Interface definition and implementation for a network distributed information system

A smart home system with sensors and actors is installed at our chair. It shall be visualized in VR/AR and the data shall be used for simulation and optimization. For this purpose, different tools and frameworks are in use and available. The goal is to connect all of these. Figure 1 shows a schema of the desired system. All orange components shall be defined and implemented by students in either their projects or theses. The interfaces have to be defined and implemented, the simulation software has to be chosen and extended by the interfaces and the VR-/AR-App have to be implemented.

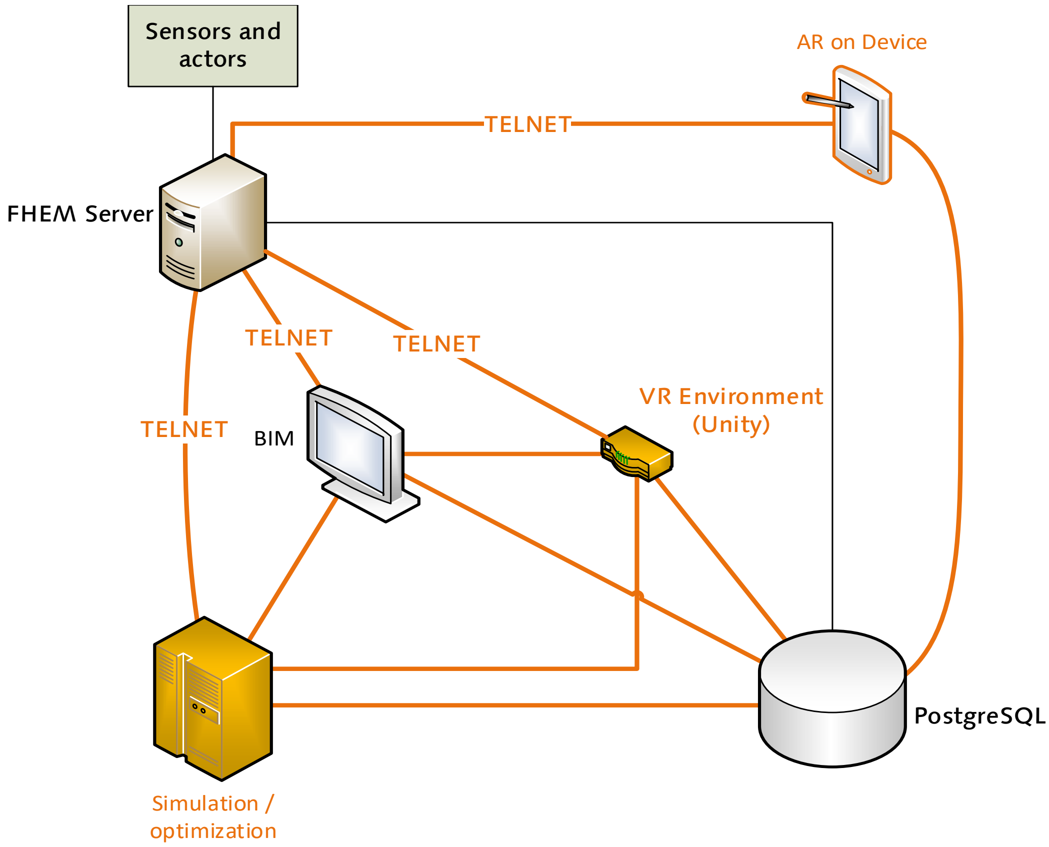


Figure 1: Contributors in the system

The FHEM server deals with the management of actors and sensors. It's a smart home Server. It receives measurement data from the sensors and transmits data to the actors. Simultaneously, It logs the data onto the PostgreSQL server. FHEM is a software for home automation implemented in Perl. It runs on a Raspberry PI 3 B+.

The PostgreSQL server is responsible for data logging and serves as a data access platform for other contributors. For VR we use a HTC Vive system. With it and Unity, a software shall be created to move in a virtual representation of our chair, in which data can be represented. Parallel an AR-app for showing data at real world positions is our target.

A second data source is the 3D model of our chair in the form of IFC (industry foundation classes. The ifc-file is handled by a BIM software. This 3D model of the ITD floor has to be created with a BIM tool and prepared for an exchange with the 3 other contributors.

Last but not least, the software for simulation and optimization has to be chosen. The requirements are real time estimation of measurement values, real time optimizations for the actors and communication to FHEM and the AR/VR-Software for visualizing simulation results.

Improved Web interface for data visualization of the smart home system at ITD

A smart home system with sensors and actors is installed at our chair. It shall be visualized in a web front-end. For this purpose, different tools and frameworks are in use and available. Figure 1 shows a schema of the system part. The standard modul delivered by FHEM (FHEMWEB) is only rudimentary.

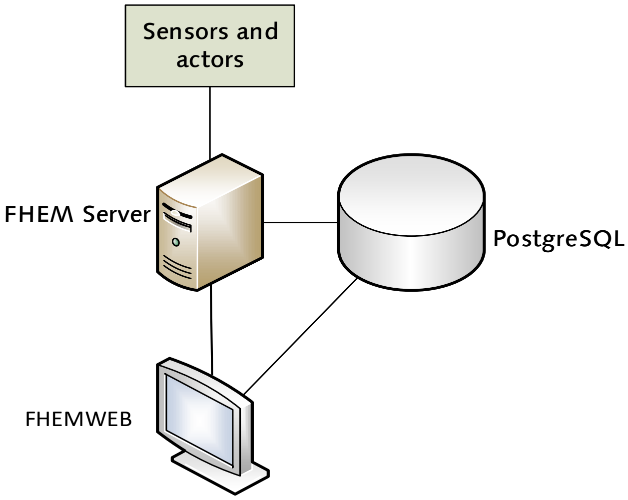


Figure 1: Contributors in the system

The FHEM server is the core of the application and is already up and running. FHEMWEB is a module of it. The software is open source, hence can be modified and extended for our purposes.

The server stores progress data in a PostgreSQL database. The data there can be visualized by FHEMWEB, too. However, the handling of this service is cumbersome.

Figure 2 shows two screenshots: left is FHEMWEB and right is a presentation of the floorplan with sensors and actors. The floor plan doesn't adapt to the device, it shows the same visualization on phones and tablets like on a PC. Therefore, a better handling and visualization of the data and control is needed.

For an improvement of this module, the existing code needs to be analyzed to understand the software architecture. Parallel to this, a design draft of the new web GUI has to be done. Finally, combining these sources of information the module shall be improved.

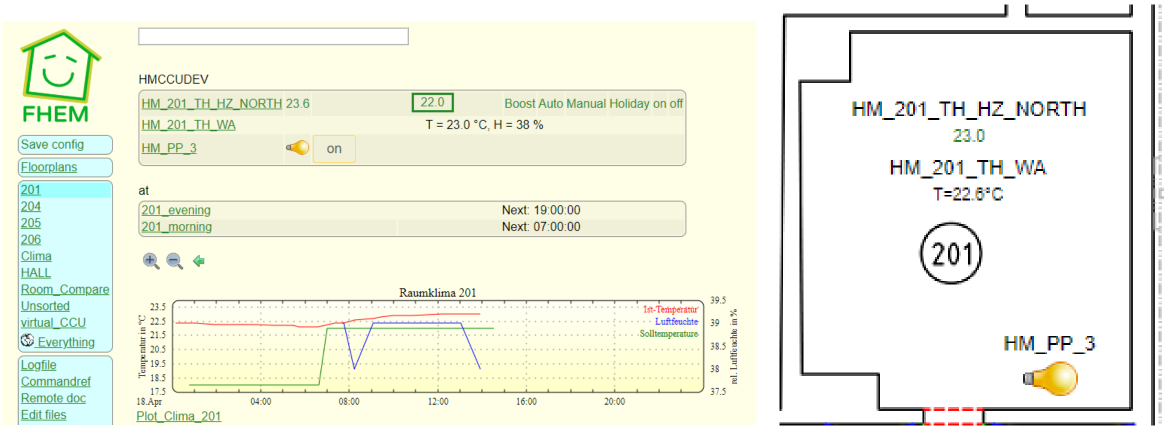


Figure 2: GUI examples

BIM interface for visualization of smart home data

A smart home system with sensors and actors is installed at our chair. It shall be visualized in a suitable BIM environment for monitoring and facility management (FM). For this purpose, different tools and frameworks are in use and available. The goal is to connect our Smart home instance with a 3D model in Revit. Figure 1 shows a schema of the desired system.

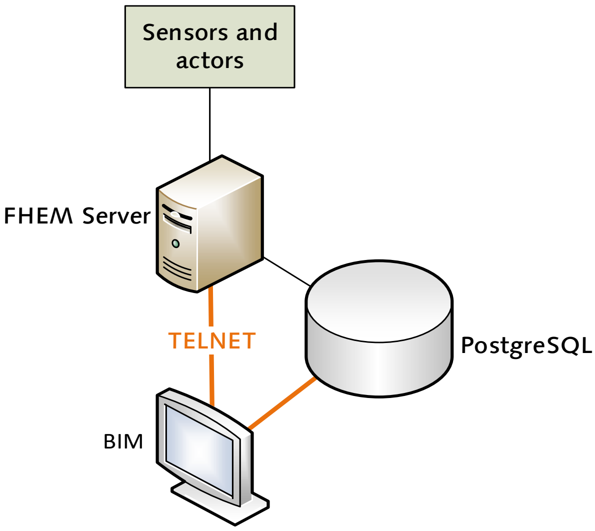


Figure1: Contributors in the part system

The FHEM server represents the smart home system. It manages all devices and logs data into the PostgreSQL database. The connection between the sensors and actors works via radio-communication at 868 MHz. Every sensor and actor has multiple channels, i.e. actual temperature, temperature setpoint, humidity, low battery, valve state and so on.

For FM it's the intention to display the data from the smart home system directly within the 3D model. This produces a fast overview about environmental conditions. FHEM has the possibility to receive and send message via TELNET. This is suitable to get actual values and adjust actors. The first tasks are design and implement an interface between Revit and FHEM using the Telnet protocol.

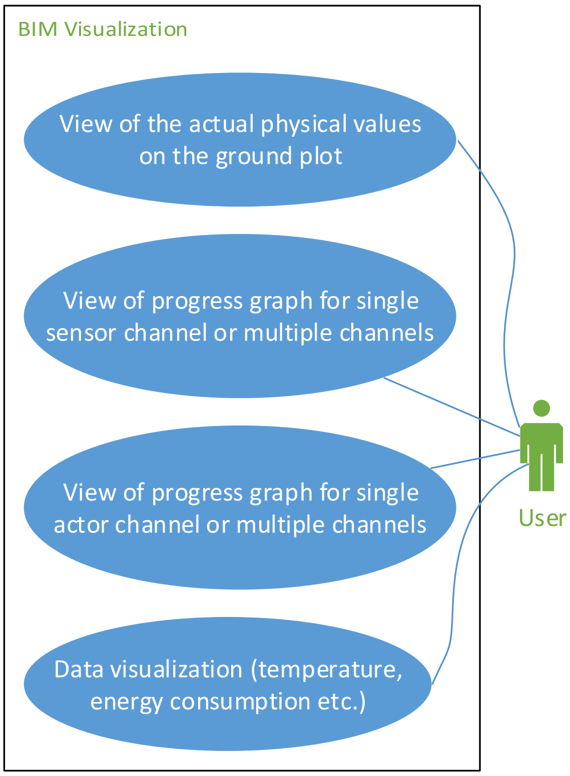


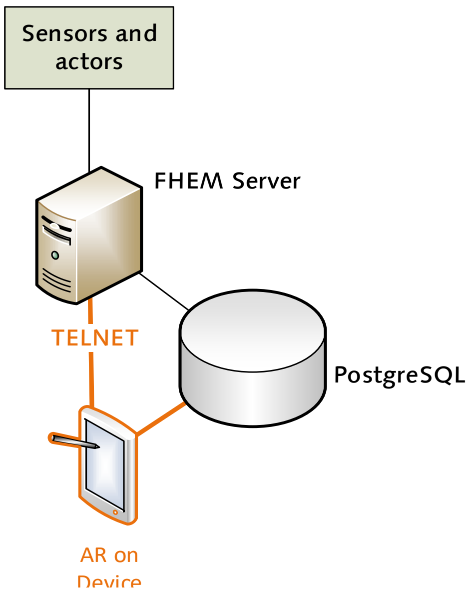
Figure 2: Use cases

FHEM pushes all data into the PostgrSQL server to store it persistently. It can be used to create graphs with progress, mean values and so on. Hence, the second task is to implement an interface for retrieving this data and displaying it in an adequate way. It's aim is the analysis about energy consumption, lights, water and so on. It serves information about ventilation, heating and energy management. Besides this, the FM is supported when making decisions about maintenance scheduling, e.g. if the radiator isn't used for a long time period, the valve of the thermostat might be stuck. Figure 2 shows the use cases for the scenario in general.

Finally this work will form the bases of a subsequent extension with simulation and optimization tools.

AR Interface for smart home system

A smart home system with sensors and actors is installed at our chair. It shall be visualized in AR and VR. For this purpose, different tools and frameworks are in use and available. The goal is to connect the data gained from sensors and actors with the real world. Figure 1 shows a schema of the desired system part.



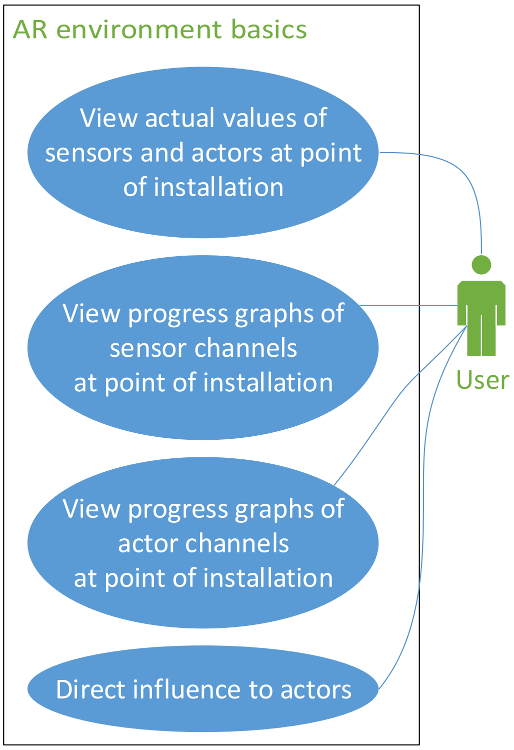


Figure 2: Use cases

Today, we know much about optimal control strategies, energy saving methods and climate changes. To give us a better perception about it, we want to visualize every day measurement data of our offices. Core values of this are Temperature, humidity and power consumption. The understanding of pure numbers is difficult for many people. Numbers are abstract and difficult to perceive. For this reason we want to make these numbers experienceable. A augmented reality (AR) app would support this.

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FHEM pushes all data into the PostgrSQL server. There they stay persistent. It can be used to create graphs with progress, mean values and so on.

The AR software should be able to display actual values into the display of a smart phone or tablet at the points of the sensors and actors. Besides this, the interaction with actors shall be possible. This all is doable over the TELNET interface of FHEM.

Second is to overlay graphical data representation over the scene. This shows temperature, humidity or power consumption in an adequate way, i.e. graph, colors and so on.

This work is the basement for a later connection with a simulation tool.

VR Interface for smart home system

A smart home system with sensors and actors is installed at our chair. It shall be visualized in AR and VR. For this purpose, different tools and frameworks are in use and available. The goal is to connect the data gained from sensors and actors with a virtual representation of our chair. Figure 1 shows a schema of the desired system part.

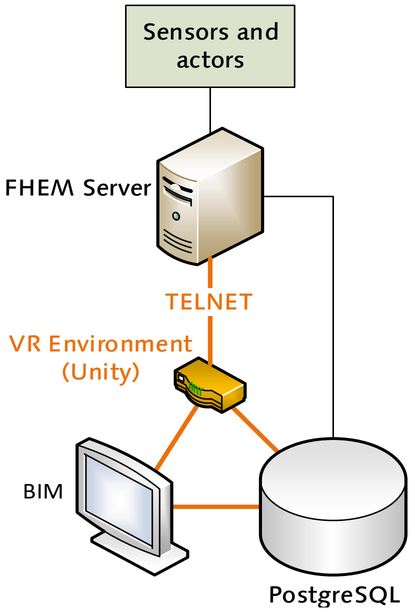

Figure 1: Contributors in the system

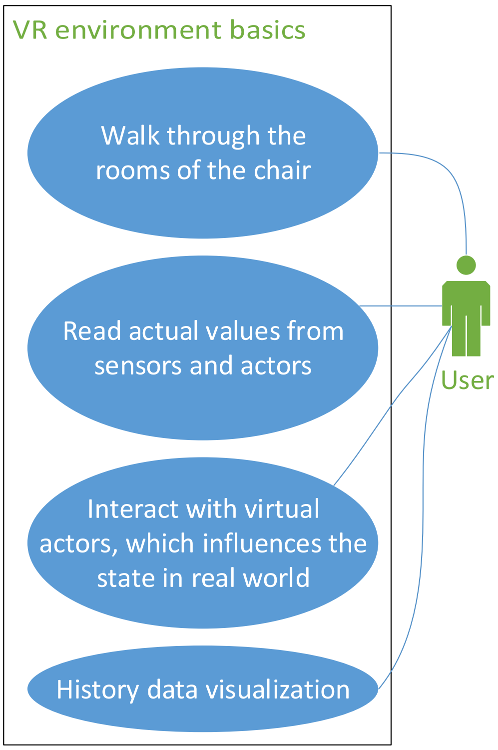

Figure 2: Use cases

Virtual reality is an actual concepts mainly for games actually. We want to analyze it's opportunities for education. Is the information gained from a virtual reality (VR) scenario different than from augmented reality (AR)? What are the differences between them in experienceing and learning? How can we use VR for future classes to improve teaching? For this purpose we've got a VR-System (HTC Vive), for which a VR-App shall be developed.

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FHEM pushes all data into the PostgrSQL server. There they stay persistent. It can be used to create graphs with progress, mean values and so on.

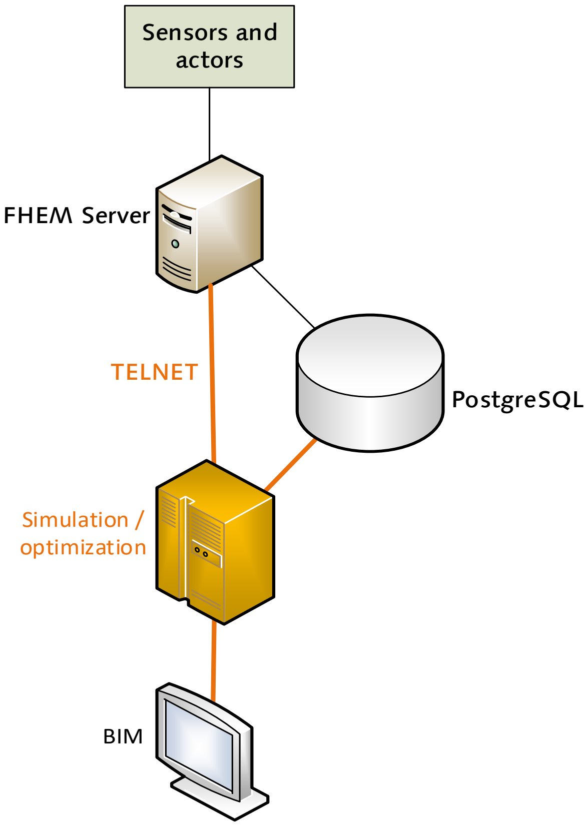
Figure 2 shows the use cases: walking through the virtual model of our Chair, get the actual data, control the actors and view some progress data from the database. This use cases shall be used inform people about energy consumption, heating processes, air flow and environment awareness.

This work is the basement for a later connection with a simulation tool.

Simulation software and interface for smart home system

At our chair is a smart home system with sensors and actors is installed. The data gained from this shall be used for simulation and optimization. For this purpose different tools and frameworks are in use and available. Figure 1 shows a schema of the desired system. All orange components shall be defined and implemented in multiple student works.

Today we now much about optimal control strategies, energy saving methods and climate changes. We want to optimize our power consumption at the chair. But there are to much system parameters to do this only with a short sight. A numerical simulation and later optimization is what we want to have.



At the moment we've got a system to gather data but nothing to work with it. There are many software available to simulate models numerical. We would like to have a system which takes the data from our smart home system and build with it a digital numerical twin. It should simulate actual states, predict future behaviour and offer optimization tools.

The simulation environment can take the data from the building model from a IFC-file (BIM). Actual sensor data can gotten from the FHEM server via a TELNET connection. Past data is saved by fhem in a PostgrSQL-Server. Both can be used for the purpose of simulation and optimization. Figure 2 shows a summary of all use cases.

First a simulation environment has to be chosen and second the interfaces between FHEM, PostgreSQL and BIM has to be implemented.

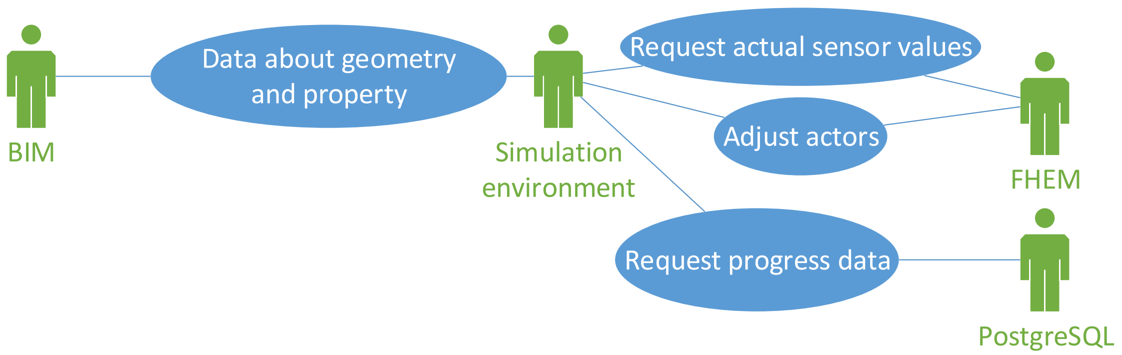


figure 2: use cases