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Developing an Accessible E-Book Reader Application for the Visually Impaired: Case Study on Husnil Muslim Book

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ABSTRACT: This study reports the development of a mobile application designed to improve e-book accessibility for visually impaired and blind users. The application employs touch gestures and a voice assistant to facilitate navigation, searching, interaction, and bookmarking of digital content. The well-known book *Husnil Muslim* was selected as a test case to evaluate usability in a culturally relevant context. A laboratory-based assessment was conducted with 25 blind participants from the Al-Diaa Association in Mukalla, Yemen. User feedback was collected using a 3-point Likert scale, revealing a high level of acceptance, with 94.77% of participants expressing satisfaction. The results indicate that the application provides an effective, user-friendly platform for independent e-book exploration, with potential benefits extending to illiterate individuals as well. These findings underscore the role of mobile technologies in promoting inclusive digital learning and enhancing information accessibility for underserved populations.

KEYWORDS: Mobile Application, Accessibility, Visually Impaired Users, Blind Users, Husnil Muslim, Reading Books

INTRODUCTION

Daily activities and tasks are supposed to be easy to perform for all people, and among those basic daily tasks are reading books and accessing information, thus promoting inclusivity and ensuring equal opportunities for all. People read for various purposes, for example, for academic learning, religious education, and the acquisition of new knowledge. Recently, the electronic book (e-book) has created new opportunities for the visually impaired as well as the blind to read and also teach [1], [19], [20], in addition to acquiring knowledge as normal-sighted people do.

According to the World Health Organization, there are more than three hundred million people with visual impairment, of whom more than thirty-nine million are blind [1]. Accessing information and reading texts in books is always a challenge for people who do not have the ability to read printed materials on paper. With the development of modern technology and the conversion of more traditional paper books to electronic formats, there will be many opportunities for blind people to enjoy access to books on an equal basis with people who can read printed books.

The National Federation of the Blind (NFB) reported that there is still a lack of many electronic books to satisfy the needs of blind individuals. Access to digital information for the blind is still limited and complicated [2],[3],[4]. For this reason, in this research, a mobile application will be developed to provide the opportunity for blind and visually impaired people to read e-books, so that the application provides suitable functions to help users navigate the contents of the book easily. And also, the ability to easily interact with the application without obstacles. Many features will be provided, such as the ability to set bookmarks, change the language, and search by voice. Touch gestures will be used to interact with the application.

This paper is structured as follows: Section 2 covers related work in this field; Section 3 gives a thorough overview of the proposed work; Section 4 shows design and implementation details; and Section 5 concludes the paper with a conclusion and future scope.

1. RELATED WORKS

This section discusses some related studies that have been made to overcome the barriers of reading faced by visually impaired, blind, or illiterate people.

mobile device systems have been developed to address the accessibility functions [5], [7], [19]. For mobile applications, most systems are based on screen readers using VoiceOver for the iOS operating system and TalkBack for the Android operating system [5]. However, the screen reader based solution is not user-friendly for navigating through the content of text. Likewise, magnification technology is used to help visually impaired users zoom in or out of interfaces for appropriate viewing [6], [7], however, this technology cannot be used for people with total blindness.

In a study [8], a system has been developed specifically for Bangla language speakers. In this system, Google Speech with computer vision techniques have been implemented. In this study, text is captured via a camera, and then the system converts

it into speech. However, in low light conditions, the system does not work perfectly, and blind people may not be able to use it appropriately to read book texts.

In the study [9], they built a mobile application to perform exams for blind people using speech technology. In this study, text is converted text speech, which made it easier for the user to answer the questions. However, it is neither intended for reading books nor for learning purposes.

A mobile application on the Android system developed by Pampattiwar [10] for blind people to fully interact with mobile phone functions by converting text into speech with an easy and simple interface. However, this application is not flexible for reading e-books due to the difficulty the user faces in navigating through the pages of the book.

A different system was developed based on Raspberry Pi by [11]. This system can recognize texts written on surfaces such as pictures and books. The system converts these texts into audio speech for users using a Text to Speech (TTS) technique.

A mobile application was produced by [12] to enable the blind and illiterate to view the content of daily newspapers for the blind and illiterate. The application converts images from newspapers into audible speech using character recognition technology and artificial intelligence. However, it requires manual guidance by the user to read books, and systems that use character recognition lack the ability to search for specific content. In addition, the study in [13] has used a device designated to serve the visually impaired by providing a digital talking book operator service to help the visually impaired read written words, in addition to the ability to navigate, search for them, and place a bookmark. The shortcoming in this study is that a special device must be provided for each user, and the e-book must be compatible with the device. Many applications provide the possibility of enabling the visually impaired to access e-books through the text-to-speech service (TTS) by converting written books into speech [14][15].

Table 1: Comparisons of Previous Works with Proposed Work

Criterion	Previous Works	Proposed Work
Navigation Method	• Screen readers (VoiceOver/TalkBack) with poor content navigation [5] • Manual camera guidance [8,12]	**Intuitive touch gestures**: • Swipe left/right: Navigate items • Swipe up: Select • Double tap: Add to favorites
Book Support	• Difficult e-book page navigation [10] • No bookmark support [12]	**Hierarchical organization**: • Chapter/dua indexing • Bookmarks
		(Double tap) • Voice search
Voice Guidance	• Text-to-speech only (no interactive cues) [9]	**Contextual voice instructions**: • Startup tutorials • Action confirmation (e.g., "Added to favorites")
Target Users	• Blind users only [8,9,11]	**Inclusive design**: • Blind • Visually impaired • Illiterate (no tech experience)
Environmental Performance	• Failed in low-light conditions [8]	**Environment-independent**: • No visual/light requirements
Experimental Results	• Rarely reported [10,12]	**Quantified effectiveness**: • Ease of use: **98.97%** • Voice clarity: **92%** • Overall satisfaction: **94.77%**
Compatibility	• Dedicated hardware [13] • Single-platform [10]	**Cross-platform**: • iOS/Android via Flutter [18]

Figure 1: Research Gap Analysis

2. METHODS

The main motivation behind creating this research is the previous attempts to create applications specifically for people with visual impairment and blindness, as well as illiterate people. These applications are touch and guide.

One of the goals pursued by this research is to develop an application capable of adapting to the needs of a user who suffers from visual impairment or illiteracy in reading books [16]. Although our application is intended for one book, the method can be applied to any other book perfectly. This application will be accessible to everyone, regardless of their age or experience in using smartphones.

From previous studies, it can be noted that the problems that mobile applications suffer from are that the interfaces are not suitable for the target group of people. In addition, it is not suitable for those with little experience, and it is difficult to adapt to it. In the same context, the inability of many applications to provide sufficient flexibility for the blind user as an alternative to physical buttons.

It can be concluded that tactile gestures accompanying a speaking voice are considered the most attractive to people with visual impairment and more preferable to blind people. It gives the user control over navigation through applications. This method can be used to navigate through the contents of the book smoothly and make the application dynamic.

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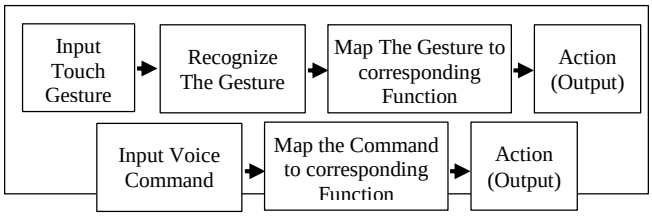

Figure 2: System Architecture

The agile methodology was used to develop this application. Agile methodology is a popular approach to software development that emphasizes flexibility, collaboration, and customer-centricity. It promotes iterative progress through small, manageable increments, allowing teams to adapt to changes quickly, as this model is conveniently maintainable and easy to use. In addition, the application is scope-specific with very low risks and also has clear requirements. These characteristics mentioned are appropriate for using the agile model in development outlines. The first step aims to define the research-specific problem as well as the research question as follows:

How can a mobile application be designed to enable visually impaired and blind users to explore e-books independently?

2.1 Qualitative Study

The primary goals of the qualitative study were to identify user requirements and explore design considerations for creating the "Ana Astamie" application tailored for the Blind population in Yemen – Mukalla city. Prior research has demonstrated that engaging users early in the design and development process provides valuable insights for developing effective mobile applications. To achieve this, a qualitative study was conducted, involving interviews with group of Blind individuals from Al-Diaa Association for the Care and Rehabilitation of the Blind in Mukalla city - Yemen. The association president stated that as of October 2024, there were approximately 85 registered members in the association, representing the research population.

2.1.1 Selection of Participants

The study commenced with the selection of participants who met the criteria necessary to achieve the study's objectives. A group of blind individuals was recruited to share their insights and preferences regarding the application.

2.1.2 Procedure

The study began by preparing key documents, including information on participants' ethical rights, and interview questions designed to elicit detailed responses. A total of twenty open-ended questions were formulated, divided into two categories:

Personal Questions: These included inquiries about participants' sex, age group, education, sex, and experience with smartphones.

Application Design Preferences: These focused on participants' views regarding the application for Ana Astamie App.

The practical steps commenced with welcoming the participants and explaining their ethical rights. After obtaining consent, the interview began with the first group of personal questions. Following this, participants were asked questions related to the idea about how to navigate e-books for blind individuals, specifically regarding the preferred way to navigate, their interest in reading e-books, and their willingness to use a mobile app for this purpose. Additional questions arose during the interviews to clarify themes and gather more insights. Finally, participants were invited to share any additional ideas that had not been addressed during the session.

After completing the personal interview with the participants, the results were as follows: All participants preferred to use smartphones to help them in their daily work, such as studying, reading books, navigating websites, and using electronic applications. For them, the idea of browsing electronic books such as the book Hisnul Muslim using gestures and audio was appreciated, and they preferred that the application be easy to use and contain the ability to add some supplications to favorites in order to quickly access frequently used supplications.

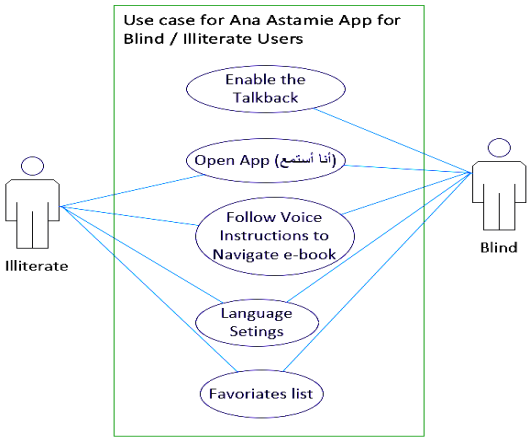

Figure 3: Apps Use Case Diagram

2.2 Application Design and Implementation

The Flutter framework has been used to develop the app. Flutter, a cross-platform toolkit, was chosen for app development due to its ease of use, high performance, and support for both Android and iOS, allowing for a wider user base [18]. Built on the Dart programming language, Flutter also benefits from a vast repository of software packages [18], [23], [24]. Figure 4 below shows the application main screen.

Figure 4: Application's main page

When users launch the app, they will hear voice instructions guiding them on its usage. They can follow the voice instructions to use the app.

The following are some instructions about the application, in Figure 5 below.

Figure 5: Instructions for moving between menus

Swipe up to view the app instructions, swipe right to browse the app features, or swipe left to go to the reminders list. Swipe left or right to move between app elements. Then swipe up to select the desired element. You can reply to the item details by tapping once on the screen, and you can pause and play the sound by long-pressing on the screen.

Figure 6: Language settings

The screen in Figure 6, shows the application settings to choose the language, either Arabic or English, by scrolling up.

Figure 7: Favorites List

The user can add the supplication to their favorites list by tapping twice on the screen

2.3 Application Evaluation

Following the development and testing of the application, the next phase was the evaluation process. A laboratory study was conducted involving a group of blind individuals to gather feedback on the app.

The evaluation involved 25 participants recruited from Al-Diaa Association for the Care and Rehabilitation of the Blind in Mukalla city, Yemen. Among them, 4 had participated in the initial requirement elicitation study, while 21 were new recruits. The group comprised 10 females and 15 males, with ages ranging from 15 to 45 years, averaging 30 years. The application was downloaded on the participants' smartphones, and they used it for two weeks. Then, the questionnaire was distributed to them, which contained two types of questions. The first type was about their personal information, such as gender, age, and educational level. The second type contained a set of questions that measured the ease of using the application, such as the first question: Is the application easy to use? The second question: Are the voice instructions clear and understandable? The third question: Can I add any of the supplications to my favorites easily? The answers were measured according to a Likert Scale on a range of 1 (disagree) to 3 (strongly agree).

3. RESULTS AND STATISTICAL ANALYSIS

The data collected from the evaluation sessions were analyzed to assess the application's usability based on three parameters: ease of use, voice and instructions clarity, and favorites list. Table 1 summarizes the results of these evaluation sessions.

Table 2: The result of the evaluation sessions

Evaluation criteria	Average	Ratio %	Rank
Ease of use	2.96	98.97	1
Voice instructions clarity	2.76	92.00	3
Favorites list useful	2.8	93.33	2

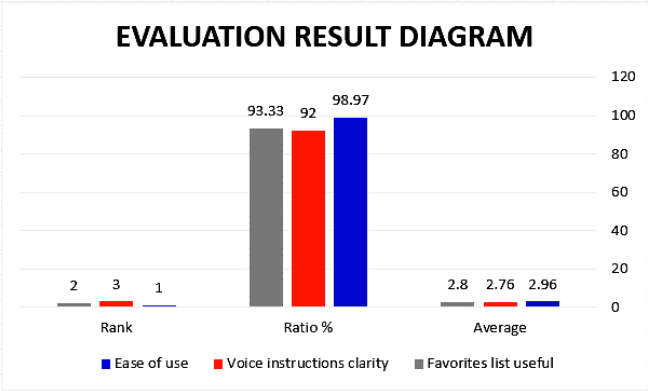

Figure 8. Evaluation Result Diagram

The researchers believe that the question ranked number (1), which is (how easy is the application to use), they believe that the study sample members answered that they strongly agree with a percentage of 98.97%. This means that the application is easy to use and useful for this category. As for the question ranked number (2), which is (the extent to which the user benefits from the favorites list feature), the researchers believe that the study sample members answered that they agree with a percentage of 92.00%, which means that the feature added to the application is useful to the user. Likewise, as for the question ranked number (3) which is (the extent to which the audio instructions are clear), the researchers believe that the study sample members answered that they agree with a percentage of 93.33%, which means that the user may need to hear the instructions more than once only at the beginning. In general, the study sample members believe that the application is easy to use and very useful, and recommend it to others.

After participants used the application for two weeks, a structured questionnaire was administered. The results, analyzed using descriptive statistics and t-tests, demonstrated a high level of user satisfaction. The mean score for "ease of use" was 2.96 (SD = 0.12), indicating strong agreement that the application was user-friendly. Similarly, participants rated the clarity of voice instructions (M = 2.76, SD = 0.25) and the usefulness of the favorites list (M = 2.80, SD = 0.20) positively. One-sample t-tests revealed that all these mean values were significantly higher than the neutral midpoint ($p < 0.001$), confirming the app's effectiveness for the visually impaired population.

The findings provide statistically significant evidence that the "Husnil Muslim" application is not only usable but highly appreciated by visually impaired users. The results support the app's adoption in similar communities and further motivate its expansion to other religious or educational texts.

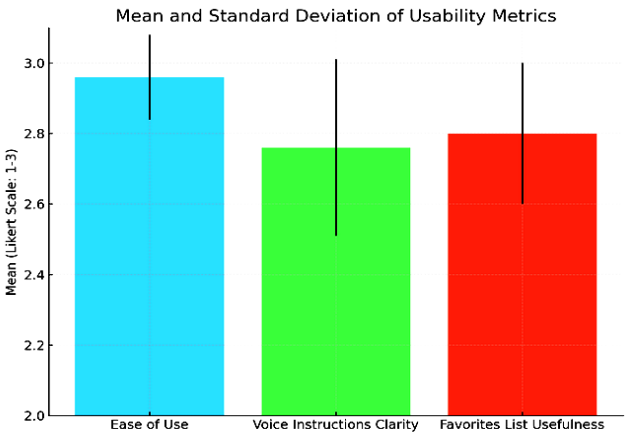

Figure 9. Mean and Standard Deviation of Usability Metrics

In this bar chart, we compare the means (bars) and standard deviations (vertical lines above the bars) for each of the three evaluation axes: Ease of Use, Clarity of Voice Instructions, and Usefulness of Favorites List. The data shows that all axes were rated highly (close to 3, meaning "strongly agree"), with little variation in participants' opinions.

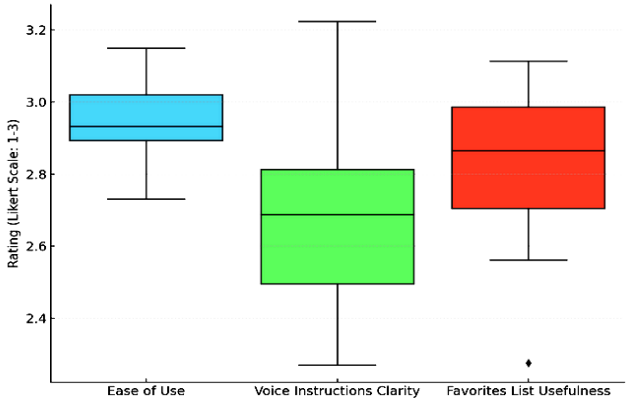

Figure 10. Boxplot of Usability Evaluation Metrics

In this boxplot illustration, each axis shows the dispersion of participants' ratings around the mean. The line inside each box represents the median. The box reflects the range between the first and third quartiles, while the outer lines (dashes) represent the minimum and maximum ratings, excluding outliers, if any.

From the graph, we can see that Most ratings were high and clustered closely together. The dispersion of ratings was slightly greater on the axis of clarity of the audio instructions, indicating little variation in user opinions.

4. DISCUSSION

The usability evaluation of the "Husnil Muslim" mobile application demonstrated high levels of user satisfaction, with 98.97% agreement on ease of use, 93.33% satisfaction regarding the usefulness of the favorites list feature, and 92% agreement on the clarity of voice instructions. These results confirm the effectiveness of the proposed system in meeting the accessibility needs of visually impaired, blind, and illiterate users.

In relation to previous works, the findings are consistent with [13], which highlighted the importance of bookmark and navigation features in digital talking book solutions. However, the present application extends this capability through the integration of intuitive touch gestures and contextual voice guidance, enabling more efficient and inclusive interaction. Compared to [5] and [10], which relied on screen readers with limited navigation support, the proposed application provides a more intuitive interaction. This aligns with recent findings in [20], [21], confirming the importance of integrating gesture-based and voice-enabled assistive systems. Furthermore, unlike camera-based OCR solutions [8], [12], our app remains environment-independent, consistent with the latest multimodal approaches in [22].

Additionally, while prior systems such as [8], [9], and [11] primarily targeted blind users, this research demonstrates a more inclusive design approach, accommodating visually impaired and illiterate users without prior technical experience. Nevertheless, unlike [14] and [15], which support multiple book types, this study was limited to a single religious text. While this narrow scope allowed for targeted optimization and high usability, future enhancements should focus on expanding supported content to maximize the application's impact.

5. RECOMMENDATIONS

Based on the positive outcomes of this research and identified limitations, the following recommendations are proposed:

1. Expand Content Scope: Adapt the application to support additional religious, educational, and cultural texts [19], [25] to extend usability across various domains.
2. Integrate Multilingual Support and cross-platform inclusivity [20], [23], [24].
3. Enhance Personalization by leveraging AI-driven interaction patterns [12], [22].
4. Align with global assistive technology strategies [26].
5. Conduct Longitudinal Studies: Evaluate the long-term effects of the application on reading habits, digital literacy, and quality of life among visually impaired and illiterate populations.
6. Apply Community Co-Design: Involve end-users continuously in the design and development process to identify emerging needs and ensure sustained usability.

6. CONCLUSIONS AND FUTURE WORK

This study demonstrates the development of a mobile phone application that enables visually impaired and blind users to independently explore e-books, navigate content, search, interact, and set bookmarks. The application's usability and accessibility features, including touch gestures and a voice assistant, have been successfully tested using the book "Husnil Muslim" as a case study. This research contributes to the creation of interactive platforms that can make learning through e-books accessible to visually impaired and blind individuals, as well as illiterate people, thereby promoting equal opportunities for education and knowledge acquisition. The

application can be tested with a group of users to collect feedback data to discover more user needs to add to the functionality of the mobile application.

The current study focused on developing and evaluating a mobile application using a single religious book. Future development priorities encompass: multi-book/multi-language expansion, advanced search integration, and personalization feature enhancement.

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