
Towards a Novel Digital Household Account Book

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Abstract

We introduce the concept of a novel digital household account book which lessens the burden of manually entering single items. In this paper, we present the results of two studies. We first conducted an online questionnaire with 142 participants to assess requirements. One of the lessons learned supports our initial notion to enhance digital household account books with automatic receipt capturing for increasing the acceptance rate. Subsequently, we analyzed a corpus of 117 German receipts in a technical study to learn about their structure and content. The results from these two studies form the basis for the realization of the concept.

Author Keywords

Household account book; Automatic receipt capturing; Receipt analysis; User centered design

ACM Classification Keywords

I.7.5 [Document and text processing]: Document capture; H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous.

Introduction

Point-of-sale scanners and loyalty card programs offer companies a lot of information on their customers [2]. Unfortunately, this information is typically not available to

Date	Description	Amount	Balance
01/12	Christmas Dinner	2400	
01/12	Christmas	49.50	2449.50
01/12	Reading	7.65	2457.15
02/12	Weekly Shopping	171.72	2628.87
02/12	Restaurant "Luzerne"	6.00	2634.87
02/12	Bank	1800	834.87
02/12	Wages	2000	2834.87
02/12	Utilities	100	2734.87
02/12	Insurance	150	2584.87
02/12	Charitable contributions	5.00	2579.87
02/12	Charitable contrib	100	2479.87
02/12	Charitable contrib	100	2379.87
02/12	Charitable contrib	100	2279.87
02/12	Charitable contrib	100	2179.87
02/12	Charitable contrib	100	2079.87
02/12	Charitable contrib	100	1979.87
02/12	Charitable contrib	100	1879.87
02/12	Charitable contrib	100	1779.87
02/12	Charitable contrib	100	1679.87
02/12	Charitable contrib	100	1579.87
02/12	Charitable contrib	100	1479.87
02/12	Charitable contrib	100	1379.87
02/12	Charitable contrib	100	1279.87
02/12	Charitable contrib	100	1179.87
02/12	Charitable contrib	100	1079.87
02/12	Charitable contrib	100	979.87
02/12	Charitable contrib	100	879.87
02/12	Charitable contrib	100	779.87
02/12	Charitable contrib	100	679.87
02/12	Charitable contrib	100	579.87
02/12	Charitable contrib	100	479.87
02/12	Charitable contrib	100	379.87
02/12	Charitable contrib	100	279.87
02/12	Charitable contrib	100	179.87
02/12	Charitable contrib	100	79.87
02/12	Charitable contrib	100	-20.13
02/12	Charitable contrib	100	-120.13
02/12	Charitable contrib	100	-220.13
02/12	Charitable contrib	100	-320.13
02/12	Charitable contrib	100	-420.13
02/12	Charitable contrib	100	-520.13
02/12	Charitable contrib	100	-620.13
02/12	Charitable contrib	100	-720.13
02/12	Charitable contrib	100	-820.13
02/12	Charitable contrib	100	-920.13
02/12	Charitable contrib	100	-1020.13
02/12	Charitable contrib	100	-1120.13
02/12	Charitable contrib	100	-1220.13
02/12	Charitable contrib	100	-1320.13
02/12	Charitable contrib	100	-1420.13
02/12	Charitable contrib	100	-1520.13
02/12	Charitable contrib	100	-1620.13
02/12	Charitable contrib	100	-1720.13
02/12	Charitable contrib	100	-1820.13
02/12	Charitable contrib	100	-1920.13
02/12	Charitable contrib	100	-2020.13
02/12	Charitable contrib	100	-2120.13
02/12	Charitable contrib	100	-2220.13
02/12	Charitable contrib	100	-2320.13
02/12	Charitable contrib	100	-2420.13
02/12	Charitable contrib	100	-2520.13
02/12	Charitable contrib	100	-2620.13
02/12	Charitable contrib	100	-2720.13
02/12	Charitable contrib	100	-2820.13
02/12	Charitable contrib	100	-2920.13
02/12	Charitable contrib	100	-3020.13
02/12	Charitable contrib	100	-3120.13
02/12	Charitable contrib	100	-3220.13
02/12	Charitable contrib	100	-3320.13
02/12	Charitable contrib	100	-3420.13
02/12	Charitable contrib	100	-3520.13
02/12	Charitable contrib	100	-3620.13
02/12	Charitable contrib	100	-3720.13
02/12	Charitable contrib	100	-3820.13
02/12	Charitable contrib	100	-3920.13
02/12	Charitable contrib	100	-4020.13
02/12	Charitable contrib	100	-4120.13
02/12	Charitable contrib	100	-4220.13
02/12	Charitable contrib	100	-4320.13
02/12	Charitable contrib	100	-4420.13
02/12	Charitable contrib	100	-4520.13
02/12	Charitable contrib	100	-4620.13
02/12	Charitable contrib	100	-4720.13
02/12	Charitable contrib	100	-4820.13
02/12	Charitable contrib	100	-4920.13
02/12	Charitable contrib	100	-5020.13
02/12	Charitable contrib	100	-5120.13
02/12	Charitable contrib	100	-5220.13
02/12	Charitable contrib	100	-5320.13
02/12	Charitable contrib	100	-5420.13
02/12	Charitable contrib	100	-5520.13
02/12	Charitable contrib	100	-5620.13
02/12	Charitable contrib	100	-5720.13
02/12	Charitable contrib	100	-5820.13
02/12	Charitable contrib	100	-5920.13
02/12	Charitable contrib	100	-6020.13
02/12	Charitable contrib	100	-6120.13
02/12	Charitable contrib	100	-6220.13
02/12	Charitable contrib	100	-6320.13
02/12	Charitable contrib	100	-6420.13
02/12	Charitable contrib	100	-6520.13
02/12	Charitable contrib	100	-6620.13
02/12	Charitable contrib	100	-6720.13
02/12	Charitable contrib	100	-6820.13
02/12	Charitable contrib	100	-6920.13
02/12	Charitable contrib	100	-7020.13
02/12	Charitable contrib	100	-7120.13
02/12	Charitable contrib	100	-7220.13
02/12	Charitable contrib	100	-7320.13
02/12	Charitable contrib	100	-7420.13
02/12	Charitable contrib	100	-7520.13
02/12	Charitable contrib	100	-7620.13
02/12	Charitable contrib	100	-7720.13
02/12	Charitable contrib	100	-7820.13
02/12	Charitable contrib	100	-7920.13
02/12	Charitable contrib	100	-8020.13
02/12	Charitable contrib	100	-8120.13
02/12	Charitable contrib	100	-8220.13
02/12	Charitable contrib	100	-8320.13
02/12	Charitable contrib	100	-8420.13
02/12	Charitable contrib	100	-8520.13
02/12	Charitable contrib	100	-8620.13
02/12	Charitable contrib	100	-8720.13
02/12	Charitable contrib	100	-8820.13
02/12	Charitable contrib	100	-8920.13
02/12	Charitable contrib	100	-9020.13
02/12	Charitable contrib	100	-9120.13
02/12	Charitable contrib	100	-9220.13
02/12	Charitable contrib	100	-9320.13
02/12	Charitable contrib	100	-9420.13
02/12	Charitable contrib	100	-9520.13
02/12	Charitable contrib	100	-9620.13
02/12	Charitable contrib	100	-9720.13
02/12	Charitable contrib	100	-9820.13
02/12	Charitable contrib	100	-9920.13
02/12	Charitable contrib	100	-10000.00

Figure 1: Analog household ledger.

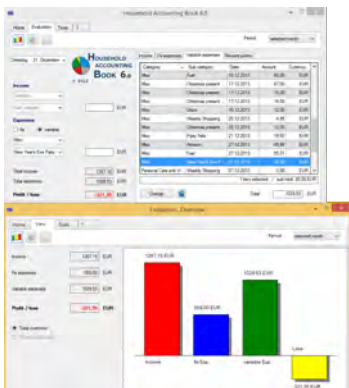


Figure 2: Digital household account book.¹

the customers themselves, although it might be useful to them, e.g. to keep track of purchases in combination with a budgeting tool for people with financial difficulties [1]. Thus, people interested in getting an overview of their expenses have to gather their purchases manually. A classical approach for this is an analog household ledger (see Figure 1). Besides entering and categorizing all data, all analysis, e.g. summing up of entries, also has to be done manually. As a first step towards digitization, computer programs were developed (see Figure 2). With the help of such programs, mainly the evaluation part is simplified, e.g. graphs can be generated to ease data interpretation. The main burden of entering the purchase data and assigning expenses to appropriate categories is still a time-consuming process. Moreover, thoroughly-kept household account books can also help in other situations, e.g. remembering food purchases for an analysis of eating habits. The increasing distribution of smartphones with built-in cameras and the maturity of optical character recognition (OCR) [4] offer new possibilities for digital household account books. We will provide the concept for a mobile app that makes use of these technologies to capture and automatically process receipts to simplify keeping a household account book. In a second step, we will implement this app as a testbed for further research.

Concept

We plan to develop a novel digital household account book as an application for smartphones with two main components: the first one covers the functionality of a traditional household account book enriched by advanced evaluation functions. As core features, purchases can be entered and assigned to categories, and based on this data, evaluations like weekly or monthly expenses, overall or category-specific, can be generated and presented in

numbers or charts. The other component targets the entering of purchase information. Based on the smartphone's camera and OCR, we offer automatic receipt capturing. As a main benefit, users are no longer required to enter their purchases manually. Moreover, we go one step further and aim to not only cover a complete receipt as one entry but offer item-specific recognition and as a consequence, also allow a more detailed categorization. Especially in multi-purpose stores where you can buy products from different categories, this ensures evaluations with higher precision. For this second component, we will utilize a crowd-based approach for improving the OCR and the categorization options.

Related Work

The work of Zhu et al. [7] from 2007 describes an early approach for automated expense reimbursement based on digitizing receipts with the help of Conditional Random Fields. In contrast to our approach, only certain elements like the date, credit card number or merchant name were extracted, whereas the individual item names and their associated prices were not further considered.

Tokunaga et al. [6] present a system for storing receipts as part of a lifelog. With the help of a receipt scanner, receipts can be digitized and made available via their so-called ReceiptLogAPI. Based on this, they sketch a social network application but only with limited functionality like reviewing and sharing receipts and basic reporting. Our concept goes further by providing an automated categorization of scanned items as would be done in physical household ledgers. Based on this, more fine-grained reports can provide insights into buying habits. To allow easy use of the system, we will not rely on specialized hardware, but provide a system that can be used with a standard smartphone.

¹Household Accounting Book 6.0, <http://goo.gl/V7kGrN>

The work of Janssen et al. [3] shows the basic feasibility of extracting information from single sided documents captured by a cell phone camera. The authors illustrate their approach based on a grocery store receipt, but similar to Zhu et al., only certain elements were

The approach of Shen and Tijerino [5] shows another possibility for extracting information from receipts based on ontologies, but as it relies on 100% perfect OCR results, it may not be directly applicable under the circumstances we will encounter. Nonetheless, it may be meaningful to follow such an information extraction approach after having validated the scanned data, e.g. based on a community-driven review process.

We also looked at related commercially available systems. Similar to the aforementioned computer programs, existing mobile account book apps² require manual input of purchases. In contrast, systems which monitor individual credit/debit accounts³ can automate this at least for some purchases, but require access to very sensitive personal data. Approaches with dedicated scanners and digital filing systems⁴ overcome this problem but require special hardware. With our app concept, we provide a capability for automatic receipt capturing without the need for providing sensitive information or purchasing special hardware. Nonetheless, further investigation of these approaches, especially with respect to their design, may be worthwhile and will be done with results found in our studies.

²e.g. Watch My Money, www.google.com/search?q=watchmymoney.com, Retrieved: 16/02/2014
³e.g. Mint, www.mint.com, Retrieved: 16/02/2014
⁴e.g. NeatReceipts, www.neat.com, Retrieved: 16/02/2014

Studies

We followed two orthogonal approaches to validate our concept. In a user-centered design process, we are conducting an online questionnaire to gather information on the usage patterns and user requirements for a digital household accounting book. For the receipt scanning, we analyzed receipts to gain insight into their structure, which will later be used for the OCR algorithm.

Online questionnaire

We directed this study towards the household account book, its usage patterns and the user's requirements for a digital version. Furthermore, we use the questionnaire to get insights into the favored level of detail regarding the categorization of items. To get a broad range of opinions, we decided to use an online questionnaire which is still underway at the time of this writing. We will therefore present preliminary results based on the answers we received in the first 15 days. To this point, 142 German people (67 female) from different age groups and backgrounds have participated. Concerning age, the data is currently skewed younger (77.5% are less than 26 years old). This can be explained due to the way the questionnaire was publicized (mostly social media and student mailing lists). We now advertise the questionnaire in forums covering topics such as living and finances to receive answers from potentially older participants. As expected, most participants were students (52.8%). Nevertheless, the living situation of the 141 participants who answered this question was better distributed: 46.8% live alone, with a partner or with a partner and children in a flat or house; 15.6% live in a shared apartment, 36.9% live with their parents and 0.7% live in barracks. Hence, for the majority, a household account book seems to be clearly suitable but for participants who live with their parents a household account book might still be useful.

	Too much effort	No interest	Missing receipts	Cashless purchases / Statement sufficient	Forgetfulness	Other
Take photo at store	71,13 %					
Scan at home	18,31 %					
Manually	9,86 %					
Other	0,7 %					
Single products	15,49 %					
Complete purchase	47,89 %					
Both	26,06 %					
Neither	2,82 %					
Other	7,75 %					
	82	16	45	5	81	7

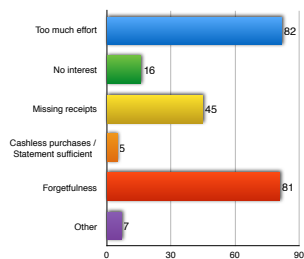
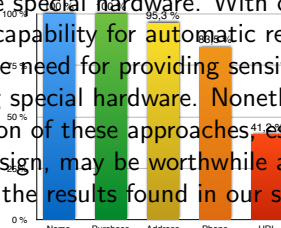
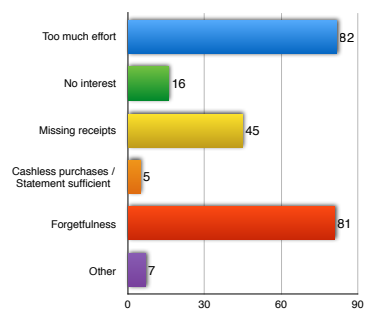


Figure 3: Frequency of reasons for not keeping a household account book.



Both	26,06 %										
Neither	2,82 %										
Other	7,75 %										
Work-in-Progress		5	81	7		100 %	100 %	95,3 %	83,5 %	41,2 %	



of shopping behavior, the questionnaire should help to validate the following hypotheses:

- H1** The main reason for not keeping a household account book is the effort involved.
- H2** People are interested in registering single products.
- H3** The concept of our app increases the willingness to keep a household account book.

Only a minority (16.2%) uses household account books; mostly (56.5%) non-digital, in spreadsheet software (30.4%) and / or within a smartphone app (21.7%). None of the participants uses a dedicated computer program. We asked for reasons why people do not keep one.

Figure 3 shows the distribution (multiple answers were possible). The answers show clear evidence for H1, but surprisingly, they also show another problem: People fear that they would not fill out the household account book completely. Thus, we reason that our app needs to have a reminder function. 27.7% of the participants used a household account book but stopped doing so at some point; the most often mentioned explanation supports H1 even further: it is too much work (72.7%) and again 9% mention forgetfulness as a problem. For all these questions we allowed users to give additional free text answers, but no definite conclusions can be drawn from the given answers. We also asked questions to assess buying behavior. First, we learned that the majority of the participants who own a smartphone or tablet (85.2%) always have it available during their shopping (71.9%) or at least most of the time (22.3%).

Second, the participants visit weekly farmer's markets (30.9%) and other specialized markets (70.4%) at least infrequently, which is a challenge due to the way receipts are provided there. Third, only a minority of the people that buy

groceries at least sometimes have specific days on which they do so (24.2%, which makes a reminder functionality based on days less useful). Fourth, 43.7% own a discount card, which shows us that the proposed app needs to be able to correctly deduce discounts on receipts.

Figure 4 shows the distribution of how people would categorize their expenses. Surprisingly, 47.9% of the participants prefer to log a complete purchase as a single entry. This rejects H2. We further analyzed the given answers and found out that 58.2% of the women preferred this option whereas only 38.7% of the men did so. Our conducted Chi-square test with Yates' continuity correction revealed that this differs significantly ($\chi^2(1, N = 142) = 4.66, p < 0.05, \phi = 0.195$). For our app, we decided to offer both options: a purchase can be logged as one entity or every product can be added individually. To receive evidence for H3, we explained the general concept of our app ("the app captures receipts and stores their content in a digital household account book with additional metadata (e.g. date of purchase, name of the store)") and asked the participants what their preferred way of capturing receipts would be. Figure 5 shows that taking a photo seems to be most suitable, which is consistent with our approach. 90.8% of the participants stated that they would use a household account book if the receipt capturing could be done automatically. We see this as first solid evidence for H3, as the only action participants need to do within the app is to capture the receipt with their smartphone's camera. Nevertheless, we acknowledge that an "in-the-wild" study is necessary to completely validate this hypothesis.

Receipt analysis

In this second study, we aim at technical aspects which inform the receipt capturing process. As stated by Shen

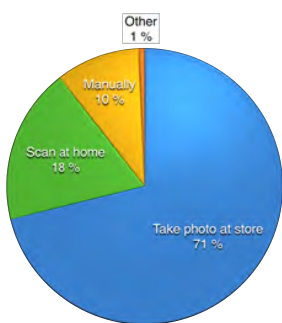


Figure 5: Distribution of preferred receipt capturing techniques.



and Tijerino [5], one of the problems in automated receipt processing is that receipts have no uniform format. As it is crucial for our app to be able to capture the content of receipts, we started with an in-depth analysis of 117 German receipts from 85 different shops (supermarkets, clothing stores, electronics shops, drugstores, stationery shops, DIY markets, gas stations, department stores, gift shops, restaurants and hardware shops) to deduce an initial model. We identified three sections (see Figure 6):

1. **Header information:** For capturing expenses, it is relevant to collect information on the purchase, i.e. the store's name or the date on the receipt.
2. **Body information:** As a minimum requirement, we must be able to identify the total sum on the receipt. For a detailed recognition, we are required to identify individual products (name, price and quantity) as well as additional information like discounts or bottle deposits.
3. **Additional information:** This section contains entries not directly necessary for the capturing process. Nonetheless, there may be information, e.g. a web address that could be helpful if the header cannot be parsed correctly.

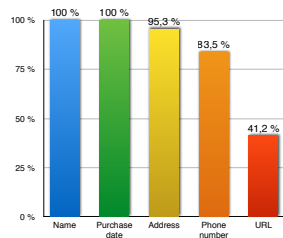
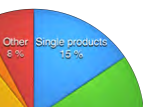


Figure 7: Frequency of included header information.

For the analysis, we focused on the first two sections. In the header, we found five entities: the store's name, date of purchase, address, telephone number and web address. Figure 7 shows their distribution in percentages. We learned that the header always contained the store's name (as plain text (84.7%) or as a logo (15.3%)) and the date of purchase. Besides, in 95.3% of cases, the address was given, which opens up possibilities for identifying the store even if the logo or name could not be parsed properly.

In the body, we determined seven ways of arranging the article names, corresponding prices and additional information (S1-S7, cf. Figure 8). For supermarkets and fashion stores we had enough data to further analyze whether specific layouts occur with higher chance. A chi-square test with Yates' continuity correction showed that the usage of layout S1 significantly differs depending on whether the shop is a member of the set {supermarket, fashion store} or the remaining categories ($\chi^2(1, N = 85) = 16.53, p < 0.001, \phi = 0.469$, respectively $\chi^2(1, N = 85) = 5.64, p < 0.05, \phi = 0.283$). Fisher's exact test reveals that the usage of layout S3 significantly differs depending on whether the shop is a fashion store or belongs to another category ($p < 0.001$). On 35 receipts, we found articles which were bought more than once and identified eight arrangements (M1-M8, cf. Figure 9); in each of them, the quantity and the unit price are in the same line. Concerning discounts, cancellations and bottle deposits, our samples contain too few examples to draw definite conclusions, but we could already learn that some compositions will be hard to match. Nonetheless, this needs to be done, as shown by study 1. Finally, we also analyzed the textual representation and layout of the line containing the overall sum of all purchased products. In about 45% of all receipts, there was no special layout, whereas in other cases the line was written in bold letters (18%), in a larger font size (8%) or a combination of both (29%). Regarding the chosen wording for the total sum, we counted 18 different representations: most often (39%) the German word for "Sum" was used, followed by "Total" (31%); the remaining words were distributed with high variance.

For our app, we conclude that the minimum information for adding a purchase to the household account book (the store's name, date of purchase and total amount) can be



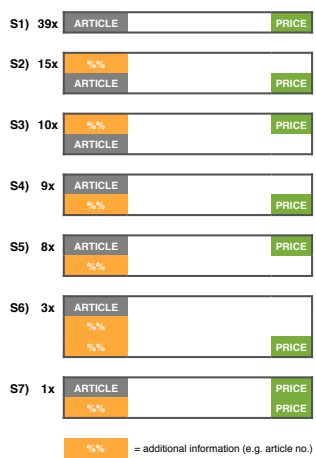


Figure 8: Layouts for single

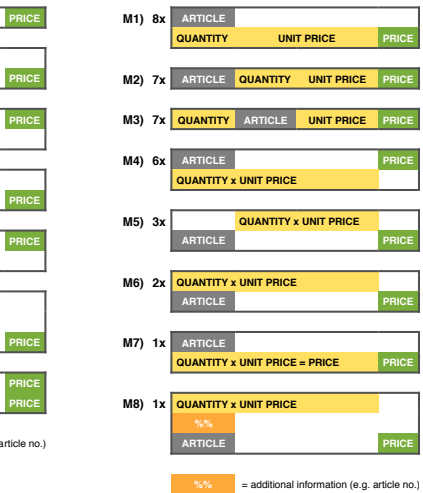


Figure 9: Layouts for multiple purchases and their frequency.

ie receipt. The header contains either a graphical or textual representation of the store's name and the date of purchase. In the body, the layout as well as the chosen wording offers the option to extract the total sum. We also see a good chance for extracting individual items and their prices as we could identify a small set of layouts which were used for all receipts. Concerning the layouts, we found two significant effects indicating that the algorithm might learn certain templates related to shop categories to improve OCR later on. The integration of new layouts can be driven by a crowd-based approach. Nonetheless, more work needs to be done for specific aspects such as discounts and reversals as only few of the receipts contained such items.

Conclusion and Outlook

This paper introduced the concept for a novel digital household account book and presented initial results of two studies: First, an online questionnaire was used to learn about the current usage of household account books and as one of the major results, we learned that only few people use a household account book because of the effort in keeping it. The proposed app seems a suitable tool to lessen this burden. Second, a receipt analysis of 85 shops was conducted to learn important aspects an OCR algorithm needs for an automatic receipt analysis. The results are encouraging in the general case, even though a more detailed analysis has to be done for issues such as discounts, as they might be hard to recognize and assign to the corresponding item. In a later step after validating the initial approach, we plan to extend our knowledge corpus beyond German receipts and German opinions. The immediate next steps are the implementation of the recognition and categorization algorithm as well as an evaluation with a diary study, followed by individual interviews. That way, we can analyze real-world practices

helping us to understand how our app will be used. Subsequently, an "in-the-wild" study seems reasonable to validate the concept in a large-scale real-life setting.

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