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Pen and Display: A Multimodal Interaction Approach for Older Office Employees

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Abstract. Pen and paper are still common tools in the daily work routine, especially of older office employees. In this position paper we present "Organio", a concept of combining (analogue) pen and paper interaction and page tracking with a digital display. This novel digitally-enhanced pen and paper solution relies on a page tracking mechanism to provide digital content to the selected page in an analogue calendar. Building on a recent case study research on older computer workers and related work we describe a first calendar mock-up enhanced with a digital display, an interaction concept, and a setup for evaluating the proposed solution in a *Wizard of Oz* study. We conclude with ideas for future study concepts to investigate the overall user experience, user acceptance and possible form factors. Moreover using the *Wizard of Oz* approach we aim for gathering user expectations and possible usage scenarios.

1 Introduction

The work routine of older office employees still relies heavily on pen and paper, as observed by Gattol et al. [4] in a recent case study. In this position paper we investigate possibilities to digitally support older office workers without changing the pattern of analogue pen and paper interaction.

We focus on how to support older office employees with a mixed modality interaction approach that capitalizes on interaction patterns familiar to this target group, yet compatible with today's digital office environments. We present a concept of combining analogue pen and paper interaction with a digital display to allow for multimodal interaction, called *Organio*. We address common time and task management needs and explore possibilities to integrate familiar analogue forms of interaction (e.g. note taking) into digital work processes (e.g. meeting scheduling).

2 Related Work

The aim of this position paper is to describe a concept that enhances the current workflow of older adults. In [4] Gattol et al. observed that analogue calendars are still a main source to store all kinds of information, e.g. appointments, to-do lists, etc. Yet, this behavior can be cumbersome, keeping in mind that information with colleagues and customers is often exchanged by email and meetings are scheduled electronically in a groupware system. Presently, this results in redundant (and thus often inconsistent) storage of information, e.g., when a meeting is scheduled electronically and then written down in the analogue calendar as well.

To provide appropriate digital content to a certain calendar page a method to track the page of the analogue calendar viewed by the user is needed, to provide the corresponding information on the digital display. So far only few approaches for tracking pages have been proposed. Iwaki et al. [7] proposed tags on paper and a camera system to track and identify pages. Back et al. [1] used RFID tags embedded in the pages. Fujinami et al. [3] used accelerometer data for detecting page flipping events. For our work we will follow the approach by Back et al. [1], as this seems to be the most accurate solution.

Multiple approaches have been proposed to support pen and paper interaction. For example Heinrichs et al. proposed design recommendations and a meta model for pen paper interaction [5,6]. Chuang et al. [2] have presented a system to support students by enhancing textbooks with a digital pen. Related to our approach is the work of Williamson et al. [8] who have proposed a pen and paper based reminder/calendar system in the domain of Ambient Assisted Living (AAL). In contrast to our approach, events written down in a paper calendar have only been used to trigger reminders but have not been integrated into a more complex routine like office work. Apart from that our contribution is also the strong focus on the context of office work and on older employees, which results in different design considerations than reminder systems in the domain of AAL.

3 Development of the Concept

Our main research question is how we can support the work routine of older computer workers that relies heavily on pen and paper interactions.

We introduce a concept for a digitally-enhanced pen and paper solution that can help cross the digital chasm and integrates into the work routine of older office employees.

This idea is based on insights derived from a case study research on older computer workers, conducted in a company developing and maintaining point of sale payment systems. The case study relied on a multi-method approach (i.e., contextual interviews & observations, an analysis of needs and frictions, a feature ideation workshop, and an expert evaluation of the resulting feature ideas) for specifying the user requirements [4]. The following three insights, reported in the above paper and formulated from the perspective of the user, give a glimpse of the underlying need in our target group for some form of traditional or analogue time and task management solution that is also compatible with today's digital office environments (pp. 6):

- "I need to keep track of open tasks but carrying them over (e.g., from my agenda to Outlook) takes effort."
- "I need to share information digitally but there is no efficient way of digitizing hand-written information."
- "I plan my day on paper because I don't see the benefit of digital solutions."

Based on these insights the authors reported the following preliminary feature ideas (pp. 7):

- Private Digital Noteboard: an always visible second screen at personal desk, used for highlighting urgent tasks, clustering tasks, etc.
- Public Digital Noteboard: an always visible second screen at a wall, used in conjunction with the Private Digital Noteboard.
- Digital Paper Calendar: a paper calendar capable of automatically digitizing hand-written notes, using digital paper or a digital pen as input.

Thus, given these insights and preliminary feature ideas, our idea for a novel digitally-enhanced pen and paper solution addresses a common and relevant need of older office employees (cf. [4]). In our work we combine page tracking and pen and paper calendar systems to develop a solution specifically for older office employees to be used in their normal work environments. Although parts of our approach have been covered in related work [1,8], to the best of our knowledge no similar system has been proposed in the context of work support for older office employees. Therefore we enhance the work of Williamson et al. [8] by providing a digital layer of information to every calendar page by using page tracking approaches by Back et al. [1].

In the following two sections we will elaborate on the interaction concept that we conceived of and describe a setup for evaluating the prototype in a Wizard of Oz study.

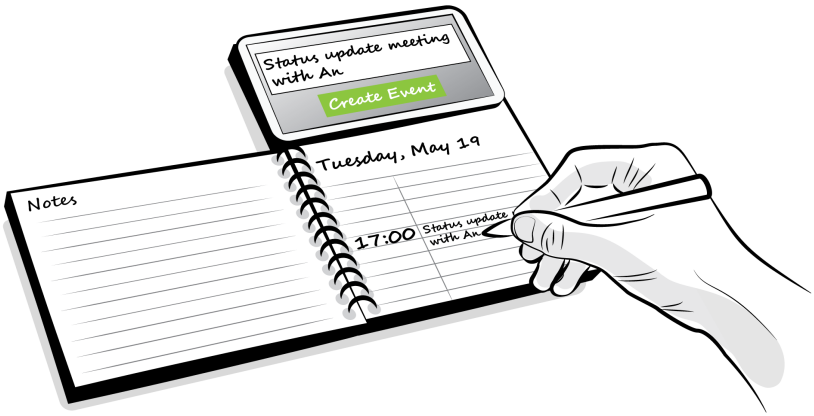

Figure 1. Mock-up of the Organio prototype concept - e.g. an employee is writing a calendar event which is previewed on the display and suggests creating an event

3.1 Interaction Concept

Organio aims to fit into typical workplace use cases, such as calendar applications (e.g. to organize meetings) or note taking (e.g. to manage a list of to-dos). The proposed concept, as illustrated in Figure 1, consists of a paper calendar with a touch display on top that is aware of the current page. Furthermore, it is supplemented with a smart pen which digitizes the hand-written input and tracks the position on the paper. The pages are prepopulated with templates to fill in notes (left page) and calendar events (right page).

The combination of these technologies enables a variety of interactions we want to investigate:

- *Touch input:* Touch input on the display allows recognizing single-touch (e.g. tapping a button) or multi-touch (e.g. pinch gesture to zoom) gestures.
- *Graphic output:* A graphic display for displaying digital content (e.g. event invitations).
- *Digitized hand-writing:* Analogue hand-written content is digitized by a smart pen and enables OCR analysis or tracking the pen position on the paper (e.g. to detect the time of the day).
- *Page flipping:* An essential interaction with *Organio* is the page-flipping mechanism that allows viewing content corresponding to a specific page (e.g. shared calendars of colleagues based on the date of the current calendar page).
- *Pen gestures:* Utilizing the smart pen for interactions with the written content on the paper opens several possibilities (e.g. mapping common hand-writing behaviors to certain actions: striking through words to delete a to-do; writing a check mark next to a line to mark a to-do as done). These interactions are common routines and can be synchronized

with a digital system. Other gestures can include circling words to select them (although without using real ink) or introducing "action words", e.g. a "T" as a prefix to indicate that the following content should be interpreted as a to-do.

The proposed combination of page tracking, pen and paper input and a digital display strives to seamlessly integrate common behaviors with widely used paper-based calendars by focusing on interaction patterns and habits that are familiar to our target group of older office workers. For example by using *Organio* a user can take notes on paper for preparing a meeting, while at the same time the user can participate in an organization's digital workflow (e.g. syncing the meetings calendar events with the groupware software). Moreover the user can share the pen and paper notes with his or her colleagues.

3.2 Wizard of Oz Prototype

We propose a prototype that allows investigation of the page tracking mechanism, as this is a crucial part in our concept. We developed a low fidelity prototype, enhanced by interactivity using a Wizard of Oz approach to simulate the page flipping / tracking mechanism for the users. In this prototype we combined a Nexus 5 smartphone and a paper block. To simulate the page flipping mechanism, we developed a smartphone application that allows for remotely switching screens on the *Organio* screen. For this reason two phones are connected using a basic Bluetooth message exchange application. When the user switches a page the facilitator presses a button on the second device, which results in a message being transferred via Bluetooth to the *Organio* and subsequently a reaction based to that message. For example (1) the user flips a page to the left, (2) the facilitator presses a button to change content; (3) a message is sent via Bluetooth from the facilitator's device to the *Organio* and (4) the content appears on the *Organio* screen accordingly.

The described prototype will be used in future studies to evaluate the proposed interaction concept with special focus on the user acceptance of the page tracking mechanism.

4 Discussion and Future Work

In this position paper we proposed a concept called *Organio* for integrating an analogue pen and paper solution into the digital work routine of older office employees. *Organio* provides digital content corresponding to the current page in an analogue calendar and suitable interfaces for sharing and distributing pen

produced content. In the future we see *Organio* in combination with a personal display located on the desk and a public display to share content.

In future work we want to investigate the feasibility and user experience of the overall approach in a co-design workshop and a user study. In the co-design workshop users will be provided with a lo-fi mock-up of the proposed pen, paper and display solution. In the workshop we want to discuss the overall concept, its applicability to different work domains, what kind of analogue content the users are willing to share and,investigate the optimal form factor. Subsequently we will conduct a user study with a Wizard of Oz prototype to simulate the page tracking mechanism for users. Using this Wizard of Oz prototype we aim to investigate the acceptance of the pen, paper and display solution and moreover gain deeper insights into the users anticipation how the proposed solutions fits into their work routine.

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