Research project

SparePartAssist

„Spare parts – we will find you!"

Prof. Dr.-Ing. Frank Neumann / 10.5.2023

Agenda

1	Introduction to the project

2	Project partner

3	We find spare parts!

4	Summary and outlook

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1. Introduction to the project

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Profile for the BMBF-funded research project SparePartAssist

- Duration: 1.6.2020 – 31.03.2023

- Funding program: KMU Innovativ of the BMBF

- 4 Project partners

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Motivation for SparePartAssist

Challenges for service technicians in the field for manufacturing equipment, escalators or elevators ...:
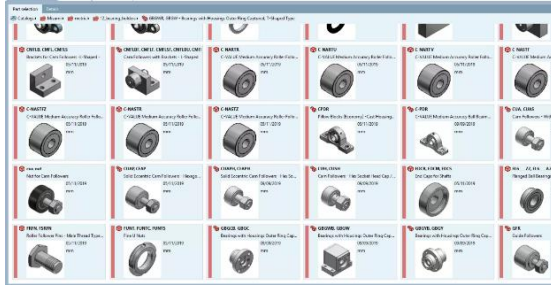
- The article number of an urgently needed spare part cannot be determined on site.

- Plant documentation is either not available or not up to date.

- Component is built-in and difficult to access.

- Component to be replaced is worn out or partially destroyed.

SparePartAssist recognizes spare parts on the basis of partial areas of the geometry

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Context

eCatalog/CAFM

- Spare parts catalogs and assembly instructions including **CAD data**
- Inventory changes
- > 1 million components
- Calling CAFM for assembly/disassembly instructions

Mobile devices

- **Object detection** in 1-2 minutes
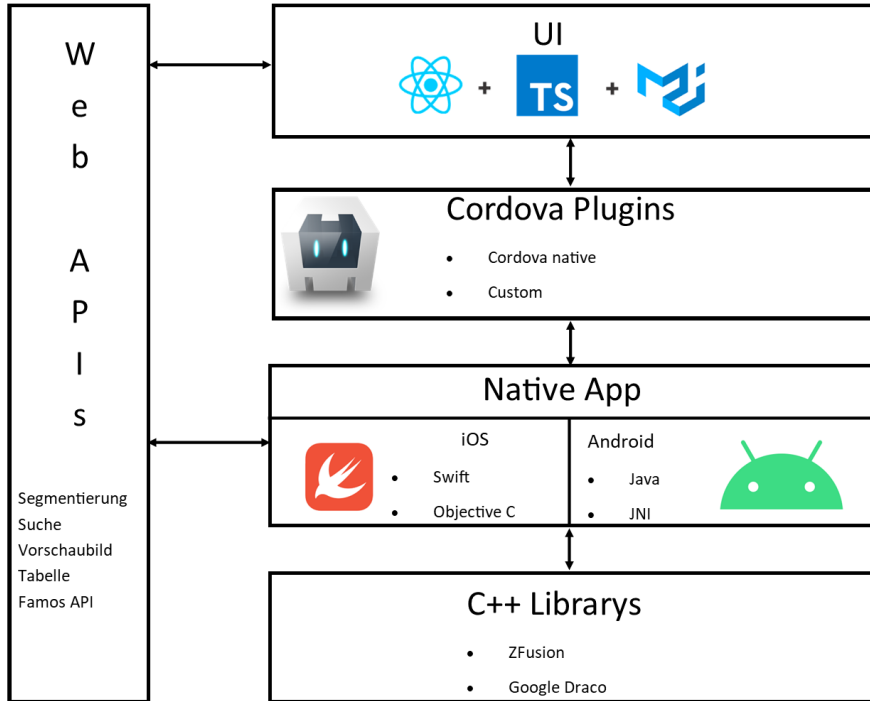- RGB and depth sensors from mobile devices

Acquisition conditions

- **Occlusion** (component is installed)
- Poor lighting
- **Dirty** surfaces
- **Reflective** surfaces
- **Little textured**

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Workflow

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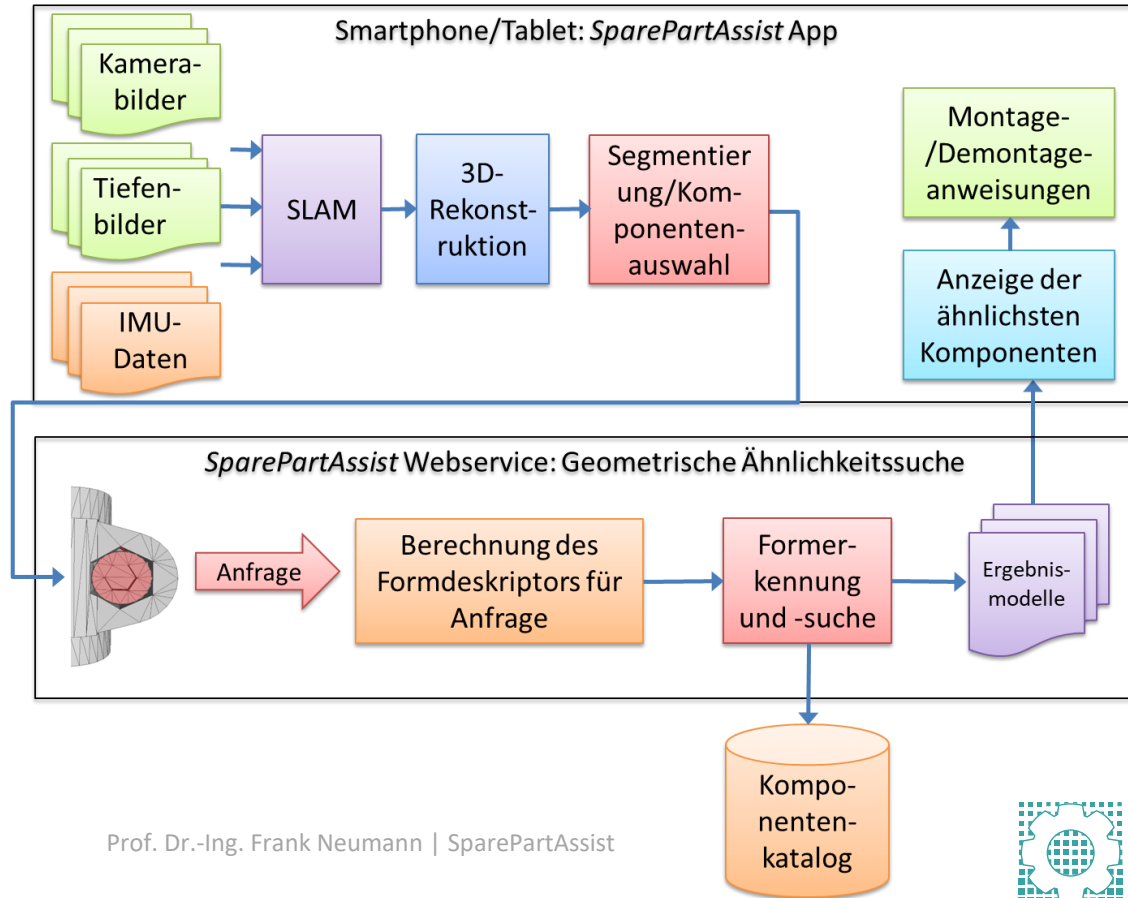
Software Architecture

Cross-platform framework: Enables support for iOS and Android

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2. Project partner

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Project partner: Keßler Solutions

CAFM – Computer Aided Facility Management

- Computer aided facility management

CAFM – a holistic perspective

- Creates cost transparaency & generates savings
- Access to changing data
- Reduction of processing costs
- Standardization of process flows
- Provides conclusions and concrete recommendations for action
- Generation of site KPIs
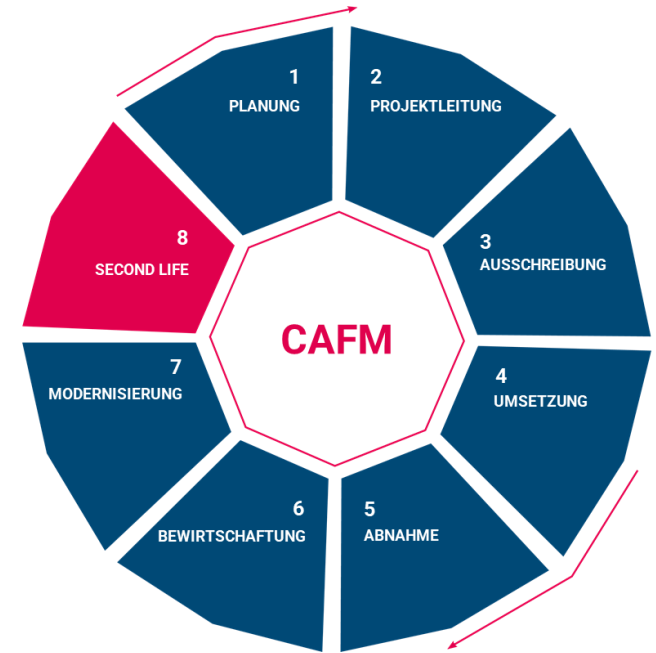
Project partner: GFaI e.V.

Association for the Promotion of Applied Computer Science

- Die GFaI is a non-profit research institution in the field of applied computer science.

- As a private, modern research institute, GFaI supports its partners in their innovations with industry-oriented, application-oriented research and development activities.

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Project partner: HTW Berlin

HTW Berlin – University of Applied Sciences

- Berlin's largest university of applied sciences

- 14,000 students

- 3,000 graduated per year

- 75 study programs

- 310 professors

- 9.5 million € third-party funding per year

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3. We find spare parts!

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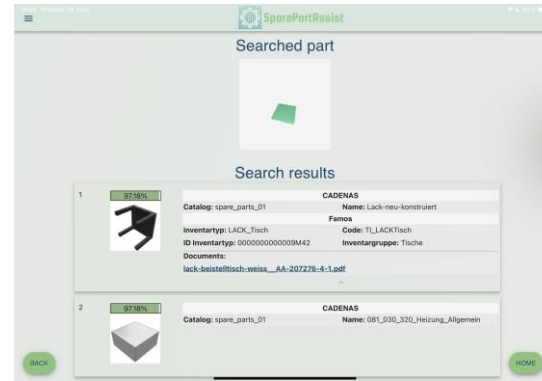# Integrated depth sensors
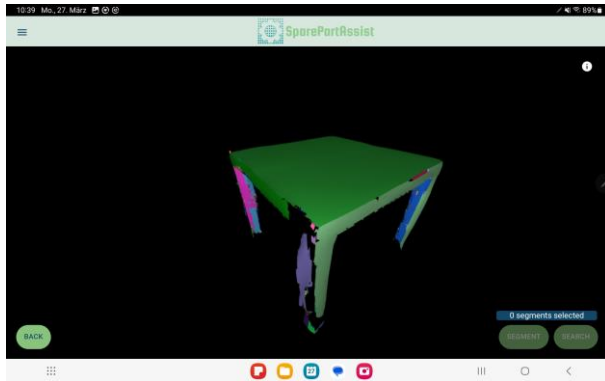
Initial idea of the project:

- Use of smartphones/tablets with integrierted depth sensor

- Available on Android e.g. Honor View 20, Samsung Note 10+

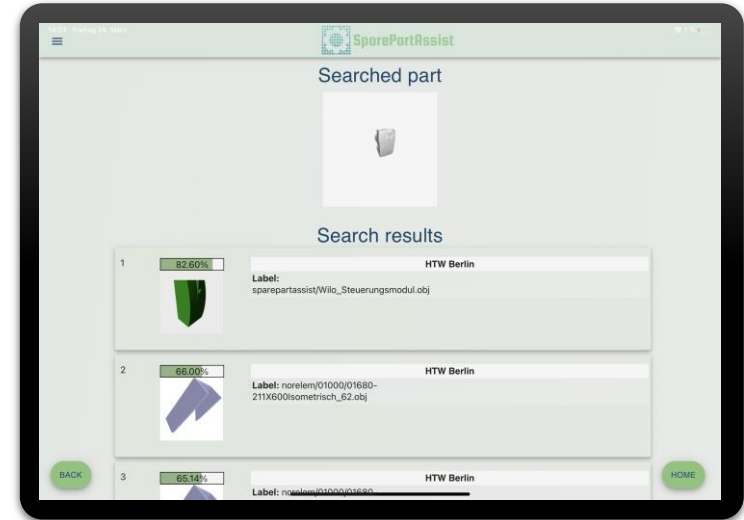- Newly available at projet start LiDAR-Sensor from iPad and iPhone Pro
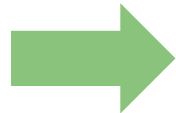
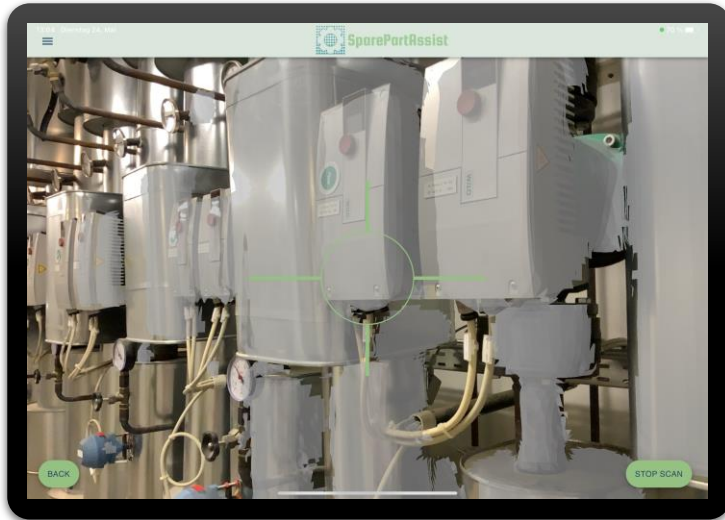**Android: iToF – Multipath Interferences**
Therefore, focus on LiDAR sensor of iPad and iPhone Pro
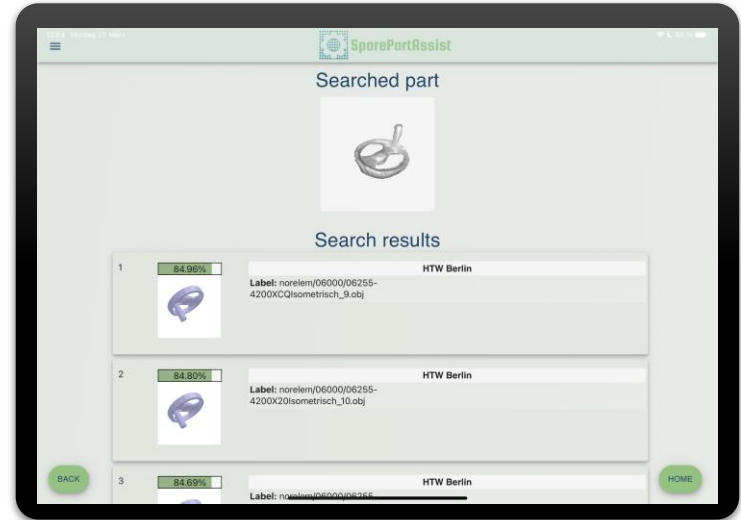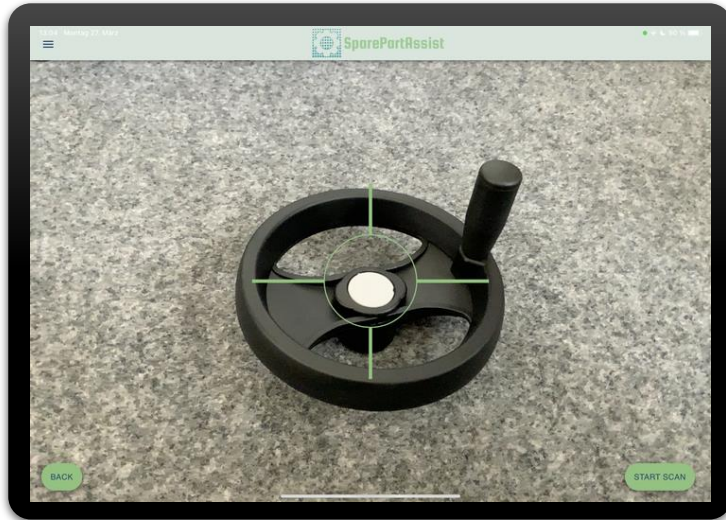
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LiDAR sensor for Ikea parts

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LiDAR sensor in the real laboratory boiler room WH G K 020

LiDAR sensor for handwheel

Results for LiDAR sensor

Identified strength

- Sensor resolution sufficient for larger objects (dimensions > 5 cm)

- Sensor results largely independent of colors and textures – here only difficulties with highly reflective surfaces.

- Robust tracking results – trajectory stable

Weaknesses identified

- Resolution of 256x192 not sufficient for scanning smaller components

- Strong smoothing and rounding of edges

- No access to raw data of the sensor possible

- Geometric shape recognition difficult for scan meshes generated with LiDAR sensor

- Hereby unclear search results for algorithms optimized for CAD models.

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External depth sensors

Since there is currently no suitable integrated depth sensor available for the parts spectrum:

- Use of external depth sensors
- Holder for attaching the sensor to the smartphone/tablet
- Calibration necessray

➡ **Research on companies and sensors**

99 mm x 20 mm x 23 mm

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External depth sensors

ToF

- Unfortunately, no dToF based camera available – Intel has discontinued L515.

Stereo camera

- Problem is the noise of the depth reconstruction
- Prototypically Intel RealSense D415 used, as integration into Android app can be implemented without risk
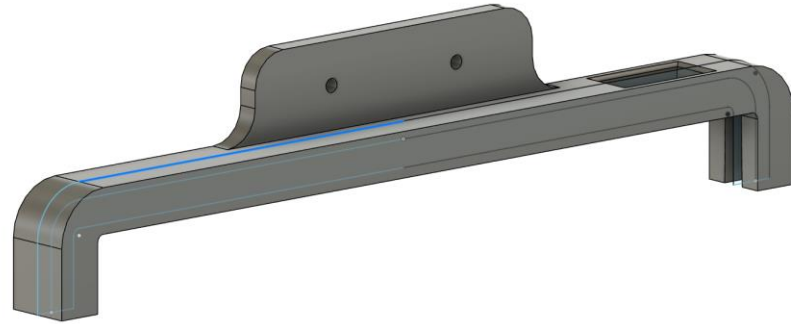

Structured Light

- Structure Sensor Pro from Occipital - very expensive (875 US $)
- Much cheaper solution from Orbbec: Astra Embedded S for 170 US $, evaluated and found to be good, integration in Android app pending

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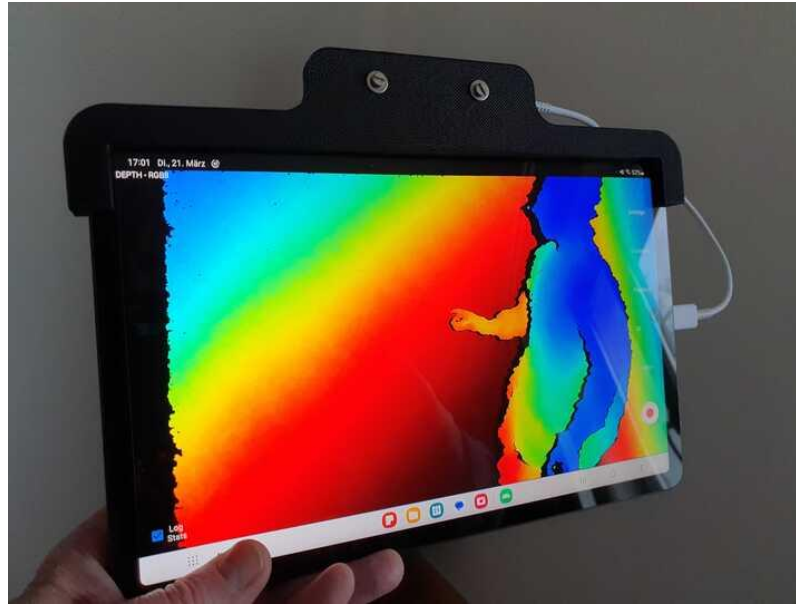
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Results for Intel RealSense D415

99 mm x 20 mm x 23 mm

Holder for Samsung Galaxy Tab S8 designed and printed

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Ergebnisse für Intel RealSense D415

99 mm x 20 mm x 23 mm

Holder for Samsung Galaxy Tab S8 mounted and evaluated

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Ergebnisse für Intel RealSense D415

99 mm x 20 mm x 23 mm

Integration in SparePartAssist App

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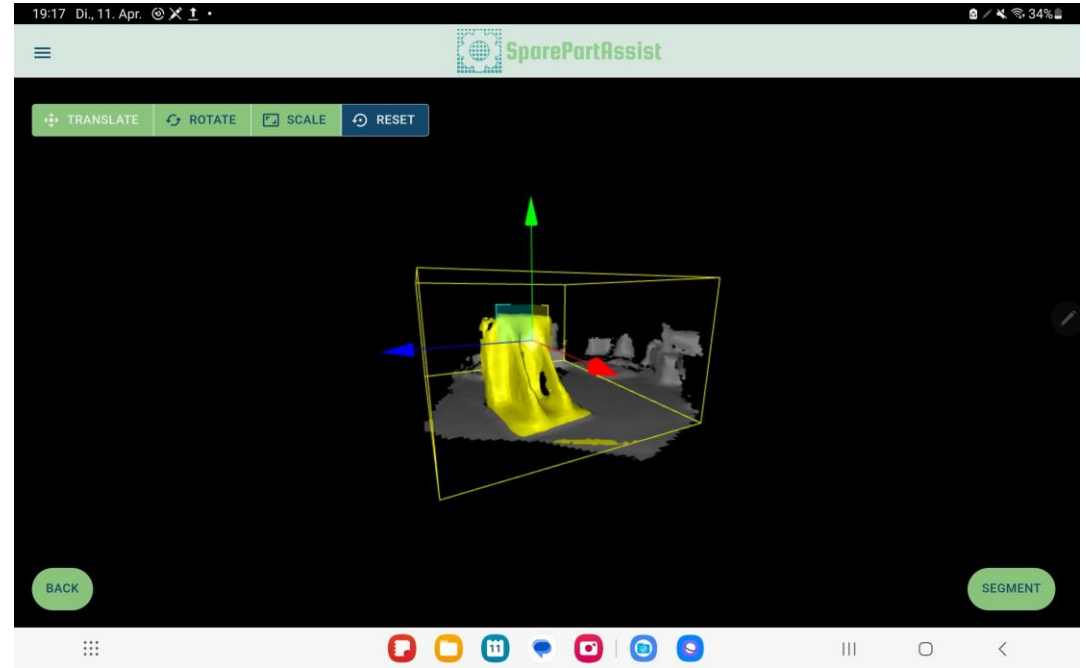
4. Summary and outlook

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Summary

- SparePartAssist has implemented an **innovative method** for spare parts search in software, demonstrated its **feasability** and made a new category of 3D-based spare parts search possible beyound Google Lens & Co.

- Integrierted depth sensors do not currently meet the performance requirements of 3D-based search.

- External depth sensors provide a viable bridge technology until better int. Sensors are available.

- Machine-learned search techniques offer significant advantages over classical approaches, especially for noisy and low-resolution data.
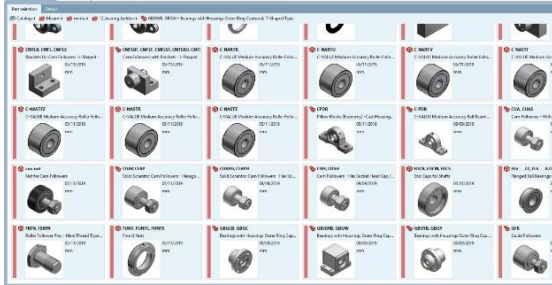
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Achievement of goals

eCatalog/CAFM

- ✓ Spare parts catalogs and assembly instructions including **CAD data**
- ✓ Inventory changes
- ✓ > 1 million components
- ✓ Calling CAFM for assembly/disassembly instructions

Mobile devices

- ✓ **Object detection** in 1-2 minutes
- ☒ RGB and depth sensors from mobile devices

Acquisition conditions

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Outlook

Next steps:

- Completion prototype with external depth sensor (Intel RealSense D415) on Android

- Extension with Structured-Light Sensor Orbbec Astra Embedded S

- Evaluation of the solution in customer scenarios

New trends:

- New integrated depth sensors in the pipeline for iPhone und iPad Pro as well as Google Pixel 8

Research activities:

- Fusion of 2D and 3D data for object recognition

- Machine-learned features for geometric descriptors

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Thank you for your attention!

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