Towards Fast and Interactive Prototypes of Mobile Apps
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ABSTRACT
With the advent of modern mobile phones and tablet devices unprecedented opportunities arise to create rich user experiences that incorporate the context in which the interaction is situated. Sensors and other built-in technologies provide designers with a variety of possibilities for new and exciting applications. Since building such applications requires specialists there is an increasing demand for tools supporting people without programming skills to access, explore and design for the opportunities of mobile devices. In this paper we present a novel prototyping system named FamOz that combines the ease of paper prototyping with the efficiency of Wizard of Oz while exploiting the interactivity offered by new mobile devices. FamOz allows designers and researchers to evaluate mobile prototypes in situated real-world settings in an early stage of development.

Author Keywords
Design; Design process; Method; Mobile; Prototyping; Wizard of Oz

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION
Mobile devices offer a growing set of high quality sensor and display capabilities that form the basis of novel interaction concepts for mobile applications. Shaking the mobile device, for example, can constitute a plausible metaphor for a rolling dices application; moreover, the same gesture can also be utilized as an intuitive metaphor for denying incoming calls. The need to situate such interactions and hardware features based on people’s needs via easy-to-make and cheap prototypes, however, remains as a challenge for designers (Sá and Churchill, 2012).

In this paper, we present the concept design of FamOz (‘Fast Mobile Wizard of Ozzing’), a prototyping tool for mobile devices that we implemented for Android. FamOz combines the convenience of paper prototypes with the interactivity offered by modern mobile phones by utilizing the Wizard of Oz technique. It helps non-programmers to prototype easily and cost effectively, and to ‘move’ with these applications to real-world contexts for evaluation. We describe the architecture of FamOz and provide scenarios for illustrating how the system can enhance the understanding of future mobile interactions.

FamOz targets the research gap of supporting a wide range of the production cycle from the preparation of a task to its in-situ evaluation without relying on additional hardware or software. Consequently, FamOz allows content creation and organization on-the-fly which in turn enables the Wizard to respond to the participants both individually and instantly.

PROTOTYPING FOR DESIGNING MOBILE APPS
Low-fi techniques such as paper prototyping with Wizard of Oz testing in lab environments are powerful tools in evaluating early interaction and interface ideas without being limited by pre-defined elements (Bolchini et. al., 2009; Chandler et. al., 2002). Such techniques have the major advantage for designers to simulate essential processes and interaction ‘behind the curtain’ (Li et. al., 2010; Linnell et. al., 2012). In recent years a small number of prototyping tools utilizing the Wizard of Oz technique for mobile phones were proposed. Each of them emphasized a particular aspect like the validity of the results (Lim et. al., 2006), the contextual involvement of the Wizard (Grill et. al., 2012) or the organizational problems of the Wizard of Oz technique (Churchill et. al., 2010; Schlögl et. al., 2011). Other researchers combined Wizard of Oz components with paper prototyping, thus, bringing paper prototyping to the digital world (Li et. al., 2010) and opening new realms such as multi-display environments (Bailey et. al., 2008).

However, low-fi prototypes do not provide the necessary affordances or fidelity of experience for the user and high-fi prototypes limit the creative engagement of the participants (Raento et. al., 2005). Balancing the shortcomings of the distinct prototype approaches will remain a challenge. Further issues of a practicable prototyping tool comprise how the Wizard cognitively copes with the information and how the Wizard can be supported to react to the users input swiftly (Davis et. al., 2007). These considerations are especially important when studying novel mobile applications ‘in the wild’. Understanding the user when interacting in-situ will remain a crucial factor in the design of novel interfaces and interactions for the mobile domain and ubiquitous computing.

With FamOz we propose a mobile prototyping system that combines the advantages of various prototyping approaches, while avoiding some the shortcomings.
FamOz provides researchers with a tool for the rapid implementation of mobile prototypes with optimized Wizard of Oz support, and assists in delivering a high fidelity user experience. As it is designed ‘for the wild’, it can be used to study the user in situated contexts and hence, contributes to the research outlined in the next section.

EXPLORING MOBILE INTERACTIONS WITH PEOPLE IN THEIR USE CONTEXTS

Due to growing needs in mobile application contexts and the affordances of new technologies, several innovative hybrid design methods for mobile applications were developed to combine user insights with research outcomes. Various techniques were introduced to understand people by studying their use of mobile technologies for gathering data (Hagen et. al., 2005). Examples of such techniques are technology probes (Hutchinson et. al., 2003) and elaborated mixed ethnography where advanced feedback and reflection mechanisms through the installed technologies capture daily life and the reflection upon it (Riche et. al., 2008).

Moreover, the importance of mixed fidelity prototyping for enhancing the design space in early design stages of mobile technologies was discussed by Sá et. al. (2008). A method called video prototyping was introduced as an inexpensive early solution for exploring the potentials of augmented reality technologies (Sá et. al., 2011). Explorative prototypes such as the augmented ethnography kit (Churchill et. al., 2010) were developed and used for collecting everyday data on the go based on various sensors worn by the participants.

These and similar approaches are important advances as we lack techniques for understanding “the unique features and constraints that ubiquity, pervasiveness and the devices’ physical characteristics introduce” (Sá and Carrico, 2012). The FamOz system, as described in the next section, is our response to the need for inexpensive, effective and powerful tools for studying the use of mobile apps in-situ.

THE FAMOZ SYSTEM

Combining Wizard of Oz with paper prototyping, while adding the capabilities offered by modern mobile devices within a single prototyping tool, brings several benefits for researchers and designers: (1) it enables easy prototyping in real world settings, (2) it allows access to sensors and actuators without programming knowledge, (3) it enables a more seamless user interface (UI) and user experience independent of pre-defined interface elements or interaction sequences, (4) studies can be conducted in-situ without being dependent on a heavily equipped laboratory. These opportunities open interesting possibilities such as moving out of the lab environment and exploring participants where real interactions take place.

FamOz is our contribution to extending existing prototyping techniques to mobile and sensor rich in-situ prototyping. It facilitates the prototyping of mobile phone and tablet applications and enhances them with modern sensors and actuators as offered by these devices.

Figure 1. The participant's mobile phone (background) and the tablet computer of the Wizard (foreground) are paired wirelessly. Input of the participant is displayed on the Wizard’s device (‘live-view’), where the Wizard can react to it remotely.

Thereby, FamOz addresses a target group that is interested in designing and evaluating new interfaces rather than in implementing software. Thus, the proposed system (FamOz) conceals technical details while offering a broad variety of interaction mechanisms.

As a piece of software FamOz provides the Wizard with tools for the remote-monitoring of the participant’s current (real time) device interactions (e.g., tilting the participants’ device, touching the screen) and for the remote-triggering of actions on the participant’s device like switching screens or starting vibration alerts (see Illustration in Figure 1).

The system comprises three hierarchical and conceptual layers. The lower two layers hide communication and sensor details from the UI designer whereas the third layer offers screen utilities for building the interfaces to be tested in-situ.

Layer 1 - Communication

Prerequisites for using FamOz are at least two Android devices paired via WiFi – one device assigned to the Wizard and one device to the participant. This assignment constitutes the first step in setting up FamOz. In a second step, the communication between the devices is finalized semi-automatically. We go on to explain technical details of setting up FamOz with an example (see Figure 2 to follow the example step-by-step). This example ought also aid the reader in understanding the interplay and structure of the three physical components of the FamOz system (mobile device of the participant, mobile device of the Wizard, and utility server).

We set the first device as the participant's device (1) as shown in Figure 2 (see next page), where the participant’s device displays its IP address and editable name (e.g., “ZEBRA”) (2). The device sends its IP and name to the server (3). The IP of the server is known by FamOz as a default value and can be edited. The second device is set as the Wizard’s device (4). The device is set and shows its IP and editable name (e.g., “ZULU”) (5). The device sends its IP and name to the server (6). The server sends a list of connected participant devices to the Wizard's device (7). The Wizard selects a participant’s device and sends the selection to the server (8). The server sends name and IP to the devices (9). After this introduction both devices dispose of each other’s name...
is basically a remote display for screens that are chosen by the Wizard. The participant’s screen interactions and touch inputs are transmitted back to the Wizard’s device instantly and are displayed as a map-overlay indicating the ‘touch positions’. The Wizard, on the other hand, responds to and manages both participant and sensor input. Depending on the input, the Wizard decides what screen (i.e., sketch, see next paragraph) and what information is to be delivered to the participant and initializes this action. The Wizard’s device features two main functions for supporting the selection of sketches to be displayed on the participant’s device:

1) Sketching: Sketches can be photos of drawings made with paper and pencil, screenshots from existing interfaces, images of objects or anything else that can be captured with a camera and seems meaningful to the UI designer. All sketches are stored in a repository on the Wizard’s device. Whenever a selection is made by the Wizard the corresponding sketch is displayed on the participant’s device immediately as the current UI screen. In addition, Internet access serves as an additional resource for relevant information, data and media items to respond to the participant’s input in-situ.

2) Enriching: We call the process of augmenting the sketch with interactive elements like sensor data or multimedia elements enriching. To this end, the Wizard’s UI is split into sections (see illustration in Figure 3).

The current screen of the participant’s device is displayed on the very left (i.e., ‘what the participant sees’). The remainder of the screen provides either 1) an overview of sensor readings transmitted by the participant’s device 2) an overview of all available sketches/photos/actions/intents 3) an Internet browser. The prototype is enriched by two ways. First, sensor data describe the state of the participant’s device. Second, the Wizard can trigger actuators (e.g., vibration alerts) or build-in apps (e.g., the camera app/intent) on the participant’s device remotely.

Combining the generic components described above with paper-prototypes and Wizard of Oz techniques exposes the participant to the experience of an interactive prototype without the need for the researcher of implementing such functionalities. Augmenting FamOz with elements such as pop-up dialogs or input boxes can be obtained easily by utilizing intents.

We go on to briefly describe three fictitious scenarios for further illustrating how FamOz can be used in the initial exploration of novel mobile apps in different ‘real-world’ settings. Each scenario features highly interactive applications that are ‘mimicked’ by the Wizard applying FamOz.

SCENARIOS
1) The Co-Design of an app to help patients lose weight: A mobile app assists patients in controlling their diet by logging their health behavior (diet). The patient (participant) is allowed to eat only specific food products, but is not experienced in recording daily routine activities. The participant starts the app ‘in the wild’ (at home) and, for example, takes a photo of some specific food. The photo is automatically transmitted to the

and IP address. From that moment on they can communicate either directly or via the server as a relay and the setup is complete. This procedure does not require any technical knowledge and can be carried out within a few minutes. It has to be performed only once.

The server is a software component built in the participant’s and Wizard’s device. It is depicted as a separate device only for clarification.

Layer 2 – Sensors, Actuators and Intents
Sensor data of the participant’s device are sent to the Wizard’s device as a constant stream. To reduce the amount of data, sensors can be activated and deactivated. FamOz features the following sensor data: accelerometer, position, ambient light, compass, microphone and camera. Actuators comprise the vibration-motor and the speaker. Intents are an Android specific concept for calling system functions and other applications to gather data or to perform certain actions such as showing the software keyboard. Both, actuators and intents, on the participant’s device can be triggered remotely from the Wizard’s device by pressing the associated FamOz UI button.

Layer 3 – User Interface
The concept of the Wizard of Oz method is to use human cognition for perceiving and reacting to complex unstructured data. As the Wizard has to mimic the system’s logic, the UIs of the participant’s device and of the Wizard’s device differ. The participant interacts with screens selected by the Wizard. Thus, the participant’s UI is basically a remote display for screens that are chosen by the Wizard. The participant’s screen interactions and touch inputs are transmitted back to the Wizard’s device instantly and are displayed as a map-overlay indicating the ‘touch positions’. The Wizard, on the other hand, responds to and manages both participant and sensor input. Depending on the input, the Wizard decides what screen (i.e., sketch, see next paragraph) and what information is to be delivered to the participant and initializes this action. The Wizard’s device features two main functions for supporting the selection of sketches to be displayed on the participant’s device:

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Wizard’s device. The Wizard analyzes the content of the photo and sends a corresponding recommendation back to the participant’s phone, for instance, approval or disapproval of this particular meal. The participant again can respond to the information, for example, asking a question via texting, whereas the Wizard can offer their answer spontaneously in return. If certain elements of the UI are missing, designers can draw or create new sketches ‘on the fly’ and integrate them into the prototype application. The sequences of this co-design process are automatically recorded (including interactions with sensors). Eventually, these recorded sequences can aid the designers in analyzing and finalizing their concept.

(2) In-situ testing of an explorative travel app for tourists: The participant ‘hits the road’ as pre-defined by the Wizard and their location is transferred and recorded by FamOz. On request, the Wizard sends data, that is, when the participant takes a photo of a building and is demanding further information. Each time something remarkable happens (e.g., passing by musicians on the street), the Wizard pushes a notification inviting to explore a function of the app (e.g., “Do you want to determine your GPS location and upload a photo of the musicians to your map?”). This leads to the exploration of new serendipitous ways for route planning and leisure time.

(3) Disruptive explorations: Despite being a common design method, disruptive exploration is rarely used in mobile design. Due to the ability of FamOz to react to the participants’ input in-situ, contextually surprising or irritating responses from the Wizard can provoke interesting participant reactions and thus enable new insights into given contexts. Areas of applications comprise, for instance, testing negative scenarios of data protection, privacy and the like.

FUTURE WORK
In this paper we presented the concept of the FamOz prototyping tool, implemented for Android. One reason for employing Android is its intent mechanism that offers a feasible way for accessing built-in components such as the camera, text input or various sensors. Such intents enrich low-fi prototypes with high-fi interactivity and allow studying real-world interaction in-situ at low cost. FamOz has the potential for empowering non-programmers (e.g., usability experts or non-expert participants) to take part in the creation of novel concepts for the mobile domain. Offering intuitive tools for the creation of sensor-rich mobile prototypes can broaden the use space for such applications even more.

FamOz sets itself apart from existing prototyping tools by allowing the Wizard to interact with the participant in-situ without the need for additional software and hardware. This all-in-one approach showed promising results in initial user tests, however, it raises three research questions for future work: (1) How will the Wizard cope with the constraints of mobile devices? (2) How will the Wizard handle the cognitive load involved in mimicking the system’s logic? (3) How will the participant deal with possible delays when waiting for responses?

REFERENCES