Mobile Recommender Apps with Privacy Management for Accessible and Usable Technologies

Marion Hersh[a1] and Barbara Leporini
[a]University of Glasgow, Scotland, marion.hersh@glasgow.ac.uk
ISTI-CNR, Pisa, Italy,
Barbara.leporini@isti.cnr.it

Abstract. The paper presents the preliminary results of an ongoing survey of the use of computers and mobile devices, interest in recommender apps and knowledge and concerns about privacy issues amongst English and Italian speaking disabled people. Participants were found to be regular users of computers and mobile devices for a range of applications. They were interested in recommender apps for household items, computer software and apps that met their accessibility and other requirements. They showed greater concerns about controlling access to personal data of different types than this data being retained by the computer or mobile device. They were also willing to make tradeoffs to improve device performance.

Keywords: recommender app, privacy management, accessibility.

1. Introduction

Apps are becoming increasingly popular and there were, for instance, over half a million apps for the iOS Apple operating system in 2011 [1]. While app accessibility and usability have been discussed, consideration has generally focused on particular applications, such as the usability of mobile passenger information systems [2] or mobile health apps [3] or usability for particular groups of disabled people, including aphasic [4] and autistic people [5].

This development of apps is supported by growing mobile and smart phone use, with average European mobile phone coverage of 111.26% in 2007 and western European smart phone ownership predicted to be 64.7% in 2017 [6]. There is also significant mobile phone ownership in the majority world (developing) countries. Smart phones are very well equipped for travel, data collection and processing and other assistive applications [7], [8], [9]. For instance, they generally have a camera, GPS, accelerometers, magnetometer and gyroscope sensors for localisation, wide bandwidth speaker, high quality directional microphone, 3G, WiFi and Bluetooth and low power consumption. In addition, smart phones and tablets generally have a positive image [9], whereas many assistive devices are unfortunately considered to be stigmatising [10]. This encourages use of smartphones and tablets, including for

[1] Corresponding Author

assistive applications. They have the further advantages of frequently including assistive technologies, such as screen readers like Talkback [11] or VoiceOver [12] for blind people or Zoom magnification for partially sighted people. The inclusion of assistive technologies has increased the accessibility of many Android- and IOS-based devices to disabled people, with an associated increase in real e-inclusion in society. However, the very small size and multi-functionality of mobile devices which make them easily portable and allow them to be used at any time and place, can lead to accessibility and usability barriers, particularly to disabled and older people. Mobility and small size result in reduced memory and processing speed, and the need for batteries to be regularly recharged [13], and small, relatively difficult to see or feel screens, keyboards and pointers. User interface and interaction need to be well-designed in order to enable efficient communication between the App and the assistive technology. In addition, general design accessibility principles need to be better specified to take account of both the context and user characteristics. For instance, work on a mobile app prototype has led to the development of principles on (i) organization and arrangement of the user interface items, and (ii) implementation of basic functionalities for blind users in a mobile context [14]. Important features include using existing knowledge of the common positions for particular elements such as links and making it as easy as possible to identify the different elements. Therefore, the app includes four buttons for the main functions, located at the four corners of the screen. This makes it easy for blind people to locate and identify these buttons, despite them being virtual and not detectable by touch. These suggestions are useful for some apps and user profiles. However, there is a need to develop guidelines which take into account both user features and the context of use, [15], [16] which may be particularly important in avoiding accessibility and usability problems for disabled and older people.

There is also a need for the increasing use of design for all [17] approaches to make more software and hardware accessible and usable to a wider range of disabled and older people. However, attempts to date, for instance to promote web accessibility, have not been particularly successful. Despite the development of several accessibility guidelines of which those due to the WorldWide Web Consortium (W3C) are probably the best known and most influential, many users still experience sometimes significant barriers to using the web [18]. In addition, there may be tradeoffs between factors, such as complexity and cost, and the range of people that can be designed for. Lastly, promotion of both usability and accessibility requires guidelines to include specifications of the context and user characteristics for which they hold. Leporini et al. [19] provide an example of the improved specification of accessibility guidelines in the case of a search engine. As the discussion illustrates, there is a need for information about the accessibility and usability of both apps specifically and software and hardware more generally. One way to provide this would be through the use of a recommender app. To the authors' knowledge to date a suggested architecture for a mobile app recommender for disabled users has been drawn up [20], but no such app has yet been developed. The architecture includes user and application environments, and user profile, context and app features stored as ontologies. However, it does not consider security and privacy issues resulting from the use of user and contextual information.

From the previous discussion it should be clear that users' accessibility and usability requirements will frequently depend on both contextual and user factors. Recommender systems have generally taken a two dimensional approach based on users and items, though there are also multidimensional approaches, which consider time, location and other contextual factors [21].

There is a body of work on the treatment of context, including several surveys e.g. [22], [23], [24]. Many contextual systems involve three-layer hierarchical architectures [22]. The roles and components of the different layers vary, but may include context sensing and data fusion, middleware, and application or ontological representation and reasoning layers [22], [25]. They generally include (i) a source of contextual information e.g. sensors, a middleware infrastructure or context server [26]; (ii) a context management model e.g. context widgets [27], the blackboard metaphor [27] and object role models [23]; (iii) context models to define and store data in a machine processable form e.g. ontology based, object oriented, graphic and markup scheme models [28]; and (iv) context based reasoning, for instance using situation calculus [23] for applications such as customisation. There is also considerable largely untapped potential for using the Internet of Things to support context awareness [29].

The use of user and contextual data raises important privacy and security issues which have received limited attention, particularly in the context of assistive technology. Privacy concerns have been found to cover information distribution and protection as well as control over personal information [30]. Existing approaches such as data anonymisers and obfuscation [31] respectively ignore the sensitivity of the data and the characteristics of data owners and recipients. The dynamic nature of privacy, the speed at which context changes [32] and users' difficulties in providing appropriate input to privacy management systems [33] give rise to a need for privacy automisation and customisation systems, which are currently lacking. A study of privacy awareness in Android applications [34] showed a lack of awareness due to the inappropriate descriptions provided for the apps. Other studies, such as [35] and [36], investigated users' privacy concerns perceived by the users. This has included investigation of the value of profiles and preferences in increasing awareness of the the privacy features in the installed Apps.

2. Methods

The study reported here is based on a questionnaire for disabled people and parents of disabled people under 16 to complete on their behalf. The study had two main aims: (i) investigating interest by disabled people in a recommender app for accessible and usable hardware and software and desired features of this app; and (ii) investigating knowledge and concerns about the associated data privacy issues and interest in privacy management systems to resolve them. Ethical approval was obtained from the Ethics Committee of the School of Science and Engineering at the University of Glasgow.

The questionnaire is divided into four sections, three of which are relevant to the work reported here. The fourth section, section C as well as some of the questions in Section B relate to a companion study on the use of digital games in rehabilitation. The two investigations have been combined due to the overlap between the questionnaires and the difficulties in obtaining responses to two surveys aimed at disabled people within a short time span.

Section A covers personal information on gender, age, country, impairment, accessibility requirements and education. Section B investigates the use of information technology, digital games and apps, with regards to both frequency and type of use.

Section D investigates interest in the use of recommender apps for accessible and usable apps and other software and hardware and knowledge and concerns about the associated privacy issues. It will also investigate the types of tradeoffs users are willing to make between applications and privacy maintenance and the privacy management features users would like to see in apps.

English and Italian versions have been produced and care taken to ensure that they are equivalent. It should be noted that both authors speak both languages. This is enabling distribution amongst Italian and English-speaking disabled people and comparative analysis of the results. The questionnaire could be completed anonymously online or as a word file. Attention was given to accessibility issues and the site privacy policy in choosing the particular online questionnaire site. The links to the online version of the questionnaire were circulated to organisations of disabled people, through email lists and forums, to the authors' contacts and by other researchers and disabled people.

3. Results

30 responses were obtained from disabled people, 17 to the Italian version and 13 to the English one. 43% were female, 53% male and 3% other. There was a good age distribution. Two thirds, including all the Italian participants, were blind or partially sighted, a third were physically disabled, 10% deaf or hard of hearing and 17% had mental health conditions, with some participants having more than one impairment. They all used computers, 97% for internet and email, three quarters (77%) for producing documents, over half (56%) for work, just over a third (37%) for games, a third for budgeting and finance and a fifth in formal education. The majority used a computer for extended periods of time, a third for more than eight hours a day, a fifth for 4-8 hours a day and just over a third (37%) for 1-3 hours a day. Participants were also frequent users of smartphones and tablets, with nearly half (47%) using them 1-3 hours a day and 40% at least four hours a day. Phone calls (83%), email (80%) and internet (67%) were the most popular applications, followed by travel and mobility apps (57%), work (37%), games (33%) and other apps (33%). The main interest in digital games was entertainment (50%) followed by professional training and personal learning, both used by a third of participants.

Most of the participants were frequent users of assistive technology, with three quarters (73%) using it every day, though a fifth never used it. The most popular technologies were screen readers and screen magnifiers, used by 63% and 30% respectively, with several participants using both. This is not unexpected, since the majority of participants were blind or partially sighted. Small percentages used adapted keyboards, Braille displays, subtitles, dictation software, speech recognition software, joysticks or similar devices or needed an avoidance of colour, animation and scrolling text. About 40% of participants found it easy or very easy to find the information they required about the assistive technology they needed and 17% difficult or very difficult. However, participants experienced difficulties in finding computer software and apps that met their accessibility and other requirements Nearly two thirds of participants found it always (10%), sometimes (17%) or occasionally (37%) difficult to find software that met these requirements. A similar percentage found it always (7%), sometimes (43%) or occasionally (13%) difficult to find apps that met these requirements. There was significant interest in recommender apps, with 70% interested in recommender apps for household items, computer software and apps that met their accessibility and other requirements.

Half the participants were aware of what information the program is storing about them and their system usage when using mobile apps, computer games and other software and half wanted to know who might have access to this information. One participant commented that they were aware that the system was storing information about them, but not what information. Several participants commented on the importance of privacy and wanted to know what information was being collected about them and what it was being used for. The difficulties in accessing privacy policies and details of how information about them was used, which were embedded in terms and conditions, were noted. Specific concerns related to disability assessors and insurance companies getting hold of health data. One participant felt that they 'lose out on a lot of resources/info' due to restricting their use of computer software and apps due to privacy concerns.

However, on average participants were only moderately concerned about the system retaining information about their age and gender (2.4 out of 5), education and employment (2.8), impairments and use of assistive technology (2.5) and the times they used it (2.8). However, they were significantly concerned about the retention of any other information about how they used the software (4.4) and had slightly greater than moderate concern about the retention of their location (3.1). In general, they had much greater concerns about being able to control who had access to this information. The greatest interest was in controlling access to information about their education and employment(4.7) followed by their impairments and assistive technology use (3.6), preferences and requirements 3.5), additional information about how they used the software (3.6) and their location (3.3).

Participants also recognised that there might be tradeoffs between app functionality and the provision of information, for instance that identification of their location would be necessary for wayfinding. They also indicated that they were less concerned about information related to them being retained in learning and rehabilitation apps than other applications. The importance of control of their lives and technologies for disabled people was noted and given as a reason for accepting storing 'some personal information in order to be more efficient' if necessary. One user 'want[ed] control of all my data, what is used, how it's used and how it is stored'.

4. Discussion and Conclusions

The paper has presents the preliminary results of a survey on the use of computers and mobile devices by disabled people, their interest in recommender apps and their knowledge and concerns about data collection by programs and apps and privacy issues. These preliminary results are based on the 30 responses obtained to date, with slightly more Italian than English speaking ones. Participants had a good gender and age distribution, but were predominantly visually impaired and/or physically disabled. This response rate is not unreasonable for a survey of disabled people. However, the work is part of an ongoing study and the authors plan a subsequent publication involving data from a larger number of participants with more varied impairments. This will also include comparisons of the results on language (English or Italian), gender, age and impairment, as well as more detailed discussion of comments and evaluation of the statistical significance of the differences found. This was prevented here by space limitations.

The results indicate that disabled people over a wide age span are regular users of computers and mobile devices. Email, internet and phone calls were the most common applications, but there was also significant usage for producing documents, work, games, budgeting and finance, education and travel and mobility. Most participants used assistive technology and nearly two thirds experienced difficulties at least sometimes in finding computer software and apps that met their accessibility and other needs. They showed a significant degree of interest in recommender apps, with 70% interested in recommender apps for household items, computer software and apps that met their accessibility and other requirements.

Participants were concerned about controlling access to personal information retained by computer systems and apps, but much less so about this information being retained by the system. Specific concerns related to who might have access to it and how it would be used and preventing access by disability assessors and insurance companies. They also noted potential tradeoffs between improving app functionality and providing information, for instance for navigation and mobility apps and were interested in tradeoffs that improved their control over their lives and the technologies they used.

This study has obtained some useful findings on participants' use of computer and mobile technologies and their interest in recommender apps, as well as greater insight into participants privacy concerns. The ongoing study is intended to provide more detailed information, including on the attitudes and experiences of participants based on gender, age and language (English or Italian). Its results will be used to produce recommendations on the development of recommender apps with privacy management.

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