# by Mada

**Issue no. 24** December 2023

www.mada.org.qa

### **Global Reach, Local Touch** Refining Assistive Technologies through Localization

Enhancing the Efficacy of Assistive Technologies through Localization

A Comprehensive Analysis with a Focus on the Arab Region Signed Languages and Deaf Communities

Mada's effort in the localization of Assistive Technology and Digital Accessibility A Gateway to Sustainable Inclusivity

Page 46



Page 32

#### **Editors-in-Chief**

Amani Ali Al-Tamimi, Mada Center, Qatar

Achraf Othman, Mada Center, Qatar

#### **Editors**

Amira Dhouib, Mada Center, Qatar

#### Reviewer Board Ahlem Assila, CESI Reims, France.

Ahmed Tlili, Smart Learning Institute of Beijing Normal University China

Al-Dana Ahmed Al-Mohannadi, Mada Center, Qatar

Alia Jamal AlKathery, Mada Center, Qatar

Al Jazi Al Jabr, Mada Center, Qatar

Amnah Mohammed Al-Mutawaa, Mada Center, Qatar

**Dena Al-Thani,** Hamad Bin Khalifa University, Qatar.

Fahriye Altinay, Near East University, Northern part of Cyprus

Fathi Essalmi, University of Jeddah, Saudi Arabia

**Haifa Ben El Hadj,** Qatar University, Qatar

> Hajer Chalghoumi, Canadian Centre for Diversity and Inclusion Consulting Inc., Canada

Hana Rabbouch, Higher Institute of Management Sousse, Tunisia

Khaled Koubaa, Medeverse, USA

Mohamed Koutheair Khribi, Mada Center, Qatar

Oussama El Ghoul, Mada Center, Qatar

Samia Kouki, Higher Colleges of Technology, UAE

**Tawfik Al-Hadhrami,** Nottingham Trent University, UK

**Zied Bouida,** Carleton University, Ottawa, Canada

# About Mada

Mada – Assistive Technology Center Qatar, is a private institution for public benefit, which was founded in 2010 as an initiative that aims at promoting digital inclusion and building a technology-based community that meets the needs of persons with disabilities (PWDs). Mada today is the world's Center of Excellence in digital accessibility in Arabic.

The Center works through smart strategic partnerships to enable the education sector to ensure inclusive education, the community sector through ICTs to become more inclusive, and the employment sector to enhance employment opportunities, professional development and entrepreneurship for persons with disabilities.

The Center achieves its goals by building partners' capabilities and supporting the development and accreditation of digital platforms in accordance with international standards of digital accessibility. Mada also raises awareness, provides consulting services, and increases the number of assistive technology solutions in Arabic through the Mada Innovation Program to ensure equal opportunities for the participation of persons with disabilities in the digital society.

# Nafath

**Issue no. 24** December 2023

ISSN (online): 2789-9152 ISSN (print): 2789-9144

#### **Reuse Rights and Reprint Permissions**

Nafath is an open access journal. Educational or personal use of this material is permitted without fee, provided such use: 1) is not made for profit; 2) includes this notice and a full citation to the original work on the first page of the copy; and 3) does not imply Mada endorsement of any third-party products or services. Authors and their companies are permitted to post the accepted version of Nafath material on their own Web servers without permission, provided that the Mada notice and a full citation to the original work appear on the first screen of the posted copy. An accepted manuscript is a version which has been revised by the author to incorporate review suggestions, but not the published version with copyediting, proofreading, and formatting added by Mada Center. For more information, please go to: https://nafath. mada.org.qa. Permission to reprint/republish this material for commercial, advertising, or promotional purposes or for creating new collective works for resale or redistribution must be obtained from Mada.

Nafath © 2023 by Mada Center is licensed under CC BY-NC 4.0.





# About Nafath

Nafath aims to be a key information resource for disseminating the facts about latest trends and innovation in the field of ICT Accessibility. It is published in English and Arabic languages on a quarterly basis and intends to be a window of information to the world, highlighting the pioneering work done in our field to meet the growing demands of ICT Accessibility and Assistive Technology products and services in Qatar and the Arab region.



4

# Content Page

# Page 08

**Enhancing the Efficacy of** Assistive Technologies through Localization: A Comprehensive Analysis with a Focus on the Arab Region

Ahmed Elsheikh

# Page 25

Localisation of a Text-based App for Arabic Assistive Technology Users

**Rebecca Bright** & Swapnil Gadgil

# Page 32

Signed Languages and Deaf Communities

Sameer Semreen

#### Nafath Issue 24

### 5

# Page 40

#### DeepFoni

An Assistive **Communication Innovation** to Empower Individuals with Communication Difficulties

Saida Hamrit



# Page 46

Mada's effort in the localization of Assistive **Technology and Digital** Accessibility A Gateway to Sustainable Inclusivity

Achraf Othman





Nafath Issue 24

7

# **Open call** for papers

Nafath, an open access journal, solicits original research contributions addressing the accessibility, usability, and key information resource for disseminating the facts about latest trends and innovation in the field of ICT Accessibility to enable persons with disabilities and the elderly. Nafath is focusing on theoretical, methodological, and empirical research, of both technological nature, that addresses equitable access and active participation of potentially all citizens in the Information Society.

#### **Topics of specific interest**

Important aspects and topics to be discussed evolve around (but are not limited to):

- Accessibility guidelines
- Accessible games
- Adaptable and adaptive interfaces
- Alternative and augmented Input /Output techniques
- Applications of assistive technologies in the mainstream
- Architectures, development methods and tools for ICT Accessibility
- Design for All accessibility education and training
- Evaluation of Accessibility, Usability, and User Experience
- Innovative Assistive applications and environments and ICT Accessibility solutions
- Localization



& Accessibility The Advent of Smartphone Ready Hearing Aids mada

- Novel designs for the very young, the elderly, and people with different types of disabilities
- Novel interaction techniques, platforms, metaphors, and devices
- Personalization techniques and ٠ personalized products and services
- Smart artifacts, smart cities and smart environments
- Web accessibility



issues, book reviews and letters to the editor, announcements (e.g. conferences, seminars, presentations, exhibitions, education and curricula, awards, new research programs), and commentaries (e.g. about new policies or legislation).

#### Why publish with us?

Nafath is registered and indexed by DOI. All issues have an ISSN number for online and print version.

#### To submit a paper please visit:

https://nafath.mada.org.qa/submit-your-paper/ or send it directly to the editors by email to: nafath@mada.org.qa



Nafath Issue 24

**Abstract** 

9

# **Enhancing the Efficacy of Assistive Technologies** through Localization

**A Comprehensive Analysis** with a Focus on the Arab Region

#### Ahmed Elsheikh

Mada Assistive Technology Center, Qatar aelsheikh@mada.org.ga



#### Enhancing the Efficacy of Assistive **Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

The realm of Assistive Technologies (AT) blossoms at the nexus of inventive solutions and user-focused design. However, these technologies must intimately resonate with their users' cultural and linguistic nuances to reach their peak effectiveness. Consider the Arabicspeaking community, encompassing over 420 million individuals, each with diverse dialects, traditions, and societal norms. This study seeks to decode the layers of the Arabic language and its cultural fabric. It delves into the richness of dialectal variations, from the melodic tones of Maghrebi Arabic to the unique sounds of Gulf Arabic, and confronts the challenges presented by the right-to-left script in digital contexts. Further, the article zooms in on the socio-cultural intricacies of the Arab landscape, examining how views on disability, religious factors, and local customs influence the reception and performance of AT. Through an in-depth assessment of

#### **Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

### Introduction

The development of Assistive Technologies (AT) has been a transformative force in the lives of countless individuals with disabilities, empowering them with tools that bolster their autonomy and selfassurance (lancu & lancu, 2017). Nonetheless, for these technologies to be genuinely impactful, they cannot be created in a vacuum. They must resonate deeply with their target communities' cultural and linguistic sensitivities (Layton, Maclachlan, Smith, & Scherer, 2020). The Arabic-speaking community, boasting a rich tapestry of over 420 million people, offers a striking example. This community is a mosaic of diverse dialects, traditions, and societal practices (Farghaly & Shaalan, 2009).

Localizing AT for the Arabic context presents multifaceted challenges. With its right-to-left orientation and myriad dialects, the Arabic language necessitates intricate technical adaptation considerations (Farghaly & Shaalan, 2009). Furthermore, the cultural landscape of the Arabic world, deeply rooted in Islamic values, regional customs, and distinct views on disability, plays a pivotal role in determining the reception Beszta, 2019).

It is crucial to acknowledge the spectrum of Arabic dialects, ranging from the melodious Maghrebi Arabic to the singular Gulf Arabic, each bearing its distinct linguistic attributes (Mancilla-Martinez, 2020). Such diversity complicates the standardization of AT across Arabic regions. Moreover, Islamic principles profoundly influence perceptions of disability, caregiving, and the role of technology in assistance (Ashour, 2020). Given these intricacies, there's an urgent call to harmonize cutting-edge technology with cultural sensitivity,

ensuring AT functions efficiently and deeply align with the Arab worldview (Ashour, 2020). This article ventures into a thorough analysis, aiming to demystify the nuances of adapting assistive technologies for Arabic speakers. By spotlighting unique linguistic and cultural challenges, offering insights from detailed case studies, and envisioning a way forward, this research endeavors to enrich the domain of assistive technologies. It aims to deepen understanding of the intricate dance between technology, culture, and language in the Arab milieu.

In essence, adapting AT for the Arabic context is not a straightforward task. The unique attributes of the language, coupled with socio-cultural dynamics, present distinct challenges (Habash, 2022). As we bridge the gap between technological innovations and cultural understanding, we strive to ensure that AT solutions truly embody and reflect the essence of the Arab world (Farghaly & Shaalan, 2009). This paper delves deep into the complexities of tailoring assistive technologies for Arabic speakers, providing illuminating insights, presenting real-world examples, and mapping out the future of AT in this rich and diverse context.

The localization of AT for the Arabic-speaking population is essential for ensuring equitable access to technology-driven solutions for individuals with disabilities in this region. It addresses linguistic and cultural considerations, aligns with legal requirements, and presents economic opportunities. Furthermore, it exemplifies a commitment to inclusivity and respect for cultural diversity, ultimately improving the lives of individuals with disabilities in the Arab world. The significance of tailoring assistive technologies to specific linguistic and cultural Nafath Issue 24

contexts is increasingly acknowledged in the field of accessibility (Paucar-Menacho et al., 2022). For the vast and diverse Arabic-speaking population, this localization holds profound implications such as:

- Enhanced Accessibility Localizing AT for Arabic users ensures that these technologies are accessible and relevant to individuals with disabilities in the Arab world (Saad & Borowska Beszta, 2019). By considering linguistic nuances and cultural norms, AT becomes more user-friendly, increasing its adoption and effectiveness.
- Improved User Engagement When AT is designed with an understanding of the Arabic language's intricacies and cultural sensitivities, and users are more likely to engage with and trust these technologies (Ripat & Woodgate, 2011). This results in better user experiences and outcomes.
- is characterized by a rich tapestry of dialects, Jazim, Abdulrab, Al-Mamary, & Khan, 2022). this diversity, ensuring that AT solutions do instead adapt to local variations.
- Legal Compliance Some regions, including Arab countries, have specific regulations and standards regarding the accessibility of digital technologies (Barakina, Popova, Gorokhova, & Voskovskaya, 2021). Localized AT aligns with these legal requirements, reducing potential barriers to adoption.
- Market Potential The Arab market represents a significant economic opportunity for developers and manufacturers of AT (Al-Mazrooa, 2018).

#### Enhancing the Efficacy of Assistive **Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

Localized solutions can tap into this market and contribute to its growth.

Cultural Empathy: Localizing AT demonstrates cultural empathy and respect for the values and beliefs of the Arabic-speaking community (Al-Mazrooa, 2018). This approach fosters a positive relationship between developers and users.

# Challenges of Arabic Localization

Localizing assistive technologies for the Arabicspeaking world requires addressing distinct linguistic, cultural, technical, and social challenges. The intricate nature of the Arabic language, combined with the multifaceted societal backdrop of the Arab world lays down a complex roadmap for AT developers and designers. These challenges can be summarized as follows:

#### ++++ Demographic Consideration

**Respect for Cultural Diversity** The Arab world With over 420 million native speakers, Arabic ranks among the world's most spoken languages (Altraditions, and societal norms (Al-Ghurbani, Ghurbani et al., 2022). This significant demographic presence underscores the need for specialized Localization respects and acknowledges AT solutions tailored to the specific needs and characteristics of this linguistic community not impose a one-size-fits-all approach but (Balasubramanian, Beaney, & Chambers, 2021).

#### **Here :** Linguistic Complexity

The Arabic language, one of the world's oldest and most widely spoken languages, possesses a rich tapestry of linguistic variations. Contrary to the popular notion of its uniformity, Arabic is characterized by multifaceted dialectal diversity. Arabic, as it is known and spoken today, comprises a multitude of regional dialects, each rooted in distinct cultural and historical contexts. These dialects often differ substantially in pronunciation, vocabulary, and even grammar. For example,

### 12

**Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

while the word for 'tomato' in Gulf Arabic might Recognizing and integrating these complexities be "طماطم" (tamatim), in Egyptian Arabic, it is ensures that AT solutions are technically competent, commonly known as "نندورة" (bandura) (Yasir culturally resonant, and inclusive. Suleiman, 2014). Such differences underscore the vast lexical variations present across different Arabic-speaking regions. Modern Standard Arabic (MSA) serves as the standard form used in formal communication, media, and education across distinct meanings share the same consonantal root Arabic-speaking countries. However, colloquial, day-to-day communication often employs regional Shaalan, 2009a). For individuals with disabilities dialects. An AT solution that solely focuses on MSA might not effectively cater to the colloquial needs of its users, making the technology less approachable and relevant to many (Younes, Souissi, Achour, & Ferchichi, 2020).

challenges for AT developers. Voice recognition diverse phonetic variations to accurately transcribe spoken words. Similarly, text-to-speech tools to discern meaning, Arabic homographs often Jomhari, & M. Abushariah, 2020).

isn't merely a technical challenge; it's an issue groups, depriving them of fully benefiting from the technology. Emphasizing the need for dialectsensitive solutions, studies have pointed out that inclusive AT solutions foster a sense of users. The linguistic complexity of Arabic, with intended meaning to the user. In this scenario, its rich dialectal variations, mandates a nuanced

#### Homographs

In Arabic, homographs often occur due to the rootbased structure of the language, where words with but differ in their vowels and diacritics (Farghaly & who rely on AT, particularly those with visual impairments using screen readers or individuals with dyslexia using text-to-speech tools, navigating through a text rich in homographs can be perplexing (Dhouib et al., 2022).

The linguistic complexity of Arabic poses unique The primary challenge lies in disambiguating these homographs and determining the intended software, for instance, would need to account for meaning based on context. Unlike some other languages where context alone may be sufficient would need to ensure the spoken output aligns require a deep understanding of the text and with the regional dialect of its user, enhancing the its context. This places a substantial burden on user's overall experience (Al-Shamayleh, Ahmad, AT systems to accurately interpret the user's intended meaning and deliver the appropriate assistance. For instance, Consider the following In the context of AT, linguistic representation Arabic sentence: الباب مفتوم"." his sentence can be translated to English as "The door is open." of inclusivity. Neglecting dialectal variations However, the Arabic word "مفتوح" (mftooh) is a might inadvertently marginalize certain user homograph that can also mean "unlocked" when used in a different context. Now, imagine an individual with a visual impairment using a screen reader to access this sentence. The screen reader encounters the word "مفتوح" (mftooh) and must belongingness and cultural validation among its determine the appropriate context to convey the the screen reader relies on contextual cues to approach in the realm of Assistive Technologies. correctly interpret the sentence. It considers not only the individual word but also the surrounding words and the overall structure of the sentence. In

Nafath Issue 24

13

#### Enhancing the Efficacy of Assistive **Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

doing so, it can provide the user with an accurate Issues like mirrored icons, alignment of text, and understanding of the sentence's meaning, ensuring proper rendering of mixed content (combining that "مفتوح" (mftooh) is correctly understood as RTL and LTR scripts) need meticulous attention "open" in the sense of the door being accessible, to ensure usability and coherence (Banouni, rather than "unlocked." This example demonstrates Mohamed, & Lazrek, 2004). the challenges posed by Arabic homographs in everyday text and the vital role of context in Arabic is known for its morphological depth, where involved in natural language processing. Predictive text input, speech recognition, and even simple text-to-speech functionalities require algorithms that can accurately recognize and process this vast El Hassani, Yazidy, Bouzouba, & Hamdani, 2008). where letters within a word are often connected. Additionally, the script incorporates diacritics or "harakat" which influence the pronunciation of words. While these diacritics are often omitted specific contexts, especially for learners or those with reading difficulties. Assistive tools, especially screen readers and Braille conversion tools, must be equipped to process these orthographic nuances to provide accurate and meaningful

assistive technologies. Whether it's reading a a single root can give rise to various derived forms, book, browsing a website, or interacting with each with its distinct meaning. This intricacy poses text-based content, accurate interpretation of challenges for assistive tools, especially those homographs is crucial for individuals using AT to access information and communicate effectively in Arabic. As a result, developers, and researchers in the field array of morphological derivatives (Abouenour, of AT must focus on enhancing the natural language processing capabilities of these technologies to Arabic script is characterized by its cursive nature, effectively disambiguate homographs in Arabic text. This includes the development of sophisticated algorithms that consider broader linguistic and contextual cues, as well as user preferences, to ensure accurate and contextually appropriate in everyday writing, their presence is crucial for assistance for individuals with disabilities. **Here :** Technical Challenges The essence of the Arabic language, enriched by its script, morphology, and unique orientation, presents multifaceted challenges, especially outputs(Farghaly & Shaalan, 2009a).

in the domain of digital platforms and tools. Understanding these technical challenges is crucial The integration of Arabic with modern digital for the effective development and deployment tools, such as voice assistants, smart devices, of Arabic-centric assistive technologies. Arabic, and augmented reality platforms, magnifies the written and read from Right-To-Left (RTL), poses technical challenges. The intricacies of the Arabic specific challenges for digital interfaces. This language, combined with the rapid advancements orientation necessitates a paradigm shift in how in technology, demand constant innovation and content is presented and how user interactions are adaptation to ensure seamless user experiences (Daud, Teck, Ghani, & Ramli, 2019). facilitated. design elements, navigation patterns, and even cursor movements that are typically tailored for left-to-right languages must be rethought and reengineered for RTL languages.

#### **Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

14

In essence, while the beauty and depth of the Arabic language enrich its cultural tapestry, they simultaneously present intricate challenges in the realm of Assistive Technologies. Addressing these challenges demands a confluence of linguistic expertise, technological prowess, and user-centric design principles.

#### **Here :** Socio-political Context

Many Arabic countries have undergone significant socio-political changes, affecting infrastructure, education, and healthcare systems. Localizing AT requires an understanding of these contexts to ensure tools are not only linguistically but also contextually relevant, catering to the specific 📲 needs arising from these unique socio-political landscapes (Haddad, 2005).

The dynamic socio-political changes in Arabic countries have profound implications for individuals with disabilities and their access to assistive technologies. These changes encompass a range of factors, including shifts in governance, economic development, healthcare policies, and educational reforms. To create AT solutions that truly meet the needs of users in these evolving environments, developers and researchers must consider the following key aspects:

- • Educational Reforms: Changes in education systems, including inclusive education policies, impact the learning experiences of individuals with disabilities. AT solutions must align with evolving educational practices to support students effectively (Almalki, Algabbani, & Alnahdi, 2021).
- Healthcare Access Evolving healthcare systems may affect the availability and affordability of medical services and assistive devices. Localized AT should adapt to changing

healthcare infrastructures and funding mechanisms (Kamel, 2021).

- Digital Infrastructure Advances in digital infrastructure, including internet connectivity and mobile technology, have transformed the landscape for AT delivery. Localization efforts should leverage these developments to enhance accessibility (Martin et al., 2021).
- Legislation and Rights Changes in disability rights legislation and policies influence the legal framework for accessibility. AT solutions should align with evolving legal standards to ensure compliance (United Nations, 2006).
- Social Inclusion Socio-political changes often aim to promote social inclusion and diversity. Localized AT should contribute to these broader societal goals by fostering inclusion and participation (Alanazi, 2023).

Alanazi's work (Alanazi, 2023) highlights the need to recognize and adapt to the ever-evolving socio-political contexts in Arabic countries when localizing AT. This approach ensures that AT solutions are not only linguistically accurate but also contextually relevant, ultimately improving the lives of individuals with disabilities in these dynamic environments.

#### **Here :** Economic Implications

A localized AT solution for the Arabic-speaking population doesn't just serve an accessibility purpose; it has substantial economic implications. By enabling a more significant portion of the population to engage actively in economic activities, nations can tap into previously untapped Nafath Issue 24

15

potential, fostering inclusive growth (Ahmad et al., 2022). Assistive Technologies tailored for the Arabic-speaking community extend far beyond accessibility as a mere humanitarian consideration. Instead, they represent a strategic investment in economic development. When individuals with disabilities are equipped with AT that resonates with their linguistic and cultural context, they gain the tools necessary to participate more fully in the workforce, educational endeavors, and entrepreneurial activities.

#### **Here :** Integration with Existing Systems

Many existing digital platforms and systems are 🔹 designed with Western languages and scripts in mind. Integrating Arabic localization can sometimes require fundamental changes to these systems, especially when considering the right-to-left orientation of the script.

The complexity of integrating Arabic localization Arabic localization, particularly for AT, often into digital systems and the need for careful involves more than just translating content. It consideration of script orientation and other requires a comprehensive approach that considers linguistic and cultural factors. Successful the linguistic, cultural, and technical aspects integration involves not only translation but also unique to Arabic. When it comes to integrating a deep understanding of Arabic language and Arabic into existing systems and platforms, culture to ensure that AT systems are functional, several challenges arise: accessible, and user-friendly for Arabic-speaking individuals with disabilities.

- Script Orientation Arabic is written from right to left, which is the opposite of many Western languages. This fundamental script Machine learning and Artificial Intelligence (AI) are orientation difference can affect the layout, design, and functionality of digital systems (Leone et al., 2018).
- Text Rendering Arabic script has unique features, including ligatures and diacritics, which may not be supported by all digital systems. Ensuring proper text rendering and readability is crucial for effective localization.

#### Enhancing the Efficacy of Assistive **Technologies through Localization**

A Comprehensive Analysis with a Focus on the Arab Region

- **User Interface Adaptation** User interfaces designed for left-to-right languages may require significant redesign to accommodate the right-to-left layout needed for Arabic, including menus, buttons, and navigation elements.
- **Cultural Sensitivity** Arabic localization extends beyond language to cultural considerations. Images, icons, and symbols may need to be adapted to align with cultural norms and preferences (Benmarrakchi, El Kafi, & Elhore, 2017).
- Accessibility Features AT solutions must ensure that Arabic content remains accessible to individuals with disabilities, including those using screen readers or other assistive technologies(Choi & DiNitto, 2013).

#### **Here is a comprehensive Data**

at the forefront of advancing assistive technologies, enabling innovative solutions to support individuals with disabilities. These Al-driven assistive tools often rely on large and well-annotated datasets to train and fine-tune their models. For machine learning-driven assistive tools, the availability of comprehensive datasets is crucial. However, there's a limited amount of annotated data available for Arabic, hindering the development of Al-driven assistive solutions (Abd-Alrazag et al., 2023).

**Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

### 16

### Arabic Solutions **Technologies**

The integration of Arabic solutions into AT has opened a realm of opportunities for the Arabic-speaking world, bridging the accessibility gap while recognizing the unique challenges and characteristics of the language and culture. This section provides a deeper dive into the noteworthy advancements, innovative approaches, and key players shaping the landscape of AT in the Arabic context.

#### **Weice Recognition and** Natural Language Processing Tools

Given the intricacies of Arabic pronunciation and dialectal variations, speech recognition systems have been developed to cater specifically to Arabic The digital era has ushered in a plethora of global speakers, with the capability to discern nuances among different dialects (Naous, Hokayem, & Hajj, 2020).

Arabic is renowned for its linguistic diversity, with numerous dialects spoken across the Arabic-speaking world. These dialects can differ significantly in pronunciation, vocabulary, and and reliability. However, the vast linguistic and grammar. This poses a unique challenge for voice cultural diversity across the globe necessitates recognition and Natural Language Processing (NLP) systems, which must accurately interpret and respond to the spoken word, regardless of regardless of their native language or region. the speaker's dialect.

#### **K** Screen Readers

challenges to the development and optimization of assistive technologies, especially screen readers.

Screen readers, which vocalize the text and interface elements on a screen, play a crucial role in making the digital world accessible to visually impaired users. The localization of such tools to cater to specific languages and cultures is paramount for their efficacy(Weber et al., 2017).

**Here :** Augmentative & Alternative Communication Augmentative and Alternative Communication (AAC) plays an instrumental role in bridging the communication gap for individuals with speech and language impairments. These devices and technologies enable users to convey their thoughts, needs, and emotions without relying on natural speech. Given the linguistic and cultural diversity across the globe, the localization of AAC devices is paramount to ensure their efficacy and accessibility (Elsheikh & Zeinon, 2019).

#### ++++ Localization of Global Platforms

platforms that cater to diverse needs, from productivity tools to assistive technologies. Screen readers, in particular, have become essential tools for visually impaired individuals, enabling them to access and navigate the digital world. Popular screen readers such as JAWS and NVDA have garnered global attention for their efficiency the localization of these platforms to ensure that they are effective and accessible to all users,

#### **Here :** Culturally Relevant Content

The Arabic language, with its rich morphological In the realm of AT, ensuring functionality is just nature and Right-To-Left (RTL) script, poses unique one side of the coin. The other, equally vital aspect is the cultural relevance of these technologies. As global AT solutions permeate diverse regions, it Nafath Issue 24

17

becomes imperative to ensure that they resonate with the local cultural and social norms. This is particularly true for regions with distinct cultural sensitivities, such as the Arab world (Thabit et al., 2021).

#### 

The technological advancements of the 21st nuances unique to Arabic (Nerabie, AlKhatib, century have been characterized not just by rapid Mathew, El Barachi, & Oroumchian, 2021). innovation but also by global collaboration. The visions often results in solutions that are more and Virtual Reality holistic and universally effective. One such domain The potential of AR can be tapped to amplify where this collaboration has been particularly real-time communication tools for those with impactful is in the field of AT. Collaboration between hearing challenges, superimposing Arabic sign the West and Middle Eastern countries, like the language translations during live exchanges or partnership between Microsoft and Mada, has learning modules (Saleh & Issa, 2020). driven forward the integration of Arabic solutions their reach and efficacy.

Considering the extensive dialectal variations across the Arab region, an uptick in inter-regional partnerships is anticipated. Such collective Solutions in Assistive Technologies mirrors a initiatives can pave the way for the creation of paradigm shift towards a more inclusive and tools tailored to a more comprehensive array of understanding technological landscape. As these Arabic speakers, promoting widespread inclusivity tools continue to evolve, it's evident that the (Flemes, 2016). Expected collaborations between essence of the Arab world, in all its linguistic and universities in the Middle East and prominent cultural glory, is increasingly finding its rightful international tech firms promise to invigorate space in the AT ecosystem. research and innovation in Arabic AT. Such alliances would merge regional expertise with global tech Emerging Horizons advancements, resulting in solutions that meet global standards while resonating with local nuances (Maegaard et al., 2008).

The domain of AT designed for the Arabic-speaking community has seen marked progress over the past years. Set against the swift pace of tech innovations, evolving societal values, and a growing emphasis on inclusiveness, there's an optimistic outlook for Arabic-centric AT solutions. Below are some projected directions and potentialities:

#### Enhancing the Efficacy of Assistive **Technologies through Localization**

A Comprehensive Analysis with a Focus on the Arab Region

#### **Here :** Al and Machine Learning Expansion

As NLP and deep learning technologies progress, the upcoming AT solutions for the Arabic language will likely witness enhanced precision, superior dialect differentiation, and enriched user interactions. These tools will be adept at discerning context, linguistic subtleties, and the intricate

18

#### **Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

#### ₩. Customization and Personalization

With the evolution of AT tools, there will be an increased emphasis on crafting experiences that resonate with individual user preferences and requirements. From tailored educational journeys in AT platforms to adaptive voice aides for routine activities, the trend will gravitate towards solutions centered around individual users.

#### ++++ Prise in Governmental Initiatives and Frameworks

Recognizing the pivotal role of inclusivity in fostering holistic societal development, governmental institutions across the Arab region are gearing up to play a more active role. It's projected that a more substantial emphasis will be placed on formulating favorable policies, allocating financial resources, and initiating communitydriven projects. Such measures are not only aimed at stimulating the creation of new Arabic AT tools but also ensuring their widespread adoption and integration across various sectors. This proactive approach, underpinned by supportive frameworks, will likely pave the way for a more inclusive environment that embraces and empowers all individuals, regardless of their abilities (Samant, Matter, & Harniss, 2013).

#### Hereit Broadening Societal Embrace

With rising consciousness and educational outreach, societal attitudes are expected to undergo a transformative shift towards greater inclusivity and understanding of individuals with disabilities. This evolution won't just be limited to individual perspectives. Organizations, institutions, and local communities will actively seek to break down barriers and promote accessible environments for all. Consequently, this will drive a heightened demand for and incorporation of AT tools. From interactive kiosks

in communal areas to tailored learning modules in academic settings, and inclusive digital platforms in professional environments, the landscape of everyday interactions will be reshaped to be more inclusive. This trend signals not just an adoption of technology, but a broader cultural shift towards a world where differences are celebrated and embraced.

#### ++++ : Shift Towards Mobile-focused Tools

In an age dominated by digital connectivity, the ubiquity of smartphones has reshaped how we interact with technology. Given this backdrop, upcoming Arabic AT strategies are anticipated to lean heavily towards mobile platforms. This transition is not merely about convenience but about ensuring that supportive instruments are consistently accessible, embedding them into the fabric of daily life. Whether it's for educational purposes, communication aids, or navigation tools, mobile-centric AT solutions will empower users by being just a tap away, offering them a smooth and uninterrupted experience irrespective of their location or activity. By marrying technological advancement with daily convenience, these tools will play a pivotal role in enhancing autonomy and independence for individuals, breaking down barriers one mobile application at a time (Best, 2021).

#### **Here :** Emphasis on Open-source and Grassroots Initiatives

In the dynamic landscape of technological evolution, one trend that stands out is the ascent of technological proficiency among the masses. This democratization of tech knowledge paves the way for an expected surge in grassroots, open-source endeavors. These community-led projects are not just about creating solutions; they embody the spirit of collaboration and shared

Nafath Issue 24

### 19

knowledge. Their open-source nature ensures transparency, fostering trust and encouraging continuous improvement through collective input.

Moreover, being inherently adaptable, these The evolution and incorporation of AT specifically projects can swiftly pivot to address emerging designed for Arabic speakers symbolizes the challenges or specific community needs. Offering harmonious intersection of modern technology, budget-friendly alternatives, they hold particular cultural appreciation, and human understanding. significance for individuals unable to invest in Several essential insights and themes crystallize commercial offerings, ensuring that the benefits from both our retrospective gaze and our forwardof technological advancements are accessible looking vision. Central to the growth story of Arabic to all, regardless of financial constraints. The AT is the ethos of comprehensive design. The rise of such initiatives showcases the potential journey is not merely about technical adjustments; of community-driven innovation in shaping the it delves into the profound interplay between future of assistive technologies. technology and the intricate facets of the Arabic language, cultural values, and the specific needs **Advancements in Wearable Tech** of its audience. This integrative approach ensures The frontier of assistive technology is poised to that the resulting solutions are more than just experience transformative shifts, particularly operational add-ons; they genuinely echo the with the advent of wearable devices tailored identities and lived experiences of those who use with Arabic AT features. Imagine the potential of them. Such a mindset is paramount, transforming smart eyewear that can instantly translate written technology from a mere tool to a reflection of shared Arabic content into audible speech, or tactile heritage and identity. True innovation thrives on wristbands that facilitate Braille interaction for collaboration. The potential of Arabic AT has the visually impaired. These aren't just gadgets; been magnified manifold through joint research, they're tools designed to be integral parts of partnerships bridging global and local expertise, users' daily routines, providing support without and cross-disciplinary efforts. As underlined drawing attention. Such innovations signify a earlier, blending global tech advancements with commitment to harmonizing technology with domestic insights has crafted solutions that are human experience, ensuring that assistance is not world-class yet unmistakably Arabic in their just available but is also unintrusive and natural essence. This collaborative spirit sketches the (Valipoor & de Antonio, 2023). To encapsulate, the roadmap for future breakthroughs, grounded pathway forward for Arabic-focused assistive in mutual goals and shared achievements. With solutions is radiant with potential. This optimism expanding technological horizons come intricate is anchored in rapid technological strides, the ethical challenges. While AI-centric solutions hold metamorphosis of societal attitudes, and the immense promise, they also bring to the fore convergence of diverse collaborative ventures. As concerns about data security, potential biases in algorithms, and fair representation. Crafting an these tools and systems persistently evolve, they stand as beacons of hope, signaling a future where inclusive tech future demand that these issues every Arabic speaker, irrespective of their unique are central, not peripheral, to the design and challenges, is embraced by a world designed to development conversations. Embedding ethical understand and support their individual needs.

#### Enhancing the Efficacy of Assistive **Technologies through Localization**

A Comprehensive Analysis with a Focus on the Arab Region

### Conclusion

20

**Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

considerations within the innovation framework the challenges ahead, one conviction stands ensures that technology remains a benevolent strong: our unwavering dedication to fostering an force for all its users, without unintentionally sidelining or disadvantaging any segment.

AT's landscape is in constant flux, reflecting the swift pace of tech evolution. The anticipated integrations of deep learning, immersive realities, and wearables are imminent realities on the horizon. Staying at the forefront of global AT advancements necessitates perpetual adaptability, swift assimilation of novelties, and a vision that's oriented towards the future. Behind the intricate codes, sophisticated algorithms, and cuttingedge devices, the true essence of AT is its user. The ultimate measure of a solution's success lies in the real-world difference it makes in its users' lives. Designing with the user in mind, fostering continuous dialogue, and adopting an iterative improvement approach ensure that AT solutions transcend their functional roles - they become integral allies in the user's journey, aiding, empowering, and enhancing experiences. To encapsulate, the saga of Arabic Assistive Technologies is not just about tech evolution; it's a tapestry of dreams, hurdles, and victories. It stands as a testament to the profound change that can be achieved when innovation is deeply rooted in cultural empathy, ethical commitment, and the spirit of collaboration. As we pause to reflect on past achievements and gear up for

inclusive, attuned, and enabling digital space for Arabic speakers, illuminating a future brimming with new possibilities.

Nafath Issue 24

21

#### References

- 1. Abd-Alrazag, A., AlSaad, R., Alhuwail, D., Ahmed, A., Healy, P. M., Latifi, S., . . . Sheikh, J. (2023). Large language models in medical education: Opportunities, challenges, and future directions. JMIR Medical Education, 9(1), e48291.
- 2. Abouenour, L., El Hassani, S., Yazidy, T., 343. doi:10.22452/mjcs.vol33no4.5 Bouzouba, K., & Hamdani, A. (2008). (2008). Building an arabic morphological analyzer 9. Ashour, S. (2020). How technology has as part of an open arabic NLP platform. shaped university students' perceptions Paper presented at the Workshop on HLT and expectations around higher education: and NLP within the Arabic World: Arabic An exploratory study of the united arab Language and Local Languages Processing emirates. Studies in Higher Education, Status Updates and Prospects at the 45(12), 2513-2525. 6th Language Resources and Evaluation 10. Balasubramanian, G. V., Beaney, P., & Conference (LREC'08),
- 3. Ahmad, M., Ahmed, Z., Bai, Y., Qiao, G., Popp, J., & Oláh, J. (2022). Financial inclusion, technological innovations, and environmental guality: Analyzing the role of green openness. Frontiers in Environmental Science, 10, 851263.
- 4. Alanazi, M. S. (2023). Innovation for all: Unleashing the power of assistive technology in special education in arabicspeaking countries. Journal of ICSAR, 7(2), 178-194.
- 5. Al-Ghurbani, A. M., Jazim, F., Abdulrab, M., Al-Mamary, Y. H. S., & Khan, I. (2022). The impact of internal factors on the use of technology in higher education in saudi arabia during the COVID-19 pandemic. Human Systems Management, 41(2), 283-302.
- 6. Almalki, S., Alqabbani, A., & Alnahdi, G. (2021). Challenges to parental involvement in transition planning for children with intellectual disabilities: The perspective of special education teachers in saudi arabia. Research in Developmental Disabilities, 111, 103872.

#### Enhancing the Efficacy of Assistive **Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

- 7. Al-Mazrooa, N. (2018). No title. Arabic Localisation: Key Case Studies for Translation Studies.
- 8. Al-Shamayleh, A. S., Ahmad, R., Jomhari, N., & M. Abushariah, M. A. (2020). Automatic arabic sign language recognition: A review, taxonomy, open challenges, research roadmap and future directions. Malaysian Journal of Computer Science, 33(4), 306-

- Chambers, R. (2021). Digital personal assistants are smart ways for assistive technology to aid the health and wellbeing of patients and carers. BMC Geriatrics, 21(1) doi:10.1186/s12877-021-02436-y
- 11. Banouni, M., Mohamed, E., & Lazrek, A. (2004). (2004). Dynamic arabic mathematical fonts. Paper presented at the TeX, XML, and Digital Typography: International Conference on TeX, XML, and Digital Typography, Held Jointly with the 25th Annual Meeting of the TeX Users Group, TUG 2004, Xanthi, Greece, August 30-September 3, 2004. Proceedings, 149-157.
- 12. Barakina, E. Y., Popova, A. V., Gorokhova, S. S., & Voskovskaya, A. S. (2021). Digital technologies and artificial intelligence technologies in education. European Journal of Contemporary Education, 10(2), 285-296.
- 13. Benmarrakchi, F., El Kafi, J., & Elhore, A. (2017). Communication technology for users with specific learning disabilities. Procedia Computer Science, 110, 258-265.

22

#### **Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

- 14. Choi, N. G., & DiNitto, D. M. (2013). The digital divide among low-income homebound older adults: Internet use patterns, eHealth literacy, and attitudes toward computer/internet use.15(5) doi:10.2196/jmir.2645
- 15. Daud, W., Teck, W. K., Ghani, M. T. A., & Ramli, S. (2019). The needs analysis of developing mobile learning application for cybergogical teaching and learning of arabic language proficiency. International Journal of Academic Research in Business and Social Sciences, 9(8), 33-46.
- 16. Dhouib, A., Othman, A., El Ghoul, O., Khribi, M. K., & Al Sinani, A. (2022). Arabic Automatic Speech Recognition: A Systematic Literature Review. Applied Sciences, 12(17), Article 17. https://doi. org/10.3390/app12178898
- 17. Elsheikh, A., & Zeinon, N. (2019). (2019). Mada tawasol symbols & mobile app. Paper presented at the 2019 7th International Conference on ICT & Accessibility (ICTA), 1-5.
- 18. Farghaly, A., & Shaalan, K. (2009a). Arabic natural language processing. ACM Transactions on Asian Language Information Processing, 8(4), 1-22. doi:10.1145/1644879.1644881
- 19. Farghaly, A., & Shaalan, K. (2009b). Arabic natural language processing: Challenges and solutions. ACM Transactions on Asian Language Information Processing (TALIP), 8(4), 1-22.
- 20. Flemes, D. (2016). Regional leadership in the global system: Ideas, interests and strategies of regional powers Routledge.
- 21. Habash, N. Y. (2022). Introduction to arabic natural language processing Springer Nature.

- 22. Haddad, B. M. (2005). Ranking the adaptive capacity of nations to climate change when socio-political goals are explicit. Global Environmental Change, 15(2), 165-176.
- 23. Horvath, A. (2021). Enhancing language inclusivity in digital humanities: Towards sensitivity and multilingualism. Modern Languages Open, (1)
- 24. Iancu, I., & Iancu, B. (2017). Elderly in the digital era. theoretical perspectives on assistive technologies. Technologies, 5(3), 60. doi:10.3390/technologies5030060
- 25. Kamel, S. (2021). (2021). The potential impact of digital transformation on egypt. Paper presented at the
- 26. Layton, N., Maclachlan, M., Smith, R. O., & Scherer, M. (2020), Towards coherence across global initiatives in assistive technology Informa UK Limited. doi:10.108 0/17483107.2020.1817162
- 27. Leone, C., Lim, J. S. L., Stern, A., Charles, J., Black, S., & Baecker, R. (2018). Communication technology adoption among older adult veterans: The interplay of social and cognitive factors. Aging and Mental Health, 22(12), 1666-1677. doi:10.1 080/13607863.2017.1381946
- 28. Mancilla-Martinez, J. (2020). Understanding and supporting literacy development among english learners: A deep dive into the role of language comprehension. AERA Open, 6(1), 2332858420912198.
- 29. Martin, C. L., Bakker, C. J., Breth, M. S., Gao, G., Lee, K., Lee, M. A., . . . Janeway, L. M. (2021). The efficacy of mobile health interventions used to manage acute or chronic pain: A systematic review. Research in Nursing & Health, 44(1), 111-128.

Nafath Issue 24

23

- 30. Naous, T., Hokayem, C., & Hajj, H. 37. United Nations. (2006). Convention on the (2020). (2020). Empathy-driven arabic rights of persons with disabilities (CRPD) conversational chatbot. Paper presented at united nations enable. the Proceedings of the Fifth Arabic Natural 38. Weber, A. S., Turjoman, R., Shaheen, Y., Al Language Processing Workshop, 58-68.
- Sayyed, F., Hwang, M. J., & Malick, F. (2017). Systematic thematic review of e-health 31. Nerabie, A. M., AlKhatib, M., Mathew, S. S., El Barachi, M., & Oroumchian, F. (2021). The research in the gulf cooperation council (arabian gulf): Bahrain, kuwait, oman, gatar, impact of arabic part of speech tagging on saudi arabia and united arab emirates. sentiment analysis: A new corpus and deep learning approach. Procedia Computer Journal of Telemedicine and Telecare, Science, 184, 148-155. 23(4), 452-459.
- 32. Paucar-Menacho, L. M., Castillo-Martínez, W. E., Simpalo-Lopez, W. D., Verona-Ruiz, A., Lavado-Cruz, A., Martínez-Villaluenga, C.,... Schmiele, M. (2022). Performance of thermoplastic extrusion, germination, fermentation, and hydrolysis techniques on phenolic compounds in cereals and pseudocereals. Foods, 11(13), 1957.
- 33. Ripat, J. D., & Woodgate, R. L. (2011). Locating assistive technology within an emancipatory disability research framework. Technology and Disability, 23(2), 87-92.
- 34. Saad, M. A. E., & Borowska Beszta, B. (2019). Disability in the arab world: A comparative analysis within culture. Psycho Educational Research Reviews, 8(2), 29-47. Retrieved from http:// www.idealonline.com.tr/IdealOnline/ lookAtPublications/paperDetail. xhtml?uld=104446
- 35. Saleh, Y., & Issa, G. (2020). Arabic sign language recognition through deep neural networks fine-tuning.
- 36. Thabit, R., Udzir, N. I., Yasin, S. M., Asmawi, A., Roslan, N. A., & Din, R. (2021). A comparative analysis of arabic text steganography. Applied Sciences, 11(15), 6851.

#### **Enhancing the Efficacy of Assistive Technologies through Localization** A Comprehensive Analysis with a Focus on the Arab Region

- 39. Yasir Suleiman. (2014). The arabic language and national identity
- 40. A study in ideology
- 41. Younes, J., Souissi, E., Achour, H., & Ferchichi, A. (2020). Language resources for maghrebi arabic dialects' NLP: A survey. Language Resources and Evaluation, 54(4), 1079-1142. doi:10.1007/ s10579-020-09490-9

### New To Autism?

madalab Sponsor

Nafath Issue 24

25



We'll help you get started. سنساعدك على البدء



On-demand video tutorials with Arabic subtitles



# www.LearnAutism.com

► F LearnAutism

**S**LearnAutismApp

Localisation of a Text-based **App for Arabic** Assistive Technology Users

#### Abstract

Ensuring the successful adaptation of Predictable, a text-based Alternative and Augmentative Communication (AAC) app for users in the Gulf region, required not only text translation and integration of an Arabic keyboard. Key considerations encompass design and user experience, particularly regarding button selection and arrangement to accommodate right-toleft orientation and address cultural and linguistic nuances. The localisation of Predictable Arabic for AAC users in the Gulf region is further enhanced by leveraging an existing symbol set while incorporating new symbols optimised for the app.

#### Keywords

Alternative and Augmentative Communication, Predictable Arabic, Localisation

**Rebecca Bright** rbright@therapy-box.co.uk Swapnil Gadgil sgadgil@therapy-box.co.uk

Therapy Box, Sun Studio 3, 30 Warple Way London W3 ORX United Kingdom

Localisation of a Text-based App for Arabic Assistive Technology Users

26

#### Introduction

Predictable (or Therapy Box) is a text-to-speech app used by people with progressive and developmental conditions who use it when their speech is limited or absent. It is an alternative and augmentative communication (AAC) aid used by people with various conditions, including motor neurone disease, cerebral palsy, autism, aphasia, and Parkinson's Disease.

The app uses word prediction to save time in composing messages, and it provides people with limited motor control accessibility options that enable them to use whichever body part or movement they can - from a switch controlled by the hand, a head or foot switch, head tracking, face gestures or eye tracking. Predictable accommodates for tremors and hand movement difficulties. People can create phrases for quick access so that they are ready for classes, appointments, or meetings. They can also use 'floorholding', which allows automatic messages to play while they are typing so others do not interrupt. It is highly customisable and flexible. Core technologies involved are synthetic speech engines, word prediction modules, and various accessibility features. Each setting can be selected and modified with a user's needs in mind to enable efficient communication and, where possible, reduce the effort and fatigue that communicating using AAC may invoke. It is currently used by people in 35 countries and nine core languages other than English. Developing an Arabic version required the app's localisation, which involved work regarding user experience, linguistic integrity, and cultural considerations.

Nafath Issue 24

27

#### **Design Process**

The seventh major release for Predictable Given that the Predictable app had previously only is currently in development. The design and been used for Left-To-Right (LTR) based scripts, development team utilise a design process the first design consideration was evaluating informed by widespread user involvement since and redesigning our key interface screens to the first release in 2011. The core components be optimised for Arabic, a Right-To-Left (RTL) of the app's design have been refined following script. Key elements of the main keyboard and direct consultations, usability testing sessions, and phrase screens were moved from the right to the feedback from existing and new app users globally. left, including our 'feature key' section, where Therefore, much of this design work has fed into the 'speak' button and other functions such as the design and development of Predictable Arabic. delete, and undo are located. The script in the Following a requirement-gathering phase and message window shifted to RTL, and several research related to Arabic design methodologies, of the essential accessibility functions that are the team undertook wireframing and visual text-related, such as highlighting and the cursor, prototyping of Predictable Arabic's user experience, were also adjusted. which was shared with stakeholders.





Localisation of a Text-based App for Arabic Assistive Technology Users

#### **User Experience Design Considerations**



#### Figure 1.

Left-to-right and right-to-left symbols for handwriting function

Interface icons were reviewed, and where relevant, they were flipped, such as in Figure 1 and Figure 2. Some interface icons included letters or words to help communicate a script-related concept, and others displayed a directional aspect. For example, the icon representing a speaker showed

Localisation of a Text-based App for Arabic Assistive Technology Users

### 28

sound waves emanating from the speaker. In the LTR context of Predictable English, for example, the sound waves come from the left, so in the RTL context, for Predictable Arabic, the icon needed to flip to show the waves coming from the right (Figure 2). However, many icons remained unchanged, such as the eye gaze icon and export icons.

Figure 2.

Figure 3.

Left-to-right speak symbol and right-to-left speak symbol

The keyboard illustrated in Figure 3, as is the word prediction strip, is integral to Predictable. For Predictable Arabic, the Arabic Keyboard aligned with the iOS keyboard for Arabic and similarly used the shift key to switch between cases (See Figure 4). Slight placement changes have been made to fit the Predictable layout, as it needs to fit with keyguards and work well with switch scanning, head tracking and eye tracking. Arabic numerals were also used for the numeric keyboard screen.

						_				
lam	good	1 lik	e it	<	>	Y	es	N	lo	
								5	3)	
								Ċ	ŵ	
								Û	ũ	
Ye	ou .			W		π	he Hi			
Q	W	Е	R	т	Y	U	1	0	Ρ	
A	S	D	F	G	н	J	к	L	۲	
仑	z	х	с	۷	В	Ν	м	ų	⊞	
123	з	ĸ					0	D	\$	

10	التاري	1	العارية	<		,	1 44	الملط	14	الملعنا
(	⊳									
Ċ	<b>\$</b>									
Ô	Û									
0	0	0	9	0	0	0	10			1
ض	ص	ث	ĩ	ف	٤	٤		ć	5	5
ش	س	ي	Ļ	J		i.	ت	۵		ك
Û	ظ	٦	ى د	6 3		1	1	3 9	4	
						1964	0	<b>(□</b> )	-12	T

Figure 4. Keyboard screen for Predictable English Keyboard screen for Predictable Arabic

Nafath Issue 24

### 29

In addition to the app's main keyboard and phrase Localising Text pages, the settings screen was also localised for right-to-left usage. The placement of toggle Localisation requires more than simple translation. in Figure 5 and Figure 6.



Figure 5. Settings screen for Predictable English

2	إعدادات		حساب
-		حساب تعريقي	
	حباب	الاسر الكامل	بزيد الكثروني
	علد	الاسم الكليل	سنوان العربة الإلكتاروني
-		للغيير كلمة المرور	حلف العساب
-	çuas	هل نسبت كلمة السر	تسميل خروج
Ž	إمكانية الوصول		
E	المظهر والمظهر	نرع الصاب 💼	خو متصل طر الاترات
4	مفاتيح الميزة	مطلوب الصبل والبر والافترنت لاستندام الم	بل جز القرب
	كلمة التبير		
	لوحة المفاتين		
	تغطيط الشبكة		
C	حرف او رمژ		
0	متحدد اللغات		
e	يدعم		
E	منصبة الويب		

Figure 6. Settings screen for Predictable Arabic

switches for choice-making within the settings The architecture for Predictable leverages an options was also adjusted where required, as approach to localising text strings for use within were the location of tick marks, back arrows, the app, such as error messages and other bullet point lists, hint text and headers, as shown content. This required a file where all resources are stored for a particular language localisation, in this case, Arabic. The routines that lookup key values in a property list file consider the user's language preferences and return the localised version of the key from the appropriate file when one exists. Using a property list in the base language, English, a local translator can provide the translations systematically rather than going through and translating each button or text string within the app.

#### **Designing Symbols**

Symbols can generally be identified or understood, regardless of the person's language or literacy skills, and many have universal applications. Huer (2000) suggested that people from some cultural backgrounds may not perceive symbols similarly. Further research has suggested challenges in the Arab region using symbol sets designed outside the region (Elsheikh and Zeinon, 2019). This leads to the potential for greater uptake of AAC in general if a localised symbol set is used (Elsheikh and Zeinon, 2019). The Tawasol symbols designed for this particular purpose have been used in the region since, and preliminary evaluation of those symbols demonstrated that the symbols encouraged participation (Draffan et al., 2015). Therefore, the Predictable Arabic app will include the Tawasol symbols (MADA Assistive Technology Center and Partners), and a full complement of symbols were localised from Predictable English for use in Predictable Arabic.

#### Localisation of a Text-based App for Arabic Assistive Technology Users

### 30

Input regarding cultural appropriateness and **Conclusion** usability was taken into consideration. Following an audit of the symbols available in Predictable Effective localisation of a text-to-speech app English, suitable alternatives were designed and implemented. For instance, Figure 7 was intended to represent the words for hospital and clinic, which were altered to include a red crescent replacing the red cross. As a result, new symbols were added to the overall Predictable database.



#### Figure 7.

Proposed Predictable symbol for hospital localised for the Arabic version of the app.

#### **Opportunities for Future Development and Research**

Future work may seek to optimise the design of AAC apps for bilingual language users, including for rapid switching between the user's language 3. Huer, M., (2000). Examining perceptions choices and code-switching behaviours. This would complement further development and research addressing global symbol usage and personalised dynamic AAC systems that are customised for each user's unique physical, linguistic, sensory and cognitive abilities and adapt to each environment, to fatigue issues and from feedback for each user.

for Arabic users requires translating text and implementing an Arabic keyboard. Design and user experience considerations related to the choice and layout of buttons to reflect a right-toleft design and cultural and linguistic factors are paramount. Building on using an existing symbol set and adding new and redesigned symbols assists in localising Predictable Arabic for AAC users in the Gulf region.

#### References

- 1. Draffan, E.A., Wald, M. and Halabi, N. et al. (2015). Generating acceptable Arabic Core Vocabularies and Symbols for AAC users. 6th Workshop on Speech and Language Processing for Assistive Technologies, Dresden, Germany. pp. 91-96. (doi:10.18653/v1/W15-5116).
- 2. Elsheikh, A., and Zeinon N, 2019. Mada Tawasol Symbols & Mobile App, 7th International Conference on ICT & Accessibility (ICTA), Hammamet, Tunisia, 2019, pp. 1–5, doi: 10.1109/ ICTA49490.2019.9144883.
- of graphic symbols across cultures: Preliminary study of the impact of culture/ ethnicity, Augmentative and Alternative Communication, 16:3, 180–185, DOI: 10.1080/07434610012331279034
- Predictable (Therapy Box), https:// 4. apps.apple.com/gb/app/predictable/ id404445007.
- 5. Tawasol symbols, https://tawasol.mada. org.qa/?lang=en (Tawasol symbols are available under a CC BY-SA 4.0 licence)

# **BuHamad**

The first Qatari virtual interpreter for Qatari Sign Language



32



# languages and Deaf Communities

### Abstract

This paper aims to shed light on the concept of signed languages globally, It examines their characteristics, development, and how they compare to spoken languages. Like spoken languages, signed languages are living languages with distinct rules and grammatical structures. It also sheds light on the societal culture of the users of this language, who are the deaf. They have a unique linguistic specificity that affects and is influenced by the environment and surroundings, which is why there are multiple societal and linguistic cultures. This paper will address the stages of development of sign languages in the Arab region and worldwide. It highlights attempts to record, share, and promote understanding of these languages among hearing communities. It will also present a definition of international signs and Arabic signs that are used as a means of communication in Arab and international forums and symposiums.

Nafath Issue 24

33

Linguistics is a the scientific study concerned with studying the nature of languages scientifically in terms of their characteristics, structures, and degrees of similarity and dissimilarity among them. It is also concerned with studying the history of languages and how they are acquired, so it is considered a science that studies signed language in all its aspects in a comprehensive way (Semrin, 2012).

#### 1.1. Signed Languages

These languages form a linguistic system used by the deaf to communicate. These languages rely on the use of gestures, movements, and hand signs (hand positions) to express ideas and concepts. The World Federation of the Deaf indicates that there are more than 200 sign languages around the world, and each language reflects the privacy and culture of its users from the many deaf communities in the world.

#### 1.2. Sign Language (SL)

It is a visual means of communication, which adopts a specific linguistic system. This system incorporates hand movements and shapes of the hands, gestures, physical movements, and facial expressions, all of which are adopted by the deaf community in any country for communication among themselves and others. It encompasses expression and learning about all aspects of life and is characterized with its own rules and structures. SL is considered the first and natural language of the deaf community.

### 1.3. National Sign Language

National SL represents a linguistic system that uses visual signs which include all the linguistic units associated with them, and carry connotations and meanings agreed upon by deaf people from the same country who use it as the communication language among themselves (the mother tongue).

### 1.4. Arabics Signs

They refer to the most common Arabic signs and are used as a secondary language in Arab conferences and forums.

Sameer Semreen semreens@aljazeera.net

Senior Presenter / Sign Language Expert, Aljazeera Network

#### Keywords:

Signed languages, Sign language, Deaf communities.

### 1. Linguistics in sign languages

### 2. The concept of Sign Language

Interest in sign language for the deaf intensified in the last era of the last century, after gaining worldwide recognition as the natural mother tongue of the deaf, because it is connected to their psychological dimensions, and because it was distinguished by its ability to easily express the needs of the deaf and create concepts for him. Indeed, some creative deaf people can write poems and literary pieces, and translate verbal poems into this language, which depends mainly on the motor rhythm of the body, especially the hands. The formations of hands and fingers form a wonderful way to express ourselves, as we can use them to laugh, cry, rejoice, get angry, express a desire, express an emotion, and express ourselves. It is also possible to sing and act with the hand instead of singing and acting with words. Someone came up with the slogan "Eyes to Hear."

Sign language is performed with one or both hands and in different places of the body, to deliver an expression that carries significance and meaning through units called parameters or elements, which are:

- Handshape
- Movement
- Location
- Palm orientation
- Non-manual signals (Facial expressions, eyes, mouth, eyebrows, shoulders).



Nafath Issue 24

# 35

### 3. Sign Language and Its Development in the World

As for the history of sign language and its development in the world, the real beginning of scientific interest in the history of the deaf communities dates back to the late of 1960s and early 1970s. Given the relatively recent focus on the history of the deaf, it becomes clear that it is difficult to trace and document the history of sign language in the world. However, this has not prevented some researchers from asserting that throughout history, and wherever there are deaf people in the world, there will be a sign language, and what is worth noting is the connection of the history of sign language with the history of educating the deaf, as many educators took it as a basis for teaching them.

The beginning of historical documentation of educating the deaf and the use of sign language in educating them dates back to the sixteenth century. This began with the Spanish monk De Leon (1520-1584), who startedteaching two deaf children from a wealthy family and s considered the first known teacher of the deaf in the world. Not much is known about the method that De Leon used in teaching, but it is believed that sign language was part of it, especially the signs that the two deaf children used at home. The Frenchman De L'Epee is considered the first to adopt the use of the manual alphabet with signs, and he was the first to establish a school for the deaf in the world in Paris in the late 1760s. De L'Epee also adopted the sign language used among the deaf in Paris to teach and educate the deaf for its success in conveying information to deaf students easily and conveniently.

In the United States of America, the beginning of change and development in sign language was linked to the opening of the first institute for the deaf in America in 1817 by Thomas Hopkins Gallaudet and Laurent Clerc. Clerc, the deaf teacher who came from the Paris Institute for the Deaf, is considered the first deaf teacher in America. Before that date, deaf people used what was known as local signs for communication. However, the institute provided the environment that contributed to the interaction between the existing American Sign Language used by deaf students and the French Sign Language used by Clerk and Gallaudet in teaching. This interaction resulted in the now-known American Sign Language (ASL) which studies indicate is derived 30% from French Sign Language.

This beginning in deaf education in the United States of America continued and developed through the establishment of more deaf institutes in many states. As a natural result of this development in public education for the deaf, the way was opened for the deaf to continue university education through the establishment of Gallaudet University in 1864, which is considered the only one of its kind in the world designated for deaf and hearing students who are proficient in sign language. This development has culminated in several studies on the grammar of American Sign Language and proving that it is a real language no less than other languages. One of the most important of these studies is that of William Stokoe, who was appointed as an English professor at Gallaudet University in 1955.

Since its establishment in 1951 in Rome, Italy, the World Federation of the Deaf has been dedicated to promoting awareness of the linguistic culture of the deaf and the necessity of respecting and using it in all aspects of liferelated to them. The International Convention

Nafath

Issue 24

on the Rights of Persons with Disabilities also came to confirm this right and recognize these languages for the diverse deaf communities in the world. Hence, many countries recognized their sign languages and considered them among the approved official languages. With technological progress and the development of artificial intelligence, deaf people and researchers around the world have benefited from this technology, and it has been used in documenting, disseminating, and teaching sign languages by designing their own applications and programs after they were limited to illustrated paper dictionaries.

This beginning in deaf education in the United States of America continued and developed through the establishment of more the deaf individuals institutes in many states. As a natural result of this development in public education for the deaf individuals, the way was opened for the deaf to continue university education through the establishment of Gallaudet University in 1864, which is considered the only one of its kind in the world designated for deaf and hearing students who are proficient in sign language. This development has culminated in several studies on the grammar of American Sign Language and proving that it is a real language no less than other languages. One of the most important of these studies is that of William Stokoe, who was appointed as an English professor at Gallaudet University in 1955.

Since its establishment in 1951 in Rome, Italy, the World Federation of the Deaf has been dedicated to promoting awareness of the linguistic culture of the deaf and the necessity of respecting and using it in all aspects of liferelated to them. The International Convention on the Rights of Persons with Disabilities also came to confirm this right and recognize these languages for the diverse deaf communities in the world. Hence, many countries recognized their sign languages and considered them among the approved official languages. With technological progress and the development of artificial intelligence, deaf people and researchers around the world have benefited from this technology, and it has been used in documenting, disseminating, and teaching sign languages by designing their own applications and programs after they were limited to illustrated paper dictionaries.

### 4. The Development of Sign Language in the Arab World

The development of sign language in the Arab region began with attempts to document sign languages, the first of which was the Egyptian dictionary in 1972 by the Egyptian National Association for the Care of the Deaf under the supervision of the Ministry of Social Affairs, then the Jordanian dictionary in 1990, after which many local dictionaries were developed. Sign languages have been documented in most Arab countries, including Egypt, Jordan, Palestine, Libya, Iraq, UAE, Kuwait, Saudi Arabia, Morocco, Sudan, Mauritania, Qatar, Sultanate of Oman, Syria, Lebanon and Tunisia.

There remains an urgent need to develop this language, and attempts have emerged to unify Arabic signs, given the Arab connection to their shared cultural, social, religious, linguistic, and geographical heritage, which prompted the Council of Arab Ministers of Social Affairs to decide to document the most common Arabic signs used by deaf Arabs and come up with an Arabic dictionary. Indeed, in 1999, the first Arabic SL dictionary was launched by the Arab community under the auspices of the League of Arab States. This significant achievement involved active participation from both the Arab Organization for Education, Culture and Science and the Arab Union of Bodies Working for the Care of the Deaf.

### 37

Nafath

Issue 24

In 1997, Al-Ramezi and Semreen began collecting scientific material to prepare a geographical dictionary of the names of countries and cities in worldwide. This project was completed in 2004 under the sponsorship of the Qatar Society for People with Special Needs.

In continuation of previous efforts, a workshop was held to document the most common Arabic signs that were not included in the first dictionary, from December 19 to 29, 2005 in the State of Qatar.

Deaf Arabs also benefited from the technological revolution in the world and began to develop, document, publish, and teach their national languages. Numerous applications focusing on the national and Arabic sign language appeared. Concurrently, many Arab researchers began to enter the world of this language, study it, and produce specialized literature in the science of sign linguistics.



# 5. Sign Language and Spoken Languages

Sign language is a natural language that evolves organically over time among its users. While its grammatical structure shares general principles with all human languages, it also has unique characteristics in its system, including distinct grammatical rules and independence from spoken language.

Over the past three decades, research on sign languages has established that they share the same linguistic characteristics as spoken languages, developed naturally like them, and no one, whether the hearing or the deaf, invented any of the natural sign languages over generations. Therefore, sign languages are not universal or comprehensive, indicating that no single sign language is used by all deaf people worldwide.

### 6. International Signs and **Arabic Signs**

There is no unified sign language in the world, instead, each deaf community boasts its distinct linguistic characteristics. This diversity can pose communication challenges, particularly for deaf individuals from different countries using varied languages. As deaf people around the world met each other in international and regional events, the need for effective communication was created. This is why the so-called international signs appeared, and they are signs taken from many sign languages used around the world, including the most common, understood, and used signs by a large number of deaf people around the world. The intermingling of languages has also generated many common signs. Moreover, international signs are not considered fixed, but they change, increase, and decrease according to place, time, and the target audience. Arabic signs, mutually agreed upon by deaf Arabs, have found use in various forums and media. . It is worth noting that the Arabic sign languages are very similar to each other by virtue of their cultural heritage and geographical proximity, except for certain North African Arab countries (Algeria, Tunisia, Morocco), as well as Somalia, Djibouti, and the Comoros, which are influenced by non-Arab linguistic cultures.



### Conclusion

Studies have proven that sign languages are living languages that have a linguistic system, rules, and structures like other spoken languages, and that they differ from them in terms of linguistic structures and rules. While sharing common elements and components likemanual movement, gestures, and physical expressions, SL vary in hands shapes, mouvements meaning, and connotations. It should also be noted that all elements are considered parts that cannot be separated from each other to form a meaningful linguistic word or words.

#### References

- 1. Sameer Semreen: The Professional Guide for Sign Language Translators, 2012.
- 2. Sameer Semreen and Mohamed Al-Binali: Unified Arabic Sign Language Rules, Supreme Council for Family Affairs, Qatar, 2009.
- 3. Sameer Semreen: The Effectiveness of a Sign Language-Based Training Program in Enriching the Language Acquisition of Deaf People, Unpublished PhD Dissertation, 2013.
- 4. Tariq Bin Saleh Al-Rayes: Bilingual Biculturalism, 2010
- 5. Maram Aljuaid and Mohammed Al-Otaibi: A Linguistic Analysis of Saudi Sign Language, 2019.



tawasol.mada.org.ga



### 40

# DeepFoni **An Assistive Communication Innovation to Empower** Individuals with **Communication** Difficulties

Saida Hamrit saida2208@gmail.com DeepFoni suarl, Tunis, Tunisia



Nafath Issue 24

41

DeepFoni

### Abstract

As humanity stands at the precipice This article delves into the of the Fourth Industrial Revolution, transformative capabilities of technology not only serves as an DeepFoni innovation, a state-of-the-art underpinning force but also as voice assistant designed to champion the vanguard, driving changes at seamless communication across unprecedented speeds (Khan, 2020). linguistic and cultural boundaries. The continuous ebb and flow of As a beacon of technological innovation, technological advancements have DeepFoni seeks to empower individuals profoundly altered the fabric of with communication challenges, societies, marking an indelible imprint fostering a global environment of on the ways individuals connect, inclusivity, understanding, and equality. interact, and communicate (Dhouib et al., 2022). Within this vibrant tapestry Also, we provide an overview of the of innovation, areas such as artificial application, its distinctive features, intelligence, machine learning, and and its potential societal impact, voice recognition have emerged as emphasizing its role in shaping a stalwarts, steering transformative more connected global community. pathways that affect myriad aspects of our daily lives. These realms are Keywords ceaselessly working in tandem, crafting Assistive communication innovation. tools and platforms that provide astute Individuals with communication solutions to hitherto insurmountable difficulties, Voice assistant. challenges (Dhouib et al., 2022). Amidst this dynamic landscape, DeepFoni distinguishes itself—a visionary voice assistant that is not merely a product of innovation but a beacon of change (DeepFoni). Conceived with the ethos of breaking down barriers, DeepFoni seeks to be the panacea for those grappling with linguistic and communicative limitations.

An Assistive Communication Innovation to Empower Individuals with Communication Difficulties

### Introduction

#### DeepFoni

Nafath Issue 24

42

An Assistive Communication Innovation to **Empower Individuals with Communication Difficulties** 

Its inception is emblematic of the overarching objective of contemporary technology: to bridge gaps and promote a world where inclusivity is the norm rather than the exception.

This article aims to delve deeper into the world of DeepFoni, unraveling its features, functionalities, and the science behind it. Through this exploration, we aim to underscore the transformative power of such tools, emphasizing their role in shaping an inclusive, communicative, and interconnected global society. As we proceed, readers will gain insights into how DeepFoni is not just a manifestation of advanced technology but a testament to humanity's relentless pursuit of creating solutions that resonate universally

### Motivation

With globalization, our world has become a confluence of diverse languages and cultures, making communication key to inclusive societies. However, for those with communication difficulties, this interconnected world can pose a significant challenge. The need for a solution to this problem is not just about convenience; it's about providing a vital tool that promotes independence and equality. This is the driving force behind the conception of the DeepFoni app. With support for multiple languages, DeepFoni aims to bridge the communication gap and promote independence for users across the globe.

### DeepFoni App

DeepFoni is a cutting-edge voice assistant, designed to ensure seamless and inclusive communication (see Figure 1). Some of its standout features include:

- In its primary configuration, the app supports English, French and Arabic. However, trials are underway to expand its linguistic capabilities to encompass Chinese, among other languages.
- Customizable voice profiles: With DeepFoni, users can personalize their experience by choosing from a diverse range of voices, accents, and speech patterns, facilitating a more customized and familiar communication experience.
- Intuitive interface: The app is designed with a user-friendly layout for users of all ages and abilities. Its straightforward navigation ensures quick and hassle-free usage.

Nafath Issue 24

# DeepFoni

### 43

- Real-time translation: The app overcomes language barriers by providing instant translations, enabling users to communicate effortlessly with others.
- Speech recognition technology: At the heart of the app is cutting-edge speech recognition, allowing for accurate and reliable voice-to-text conversion.



Figure 1. DeepFoni user interfaces.



DeepFoni was developed as part of the Mada Innovation Program 2022 (Al Thani et al, 2019). It was created following rigorous research and testing to guarantee user satisfaction and optimal functionality. Preliminary tests involving individuals with varied communication difficulties proved the application's efficacy and usability.

An Assistive Communication Innovation to Empower Individuals with Communication Difficulties

### Impact on Society

The advent of DeepFoni brings to the fore a myriad of possibilities, catalyzing positive societal change through enhanced communication. Its features, designed with both breadth and depth, offer solutions that transcend mere technological advancements, touching the very core of human interactions. Highlighting its profound impact:

- The application has transformative implications for society: DeepFoni is not just another app; it is a paradigm shift, redefining how we perceive and address communication challenges. Its introduction signals a new era where technology actively bridges societal gaps.
- Provides a vital tool to dismantle communication barriers: By leveraging state-of-the-art voice recognition and translation mechanisms, DeepFoni eliminates obstacles that hinder effective communication. This functionality becomes especially crucial in an interconnected global landscape.
- Cultivates an environment of inclusivity and understanding: The app transcends linguistic boundaries, ensuring that no one feels left out because of language barriers. As a result, it fosters a world where every voice, regardless of origin, is heard and understood.

#### DeepFoni

Nafath Issue 24

#### An Assistive Communication Innovation to Empower Individuals with Communication Difficulties

- 44
- Acts as a game-changer for individuals with communication challenges, facilitating free expression and connection: For those who've historically struggled with communication, DeepFoni offers a newfound freedom. It provides them with the tools to articulate their thoughts and engage with others without constraint.
- Supports multiple languages, magnifying its global reach: DeepFoni's multilingual capabilities ensure its relevance and utility across different continents and cultures. Such a broad linguistic spectrum amplifies its potential impact on a global scale.
- Fosters cultural exchange and a deeper understanding between diverse communities: With the ability to translate and communicate in various languages, users are exposed to diverse cultures. This paves the way for enriched interactions and mutual cultural appreciation.
- Addresses a pivotal social concern, highlighting the role of technology in solving such issues: Beyond its technical prowess, DeepFoni underscores technology's potential in resolving societal challenges. It stands as a testament to how innovation can lead to tangible positive change.
- Sets the stage for future innovations in communication technology: As a pioneering solution, DeepFoni establishes a benchmark for what's possible in the realm of communication tech. It challenges and inspires developers and innovators to push boundaries further.

### Conclusion

In conclusion, DeepFoni transcends its primary designation as a voice assistant. This sophisticated tool champions principles of equality, inclusivity, and autonomy. By effectively dismantling communication impediments, it paves the way for a more interconnected and empathetic global society. As technological advancements persist, innovations such as DeepFoni serve as poignant reminders of the profound potential technology possesses to ameliorate human experiences. We encourage further exploration into its capabilities to fully appreciate the expansive communication opportunities it offers.

#### References

- 1. Khan, M K. "Technological advancements and 2020." Telecommunication Systems 73 (2020): 1-2.
- 2. Dhouib A, Othman A, El Ghoul O, Khribi k, and Al Sinani A. "Arabic automatic speech recognition: a systematic literature review." Applied Sciences 12, no. 17 (2022): 8898.
- 3. DeepFoni website, https://deepfoni.com/ (accessed on 1/10/2023)
- 4. Al Thani D, Al Tamimi A, Othman A, Habib A. Lahiri A. and Ahmed S. "Mada Innovation Program: A Go-to-Market ecosystem for Arabic Accessibility Solutions." In 2019 7th International conference on ICT & Accessibility (ICTA), pp. 1-3. IEEE, 2019.

# بوابة برايل العربي الموحد **Unified Arabic Braille Portal**



braille.mada.org.ga

Mada's effort in the localization of Assistive **Technology and Digital Accessibility A Gateway** to Sustainable Inclusivity

#### Achraf Othman

aothman@mada.org.ga

Mada Assistive Technology Center, Qatar

Nafath Issue 24

47

### Abstract

The role of technology in promoting inclusivity for individuals with disabilities is increasingly recognized in today's digital age. However, a critical aspect often overlooked is the intersection of localization, assistive technology, and digital accessibility in fostering a sustainable and inclusive digital environment.



Mada's effort in the localization of Assistive Technology and Digital Accessibility A Gateway to Sustainable Inclusivity

> This paper aims to elucidate the importance of localization in assistive technology and how it is intrinsically linked to the broader goals of sustainability. An exemplary initiative in this realm is Mada's series of projects, including the Tawasol Symbols, Unified Arabic Braille, Jumla Sign Language, WCAG 2.1 Arabic Authorized Translation, and the Mada Glossary. These endeavors are geared towards localizing assistive technologies and solutions to cater to the specific needs of the State of Qatar and the Arab region.

Localization; Assistive Technology; Digital Accessibility; Sustainability; Inclusivity

### **48**

### Introduction

The digital age, as an outcome of the fourth industrial revolution, marked by unprecedented technological advancements and global connectivity, offers profound opportunities for societal transformation where artificial intelligence became a key stone in all domains [1]. At the heart of this evolution lies the potential to foster inclusivity and bridge the divides that have historically marginalized certain segments of the population, notably individuals with disabilities. The democratizing power of technology has made it possible for these individuals to access, participate, and contribute to the digital realm in ways previously unimagined. However, while the potential of technology as a force for good is universally acknowledged, its real-world implications and benefits are not uniformly distributed. For technology to be truly inclusive, it must resonate with the cultural, linguistic, and individual needs of its users. A one-sizefits-all approach, though often convenient, can inadvertently overlook the unique challenges and requirements of specific communities or regions [2].

Assistive technology refers to any device, software, or equipment specifically designed or adapted to maintain, increase, or improve the functional capabilities of individuals with disabilities. It encompasses a wide range of tools, from simple adaptive devices such as ergonomic grips or magnifying glasses to more sophisticated digital solutions like screen readers, voice recognition systems, and customized computer interfaces. The primary purpose of assistive technology is to enhance the independence, productivity, and participation of people with disabilities in everyday tasks and activities [3]. Enter the concept of localization – the process of adapting a product or content to meet the language, cultural, and other requirements of a specific target market or region. In the context of assistive technology, localization transcends mere translation. It encompasses the adaptation of technological tools to ensure that they are culturally appropriate, sensitive, and effective in meeting the unique needs of individuals with disabilities in different regions.

The State of Qatar recognizes the profound impact of digital inclusivity on societal well-being and economic prosperity. And at the forefront of this movement in Qatar is Mada, the Qatar Assistive Technology Center. Through its groundbreaking initiatives, Mada has championed the cause of digital accessibility, ensuring that technological advancements are not just widespread but also deeply rooted in the local context.

This paper delves deep into the symbiotic relationship between assistive technology, digital accessibility, and localization. Using Mada's pioneering projects as a lens, we will explore how tailored technological solutions can drive sustainable inclusivity in the digital realm.

Nafath Issue 24

### **49** The Imperative of Localization for Assistive Technology

The experience of disability is not a monolithic addressed across various contexts. one; it is inherently influenced by the cultural and linguistic contexts in which individuals with disabilities find themselves. Cultural norms, The lack of localization often results in tools that, while technically functional, can prove values, and societal structures play a pivotal role in how disability is perceived and experienced ineffective or even detrimental when applied across various communities and regions. At the in diverse cultural and linguistic contexts. Here are a selection of case studies highlighting the core of understanding disability is the recognition pitfalls of non-localized assistive technologies: that every culture has its own set of beliefs and practices concerning health, well-being, and Screen Readers and Non-English Web Content: disability. These beliefs often determine the A notable example is the experience of nonlevel of societal acceptance, access to resources, English speakers with popular screen readers and overall guality of life for individuals with disabilities [4]. that primarily cater to English-speaking

Linguistic diversity further complicates the disability experience. Language not only shapes how we communicate but also how we perceive the world and our place within it [5]. For individuals with disabilities, the availability of assistive technologies and services in their native languages can significantly impact their ability to engage with digital platforms and their broader communities. A lack of localized assistive tools can inadvertently exclude non-English speakers or those from linguistically diverse backgrounds from fully accessing digital content [6]. Moreover, certain languages might have rich vocabularies and terminologies for expressing various sensory experiences, emotional states, or physical ••• conditions which can be pivotal in designing

•••

•••

•

•••

•••

assistive tools [7]. Not accounting for this linguistic diversity can lead to a misrepresentation or misunderstanding of the disability experience for many.

To ensure true inclusivity, it is paramount to consider the rich tapestry of cultural and linguistic diversity present within the global disability community. Doing so not only promotes greater equity but also enriches our collective understanding of the myriad ways disability can be experienced and addressed across various contexts.

 Screen Readers and Non-English Web Content: A notable example is the experience of non-English speakers with popular screen readers that primarily cater to English-speaking audiences. When deployed on websites with content in languages that follow different syntactic or grammatical rules, these screen readers often mispronounce words or read content out of its intended order. Such discrepancies can confuse users, rendering the digital content inaccessible or incomprehensible [8].

 Voice-Activated Systems in Diverse Accents: Voice recognition technologies, when not localized for diverse accents or dialects, often struggle to decipher and process commands accurately. For instance, users from regions with distinct accents, like parts of Africa or Southeast Asia, have reported challenges in using voice-activated systems that are not trained on their specific vocal nuances. This lack of localization hampers their ability to interact with the technology effectively and might lead to feelings of exclusion [9].

- Mobility Aids in Varied Terrains: Assistive devices like wheelchairs or mobility aids designed primarily for urban, flat terrains might prove ineffective or even dangerous in rural or rugged landscapes. For instance, a standard wheelchair designed for paved roads can be challenging to maneuver on sandy or rocky terrains prevalent in parts of the Middle East or certain African countries. Such non-localized designs could potentially put users at risk of accidents.
- Digital Platforms with Non-localized User Interfaces: Digital platforms designed without considering regional customs or usability practices can be perplexing for users. For instance, a digital educational tool using leftto-right reading order might disorient users from cultures accustomed to right-to-left scripts, such as Arabic. This might make the tool less effective as an educational resource and might inadvertently marginalize users from certain linguistic backgrounds.

While assistive technologies aim to bridge accessibility gaps, a lack of localization can inadvertently widen these gaps. The above case studies underscore the necessity of tailoring assistive tools to specific cultural and linguistic needs to ensure they are truly inclusive and effective.

### The significance of region-specific disability regulations and standards

Building on the observations from the previous section, which highlighted the challenges of nonlocalized assistive technologies, it becomes evident that the diverse cultural, social, and linguistic fabric of the world cannot be addressed with a one-size-fits-all approach. Rather, it necessitates region-specific regulations and standards tailored for the unique needs of individuals with disabilities within different contexts. These region-centric guidelines not only offer solutions to the pitfalls of non-localized technologies but also play a pivotal role in shaping the technological, infrastructural, and societal landscapes to be more inclusive.

Figure 1 shows a visual representation that encapsulates the five critical dimensions discussed in this section: the need for Customized Technical Requirements, the importance of Socio-Cultural Appropriateness, the drive towards Enabling Accessible Infrastructure, the intertwining Economic and Policy Implications, and the role of Advocacy and Awareness in reinforcing regionspecific disability regulations and standards. The



Customized Tecnhical Requirements



Social-Cultural **Appropriateness** 

Enabling Accessible Infrastructure

**Economic &** Policy Implications



Advocacy & Awareness

#### **Dimensions of Region-specific Disability Regulations and Standards**

Figure 1. Dimensions of Region-specific Disability **Regulations and Standards** 

#### Nafath Issue 24

### 51

figure underscores the multifaceted nature of these dimensions and their collective significance in formulating effective and inclusive policies for individuals with disabilities.

In addressing the unique challenges and needs can only be achieved when all members of society, tied to each region's culture, geography, and including those with disabilities, are included in demographics, region-specific disability standards the developmental narrative. Inclusivity ensures play a pivotal role. These standards ensure that policies, technologies, and infrastructures that technological solutions, such as assistive are designed to cater to the broadest range of devices adapted for colder climates or speech users, promoting equitable opportunities and recognition software in multi-linguistic regions, ensuring that no one is left behind. cater specifically to local users. Moreover, when crafted with a deep understanding of local beliefs, The economic implications of this inclusive approach customs, and societal norms, these standards are are profound. Localized digital accessibility opens more likely to be embraced by communities. This doors to an often-neglected market segment. The is particularly evident in regions where stigmas global community of individuals with disabilities associated with disabilities exist, necessitating is vast, and their needs present a myriad of discreet assistive tools or those incorporating local opportunities for innovation and economic growth. symbols and designs. Infrastructure development By focusing on creating digital tools that are too is influenced by these guidelines, leading accessible and tailored to specific regional needs, to features like accessible beaches in coastal businesses can tap into this untapped market areas or enhanced public transport facilities potential. This not only leads to increased revenue in urban regions. Economically, the adoption of streams but also promotes the development local standards has far-reaching implications on of a more diversified and resilient economic governmental policies, efficient fund allocation, ecosystem. Furthermore, when businesses cater and spurring innovation in the assistive technology to this segment, they inherently foster a culture sector. Such standards offer businesses a clearer of innovation, as the challenges presented by framework to cater to the often-underserved diverse needs often necessitate out-of-the-box market of individuals with disabilities in specific solutions. regions. Beyond the tangible, these regulations also

fortify advocacy efforts, offering structured pathways for advocacy groups to rally around and amplifying awareness about inclusivity and the varied challenges faced by individuals with disabilities [10].

### Sustainability through **Inclusive Digital Environments**

The dialogue around sustainability has evolved to encompass more than just environmental considerations; it now significantly intertwines with the social and economic fabric of our society. At the heart of the social dimension of sustainability lies the core tenet of inclusivity. True sustainability

Lastly, the nexus between digital inclusivity and environmental sustainability is undeniable. For many in the disabled community, physical mobility can pose significant challenges. Digital tools that are accessible and tailored to their needs can reduce the necessity for physical travel, thereby diminishing carbon footprints. For instance, a visually impaired individual might benefit from an app that provides detailed auditory descriptions of their surroundings, allowing them to navigate unfamiliar territories without the need for a personal guide. Similarly, digital platforms that enable remote work or offer educational resources

### Successful Integration of **Localization in Assistive Technology from Mada** Center

can diminish the environmental impact by reducing the need for transport and infrastructure. By promoting digital accessibility, we inadvertently support environmental sustainability goals, crafting a world that is more inclusive and greener.

In essence, the pursuit of inclusive digital environments is not just a noble endeavor but a holistic approach to sustainability. It interlaces the social obligation of inclusivity with the economic potential of innovation and the imperative of environmental responsibility. As we move forward in the digital age, ensuring that our tools and platforms are accessible to all becomes paramount in our collective journey towards a sustainable future.

The importance of localized assistive technologies cannot be understated, as evident from our earlier discussions on the significance of region-specific regulations, sustainability through inclusive digital environments, and the various dimensions shaping accessibility. Nestled within this complex mosaic of technological and sociocultural considerations is the pioneering work of Mada Qatar Assistive Technology through the different streams of Mada Innovation Program [11]. Their endeavors offer a blueprint for how localization can be adeptly integrated into assistive technologies, ensuring that tools are not only functional but also deeply resonant with the target audience's cultural, linguistic, and societal context. Mada Center's commitment to this cause is evident in its diverse range of solutions, each meticulously tailored to address specific challenges faced by the Arabic-speaking disability community. These solutions include: Tawasol Symbols, Unified Arabic Braille, Jumla Sign Language, WCAG 2.1 Arabic Authorized Translation, and the Mada Glossary.

The success stories from Mada exemplify the profound impact of localization in assistive technology. Their solutions not only bridge technological gaps but also cultural, linguistic, and societal divides. As we journey forward in the realm of digital accessibility, the efforts of institutions like Mada Center illuminate the path, underscoring the importance of holistic, localized

> solutions. The subsequent sections delve deeper into each of these localized solutions, shedding light on their development, implementation, and impact.

Nafath Issue 24

53

#### **Tawasol Symbols**

A pictorial communication system, Tawasol Symbols are designed keeping in mind the cultural nuances of the Arab world, ensuring that individuals with communication difficulties can express themselves effectively and authentically within their cultural milieu.

The Tawasol Symbols project's aim was to develop a freely available Arabic Symbol Dictionary suitable for use by individuals who have a wide range of communication and language difficulties and to develop a set of symbols that are culturally, 5 linguistically, and environmentally appropriate for AAC users in Qatar and the Arab countries [12]. The Tawasol Symbol dictionary contains Figure 3. An example of a 3D Tawasol Symbol until today 1600 localized symbols [13]. There from different angles are many reasons for introducing a new set of localized symbols in the Arab World such as the **Unified Arabic Braille** vast differences in linguistic structures between Addressing the challenge of multiple Braille the Arabic and English languages, which can be systems across the Arab world, the Unified Arabic confusing and generate fragmented sentences, Braille initiative aims to standardize the Braille as illustrated in Figure 2.



script for Arabic, enhancing its accessibility and usability across the region [14]. The Unified Arabic Braille Portal from Mada Center, Qatar, aims to develop the Arabic Braille table in math and science signs/ symbols, as well as to develop the first eight-dots Arabic computer braille table to take advantage of Its multiple features, such as writing or reading a single code in a single cell and supporting some computer signs. Braille is the Figure 2. Differences in structure between Arabic only way that enables blind or blind-deaf people and English languages who have difficulty accessing printed materials to read and write using assistive technology. The portal will benefit the blind, deaf-blind people, experts, teachers, students, software developers, and assistive technology manufacturers in Qatar and abroad [15].



In 2020, Mada Center launched a new initiative to provide researchers working on the use of Augmented Reality to improve communication skills of children on ASD. The aim of the project is designing a set of existing symbols in three dimensions. The library is useful to develop new applications using Augmented Reality technology. The 3D symbols are provided under the creative commons license. Until today, 200 3D symbols are available for download.



#### JUMLA Sign Language

Recognizing the diversity and richness of sign languages, Jumla offers a unified approach tailored for the Qatari/Arabic-speaking deaf community, ensuring that communication barriers are minimized, and cultural relevancy is maintained. As well as all spoken languages, Sign Languages SL have structured grammar and syntax. Even though it was visual, multidimensional and mainly based on gestures, sign languages follows specifics grammatical rules. Consequently, the automatic generation of sign language should follow these rules. It's for this reason that Mada works on the development of a new framework that aims to support researchers and developers to create new innovant tools for the deaf. The objective is essentially to create tools that enhance the development of software using grammatically validated sentences. The main feature of the project are: (1) a localized sign language virtual interpreter (avatar) called BuHamad [16] (2) a dataset containing more than 6300 sentences in sign language [17] (3) tools and codes for sign language annotations, synthesis and recognition [18].

#### WCAG 2.1 Arabic **Authorized Translation**

Accessibility guidelines are pivotal in shaping inclusive digital landscapes. Mada Center's translation of the Web Content Accessibility Guidelines (WCAG) 2.1 into Arabic ensures that web developers and designers in the Arab world have a clear roadmap to create inclusive digital platforms.

Since January 2020, Mada led the Authorized Arabic Translation of WCAG 2.1 with the support of W3C Chapters of GCC and Morocco and the Reviewers' Committee members from 49 organizations. Web Content Accessibility Guidelines cover a wide range of recommendations for making Web content more accessible. Following these guidelines will make

content more accessible to a wider range of people with disabilities, including accommodations for blindness and low vision, deafness and hearing loss, limited movement, speech disabilities, photosensitivity, and combinations of these, and some accommodations for learning disabilities and cognitive limitations; but will not address every user need for people with these disabilities. These guidelines address the accessibility of web content on desktops, laptops, tablets, and mobile devices. Following these guidelines will also often make Web content more usable to users in general.

#### Mada Glossary

Language is a powerful tool, and the Mada Glossary serves as a repository of terms related to digital accessibility, ensuring that discussions and initiatives in the field are grounded in clarity and mutual understanding [3]. The main objective of developing the glossary is to promote innovation in the Arabic language in various fields of technology. The glossary provides a list of terms in Arabic and English to help stakeholders, experts, innovators, parents, users, teachers, students, therapists, and related institutions understand key terms related to ICT, digital accessibility, and Assistive Technology (AT) to achieve the Mada's vision to improve ICT accessibility. Subsequently, effectively unleashing the potential of all persons with disabilities and the elderly through capacitybuilding and supporting the development of accessible digital platforms in Qatar and the world. The glossary includes technical terms that could be used in developing scientific papers and general articles by authors to produce scientific and academic resource content in Arabic among other languages.

Due to the infancy of Arabic digital resources related to ICT and digital access for persons with disabilities, Mada sought to launch a specialized glossary to improve the knowledge and guality resources of assistive technology solutions in the Arabic language. This will help establish a more well-versed society in line with the Fourth Industrial Revolution, artificial intelligence, and all that is new in the field of innovation. Furthermore, this resource will help raise awareness related to inclusive digital accessibility and highlight the role of Mada as a key contributor towards capacity

Nafath Issue 24

### 55

building in the field of Digital Accessibility and AT in Qatar and the region.

Mada's Glossary consists of 354 terms, each of Challenges which provides a concise definition of matters related to persons with disabilities, accessibility, and technology. Mada seeks to expand this project to its next stages by adding more terms available in various languages. The resource is now available online, free of charge, through Mada's web presence, providing a much-needed resource for People with Disabilities, caregivers, therapists, technologists, policymakers and academics interested in the field.





### **Challenges and Opportunities**

As regions and societies navigate the intricacies of creating inclusive environments, they are met with both hurdles and prospects for innovation. Understanding these challenges and opportunities is instrumental in shaping a future where technology truly serves all.

- **Diverse Needs Within Disability Communities:** Disability is not monolithic. The spectrum of needs within the community is vast, and designing one-size-fits-all solutions can often lead to exclusionary practices.
- Rapid Technological Advancement: As technology evolves at an unprecedented pace, there is a constant race to ensure that assistive tools and platforms remain updated, relevant, and accessible.
- Cultural and Linguistic Differences: The nuances of different cultures and languages can pose significant barriers, as discussed in our sections on localization. Finding universally accepted symbols, terms, or gestures can be a daunting task.
- Financial Constraints: Developing assistive technologies, especially those that are highly specialized, can be capital intensive. Moreover, ensuring that these technologies are affordable for all can be a significant challenge.
- Lack of Awareness: Many regions still lack a comprehensive understanding of the importance of digital accessibility, leading to slow adoption rates and limited advocacy.

#### **Opportunities**

- Interdisciplinary Collaboration: The intersection of technology, sociology, linguistics, and design offers fertile ground for interdisciplinary collaborations, leading to innovative solutions.
- Growing Market Potential: As discussed in our sections on economic implications, the disabled community represents a significant yet untapped market segment. Catering to their needs can unlock vast economic potential.
- Environmental Sustainability: As highlighted earlier, digital tools have the potential to promote environmental sustainability. Assistive technologies can reduce physical mobility needs, leading to decreased carbon footprints.
- Global Communities and Knowledge Sharing: With the rise of global communication platforms, there's an unprecedented opportunity for knowledge exchange. Best practices, successes, and learnings can be sharedacrossborders, accelerating progress.
- **Empowerment and Advocacy:** Assistive technologies can play a pivotal role in empowering individuals, giving them a voice, and amplifying their advocacy efforts.

While the journey towards universal digital accessibility is fraught with challenges, it is also replete with opportunities for growth, innovation, and positive societal change. By acknowledging these dual facets and navigating them with intention, a more inclusive digital future can be realized.

### Recommendations for a Sustainable and Inclusive **Digital Future**

As we look towards shaping a future that harmonizes digital inclusion with sustainability, certain proactive steps become paramount to ensure that our vision aligns with practical implementations. Central to this is the establishment of frameworks for global collaboration on localized assistive technologies. The diverse needs of different regions, influenced by cultural, linguistic, and geographical considerations, require collective brainstorming and solution development. Pooling resources, expertise, and experiences from across the world can lead to the design of tools that are both universally functional and locally resonant. Such collaborations could take the form of international consortiums, digital knowledge-sharing platforms, or even regular global symposiums dedicated to the cause.

Simultaneously, it is imperative to advance research on the complex interplay between digital accessibility, localization, and sustainability. The relationships between these domains are intricate and multifaceted, warranting in-depth studies to understand their nuances and intersections. Such research can not only guide policy-making and technological development but can also shed light on unforeseen challenges and opportunities. By fostering academic and industry partnerships, we can ensure that the research remains grounded in real-world needs while pushing the boundaries of theoretical exploration.

Nafath Issue 24

### 57

Lastly, the significance of advocacy and awareness Conclusion cannot be understated. The advancements in assistive technologies and the strides towards The digital realm, with its vast expanse and rapid localization can only achieve their desired impact evolution, presents a unique dichotomy. On one if they are accompanied by a broader societal hand, it holds the unparalleled potential to bridge understanding and appreciation. Advocacy and divides, enable communication, and provide tools awareness campaigns can play a pivotal role in that can transform lives. On the other hand, it this regard, disseminating information, challenging poses the risk of deepening disparities if not existing biases, and building a strong case for the approached with intention and foresight. The importance of localization in assistive tools. Such discourse on assistive technologies, localization, campaigns, while highlighting the tangible benefits, and sustainability is a testament to this intricate should also appeal to the collective conscience, dance between potential and responsibility. underscoring the moral imperative of creating Throughout our exploration, it became evident a world that is inclusive and sustainable for all. that true digital accessibility isn't merely about In essence, our journey towards a sustainable creating tools; it's about ensuring these tools and inclusive digital future is not a solitary resonate with their users, both functionally and endeavor. It requires collaborative efforts, rigorous culturally. The pioneering efforts of entities like research, and a shared vision. By prioritizing Mada Center Qatar underscore the profound impact global collaborations, fostering research, and of thoughtful localization in assistive technology, championing the cause through advocacy, we illuminating the path for others to follow. can pave the way for a digital landscape where everyone, irrespective of their abilities or location, Moreover, the symbiotic relationship between can thrive.



inclusivity and sustainability offers a compelling narrative for the future. As we work towards creating a world that is digitally inclusive, we inadvertently craft a blueprint for sustainability, ensuring that our actions today have positive reverberations for generations to come. However, the path forward isn't without its challenges. From understanding diverse needs to navigating rapid technological advancements and cultural nuances, the journey is complex. Yet, it's within these complexities that opportunities for collaboration, innovation, and growth emerge.

As we conclude, it's essential to remember that the guest for a sustainable and inclusive digital future is ongoing. It demands persistence, collaboration, and a shared vision. But with concerted efforts, guided by the recommendations and insights discussed, we can indeed create a digital world where everyone finds a place, a voice, and an opportunity to thrive.

#### References

- G. Kova@evi@, "Research, development and innovation in ICT: View from the industry," presented at the International Conference on Telecommunications, Jun. 2013. Accessed: Oct. 26, 2023. [Online]. Available: https://www.semanticscholar.org/paper/Research%2C-development-and-innovation-in-ICT%3A-View-Kova%C4% 8Devi%C4%87/ce050e157369816cbb-51e33c54d3841b150fd89a
- F. Tödtling and M. Trippl, "One size fits all?: Towards a differentiated regional innovation policy approach," Res. Policy, vol. 34, no. 8, pp. 1203–1219, Oct. 2005, doi: 10.1016/j.respol.2005.01.018.
- A. Lahiri, A. Othman, D. A. Al-Thani, and A. Al-Tamimi, "Mada Accessibility and Assistive Technology Glossary: A Digital Resource of Specialized Terms," in ICCHP, 2020, p. 207. Accessed: Oct. 26, 2023. [Online]. Available: https://re.public.polimi.it/ retrieve/handle/11311/1151879/556591/ ED\_1\_ICCHP\_Forum.pdf#page=207
- N. Gupta, A. R. H. Fischer, and L. J. Frewer, "Socio-psychological determinants of public acceptance of technologies: A review," Public Underst. Sci., vol. 21, no. 7, pp. 782–795, Oct. 2012, doi: 10.1177/0963662510392485.
- N. Van De Meerendonk, H. H. J. Kolk, D. J. Chwilla, and C. Th. W. M. Vissers, "Monitoring in Language Perception," Lang. Linguist. Compass, vol. 3, no. 5, pp. 1211–1224, 2009, doi: 10.1111/j.1749-818X.2009.00163.x.
- I. Jhangiani, "Usability and accessibility issues in the localization of assistive technology," in Proceedings of the 8th international ACM SIGACCESS conference on Computers and accessibility, in Assets '06.

New York, NY, USA: Association for Computing Machinery, Oct. 2006, pp. 299–300. doi: 10.1145/1168987.1169065.

- P. dos S. Paim and S. S. Prietch, "Problems and Solutions in the Design for Deaf Persons who are Sign Language Users to Adopt Assistive Technology Products," J. Interact. Syst., vol. 10, no. 2, Art. no. 2, Dec. 2019, doi: 10.5753/jis.2019.554.
- J. Zong, C. Lee, A. Lundgard, J. Jang, D. Hajas, and A. Satyanarayan, "Rich Screen Reader Experiences for Accessible Data Visualization," Comput. Graph. Forum, vol. 41, no. 3, pp. 15–27, 2022, doi: 10.1111/ cgf.14519.
- [9] S. Sahoo and B. Choudhury, "Voice-activated wheelchair: An affordable solution for individuals with physical disabilities," Manag. Sci. Lett., vol. 13, no. 3, pp. 175– 192, 2023.
- 10. A. Othman, A. Al Mutawaa, A. Al Tamimi, and M. Al Mansouri, "Assessing the Readiness of Government and Semi-Government Institutions in Qatar for Inclusive and Sustainable ICT Accessibility: Introducing the MARSAD Tool," Sustainability, vol. 15, no. 4, p. 3853, 2023.
- D. A. Thani, A. A. Tamimi, A. Othman, A. Habib, A. Lahiri, and S. Ahmed, "Mada Innovation Program: A Go-to-Market ecosystem for Arabic Accessibility Solutions," in 2019 7th International conference on ICT & Accessibility (ICTA), Dec. 2019, pp. 1–3. doi: 10.1109/ICTA49490.2019.9144818.
- A. Othman and A. Al-Sinani, "Tawasol Symbols: Alternative Augmented Communication Pictograms to Support the Inclusion During Pandemics," in Radical Solutions for Education in a Crisis Context: COVID-19 as an Opportunity for Global Learning, D. Burgos, A. Tlili, and A. Tabacco, Eds., in Lecture Notes in Educational Technology., Singapore: Springer, 2021, pp. 225–239. doi: 10.1007/978-981-15-7869-4 15.
- 13. "مَرْحَباً," Tawasol Symbols. Accessed: Oct. 26, 2023. [Online]. Available: https://tawasol.mada.org.qa/welcome/

Nafath Issue 24 Mada's effort in the localization of Assistive Technology and Digital Accessibility A Gateway to Sustainable Inclusivity

### 59

- 14. O. El Ghoul, I. Ahmed, A. Othman, D. A. Al-Thani, and A. Al-Tamimi, "An Overview of the New 8-Dots Arabic Braille Coding System," in Computers Helping People with Special Needs, K. Miesenberger, R. Manduchi, M. Covarrubias Rodriguez, and P. Pe@áz, Eds., in Lecture Notes in Computer Science. Cham: Springer International Publishing, 2020, pp. 339–345. doi: 10.1007/978-3-030-58796-3\_40.
- A. Othman and O. E. Ghoul, "Unified Arabic Braille Portal by Mada: Innovative digital resource to reduce braille literacy in the Arab region," Nafath, vol. 6, no. 19, Jan. 2022, doi: 10.54455/10.54455/MCN.19.06.
- 16. A. Othman and O. E. Ghoul, "BuHamad: The first Qatari virtual interpreter for Qatari Sign Language," Nafath, vol. 6, no. 20, May 2022, doi: 10.54455/MCN.20.01.
- 17. O. El Ghoul, M. Aziz, and A. Othman, "JUM-LA-QSL-22: A Novel Qatari Sign Language Continuous Dataset," IEEE Access, vol. 11, pp. 112639–112649, 2023, doi: 10.1109/ ACCESS.2023.3324040.
- 18. A. Othman, O. El Ghoul, M. Aziz, K. Chemnad, S. Sedrati, and A. Dhouib, "JUM-LA-QSL-22: Creation and Annotation of a Qatari Sign Language Corpus for Sign Language Processing," in Proceedings of the 16th International Conference on PErvasive Technologies Related to Assistive Environments, in PETRA '23. New York, NY, USA: Association for Computing Machinery, Aug. 2023, pp. 686–692. doi: 10.1145/3594806.3596525.



