IHMES - Intelligent home music entertainment system

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1 System Introduction

Increasing people's efficiency and comfort is an important topic of research. Making everyday life more comfortable and easier is a predominant aspect of development related to smart buildings and especially smart homes. Therefore, it is not surprising that companies offering solutions for smart cities and smart home devices have significant market growth.

Since we are participating in the lecture "Smart Cities and IoT" we want to gain practical experience in addition to the theoretical fundamentals taught by the lecture. Since Smart Cities are just a bigger model or a further development of a smart home system, we will consider a smart home system as our project.

Let´s assume we live in an appartement with e.g. a kitchen, a bathroom, a living room and a bedroom. Since we have a huge music affinity we want to listen the whole day to music while moving in our appartement. Without any smart home functionality we would have to turn on the speakers in the room we are currently in or turn it off once again when leaving. Additionally, of course we would have to connect our smartphone to some speaker first and play our favorite music. Once we got established the connection and the music is playing we would have to regulate the volume of the music according to many factors such as noise in the room.

In the following based on this basic problem definition and main scope of our work we want to specify our use cases and requirements for a smart home system which aims to automate such tasks as well as some additional ones for a user.

2 System Analysis

There are some core requirements and functionalities a user wants from this smart home system. Given the described scenario we want to improve a users situation by providing a way to play their favorite music in every room where people are currently in. In addition we want to extend comfort by increasing and decreasing the volume of the music according to external factors, e.g. the noise in the environment. Another part of our smart home system can be to identify the mood of a user and adapt music and environment according to this.

The systems core functions will be separated into functional and non-functional requirements according to ISO 25010. All requirements will be priorized by - -

/ - / o / + and ++, where all requirements with + or ++ are considered to be mandatory for our project. All other requirements are considered as desirable or optional requirements.

2.1 Functional Requirements

ID FA-1
Title Autonomous Volume regulation
Description The system should be able to regulate the volume of our music.
Dependencies FA-2, FA-3, FA-4
Priority ++

ID FA-2
Title Play Music
Description The system should be able to play music.
Dependencies FA-5
Priority ++

ID FA-3
Title Recognize people in room
Description The system should recognize how many people are currently in the rooms of the appartement.
Dependencies None
Priority ++

ID FA-4
Title Recognize loud environments
Description The system should recognize when it is noisy. For example when the shower in the bathroom is turned on, it should recognize that.
Dependencies FA-3
Priority ++

ID FA-5
Title Classify mood of the music
Description The system should be able to identify the mood of a music that is currently played.
Dependencies None
Priority o

ID FA-6
Title Light regulation
Description The system should be able to regulate the lights in the appartement.
Dependencies FA-5
Priority o

ID FA-7
Title Human music interaction
Description A human should be able to regulate the volume of the system.
Dependencies None
Priority o

ID FA-8
Title Night regulation
Description At night the humans should be prohibited from increasing the volume above a certain limit.
Dependencies None
Priority o

ID FA-9
Title Classify mood of a user
Description The system should be able to identify the mood of a user and act accordingly.
Dependencies FA-5
Priority o

ID FA-10
Title Activate and deactivate speakers
Description The system should be able to turn speakers from which music can be played on or off.
Dependencies None
Priority ++

2.2 Non-functional Requirements

ID NFA-1
Title Realworld application
Description The system should be easily transformed to a real world running smart home system.
Dependencies None
Priority -

ID NFA-2
Title AI-planning
Description AI-planning will be used for volume regulation in all the rooms.
Dependencies None
Priority ++

ID NFA-3
Title Message Queuing
Description Message Queuing (MQ) middleware will be used for the communication between devices in the system
Dependencies None
Priority ++

3 System Architecture Design

In the following we will specify our main components that execute our main functionalities. All components are separated into the following Layers according to ISO/OSI Model.

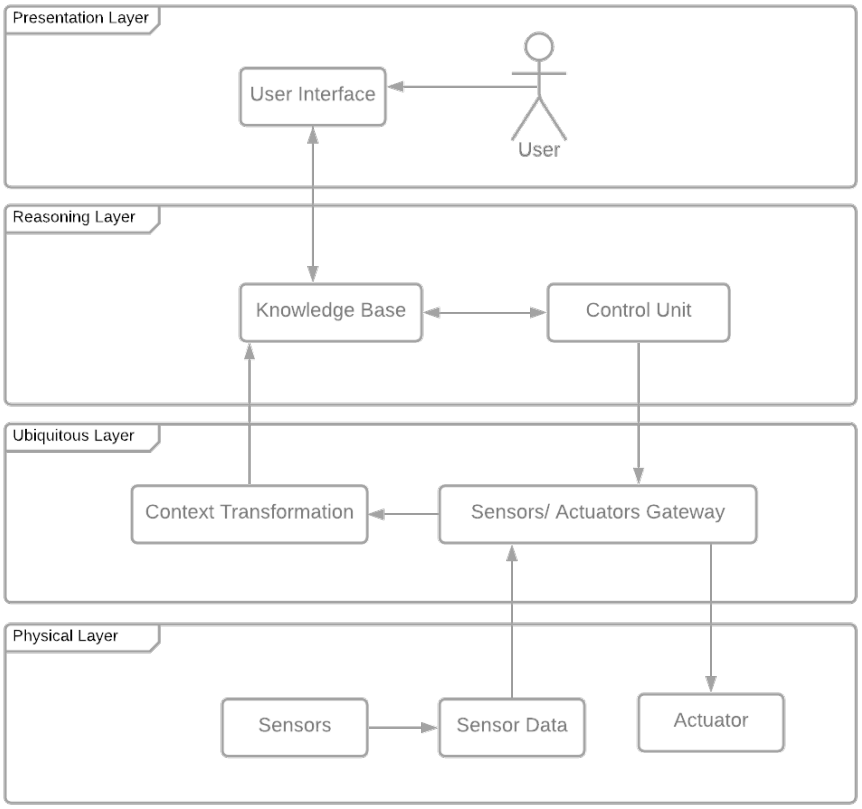

Fig. 1. The system design illustrated as a diagram

3.1 Presentation Layer

The Presentation Layer consists out of the User Interface and the User itself. The (human) User interacts with our system via the User Interface which provides a GUI. The user can execute the functional requirements provided in FA-7.

3.2 Reasoning Layer

The reasoning layer consists of the knowledge base and the control unit. The knowledge base stores all the sensor data that is generated and stores information about the individual rooms with the state of all the actuators. It receives all data from the Context Transformation component in the Ubiquitous Layer. The Control Unit interacts closely with the Knowledge Base, as it receives a notification as soon as new sensor data is stored in the Knowledge Base. Based on all the data, the Control Unit decides in which rooms the music volume needs to be adjusted or regulated. As soon as it has reached a conclusion, it communicates this via the Sensors/Actuators gateway in the Ubiquitous Layer.

3.3 Ubiquitous Layer

The main component of the ubiquitous layer is the sensor/actuator gateway which communicated between the physical layer devices and the components of the reasoning layer. It will process commands from the control unit of the reasoning layer directly in order to relay commands to the actuators of the system. Sensor data however will be given to the Context Transformation component which has the job to take this raw data and transform it to a more precise and informative format which will then be communicated with the knowledge base of the reasoning layer.

3.4 Physcial Layer

There are two main components of the physical layer. Firstly the sensor which produces data that will be sent to the gateway. Sensors will be used to satisfy functional requirements such as FA-4 and others. Secondly actuators will get instructions from the gateway and execute upon these as is described in the functional requirements part, such as FA-10.