# SBB Preventive/Predictive Maintenance with AR Assistant

Mixed Reality Project Proposal
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GROUP MEMBERS

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## I. DESCRIPTION OF THE PROJECT

The goal of this project is to develop an application that assists SBB operators in performing train door maintenance using Augmented Reality (AR). Recent research has thoroughly emphasized the need for a structured approach to enhance decision-making within the railway industry through the use of AR [1]. In our project, operators will utilize the Microsoft HoloLens 2 to view a holographic representation of the train door, with relevant components highlighted based on the specific maintenance task, thereby facilitating quick identification. Additionally, step-by-step instructions will guide the operators through each task. Another important aspect of the project is the creation of a user interface that enables maintenance staff to conveniently view upcoming door maintenance tasks.

## II. WORK PACKAGES AND TIMELINE

***Work Package 1: Data Management***

The first work package involves handling data from SBB, which is crucial for identifying maintenance tasks and how they should be performed. These tasks can come from two data sources: occasional faults reported by the train conductor and regularly scheduled maintenance tasks from the manufacturer. These data sources will be integrated into a single database, converted into a unified format, and structured specifically for our project. Since operator notes are often written in Swiss German with professional slang, a tailored translation step is required. Initially, we will process 2-3 cases manually to understand the best format and structure for the data. Once the system is refined, the goal is to automate the integration process for future log entries.
**Platform & Language:** PC, Python for data handling.
**Challenges:** Data format conversion, initial manual process.
**Solution:** Manual processing of limited cases before scaling and automating.

***Work Package 2: Door Model Analysis***

In this step, we will analyze the door model provided by SBB, segment it if necessary, and match the logs with the visible component. We will choose 2-3 maintenance tasks of varying difficulty, from simple to more complex with smaller and more hidden components, to evaluate the limits of our method. The goal is to review the model and maintenance tasks so we can design the user interface more effectively in the next step.
**Platform & Language:** PC, C# for model analysis.
**Challenges:** Analyzing the model and selecting appropriate maintenance tasks.
**Solution:** Diversifying maintenance cases by complexity and size of components.

### *Work Package 3: Door Identification*

We will not develop an automatic identification system, as that was part of last year's project [2]. Instead, the operator will manually input the corner points, and the door model will be scaled and positioned accordingly. By focusing on manual input, we can avoid the complexities of developing a fully automated system.
**Platform & Language:** PC, HoloLens 2, Unity for UI development.
**Challenges:** Precise alignment of the door model with the physical door.
**Solution:** Using a pairing system that allows the operator to manually align the corner points to ensure precision.

### *Work Package 4: AR Interface for Maintenance*

In this step, after the door is correctly aligned, the AR assistant will provide a visual overlay to highlight the components that need attention during the maintenance task and guide the operator through the necessary steps.
**Platform & Language:** HoloLens 2, Unity for AR development.
**Challenges:** Ensure that the overlay does not obstruct the operator's view, especially when they need to get close to the door to perform the task.
**Solution:** Develop a dynamic AR model that automatically disappears when the operator approaches the door or can be toggled on and off, with strategically placed information to minimize distractions.

### *Work Package 5: UI Development*

This work package focuses on developing the user interface that allows the operator to log in, view upcoming maintenance tasks, and navigate between components.
**Platform & Language:** PC, HoloLens 2, Unity for UI development.
**Challenges:** Creating a user-friendly and logical UI.
**Solution:** Focus on simple, intuitive navigation.

### *Work Package 6: User Study*

The final step involves comparing the effectiveness of the AR assistant with a traditional manual. Users will perform two maintenance tasks of equal difficulty: one using the manual and the other with the AR assistant. Key performance indicators, such as task completion time, accuracy, and user satisfaction, will be measured and analyzed. If possible, SBB operators will participate in the study.

*Timeline Overview*

- **Weeks 1-2**: We shall split into two teams. One team will focus on data management (Work Package 1), while the other will work on both Work Packages 2 (door model analysis) and 3 (door identification).
- **Weeks 3-5**: We shall work in parallel, with one team focusing on Work Package 4 (AR interface) and the other on Work Package 5 (UI development). If time allows, we aim to also start Work Package 6 (user study) before the midterm presentation.
- **Midterm Presentation**: We aim to present a functional prototype and gather feedback for further development.
- **Post-Midterm (Weeks 6-8)**: We shall conduct bi-weekly cycles of testing and enhancements based on user feedback. This will ensure a stable and well-tested application by the end of the project.

## III. Outcomes and Demonstration

We expect to deliver a fully functioning app that simplifies maintenance tasks for SBB operators. The app will feature a home screen listing all pending maintenance tasks. After selecting a task, the operator will position the door model and see each maintenance step displayed one at a time, with the relevant door component highlighted. As the operator approaches the door, the hologram will disappear to improve visibility. The process continues step by step until the task is completed and archived as such. Our demo will be offline, demonstrating tasks of increasing complexity using a mock door (poster) and the HoloLens 2.

## References

[1] Sara Scheffer, Alberto Martinetti, Roy Damgrave, Sebastian Thiede, and Leo van Dongen. How to make augmented reality a tool for railway maintenance operations: Operator 4.0 perspective. *Applied Sciences*, 11(6), 2021.

[2] Federico Mantovani, Leonardo Salsi, Diego de los Santos Gausí, and Luca Vögeli. Sbb: Preventive/predictive maintenance with ar assistant. *ETHZ - Mixed Reality Fall Semester 2023*, January 2024.