BaMoS - A Mobile Medical Information System that Provides Assistance to Elderly People as well as Illiterates

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Abstract:

Today, people with certain reading disabilities, such as, illiterates or elderly people, are impacted in accessing and understanding highly relevant medical information in daily. Medical package information is presented in scientific writing style, with small font size, and can hardly be associated to severe diseases to the users, therefore resulting in bad usability. Paradoxically exactly those people who have difficulties reading the package insert are most likely to take medicine. The mobile service BaMoS (Barrier free Mobile Service) aims at providing assistance to people who have difficulties reading package inserts. BaMoS supports the user by using the mobile phone to read the relevant medical information and transfer the information into an understandable manner to him/her. Specifically adapted audio based menu navigation allows the user to interact with the application even though the user might have little or no reading skills at all. The audio based menu navigation provides assistance for illiterates, but also elderly people might benefit from it. This paper presents the innovative concept, the complete outline of the system architecture, and preliminary results. In future work it is planned to facilitate the usage of BaMoS by enabling the service to be attached with an alternative input device that is primarily designed for elderly people.

1 Introduction

The years 2003 to 2012 are officially declared as the literacy decade by the United Nations. Illiteracy is a serious problem all over the world that must not be underestimated. Special attention has to be paid to the fact that not only Third World countries but also highly educated countries are affected by illiteracy. E.g., about 300,000 illiterates live in Austria, according to UNESCO estimates [1]. This demonstrates that compulsory education alone is not a guarantee for literacy. Furthermore it has to be mentioned that the term “illiteracy” is often used incorrectly. In most cases the term “illiteracy” refers to a certain type of illiteracy. This well-known type is called functional illiteracy, which is defined as follows:

Functional illiteracy: A functional illiterate person is defined as a person that is not able to make use of textual information in everyday life. On the one hand it can mean that the person does not have any knowledge of literary language at all. On the other hand it can also mean that the person does have knowledge of literary language, but the knowledge is limited in a way that it cannot be applied in an appropriate way in everyday life [2].

Figure 1 illustrates how somebody can become affected by functional illiteracy over time even if the level of individual knowledge remains constant over the years.

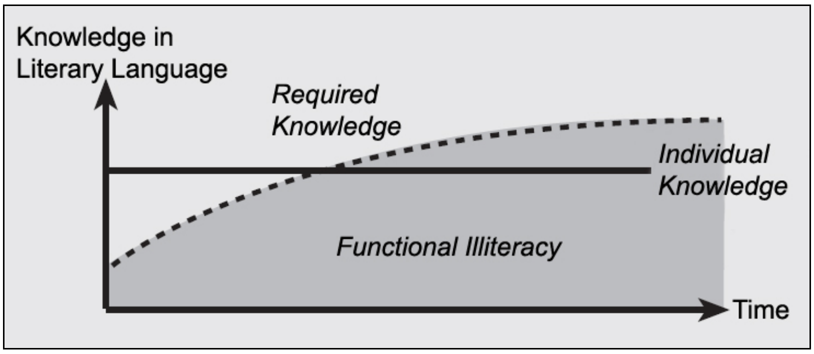


Figure 1: Required Knowledge vs. Individual Knowledge in Literary Language [2]

While numerous studies focus on the fact that modern societies is turning more and more into an extremely fast moving knowledge society, the relatively high number of illiterates amongst their population is mostly ignored by the public. The divide between higher and lower educated people cannot be ignored any longer. This perception is underscored by the results of numerous international studies on the correlation between social disadvantages and negative health effects. E.g., within the scope of an Austrian study from 1999, conducted by the ÖBIG (Österreichisches Bundesinstitut für Gesundheitswesen), social disadvantages in correlation with health were explored with special focus on the Austrian society. According to the results of this study there is certainly a correlation between the social standing and the particular state of health of a person [3]. It can be said that illiteracy is a phenomenon that occurs frequently within the lower social layers. Therefore it can be assumed that illiterates have to face health problems more often than others [2].

Correlation between health and education: [4]

- A minor level of education decreases the prospects on job market. As a result the lower social and economic resources impair the health of the people concerned.
- The lower the education the higher the mortality risk.
- People with deficits in education are frequently not reached by health information.
- Functional illiterates are less respected by the society. This can lead to an impairment of both psychological and physical health.

Furthermore it has to be noted that these correlations can lead to a vicious circle. As illiterates often have to take drugs they also have to read the package inserts. In most cases it is impossible for an illiterate person to understand a package insert. As a result inappropriate medication can lead to more health problems.

The development of the accessible mobile system BaMoS (Barrier free Mobile Service) intends to counter this alarming trend and by trying to support the particular needs of illiterates. The second target group of BaMoS is the group of elderly people, as they generally face the same problems as illiterates in this context. It is widely known that elderly people are confronted with more health problems than the average person. They often suffer from certain eye defects which make it difficult to read the package inserts which are commonly written in extremely small font size.

In the following Sections we explain the architecture and the functionality of the mobile system BaMoS and we give the technical and technological background of the application. In addition some exemplary use cases are presented to illustrate in which situations the usage of BaMoS would be reasonable.

2 BaMoS System Concept

2.1 System Architecture

Figure 2 shows the basic system architecture of BaMoS. The architecture of BaMoS is planned to be outlined in terms of a client-server model. This model makes use of both client and server-side advantages. The application can benefit from the mobility of the client as well as the high performance of the server. During the project it has to be evaluated in which way the communication between the server and the client should happen. Furthermore aspects such as cost, transfer rates, availability and reliability have to be considered. The system architecture is planned to keep the network load low. The data transfer is restricted to a minimum and therefore does not impose any problems.

Figure 2: BaMoS System Architecture

In the following the process sequence, as it is illustrated in Figure 2, will be explained in detail. It is assumed that BaMoS is installed on the mobile phone and that the application is started before the actions can take place.

1. **Photo**
   The user takes a picture of the drug packaging with the camera attached mobile phone.

2. **Text Recognition**
   The picture is sent to the server where the text recognition takes place. In that way the name of the drug is extracted from the photo. For the data transfer the two technologies GPRS (General Packet Radio Service) and UMTS (Universal Mobile Telecommunications system) are considered.

3. **Database Access**
   The package insert information for the particular drug is extracted from an appropriate database.

4. **Package Insert Information**
   The relevant information on the drug is sent back to the mobile client.

5. **Text-to-Speech Synthesis**

An embedded text to speech synthesis module allows the application to read out the drug information to the user.

2.2 Use Cases

The following use cases illustrate in which situations BaMoS can give assistance. The interaction between the user and the mobile system is illustrated in Figure 3, showing a generic use case that can be seen as exemplary for the use cases 1 to 3 which are described below. The mobile system BaMoS is used as a black box in this context. For information on the background processes please refer to Section 2.1 and Figure 2 which give further information on the system architecture.

Figure 3: Generic BaMoS Use Case

Use Case 1:
A young woman enters a pharmacy and asks for a headache tablet. The pharmacist hands her an adequate drug. When the young woman asks for the directions for use, the pharmacist refers to the package insert. The young woman kindly thanks for the information, buys the headache tablet and leaves the pharmacy.

This seems like an ordinary situation that takes place in a pharmacy very often. What should be mentioned is that the young woman is functionally illiterate. This means that she is not able to gather information from the package insert but didn't have the heart to admit her inability to read when the pharmacist referred to the package insert. Now the young woman has two possibilities: either ask someone to read the package insert to her or take the tablets without detailed information. The aim of BaMoS is to offer her a third possibility. With BaMoS she can easily obtain the information she needs without further assistance.

Use Case 2:
A mother is at home with her two little children. Suddenly one of the children complains about stomach ache. The mother knows that there is a medication that is used for stomach ache in the medicine cabinet. She bought it the last time one of the children had a stomach ache. But as the mother searches for the medicine she realises that she is not sure which medicine is the right one.

Normally it would not impose a big issue to the mother to read the package inserts and by this find out which medicine is the right one. But it is a big deal for the mother who is a functional illiterate. BaMoS can provide support in this situation. In Figure 4 photographs of different medical packages, taken by a camera attached mobile phone, are presented.

Figure 4: Pictures of medical packages, taken by a camera attached mobile phone

Use Case 3:
The doctor prescribes her patient, an elderly woman, multiple medicaments when the patient comes for an examination. The doctor explains to the elderly woman, that one of the drugs can cause some negative side effects. She also tells the patient that she should stop taking that particular drug if the discussed side effects occur. The following days the elderly woman takes the medicine, as prescribed by the doctor. As side effects occur the woman remembers that the doctor had told her to stop taking a certain drug but she cannot remember which drug it was.

Certainly the elderly woman could ask somebody to read the package inserts to her to find out which of the drugs can lead to those side effects. Furthermore she could call the doctor and hope that she could provide her with information she is looking for. But the quickest and easiest way would be to use the mobile service BaMoS to get the information. Figure 5 shows a sample use of BaMoS of an elderly woman, pointing the camera device to a medical package, capturing an image, and receiving the medical information via the client-server architecture in order to be able to use the medical content in the appropriate way.


Figure 5: A sample use of BaMoS

3 Alternative User Interface

Illiterates face several difficulties in respect of the new media technologies. One of the greatest challenges is the fact that it is almost impossible to use for example a mobile phone without reading skills. With the development of BaMoS a positive change should be initiated in this context. Naturally also elderly people should benefit from the alternative user interface of BaMoS. To satisfy the needs of the two target groups the implementation of a specific audio-driven menu navigation is intended. The audio menu navigation should simplify the handling of the mobile application. Furthermore an alternative input device can be attached to the mobile phone. The mobile application BaMoS can thus to be controlled optionally via that alternative input device or via the traditional mobile phone keypad.

The input process, namely the audio menu navigation and the alternative input device, is certainly innovative. BaMoS' output process is also notable. Once BaMoS receives the package insert information from the server it provides the user with the desired information in a barrier-free way. BaMoS makes the mobile phone read out the information to the user. In this way it is ensured that there are no reading skills necessary to make use of BaMoS. In the following section these three innovations in the field of mobile usability are elaborated.

3.1 Audio Menu Navigation

Normally, menu navigation is primarily based on text. During the project BaMoS it is tried to develop a menu navigation that can be used without reading skills. It is planned to use speech instead of text. More precisely speech will be used in addition to text. This way it is guaranteed that not only the handling of the application is simplified but that people with little or no reading skills can improve their reading skills during the usage of the mobile system as well.

In general the menu navigation is organised like a text based menu navigation. The difference between ordinary text menu navigation and audio menu navigation is small but important. With the audio menu navigation every menu item is represented not only by text but also by an audio file. Every time the focus is put on a menu item the respective audio file is played. For the creation of the audio files a text-to-speech synthesis module is used. As menu navigation is usually static it is not necessary to generate the audio files during runtime of the application. The text-to-speech conversion of the navigation items is not done on the mobile phone itself, but on a desktop computer. The files created are transferred to the mobile phone during the installation of BaMoS.

One of the advantages the text-to-speech generation is not done during runtime is the fact that the performance of the mobile application is not impaired. In addition the quality of the audio output is considerably better when the text-to-speech synthesis is done on a computer instead of a mobile phone. Furthermore freeware text-to-speech synthesis modules for computers can easily be found on the web. Text-to-speech synthesis modules for mobile phones are rare and free modules are hard to find.

3.2 Alternative Input Device

Very often elderly people have difficulties with the handling of mobile phones. Several studies concerning mobile phones have shown that there are practically no mobile phones on the market which fulfil the needs of elderly people. In this context a study conducted by the Austrian consumer magazine “Konsument” shall be mentioned. According to the study, which was set up as usability test, the elderly mainly complained about the difficult handling of the mobile phones. It addition they complained about the small keypad and the tiny buttons of the mobile devices. [5] Many of us know from experience that elderly people often are annoyed with the small size of mobile phones. Elderly people have difficulties with reading the small text on the display or with the handling of the phone in general, caused by the small sized buttons.

To find a remedy BaMoS likes to provide its users the possibility to use an alternative input device. That alternative input device is a so called single way input device and should further simplify the handling of the mobile application BaMoS. The single way input device that should be adopted can be described in general as a big soft button that bears likeliness to a pincushion. The alternative input device can easily be attached to the mobile phone. Afterwards the user can control the mobile phone just by pressing the soft button. Thus it can be ensured that nobody has to complain about buttons that are too small or menu navigations that are too complicated. During the development of BaMoS the technical challenge concerning the alternative input device has to be explored in detail.

3.3 *Text-to-Speech Synthesis*

Text-to-Speech Systems (TTS) focus on generating speech out of text. The main challenge in that context is not the generation of speech itself, but the generation of human sounding speech. Speech cannot be created by simply stringing together single words. Emphasis and intonation are indispensable for the creation of understandable and natural sounding speech. [6] Figure 6 illustrates the architecture of a generic text-to-speech system. The figure shows that a typical text-to-speech system consists of two main modules. The first step is the analysis of the text in the text analysis module. The second step is the speech generation. In this step the previously analysed text is converted into speech.

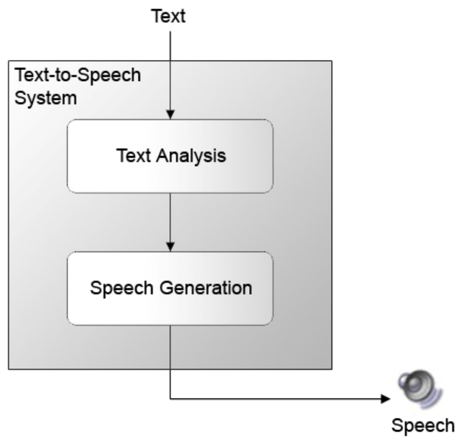


Figure 6: A generic Text-to-Speech System [7]

Text-to-speech synthesis modules designed especially for use with mobile phones are rare. Main reason is certainly the difficult development due to the narrowed resources on a mobile device. Even it is not easy to find text-to-speech synthesis modules that run on mobile phones there are few companies which offer such embedded modules. Currently the two companies Svox (http://www.svox.com) and Loquendo (http://www.loquendo.com) lead the field of embedded text-to-speech synthesis.

An embedded text-to-speech module allows a text to speech conversion during runtime of the mobile application. This functionality is indispensable for the BaMoS mobile service. The network traffic between the BaMoS server and the BaMoS client should be kept to a minimum. Therefore it is not possible to perform the text-to-speech conversion on the server before sending the audio files to the mobile client. To keep the network traffic low only plain text is sent from the server to the client. The client is responsible for the text-to-speech generation. At this stage the embedded technologies offered by Svox and Loquendo have to be integrated into the mobile service BaMoS. During the development of BaMoS it has to be evaluated which of the products should be used and how the integration of the embedded text-to-speech module can be realized.

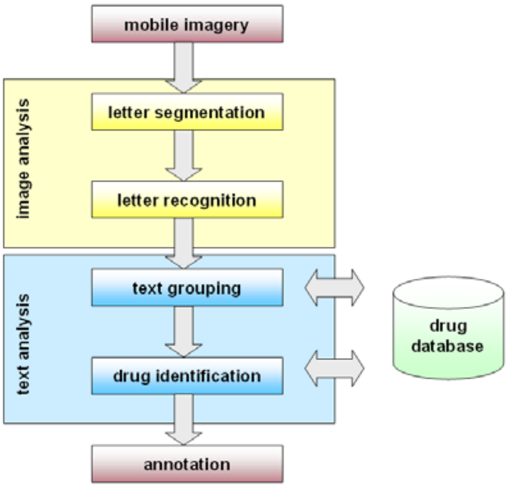
4 Vision Based Unconstrained Text Recognition

An important technical component in BaMoS is represented by the annotation of drug information by means of text recognition from unconstrained imagery. While optical character recognition systems (OCR) are already well functioning standard modules in everyday computing, unconstrained text recognition still represents a challenging research issue [8]. However, in BaMoS, we expect from the person under service to direct the mobile camera towards the object of interest and to capture an image of the drug information. We assume in general average illumination conditions and slight projective distortions of the object so that the system should work well, returning information about the success of the recognition performance (e.g., generating ‘beep’ sounds for either success or impossibility to deliver a meaningful object) and to guarantee with extremely high accuracy the orderly detection and recognition of drug information (above 99% both in detection and recognition performance tests). While the unconstrained text system of BaMoS is still in its preliminary stages of development (Figure 4), we already obtained promising first results documented within this paper. In the following, we present an overview of the text recognition system architecture, and provide an outline of our innovative approach of unconstrained letter recognition.

4.1 Text Recognition System Architecture

Text recognition in BaMoS refers to the interpretation of unconstrained text information from imagery captured from camera equipped mobile phones. We expect from the system to accurately recognize the text information in the image, to identify information that is relevant to the recognition of drug information, and to associate appropriate annotation for the support of the disabled person. In this system, we identify two major component groups (Figure 7(a)), (i) image analysis, i.e., in order to properly recognize individual letters from the image, and (ii) text analysis, i.e., in order to group relevant text items into meaningful names.

(a)



(b)

Figure 7 (a) Concept of the text recognition system architecture. (b) Preliminary results in unconstrained text recognition on mobile phone imagery. The letters of drug name are overlaid with information about the boundary of the region segmentation, a first and most important and critical step in text recognition, enabling a full mapping and finally translation of the individual letters for a further processing by the BaMoS system.

The mobile imagery is first captured by the mobile phone and, in an initial step of implementation, transferred from the mobile client to a server by means of internet protocols (Figure 7(a)).

The first critical step in image analysis is then to segment the letter information from other, irrelevant visual information. We are planning to involve an attention system [9] that should identify regions of interest in the image, typically focusing on texture that is characteristic for text supported visual information. The attended regions are then fed into a segmentation module [10] that groups visually homogeneous (sub-)pixel information into coherent 'letter' type region. This region is then normalised with respect to perspective distortion, assuming a simplification by assuming only affine transformation, and fed into a classification module. The classification in terms of letter recognition is implemented by means of (i) a mapping from the visual information onto a low-dimensional representation by principal component analysis (PCA), and (b) a discrimination step by means of a decision tree [11] that is able to identify relevant attributes, i.e., intervals in the PCA dimensions that are associated to particular letters, i.e., alphanumeric symbols of relevance for the interpretation of drug information. The decision tree is extracted from a machine learning stage where attributes are isolated from the information theoretic value in the individual intervals of the PCA dimensions. We prefer to use the decision tree instead of standard OCR software in order to accelerate the whole process of drug annotation.

In a second step, we apply text recognition in order to sort out chunks of text information that are meaningful with respect to drug information. This will involve the matching of text chunks with attributes of a drug database that will be generated in cooperation with pharmaceutical and medical experts in the second stage of the BaMoS project. We will group individual letters into groups from the spatial context of the image and match the group based text information with substrings of drug names contained in the drug database. As a result, we will obtain hypotheses on drug names associated with each text group, and apply a rule based classification system to determine the confidences in individual text group associations. In addition, text groups with identical hypotheses will be concatenated in order to generate new text groups and hypotheses, respectively. Resulting text groups with a sufficiently high level of confidence in the interpretation will be fed into the final stage, i.e., the annotation system.

First results of the segmentation methodology are presented in Figure 7(b). The critical step of letter based information precedes any classification of text, and presents a key element for determining the quality of the interpretation. From the first experiments we are rather confident that we will achieve satisfying results for the text recognition and eventual drug annotation for the functioning of the natural vision based interface in BaMoS.

4.2 *Innovative Approach to Unconstrained Text Recognition*

In a first step of unconstrained text recognition, we will apply a visual attention system [9] on the mobile imagery. The weights of the attention system will be learned from an extensive training database on text based visual information, in order to determine a classification network that discriminates text from any other visual information. While the input to the system is any sample image captured from the mobile system, the output will present a list of regions of interest associated with a confidence number that quantifies the uncertainty in the classification of a text type region. These regions are the normalized with respect to illumination and fed into the region segmentation module.

Region segmentation is applied by means of MSER type local descriptors [10]. MSER represents a new class of locally threshold separable detectors based on extreme regions, which can be adapted by machine learning techniques to arbitrary shapes. In the test set of drug box images taken from different viewpoints, scales even in bad illumination conditions and partial occlusions, promising region detection accuracy was achieved.

While the unconstrained text recognition system is still in its preliminary stages, we have already gained confidence that the specific and innovative combination of the attention system together with the MSER type region segmentation will achieve the desirable results for BaMoS. In the next step of implementation, we will train a decision tree to classify the segmented and normalized region information (Section 4.1) in order to arrive at intermediate results for letters and text groups, and then to come up with efficient hypotheses about the association to meaningful drug name information.

5 Database Access

For the mobile service BaMoS it is fundamental that the service can access a considerably and reliable database. During the development of the project is has to be decided whether it is reasonable to create a self-made database for test purpose at the beginning. The alternative would be to search for a company or an organisation that is willing to provide a complete database that can be used by BaMoS.

6 Conclusion and Future Work

People with certain disadvantages need more public attention as pointed out by several national, European and international socially engaged institutions. It is agreed that it should not be ignored any longer that even in highly educated European countries, such as, Austria, the illiteracy rates have reached an alarming level. With the development of the accessible mobile service BaMoS we intend to support endeavours against socially underprivileged persons using technological advances that have previously been misused in enlarging the gaps in knowledge societies.

Furthermore it should be stressed that there are several developments and efforts necessary to further improve the situation concerning the illiteracy rates. E.g., there are programs needed that beware children as well as adults of becoming functional illiterates. Socially targeted organisations such as ISOP (Innovative Sozialprojekte) in Austria, offer special literacy courses for adults. These courses aim at improving the literacy skills of people that have difficulties with reading or writing. On the other hand it has to be ensured that the barriers illiterates are facing every day are kept as low as possible. In no way difficulties with reading may lead to health problems.

There is a great demand for future work in the field of mobile services designed for special target groups of disabled people. We intend to expand in the future the functionality of the mobile application BaMoS in respect of providing better access to the food market. Certainly there is a need for an application that reads out the food ingredients that can be on the packaging.

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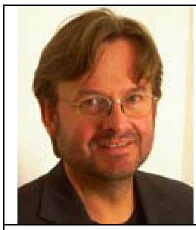

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Otto Rath, born in 1963, studies of the German and English Language and Literature. Trainer for German as a foreign/second language, teacher trainer in Slovakia and Hungary; university lecturer at the Technical University of Budapest from 1994 to 1998. Project manager since 1998. Founder of the Austrian Literacy and Basic Skills Network. Presently coordinating a development partnership funded by the European Social Fund. Publications in the fields of Austrian literature, German as a foreign/second language, Literacy.