The mATHENA Inventory for Free Mobile Assistive Technology Applications

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Abstract. The entry of smartphones and tablets in the market yields new opportunities in the domain of Assistive Technology (AT) for persons with disabilities. The search process for mobile AT applications that fulfill specific user needs is not an easy task for the end-users, their facilitators as well as the professionals in the area of rehabilitation. Even, when they finally find what they are looking for, a number of questions are raised relative to the reliability, stability, compatibility and functionality of the AT applications. These questions can be answered safely only by a team of AT experts. In this work we present the methodological approach for the design and development of the mATHENA web-based inventory, which aims to make the search and selection of free mobile AT applications simple and sound. This methodology is based on the consistent and well-documented presentation of the information for each mobile AT application, after it is tested in an AT lab. mATHENA offers social interaction services for its diverse target groups. Moreover, we present the advantages of mATHENA compared with the functionalities of six other inventories for AT applications. Currently, mATHENA includes 420 free mobile AT applications, carefully selected among a total of 1,100.

Keywords: Assistive technology · Accessibility · Mobile-applications · Free of charge apps · Smartphones · Tablets · Online inventory · Persons with disabilities

1 Introduction

Computer-based Assistive Technology (AT) offers devices, tools, equipment and services that can be used to maintain, increase or improve the functional capabilities of persons with disabilities and the elderly. The last few decades, there is an increasing strong interest in the domain of AT. This interest comes out from the research institutes, the industry, the academia and various professional disciplines, such as rehabilitation sciences, computer engineers (mainly developers of human-computer interfaces, Web designers and Web content providers), ergonomists, therapists, teachers in inclusive and special education [1]. The main forces that boost this interest

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come from: i) the policy frameworks of the United Nations and the European Union, as well as the national legislation for the benefit of the disabled and their societal inclusion and participation, and ii) the increasing demographic figures of the aging population, given that the number of the disabled rises significantly for those above the 65 years old. In recent years, the field of AT has made substantial progress in consolidating theoretical approaches, scientific methods and technologies, as well as in exploring new application domains [2].

The recent developments in mobile technology, including the introduction of tablets and smartphones, and especially the mobile applications, yield new opportunities in the domain of AT, and had a new impact on the participation of the disabled and the elderly in the everyday life [3-6] but also on the behavior of the disabled and elderly as consumers [7]. Besides, the mobile AT applications can be used with a much broader scope. For example, under the framework of Universal Design for Learning (UDL), mobile AT apps have been found to engage all students, including those with disabilities, in collaborative learning, reasoning, and problem-solving activities [8-12].

Current statistics [13] show that Android and iOS users have the possibility to choose between 3 million mobile apps. Furthermore, the mobile app stores do not include a category for AT or a classification by disability. Thus, the search process for mobile AT applications that fulfill specific user needs is not an easy task by all the target groups: the end-users, their facilitators, as well as the professionals in the area of rehabilitation. Moreover, in many cases the users don't know the right keywords for searching in the app stores. Furthermore, the description of an AT app does not always include the proper keywords relative to the terminology used by the end users. Even when they finally find what they are looking for, a number of questions are raised relative to the reliability, stability, compatibility, functionality and usability of the AT applications [14-17]. These questions can be answered safely only by a team of AT experts following appropriate evaluation methodologies [18]. Also, the description of the AT apps is not consistent as the fields included to describe each app differ, as well as the amount of information provided in each field. Consequently, dedicated online databases or repositories have been recently developed for the elderly [19], the visually impaired [20], the communication impaired [4, 21] and for medical applications [22].

In this work we present the design and development of the mATHENA web-based inventory, which aims to make the search and selection of free mobile AT applications simple and sound. First, in section 2 we review the existing inventories of mobile AT apps. In section 3 we describe the methodological approach for the design and development of web-based inventories for mobile AT applications. Then in section 3 we present the results of the development of mATHENA and a comparison of its functionalities with the existing similar repositories.

2 Existing Inventories for Mobile AT Apps

Below we present a review of the most important existing inventories dedicated to mobile AT applications, along with their main characteristics.

Special Needs Apps [23]: currently lists 357 free of charge or commercial applications for iOS and Android. A description of each application is given. Users have the opportunity to download apps directly from the App Store or Google Play. Users can search for a specific application using three different ways: a) the general search field, using keywords, b) category-based search (Speech & Language, Scheduling, Education, Behavior, Life Skills, Social Skills, Games and Communications), and c) through sorting the entire app list by choosing: most popular, average rating, newest, price range. Furthermore, the inventory includes a rating system, a comments' field for members, screenshots and videos for each mobile AT application.

BridgingsApps [24] provides an inventory with 1,515 mobile AT apps (free or commercial). It includes nine main filters for searching: Keyword search, Skill levels, Mobile Devices, Embedded Skills, Independent Traits, Assistive Traits, Assistive/ Independent, iTunes Categories, Android Market Categories. Moreover, there are more than 100 sub-filters for all the previous nine filters, which users can apply in order to fine-tune their search, a facility that is rather complicated for the inexperienced user. For each application there is a separate webpage with a description from AT reviewers, a rating system and a URL for downloading.

AppleVis [25] inventory includes more than 150 free of charge apps for iOS devices, specially designed for visual impaired people. The inventory provides an alphabetical list of applications. After selecting an application, the user is informed with a general description of the app and can search for similar apps using the filters or using the "More Like This" section. Moreover, there is a keyword search field and a field for user comments.

AppsforAAC [26] is a website that lists alphabetically about 300 commercial or free AAC applications in the domain of Augmentative and Alternative Communication (AAC) for Android and iOS users. There are three different ways to search the inventory choosing: device (iPad, iPhone, Android), type of app (Access, Education Support, Eye Pointing, Language Development, PECS, Photo Story, Phrase Bank, Set Phrases, Symbol Grid System, Text To Speech, Word Prediction) and price range. Each application has its own page with a description, a URL for downloading, a URL connecting with the developer's website, screenshots, a rating system and a field for user comments.

AssistIreland [27] provides a list of 70 iOS or Android, commercial or free, mobile applications for persons with disabilities and the elderly. Users can select apps according to five main classes of disabilities: Visual Impairment, Hearing Impairment, Alzheimer or Dementia, Autism and other related disorders, Mobility difficulties. Users can choose between sub-categories that classify the applications taking into account the purpose of use. Unfortunately, there is no extra page for each application, no download URL, no URL of the developer, no rating system and no field for user comments.

LowVisionBerau [28] lists 326 iOS mobile apps for the visual impaired. Search is facilitated through 22 application classes: Communication, Education, Entertainment, Food and Drink, Games, GPS/Navigation, Greeting Cards, Health, Magnification, Music/Radio, News, Pets, Photography, Productivity, Reading, Social Network, Sports, Travel, TV/Movies, Utilities, Voice Controlled. A team of experts is responsible for the selection and testing of each app. A small description, a download URL, system requirements and a rating field are included for each application.

Table 1 presents the main features of the different inventories discussed in this section showing the differences / similarities among them.

Table 1. Main features of existing inventories for mobile AT applications. a: SpecialNeedApps [23], b: BridgingApps [24], c: AppleVis [25], d: AppsforAAC [26], e: AssistIreland [27], f: LowVisionBureau [28]

	a	**b**	**c**	**D**	**e**	**f**
Number of apps	357	1,515	150	300	70	326
iOS	YES	YES	YES	YES	YES	YES
Android	YES	YES	NO	YES	YES	NO
Free	YES	YES	YES	YES	YES	YES
Commercial	YES	YES	NO	YES	YES	YES
Searching filters	3	9	3	3	5	1
User rating	YES	YES	NO	YES	NO	YES
User comments	YES	NO	NO	YES	NO	NO
Other				only AAC apps	only for the visual impaired	

3 Methodology

As we have described in the Introduction, it is crucial for an inventory of mobile AT applications: i) to be developed in a systematic way, ii) to include apps after a selection and evaluation process, preferable by experts in the field and c) provide a consistent description of all apps. Following these principles, we propose the following six-step methodology for the design and development of functional and reliable inventories of mobile AT applications:

a) Search and Locate Mobile AT Apps

Depending on the inventory scope, the exploration must cover either one or more mobile operating systems (iOS, Android, mobile MS-Windows). Moreover, the search must not include only the mobile app store(s) of the specific operating system(s), but has to include forums, websites, blogs, newsletters, databases, inventories, repositories and mailing lists in the domain of AT.

b) Download and Install the Apps

The identified mobile AT apps have to be installed on representative mobile devices (both smartphones and tablets) running one of the latest versions of mobile operating systems. The inventory has to include information on the specific models of the

mobile devices and the version of the operating system that have been used for installation and testing. Mobile apps that cannot be installed or are failing to run are excluded from the next steps.

d) Test and Evaluate the Installed Mobile AT Apps

AT experts test and evaluate the installed mobile AT apps, in order to identify whether the application is in line with the scope and functionality referred by its manufacturer.

e) Create a Consistent Documentation for Each App

It is important to have a consistent description for each selected mobile AT app. The description must include the same fields for all apps and approximately the same amount of information. Optimally, the experts involved in the previous step must create the documentation. We propose the following fields to be included: the official app name, the name and URL of the manufacturer/developer, the app logo, the URL for downloading from the app store (iTunes App Store, Google Play), the required operating system and the minimum version, the latest app version, the disability/ies it addresses, a classification according to its application domain or scope, a description of its functionality and its main characteristics, the languages it supports, and the specific models of mobile devices used during the tests along with their version of their operating system.

f) Design the Facilities of the Inventory

It is crucial to select the appropriate search facilities and functionalities of the inventory. We propose the following five search and selection modes: a) by disability, b) by the operating system (Android, iOS, MS-Windows), c) by application category, d) using keywords, and e) in alphabetical order. A rating system along with a field for user comments are also suggested. It is preferable to present all the information for a specific app in a single webpage. Moreover, it is essential for the inventory to be accessible according to the Web Content Accessibility Guidelines (WCAG) 2.0 [29] at least for the level AA of conformance [30].

g) Update and Maintain the Inventory

Checking frequently for new mobile AT applications, as well updating the information of an existing app when a new version is released constitute an important part of the life cycle of the inventory.

4 Results

Following the above methodology, we have designed and developed the mATHENA Inventory of free mobile AT applications [31]. mATHENA is based on the approach followed in the ATHENA Inventory of Open Source AT software [32-33].

We decided to include only free of charge apps in mATHENA. Free Apps, are applications developed by an organization, company or freelancer developers and are

available without any cost to users [34-37]. Many times, the purpose of a free app is the demonstration of the company's quality of app design, in order for the user to buy another commercial application from the same company in the future. The Organizations and freelancer developers who develop such applications don't have any financial profit, but just want to offer their services to the society in this way. Some Free Apps earn money from the advertisements in the pop-up windows that appear in frequent periods of time as the application runs. Free App Lite edition, is the application with less features than the commercial one. The user comes in contact with the interface and the basic function of the app, and he must pay for extra features if he needs them. Finally, a Free App Trial edition is the original commercial edition of the application but with a limitation in the usage period.

We explored and examined more than 200 different forums, websites, blogs, newsletters, application stores (iTunes App Store, Google Play), including the inventories mentioned in Section 2. We collected a total of 1,500 free applications (Table 2). Among them, thirty applications failed to download. Moreover, 15 apps failed to run smoothly (either because of software crashes, or because of failure of opening their interface on the device display). 190 applications, although they are referred as AT apps, were excluded after the evaluation as they were classified as non-AT apps. 75 applications that did not have their menu in English were also rejected. Finally, 420 mobile AT applications for iOS and Android devices were selected to be included in the mATHENA inventory (Table 2).

All the applications included in mATHENA have been tested by AT experts of the Speech and Accessibility Lab, University of Athens. Also, these experts are the authors of their documentation in mATHENA.

mATHENA is accessible according to the Web Content Accessibility Guidelines (WCAG) 2.0 [29] for the level AAA of conformance [30].

Table 3 presents the main fields of mATHENA, including details for each mobile AT application, as well as the inventory features, in comparison with the relative information for the six inventories presented in Section 2.

Table 2. Mobile AT applications located, tested, and selected by applying the proposed methodology

	Number	%
Total mobile AT apps located	1.100	100,0
Applications not free of charge	380	34,5
Applications failed to run	35	3,2
Non-AT apps	190	17,3
Applications not supporting the English language	75	6,8
Applications finally selected for mATHENA	420	38,2

Table 3. Overview of the information fields given for each product, and the most important website features for A: BridgingApps [24], B: SpecialNeedApps [23], C: AssistIreland [27], D: AppleVis [25], E: LowVisionBureau [28], F: AppsforAAC [26], G: mATHENA [31]

A	B	C	D	E	F	G	
				Details for each application			
•	•	•	•	•	•	•	Application Name
•	•	•	•	•	•	•	Description
•	•		•		•	•	Manufacturer
•	•	•		•		•	Application Logo
			•			•	Version
•	•					•	Screenshots
						•	System Requirements for App
•	•		•	•		•	Download URL
•			•			•	Developer URL
			•			•	Add Comment
•						•	Languages
				Inventory features			
•	•		•	•		•	Search field
•	•	•	•	•	•	•	Filter Categories
		•				•	Filter Disability
						•	Only Free of charge Apps
•	•					•	Rating System
•	•		•		•	•	Alphabetical List of all Apps
•	•				•	•	Filter Operating System

5 Conclusions

We presented a methodological approach for the design and development of web-based inventories for mobile AT applications. This methodology is based on the consistent and well-documented presentation of the information for each mobile AT application, after it is tested in an AT lab. This methodology has been applied in the case of mATHENA, which targets the disabled end-users, their facilitators, as well as the professionals in the area of rehabilitation. Moreover, we presented the advantages of mATHENA compared with the functionalities of six other inventories for AT applications. Currently, mATHENA includes 420 free mobile AT applications, carefully selected after testing among a total of 1,100.

We plan to extend mATHENA by adding more languages, such as German and Spanish. Moreover, we plan to include apps related to new innovations in mobile technologies, both in hardware (e.g., smartwatch) and software that can benefit the disabled and elderly.

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