MULTIMODAL INTERFACE MODELING LANGUAGE – FROM A METAMODEL TO AN ASSISTIVE AND FLEXIBLE USER-SYSTEM INTERFACE

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ABSTRACT: Multimodal interfaces are a state of the art topic in the development of assistive smart home technologies. An example for such an assistive system is the project Human Behavior and Support (HBMS) [1] were elderly people with dementia are supported. In such systems, it is important that the system can change its input and output possibilities in time without changing the whole system-software or -hardware components. Therefore, the Multimodal Interface Modeling Language (MMI-ML) was implemented to provide a conceptual modeling language and modeling tool to software engineers to develop these multimodal interfaces rapidly. In this paper, the language MMI-ML and the appropriate modeling tool as well as a short example will be presented.

1 INTRODUCTION

Human diversity represents possibilities and challenges for state of the art assistive technology systems. To develop such a system that supports e.g. elderly people during ordinary activities in their homes, it is necessary to focus on the aspect, that not every user can use all possible technologies. Furthermore, the current cognitive and physical status is unstable and changes over the time as well. Hence, systems working properly in the present can remain unusable weeks after the implementation in the homes. Therefore, a flexible human-system interface that can react according to the habits of the user is needed. Such an interface is longer usable, if it is multimodal and can change its input/output modality with regard to the current user-needs. To develop an interface, which changes by itself in relation to the behavior of the user, the conceptual modeling approach is used to create an interface-development language. The developed "Multimodal Interface Modeling Language" short MMI-ML will be presented in chapter 2 with the representation of the metamodel and its language-elements and grammar. To get an idea how to work with this technology, additionally, the modeling tool developed in ADOxx®[10] that is provided for open-source use on the OMiLAB®[11] platform is presented in chapter 3.

1.1 STATE OF THE ART

Smart homes on the consumer market nowadays offer a lot of different sensors, control units or applications but every change on the system requires an action of the customer itself. That means that people who are not familiar with such systems need to ask for help (customer

[10] ADOxx: https://www.adoxx.org/live/home
[11] OMiLAB Austria: https://austria.omilab.org

service, technicians etc.) this requires a lot of time and often money. In the HBMS an artificial intelligence (AI) is implemented, that changes the content (software) and used hardware interaction devices (pre-installed in the flats) currently by itself based on the behavior-information collected over time. To realize such a human-system interface the AI needs a software component that changes the interaction possibilities / modes on time. Therefore, the MMI-ML language was developed.

2 MMI-ML

Developing assistive smart home technologies for people with or without cognitive and/or physical impairments can be a hard task, because the condition can change rapidly. Therefore, the MMI-ML was developed to support on the one hand seniors during their daily businesses and on the other hand, to help software engineers to develop flexible interfaces rapidly. As development method in case of the MMI-ML the conceptual modeling approach was used. It helps to understand the needed elements and relations for interfaces on different abstraction levels. The created metamodel is, therefore, the basis that can be instantiated in models, that represents concrete interface instances.

2.1 MMI-ML METAMODEL

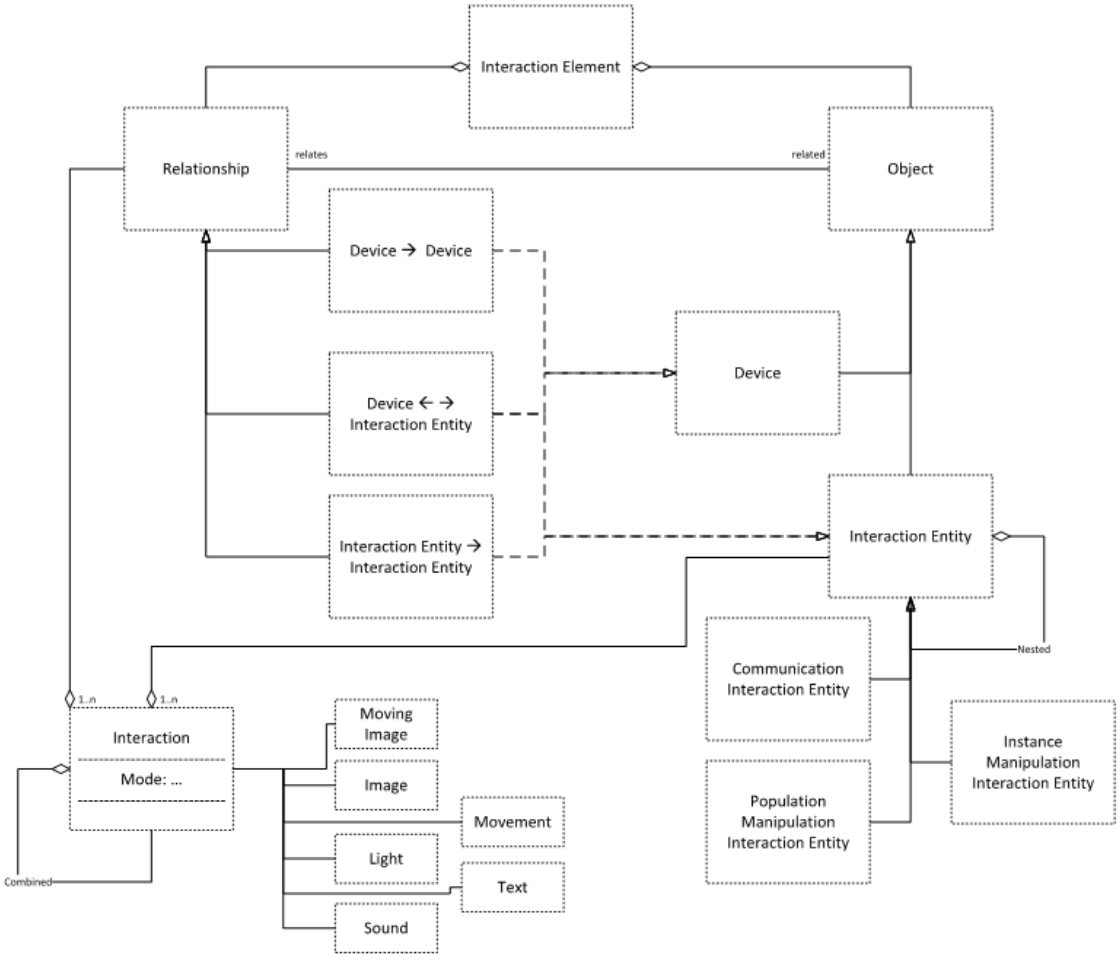


Figure 1: MMI-ML: final version of the metamodel

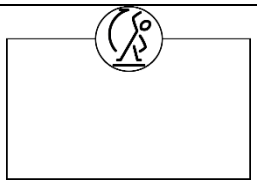
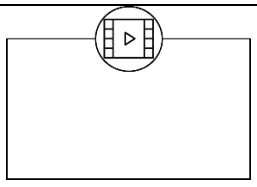
As shown in Figure 1 the MMI-ML metamodel contains all relevant constructions for a multimodal interface. Different Objects can communicate via Relationships (language grammar) in a certain Interaction Mode with other Devices or with Interaction Entities (IE). Interaction Entities represent different software interfaces, e.g. the Communication IE represents the input / output interface or Population Manipulation IE represents sorting or filtering algorithms. Depending on the system interface needs, it is possible to create models for human-system interfaces (with human interaction) and system-system interfaces (without human interaction).

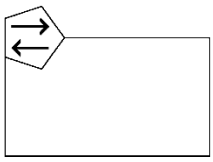
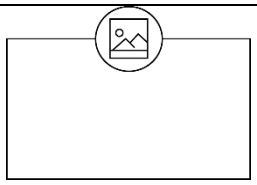
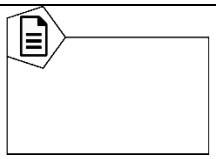
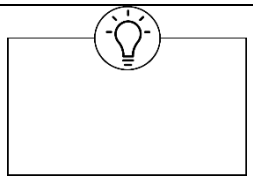
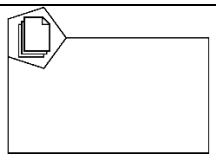
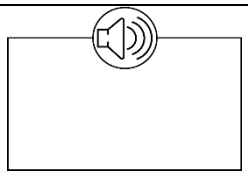
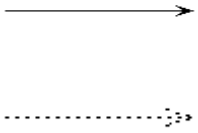
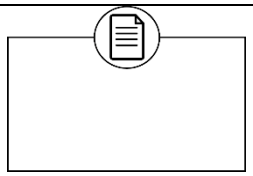
2.2 LANGUAGE COMPONENTS

To work with the metamodel a modeling tool with a graphical representation was implemented. Therefore, the elements of the MMI-ML were designed as shown in Table 1. Possible end-users (software engineers) evaluated in three iterations the design. After every session, it was redesigned. The first graphical concepts [2] differ in color usage and style to the final version. In the evaluation the participants mentioned, that color just for design reasons is useless and referring to the idea of barrier free development it should be avoided in order to provide the highest contrast and clearness possible. Furthermore, the software engineers said, that they are used to black and white colored diagram representations (E.g. standard Unified Modeling Language – UML). Not every element of the metamodel is represented in the MMI-ML modeling toolkit because some have an abstract character like the Interaction Entity (superordinate representation of the different interactions in the system e.g. Communication IE) or the Relationship Element (superordinate representation of relations between elements in the metamodel) itself. In this case, just the concrete classes got a graphical representation.

In case of Interactions, a different strategy was used. It had been possible to create just one element with an attribute “mode” that represents the chosen interaction mode, but this would not be visible for the model developer by the diagram design. Therefore, different design elements for Interaction with the different modes as icons were chosen for the modelling toolkit.

Table 1: MMI-ML: graphical representations of the model

	Interaction Element: represents the interaction		Interaction with mode movement
	Device		Interaction with mode moving image

	Interaction Entity – Communication IE		Interaction with mode picture
	Interaction Entity – Instance Manipulation IE		Interaction with mode light
	Interaction Entity – Population Manipulation IE		Interaction with mode sound
	Relations O-IA / IA-O Nested IE / Combined Interaction		Interaction with mode text

3 APPLICATION AND SCENARIO

To provide an implementation environment for the MMI-ML a modeling tool was implemented at the ADOxx® platform. This tool represents the metamodel with its grammar and language components shown in chapter 2.1.

3.1 MMI-ML OPEN SOURCE TOOL

The developed language library (Figure 2 MMI-ML official logo) is available for usage at the Austrian OMiLAB platform (URL: https://austria.omilab.org/psm/content/mmiml).

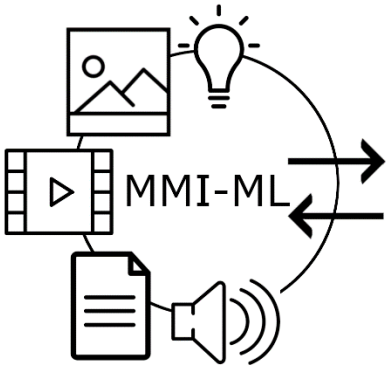


Figure 2: MMI-ML Logo

This platform provides different metamodel-based modeling toolkits and libraries referring to a variety of application fields. They are free to use for registered OMiLAB and ADOxx®users.

3.2 SCENARIO

For evaluation and testing purposes, a main-scenario was developed beforehand. This main-scenario takes place in the bathroom during the morning routine [3]. To give a short inside, a sub-scenario “washing hands” was chosen. MMI-ML is not limited to this example, it can be used during various real life scenarios were assistive smart home technologies can be used.

User Stories:

- Maria wants to wash her hands, to get rid of dirt and bacteria.
- Maria wants to dry her hands, that she can do her daily work again.
- Maria wants to take care of her hands and use the hand lotion, because she feels that her skin dries out after washing.

Sub-scenario: Maria wants to wash her hands after turning on the tap. Depending on her cognitive condition, she needs more or less help as she suffers from a mild form of dementia. Usually a reminder to turn on the tap at a reasonable temperature is enough, on other days she needs a more detailed guide. Afterwards, Maria also wants to dry her hands with a towel and to complete the process of washing her hands she always uses a lotion. Due to her physical and mental condition, she likes the tablet computer and the speakers with microphone as input / output devices the most.

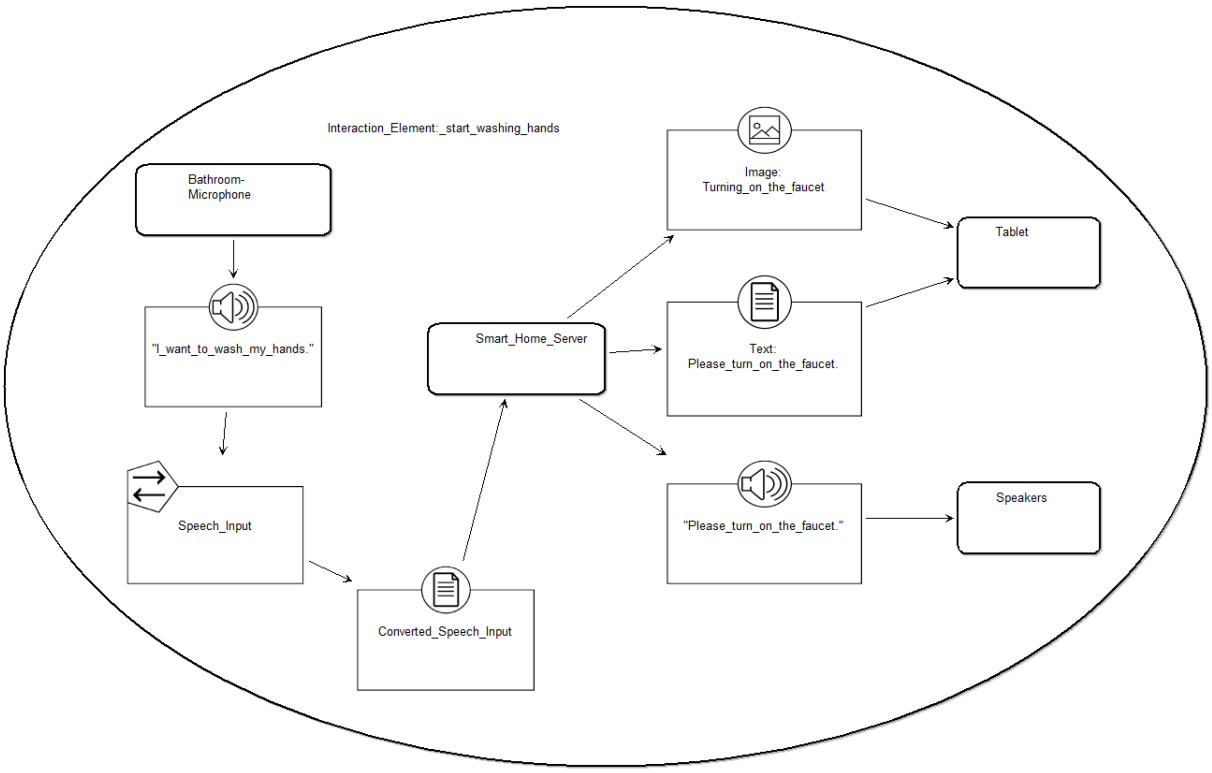


Figure 3: Sub-scenario Start washing hands model made in the MMI-ML model tool

Parts of the sub-scenario are shown in the model instance presented in Figure 3. This diagram was made with the MMI-ML modeling tool that is developed at the ADOxx® platform. The tool provides based on the MMI-ML metamodel (language and grammar) the graphical

interpretation for usage. Furthermore, the modeling tool provides the ability to export the graphical model into XML or ADL (ADOxx® definition language [4]) files. These files can be used as exchange formats in different smart home environments.

4 OUTLOOK

In the future, the library will be extended to support customized XML import and export formats for different existing smart home environments. Further, to get rid of the unimportant values from the graphical representations (e.g. position parameters of the graphics on the screen) the general XML export format will be optimized.

Over all, the MMI-ML library is not finished; it will be extended and optimized in future regarding to the feedback of the library users.

5 REFERENCES

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