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An augmented reality-based mobile application for visualizing robot models and robot states

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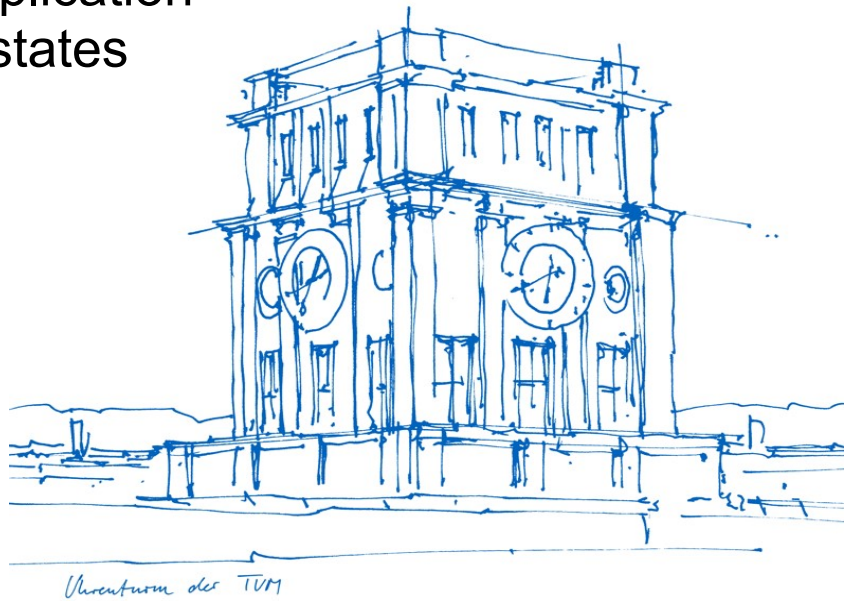
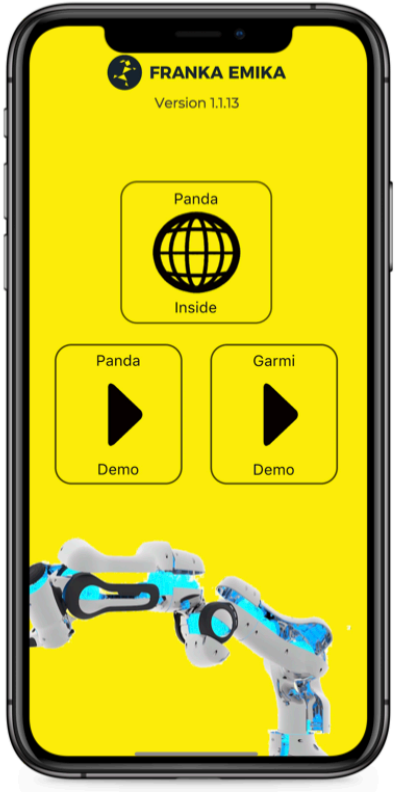


Outline

1. Introduction
2. Pre-Study
3. Implementation
4. User Study
5. Conclusion



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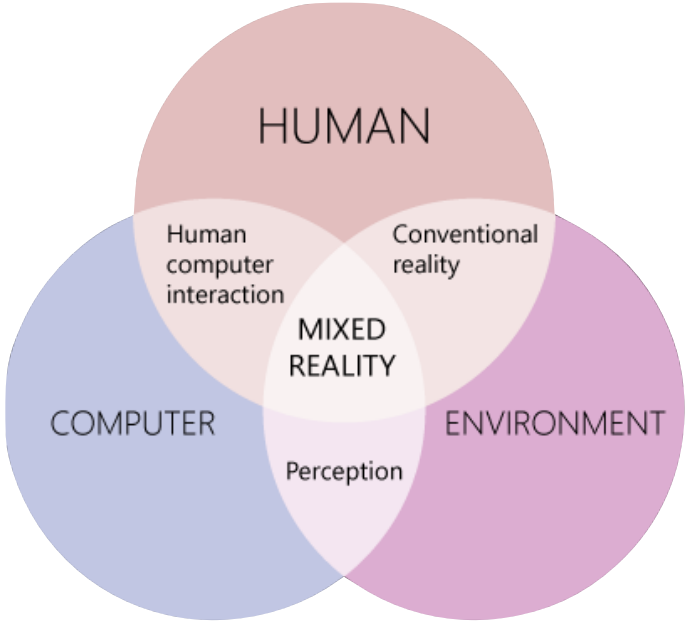
Introduction



https://docs.microsoft.com/de-de/windows/mixed-reality/discover/images/mixed-reality-venn-diagram-300px.png

What is mixed reality?

- Blend of physical an digital world
- Links humans, computer and the environment
- Visualizing interaction

Research Question:
Can an AR application improve Human-Machine communication?

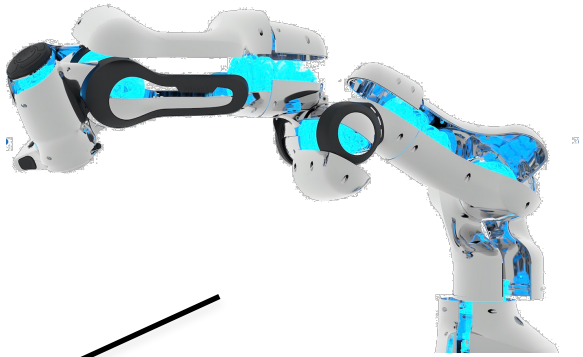
Source: Link

Human perception

Source: Own Figure

Franka Emika Augmented Reality Application

FEAR App



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Robot perception

Pre-Study: Which functions should be in this application?

Questions

1. Problems with:
• Joint limits?
• Payload?

2. Is a […] useful?
• task preview
• recording function

Results

Joint Limits:
Problem for 9/12

Payload:
Problem for 8/12

Task Preview:
Useful for 11/12

Recording function:
Useful for 4/12

Pre-Study: Which functions should be in this application?

Questions

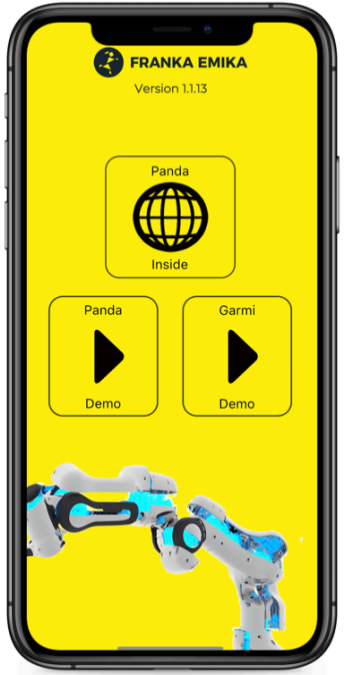
Personal feedback:

Results

Feedback:

- Garmi model
- Panda model
- External forces of the Panda

Conclusion



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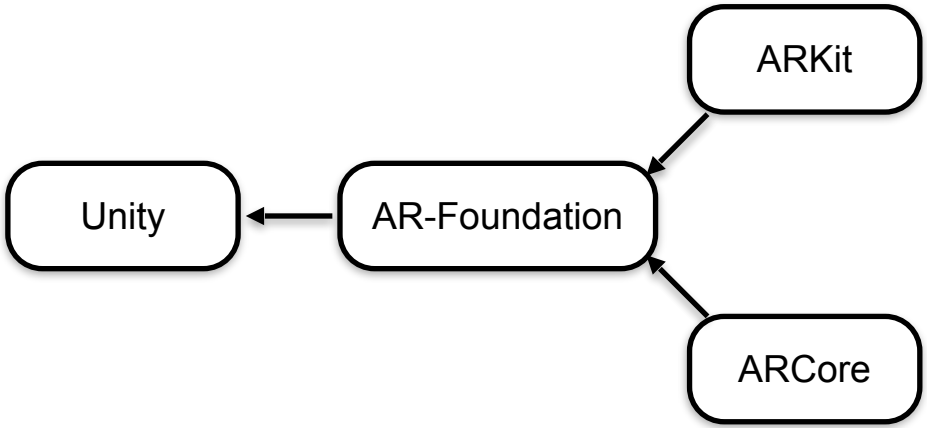
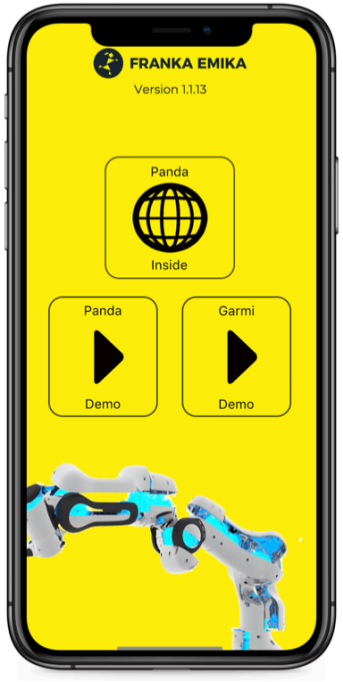
Implementation: Which development environment?

Requirements:

- Platform-independent
- Latest API
- Surface recognition
- 2D image recognition
- Anchor settling



Structure of the FEAR application



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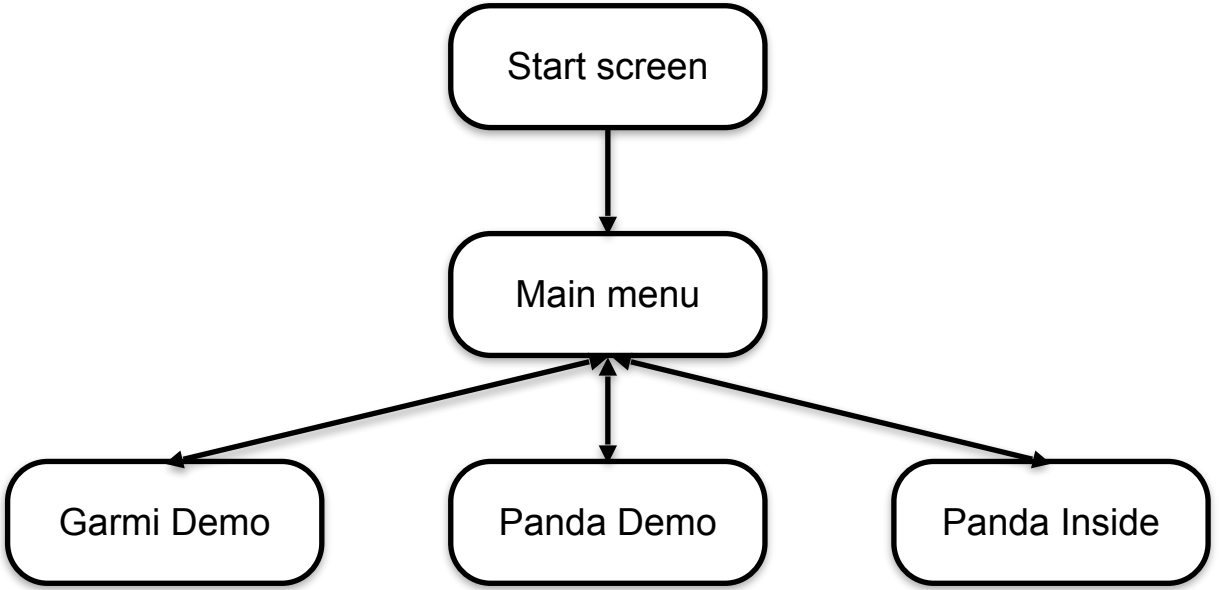
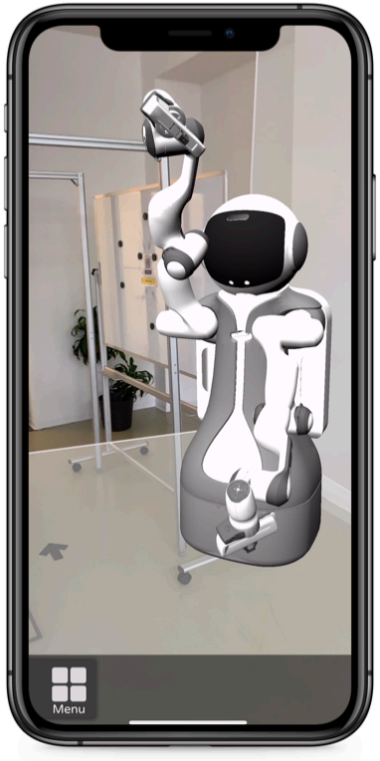


Function: Garmi Demo



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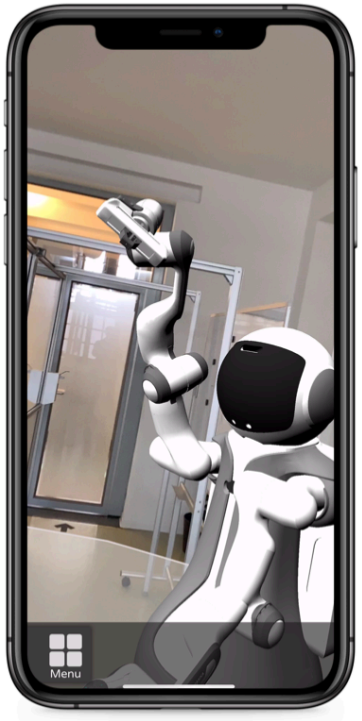
Components:

- Surface recognition by the AR-Foundation API
- Garmi (Humanoid Robot of Franka Emika)
- Tap to place model
- Shaking arm



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Function: Garmi Demo

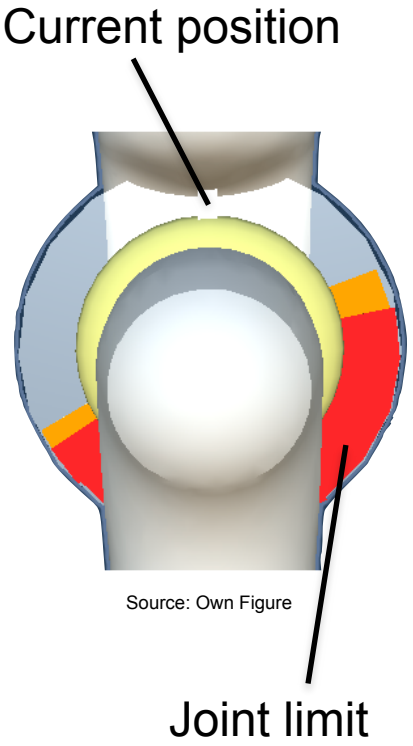
Source: Own Figure

Function: Panda Demo

Source: Own Figure

Components:

- Same surface recognition
- Same tap to place
- Panda Arm model
- Slider for joint rotation
- Joint limits



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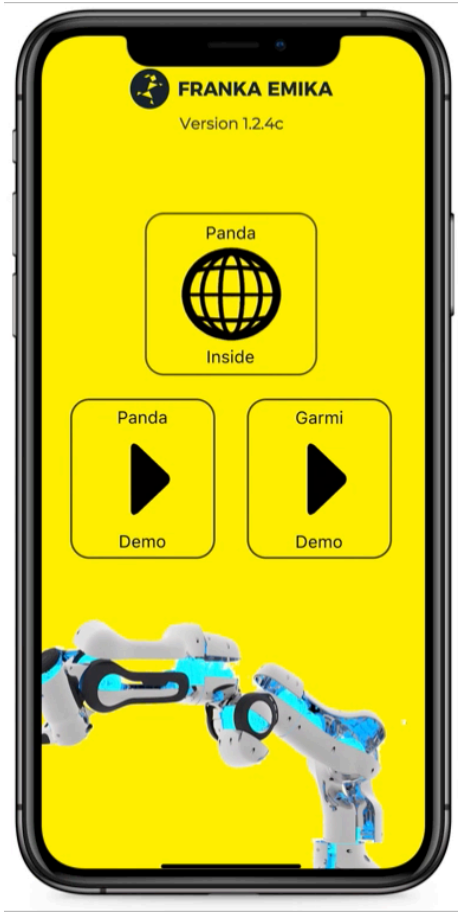
Function: Panda Demo



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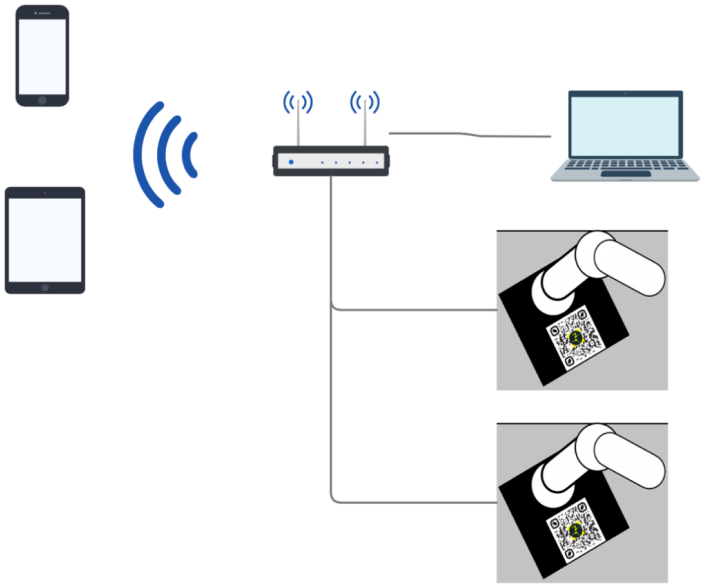
Function: Panda Inside



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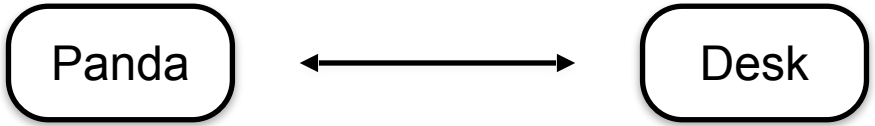
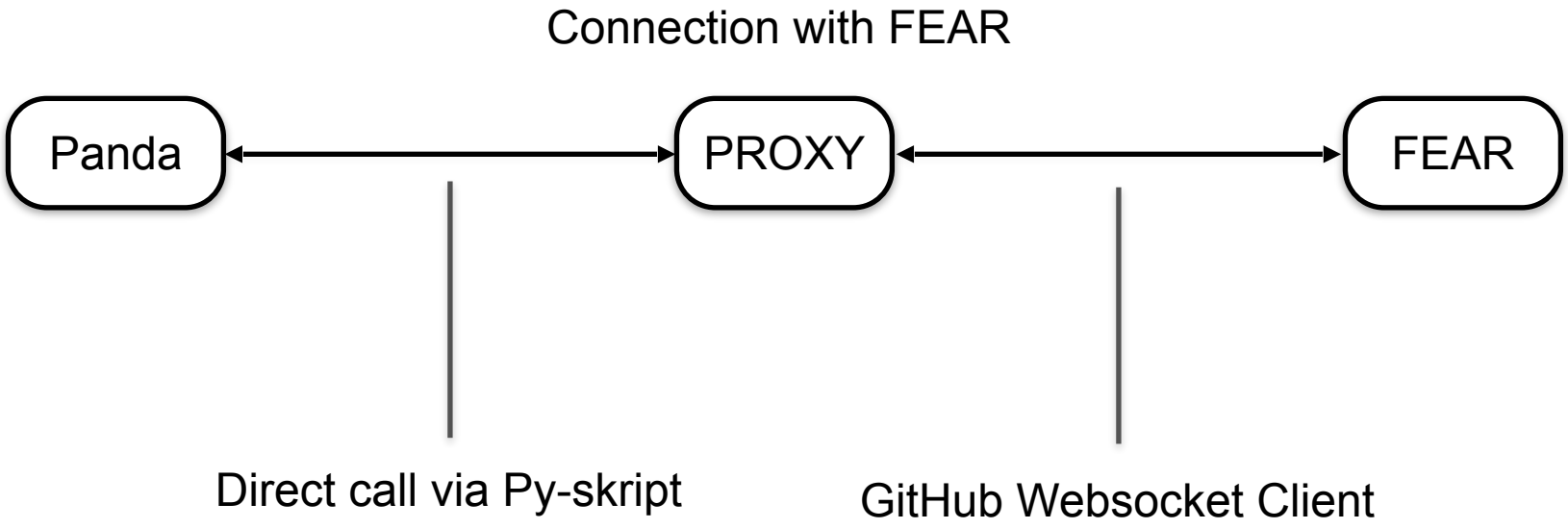
Normal Connection



Connection with FEAR

Function: Panda Inside



Function: Panda Inside

Source: Own Figure

Step 1: Scan the QR-Code

Step 2: Connect to the Panda Arm

Step 3: Calibrate the digital model

Function: Panda Inside

Problem

Source: Own Figure

Solution:

- Human hand detection
- recognizes human hands and forearms
- AR-Foundation API

Solution

Source: Own Figure

Function: Panda Inside

Source: Own Figure

User study

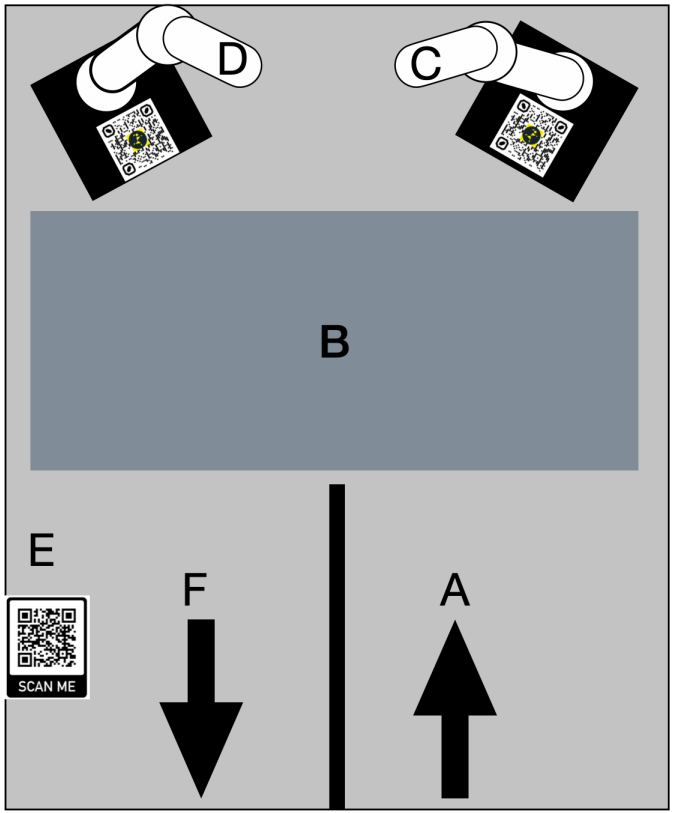
- 28 employees of Franka Emika to evaluate the Fear App
- 22 responded to the survey

Functions tested:

Garmi Demo (B)

Panda Demo (B)

Panda Inside (C&D)



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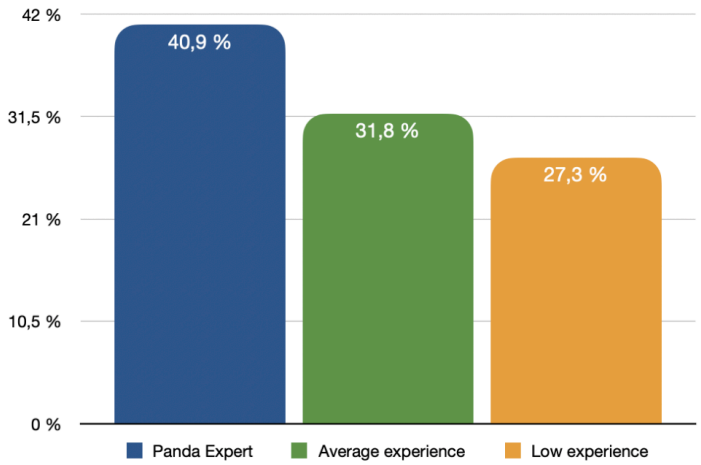
Results

How would you rate your experience with the panda?



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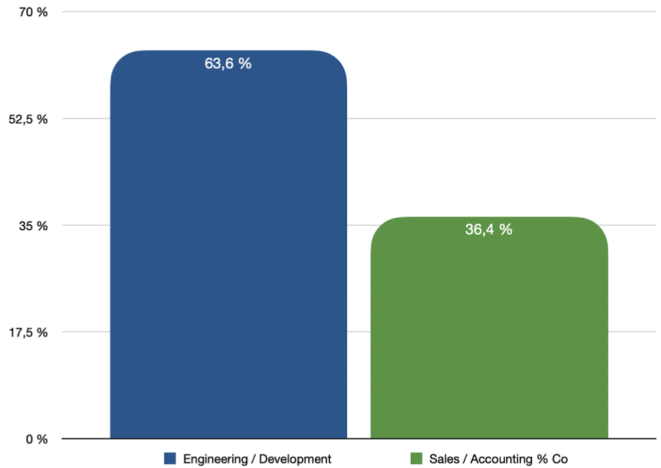
In which category of Franka Emika are you working?



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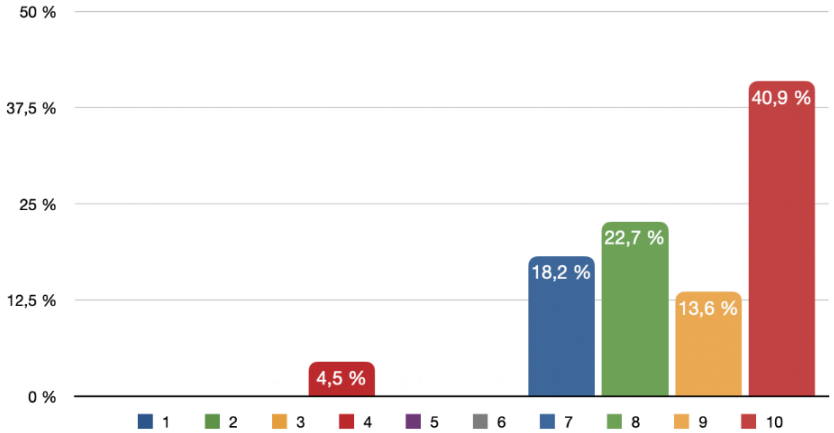
Results

How did you feel about the stability of the models?
(1-10)



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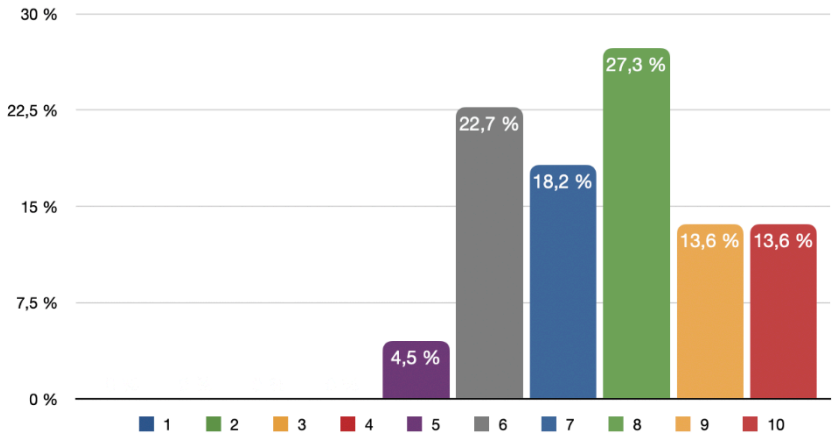
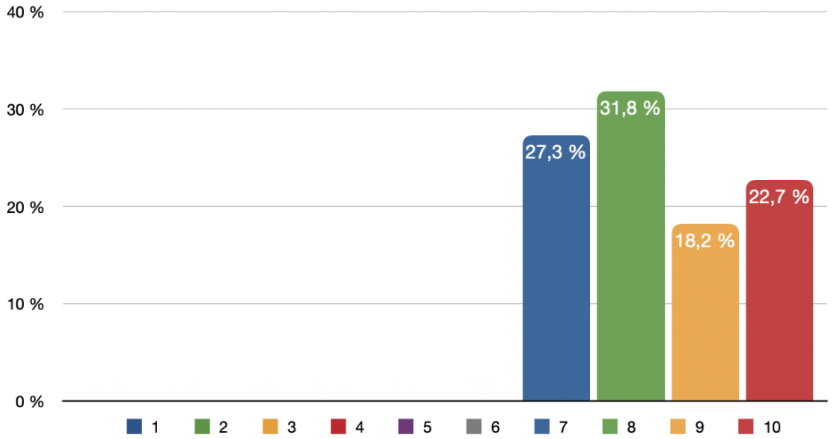
How much does the application improve the
use of the panda? (1-10)



Source: Own Figure

Results

How much potential and usability does an app
like this have for customers and partners?
(1-10)



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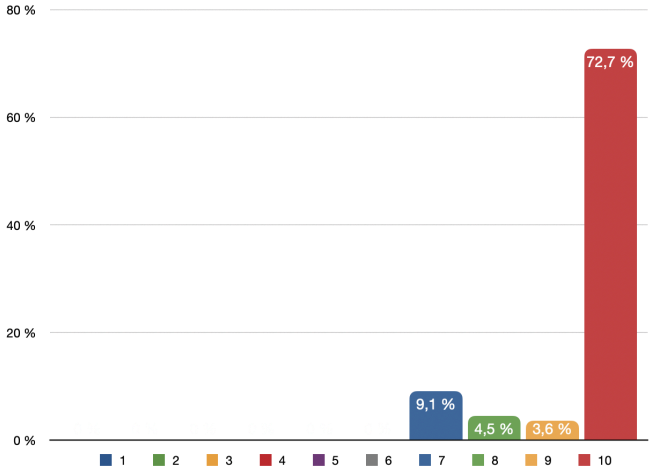
Do you think that AR will play an important role in the future when working with robots and machines?
(1-10)



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Limitations of this thesis

Main feedback (User study):

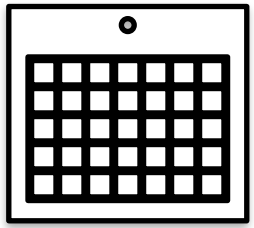
- Cartesian motion fo the Panda demo
- Soft and hard joint limits
- Network connection

Other limitations

- Screen size
- No depth sensor

Source: Own Figure

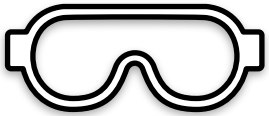
Conclusion



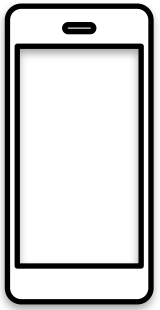
1. Pre-study to show the need of an AR-application
2. FEAR-App implemented in Unity with three main functions
3. User study to analyze the benefit

The results indicate that the Fear-App improves the human-machine communication.

Future Work



- New apple devices do have a depth sensor
- Easy to implement in Unity for the HoloLens 2
- Robot detection instead of QR-Code detection
- Support for multiple robots at the same time



Questions?

References

- Microsoft. (2020a, August 26). *Was ist Mixed Reality? - Mixed Reality*. Microsoft Docs. https://docs.microsoft.com/de-de/windows/mixed-reality/discover/mixed-reality

Figures:

- Slide 3: https://docs.microsoft.com/de-de/windows/mixed-reality/discover/images/mixed-reality-venn-diagram-300px.png
- Slide 4: Kopf mit Gehirn icon Icon v Icons8