the flagship of the project.

Keywords*: augmented reality, test stand, HoloLens.*

1. Introduction

Augmented reality is a technology that allows digital content such as images, sounds or text to be superimposed on a real environment. Augmented reality uses the tangible, unaltered environment and adds virtual information to enhance the experience. The technical means this type of technology used in this type of technology include multimedia, 3D modelling, real-time tracking and recording, and intelligent interaction. The principle is to apply computer-generated virtual information - text, images, 3D models, music, video - to the real world. In this way the two types of information complement each other, resulting in an enhanced picture of the real world. The resulting experience can be compared to a scene in a video game, as the interaction with the fictional objects in the frame is as real as possible.

The topic of the work was proposed by a company in order to solve a real requirement: the creation of an augmented reality application to be used in the company's test centre.

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Schaeffler Romania is active in the production of bearings, manufacturing components for the automotive and mechanical engineering industries, as well as for the wind industry. As part of these activities, the company needs to verify and test its products by subjecting them to a series of tests on special test benches, in environmental conditions that are as close to reality as possible.

The proposal for the theme came from within the Schaeffler Group, which has supported its implementation and practical application. By solving the problem, the theme is successful and is also implemented and used in other business areas than those originally targeted.

2. Paper's structure

The paper focuses on the branch foreseen for the correction of the detected errors (Figure 1), so the processing of some captures made with HoloLens2 is presented in order to create the portfolio of steps needed to solve the problem.

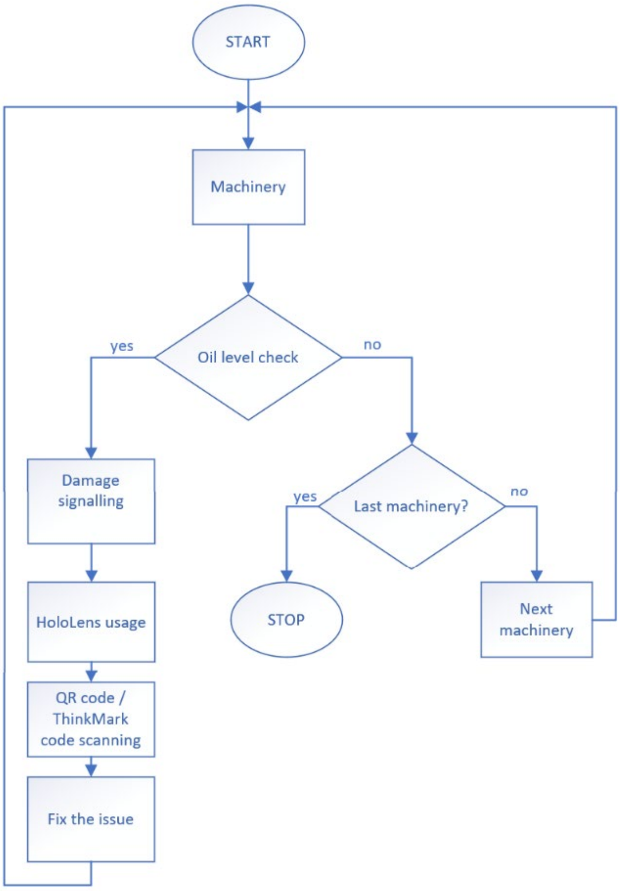

Fig. 1. *Process for error detection and correction*

The paper contains two parts which are essential to the subject as follows:

1. Create a step-by-step guide to solving the problem using real, specific and illustrative images.
2. 3D modelling of the test rig, the bearing and the entire assembly on which the bearing will be tested, including the sequence of steps taken to mount the bearing on the test rig.

The initial phase of the project is characterized by capturing images/movies with the HoloLens device and sending them to the augmented reality platform. Processing such a sequence of images will include all the steps that need to be taken to solve the problem. In addition, employees unfamiliar with such a process become “competent”. The guidance is designed to match the reality in the test room so that it can be followed simultaneously with the work being carried out. The advantage of augmented reality in this context is seen in the availability of hands, the exposure of the real environment behind the images projected through the lens of the goggles, and the coordination of the activity in one-to-one rhythm with the sequence of images.

The work is being developed on two levels, one focusing on the 3D design of the elements that make up a test assembly, and the other on 'sending' the projected images and models onto glasses to create the augmented reality experience.

3. Working steps

- *Parametric design of elements and assemblies.*
- *Creating transitions and translations.*
- *Creating the augmented reality application.*
- *Transferring information to the glasses.*
- *Achieved results*

The two development branches of the project are:

- Design and development of an autonomous mobile robot for the detection of frequent failures on test benches.
- Development of an augmented reality system to assist operators in troubleshooting faults detected on test benches.

The following technologies were used to carry out the second part of the project corresponding to the present work [1]:

- Creo - 3D model design.
- Creo Illustrate - animations and step-by-step walkthroughs for the assembly and disassembly process (Figure 2).
- Vuforia Studio - transfer the 3D model to the augmented reality platform and create the augmented reality application with direct reference to a targeted smart device (either mobile phone, 2D glasses or 3D glasses - HoloLens).

Fig. 2. *Illustration of the work steps*

4. Design and development

4.1. Parametric element design

Parametric design involves incorporating into the models resulting from the computer aided design process the features necessary to meet the requirements of the final product by means of parameters, relationships and references [2], [5].

To enable a bearing assembly to be designed, its elements are identified at an early stage and each is designed separately [5]. By enumeration, the elements of a bearing are (Figure 3):

- Inner ring
- Outer ring
- Washer
- Cage
- Ball

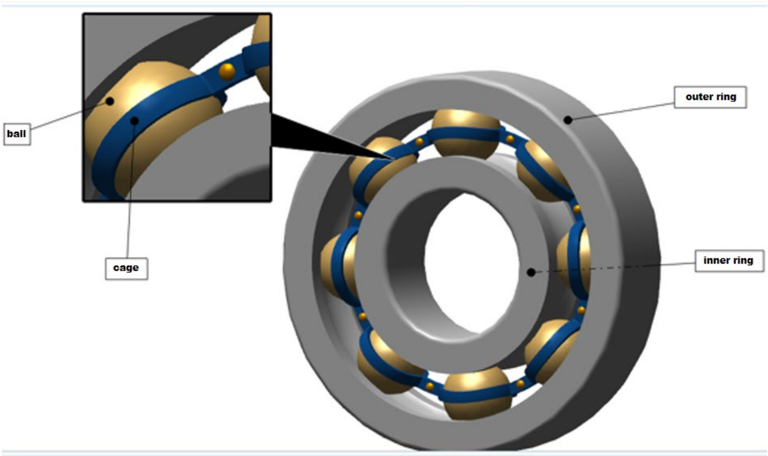

Fig. 3. *Illustration of the designed elements of the assembly*

The main commands in Creo used to model components are [2]:

- ***Extrude*** – pressed from the keyboard, the Draw menu or the moving toolbar. Extrude command creates a solid by extruding a closed planar geometric shape;
- ***Chamfer*** – is a transition edge between two faces of an object. There is Edge chamfer, which performs edge chamfering using edges and faces as a reference, and Corner chamfer, which performs corner chamfering using a point defined by three edges as a reference;
- ***Revolve*** – creating 3D geometry by rotating a 2D section - creates three-dimensional solids by rotating flat profiles about an axis;
- ***Round*** – the rounding of edges or space between surfaces using a radius or chord. Curves can have a constant radius or vary using multiple radius;
- ***Hole*** – creates a hole by selecting the type, shape and location of the hole. Specify the depth of the hole and the intersecting components;
- ***Mirror*** – flips against an axis of an existing surface.

4.2 Model design by joining elements

The actual design of a multi-part model involves combining previously designed elements into a new design. Once each component of a bearing has been designed, it can be 'assembled' to produce the object.

Steps towards the achievement of a whole:

1. Independent design of components
2. Create a new project
3. Create an assembly and add components manually. There is an Assemble option in the menu (Figure 4).

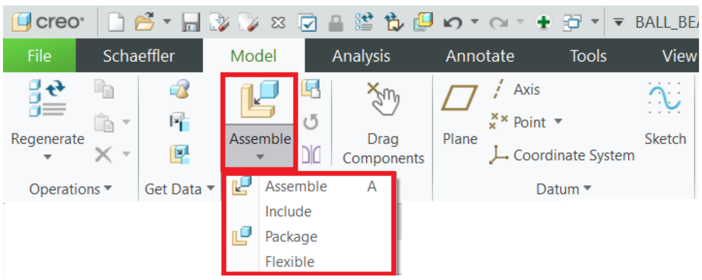

Fig. 4. *Option for mounting assembly*

4.3. Creating transitions

Creo Illustrator, a working environment that allows interaction with 3D models, is used to create suggestive assembly/disassembly transitions. As assemblies are made up of separable elements, transitions can be created for each step, resulting in a chain of sequences. It is desired to create a transition at the test stand level, so using the 3D model of the assembly that makes up the stand and the bearing, the transitions specify how the bearing should be fitted into the test machine. The way to work with the model of a 3D assembly is to separate the components and create transitions for each step that needs to be performed [3].

How to work

- Save the Creo template with an extension supported by Creo Illustrator, the specific extension is .pvz.
- Import the desired template into Creo Illustrator and select Default (Figure 5).

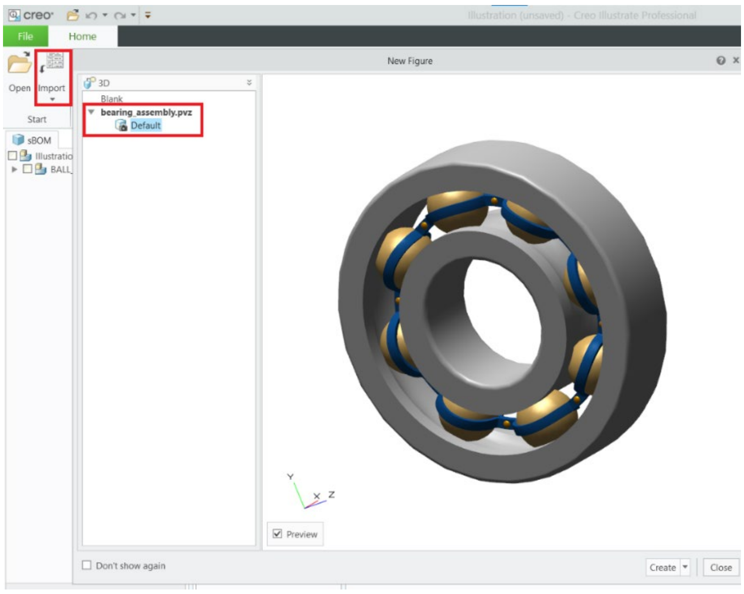

Fig. 5. *Importing the 3D model with the specific extension into Creo Illustrator*

- From the Animation menu, select the type of transition you want to create - Sequence or Animation, which have different results (Fig.6). Sequence shows a sequence of images, while Animation shows transitions in a clear way and comes with a small tutorial.

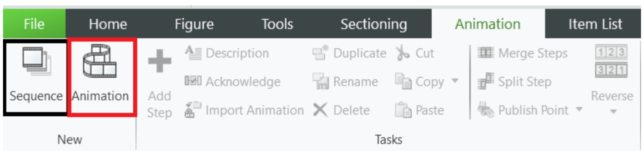

Fig. 6. *Processing options*

4.4 Creating the augmented reality application

Select the device for which you want to create the augmented reality app and create a new project (Fig.7). There are 3 options - 2D glasses, 3D glasses or mobile phone.

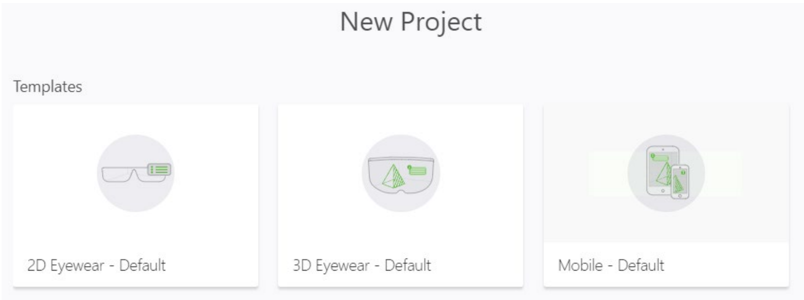

Fig. 7. *Project implementation options*

On the main page, the specific elements of the project are introduced, namely the ThingMark (specific sign identifying the application) and the model.

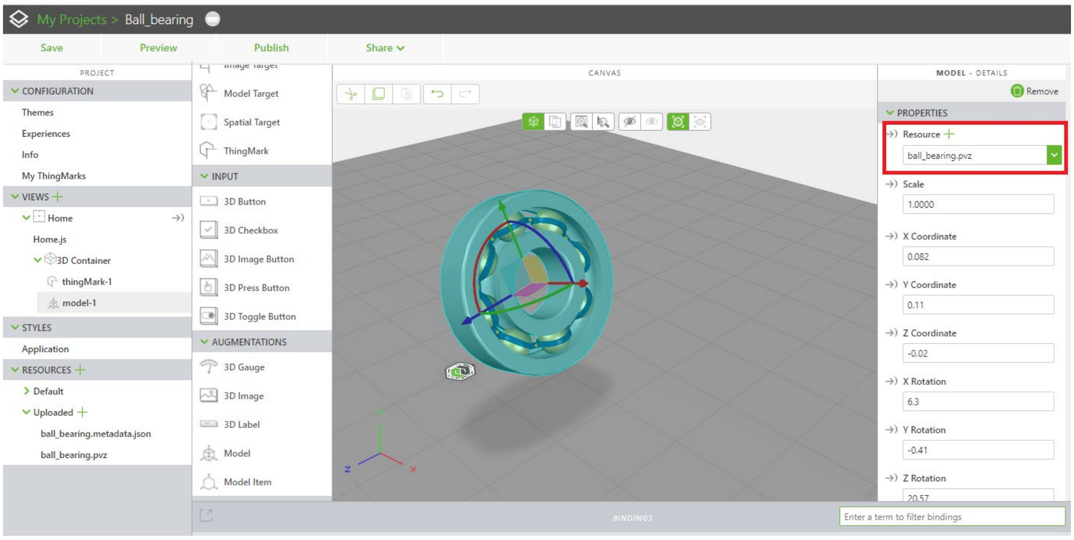

Fig. 8. *Adding resources to the augmented reality platform*

3D assets saved with the .pvz extension are added and the animation associated with the designed model is transferred.There is also the option of selecting a service - associating a voice command with an action. For example, the voice command PLAY is associated with the start of the illustrative sequence [4].

4. Conclusion

This project developed an augmented reality application for smart devices to assist operators in troubleshooting common malfunctions. The topic was proposed by a company in order to solve a real need: the creation of an augmented reality application to be used in the company's test centre. Schaeffler's business is the manufacture of bearings, producing components for the automotive, mechanical engineering and wind energy industries. As part of this activity, the company needs to check and test its products by subjecting them to a series of tests on special test rigs that run under environmental conditions that are as close to reality as possible. The proposal for the theme came from within the Schaeffler Group, which provided support for its implementation and practical application. Solving the problem makes the theme successful and it is also implemented and used in other business areas than the test centre.

Objectives achieved by the project:

- To move the robot autonomously in a mapped space.
- Detection of an oil leak.
- Error signalling.
- Augmented Reality application allowing hands-free viewing of the instruction manual.
- Experience interacting with a digital assistant.
- Assisting non-initiated operators to solve the problem.

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