Accessible Elevator
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Abstract
This paper describes an proof-of-concept with the goal of providing new interactions for elevators. By connecting the control unit of the elevator to the ISO/IEC 24752 Universal Remote Console (URC) middleware – the Universal Remote Console (UCH) – we show some examples of alternative and accessible User Interfaces. By this, we achieve not only accessible UIs, e.g., spoken language interfaces, but also more efficient and even joyful UIs.

1 Introduction
One of the major goal within the AAL community has been to create user interfaces (UIs) for appliance and services in the smart home thereby neglecting the area of environments such as entrances, pedestrian zones etc. This work extends this situation to encompass elevators. By changing the traditional user interfaces based on physical buttons and optionally displays, we achieve not only accessibility, e.g., for persons who are not able to operate traditional elevator interfaces, but also increase the comfort and fun factor as well as let users save time in everyday life.

The infrastructure on which our innovative user interfaces are based is the ISO/IEC 24752 Universal Remote Console (URC) which has successfully been used in a number of projects, such as, i2home, VITAL and MonAMI (EU/FP6), SmartSenior, SensHome etc. for realizing UIs for diverse user groups, such as, elderly, blind or cognitive impaired persons. It is our long-term goal to establish this technology as a fundamental building block when it comes to create user interfaces in public and private environments. By doing so, we provide a platform for providing personalized and thus accessible user interfaces. In the case of elevators, we increase their accessibility and enable more intelligent behaviour in reaction to the peoples' pattern of using the elevator. In the first part of this paper, we show some examples of prototypic user interfaces, allowing the user to control the elevator in a novel manner. In the second part we reveal our plans on bringing user-centric artificial intelligence to the traditional elevator.

2 Alternative User Interfaces for Elevators
With few exceptions, elevators for persons – passenger elevators – have since decades UIs based on physical buttons immediately outside as well as within the cage and possibly some output device, such as displays. Elevators in some countries are regularly equipped with speech output for uttering the reached level and/or whether the door is opening/closing. Whereas this is common in countries like England, it is not in Germany. However, the control of the elevator is almost always realized by push buttons. Sometimes the buttons are positioned so that they become reachable for wheelchair drivers, and sometimes the buttons have Braille signs. However, to our knowledge, there are up to today no alternative, mobile or accessible UIs, such as those describe in this paper. There is certainly no open platform that allows for alternative UIs – indeed many elevator controllers are interfaced with the CANopen standard1, however this platform is not meant for realizing user interfaces for passangers.

In this work, we describe several alternative user interfaces that are meant to be used via mobile devices, e.g., Smartphones. In our mobile UIs, the Smartphone is connected to the elevator via the local WiFi. By doing so, we restrict the operating range to the local environment. We use an open standardized platform called ISO/IEC 24752 Universal Remote Console (URC), e.g., http://www.openurc.org. Integration of the elevators control unit to this technology consists of writing a Target Adaptor and a Socket. The socket is an abstract

1 For instance, http://en.canopen-lift.org/
description of the functionality of the elevator that is made concrete as described above, whereas the Target Adaptor represents the driver of the external unit to be controlled, here the elevator. For more information on the URC technology, see [7]. In the future by using the URC technology it will be possible also for third-party stakeholders to create and deploy their UIs.

2.1 Web Interface for Smartphones
We have designed a HTML-based web page aimed for mobile webbrowser using CCS and Javascript. Due to this approach, no app installation on the user's device is required. The web page, see Figure 1, shows the elevator's current position, movement and the state of the door in a real-time animated graphic. This interface allows for traditional usage of the elevator, e.g. calling the elevator to the desired floor, waiting for it to arrive and not until then informing the lift about the destination floor. Additionally, it also offers an innovative sliding gesture in order to submit the desired departure and destination floor within one swipe of a finger along the graphical representation of the building's floors. This way, the elevator's controller is informed a priori about all required information, allowing for more efficient routing management.

2.2 An App
Our second user interface is a native app for Android Smartphones, see Figure 2. The app is personalizable in that the user can create his own elevator control interface to match his specific needs. For example, he can reduce the amount of control elements to two buttons, one for riding the elevator from the parking lot up to his office and the other to go back down to his car. This customization enables the user to free the interface from unused features and to concentrate on the most needed action commands. To speed-up the interface's usability the user can choose custom images to put on UI elements to remind him of what each button's function is.

2.3 Multimodal User Interface
Other experimental prototypes include control via speech or gestures. Speech control is interesting for persons with physical disabilities who are not able to push buttons either on the elevator itself or on a smartphone's touchscreen. Not only common commands like "Take me to the second floor" but also utterances like "I would like to visit Mr Alexandersson" could be interpreted. In the latter case the system would look up the floor number of this employee's office from a database (also connected to the UCH) and take the user to the appropriate floor. The
gesture interaction consists of drawing the desired floor number in the air with the Smartphone. An appropriate gesture recognition algorithm, which analyzes movement based on measurement data from the smartphone's acceleration sensor, has already been developed at the DFKI and could be reused in conjunction with this alternative approach to control an elevator, see [8].

2.4 User Interface for Reception
To this facility, for first-time visitors it is often difficult to find one's way around in the building. The idea here is to provide name and language as well as the name of his desired contact person to the reception. Following this, the visitor is requested to enter the elevator as it arrives. As soon as the visitor steps into the cage, he is welcomed by the elevator's synthesized voice with his real name in his native language. As the visitor has specified the name of his desired contact person, the elevator has determined the correct destination floor on its own (see previous section). During the ride, the elevator's voice output gives navigation directions in the visitor's language on how he will reach the desired employee's office after he will have left the elevator.

3 Conclusion
We have shown that, by using the ISO/IEC 24752 URC standard, we are able to not only realize smart and accessible but also enjoyable user interfaces which, in the end, save time and increase the comfort in everyday usage. Unfortunately, we currently have only limited read access to our elevator's control unit which we interfaced with an Arduino microcontroller. To overcome this constraint, we plan on interfacing the control unit using the CANopen standard which would allow us to gain deep access to the elevator's control logic. This way we would be able to manipulate the elevator's queue, e.g. the order in which the different floors are being approached depending on given user requests, which is essential to create the impression that the elevator behave intelligently in reaction to unpredictable user actions.

3.1 Outlook
The long-term goal of this project is to enhance the traditional elevator with advanced intelligence. There are several challenges that have to be solved in order to realize this vision:

- Is there someone in the elevator?
- Who is in the elevator?
- What is the intention of the person(s)?
- Etc

The main difference from traditional interaction is that manipulation/control has always been from in front of the elevator or from within the cage. As for now on, we don’t know exactly where the passenger is. Therefore, spoken utterances, such as, “Take me to the second floor!” cannot be interpreted since the passenger can be in the cage or outside the cage. In the latter case, the elevator should probably pick up the passenger at the relevant floor and then take him/her to the desired destination. We are currently working on several issues:

3.1.1 Classification of individuals
By using a high-resolution light curtain (one light beam per centimeter) in the cage door, we can measure the body height and direction of a passengers entering or leaving the cage. Additionally, we can recognize his/her body shape by analyzing which beams get blocked over time as the passenger passes through the light curtain.

Additionally, we will explore a pressure-sensitive sensor floor inside the cage and in front of the elevator. This would deliver information about the weight of individual passengers and the amount of people in the cage as well as in front of the elevator. The size and shape of footprints allows a distinction between female/heeled and male/flat shoes as well as between human feet and other objects like suitcases and wheelchairs.

The constellation of a passenger’s two feet (side by side, crossed-over, small/large distance from each other) is also a characteristic feature of this person. By observing the constellation of feet over time, we hope to to derive the passenger’s behaviour, for example, if he is nervous/impatient (walking around in the elevator, pattering of feet) or rather calm/relaxed (few movements, crossed legs).

3.1.2 Activity modeling
By adding this information to the passenger’s personal profile, we will be able to record an individual’s typical habits thus paving the way for activity modeling, e.g., [9]. We hope to anticipate the passenger's intention of where he wants to go. For example, if an individual rides the elevator from floor number three to the ground floor every Wednesday at around noon, the elevator will take this person down to the ground floor automatically while the user himself is not required to push any buttons at all.

This approach is dependant on the regularity of peoples' habits to make useful autonomous decisions. One-time only events, where the user wants to go to a different floor than typical, could be detected by incorporating appointments from the user's calendar and/or the history of chat messages sent to other people.

4 Literatur

