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Innovative AAC solutions for persons on the autism spectrum disorder

Emerging accessibility solutions for physical and mobility impairments

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Content

Emerging Accessibility Solutions for Physical & Mobility Impairments

Anirban Lahiri
Mada Center

1. Introduction

Innovation has played a substantial role in the field of Accessibility to the Information Communication Technology (ICT) throughout the past decade. The impact of these groundbreaking achievements has been reflected throughout all industries including Accessibility and Inclusive Technologies. The technological breakthroughs in areas like miniaturized computer hardware (e.g. wearables, smartphones, etc.), Artificial Intelligence (AI), Deep Neural Network, Machine Learning, Robotics, and Internet of Things (IoT) have paved the way for innovative solutions to meet a wide range of needs for people with disabilities (Al-Thani et al., 2019).

Since the past few years, Assistive Technologies and ICT Accessibility Solutions have demonstrated a trend of being incorporated into mainstream technological solutions through built-in accessibility features available within products. Trends of emerging assistive technologies currently being explored are converging towards being a hybrid of mainstream and medical technologies including technologies like implants and exoskeletons. These emerging solutions tends to compliment conventional assistive products rather than replacing them.

2. Background

According to World Intellectual Patent Organization (WIPO), currently there are over 1 billion potential users of assistive technology and accessibility solutions. It is estimated that this population would grow to 2 billion by 2050 as human life expectancy increases over this period along with the convergence of mainstream products and assistive technology features. The United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) recognizes access to assistive technology as a human right, bearing responsibilities and obligations towards the accessibility industry and market

influence. UNCRPD identifies legislations and policies play a crucial role in attracting market sector investments along with related demographics and consumer demand. Significant work is being done to develop assistive technology solutions for individuals with mobility impairment to augment or recover human functional limitations. Emerging assistive technologies leverage on a combination of groundbreaking technologies such as Artificial Intelligence (AI), Internet of Things (IoT), Brain Computer Interface (BCI), and advance sensors (Lahiri et al., 2020).

3. Cutting-edge Technologies

Primary cutting-edge products in this sector are evolving from conventional assistive products such as advanced walking aids (balancing aids and smart canes), advanced prosthetics (neuroprosthetics, smart and 3D printed prosthetics), advanced wheelchairs (including self-driving wheelchairs and wheelchair control) and exoskeletons (full-body exosuits, lower and upper body exoskeletons). An example of such trend is indicated by the fact that there has been a 34% growth rate in the patent filings for advanced wheelchairs last year (Source: WIPO). The present article will highlight the advanced prosthetics, Brain Computer Interface, Exoskeletons and Advanced walking aids.

Table 1: Comparison of Conventional Vs. Emerging Assistive Technology

Conventional Assistive Technology	Emerging Assistive Technology
Walking aids	**Advanced prosthetics**
Accessories for walking aids	**Exoskeletons**
Wheelchairs	**Advanced walking aids**
Accessories for wheelchairs	Advanced wheelchairs
Other mobility and mobility accessories	**Brain–computer interface (BCI)**
Accessories for changing body position or lifting persons	Smart assistants
Orthoses	Smart homes
Prostheses	
Standing frames and supports for standing	

3.1. Advanced Prosthetics

An example of innovative emerging assistive technology is advanced prosthetics which

compared to conventional prosthetics and orthoses offer features well beyond mechanical and cosmetic support. The utilization of sophisticated technologies such as cameras & pressure, temperature or strain sensors combined with machine learning algorithms, enables the device to understand the user's prosthetic control behavior and harness neural signals to be controlled by the nervous system and signals from the skeletal muscles.

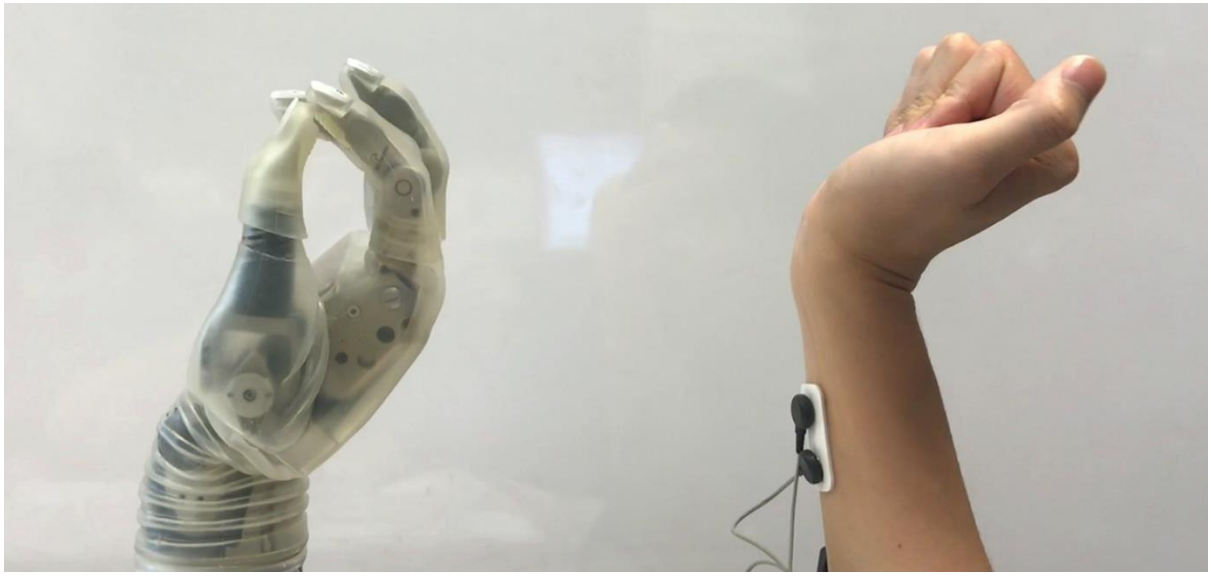

Figure 1. New Tech May Make Prosthetic Hands Easier for Patients to Use (Source: NC State University news.ncsu.edu)

Current state-of-the-art prosthetics rely on machine learning to create a "pattern recognition" approach to prosthesis control. This approach requires users to "teach" the device to recognize specific patterns of muscle activity and translate them into commands – such as opening or closing a prosthetic hand.

"Pattern recognition control requires patients to go through a lengthy process of training their prosthesis," according to the research conducted by (Pal et al., 2018) and this process can be both tedious and time-consuming.

3.2. Brain Computer Interface (BCI)

An innovative area of technology being actively explored to develop emerging assistive technology is Brain Computer Interface (BCI). BCI is a branch of computing technology that seeks to detect brain activity patterns and map them to specific output commands

to be processed by a computer application or device. BCI technology can be used as an alternative input method where the user is unable to use conventional input devices (e.g. mouse, keyboard, etc.). BCI can be in invasive and non-invasive forms. Invasive BCI consists of connecting hardware computing device(s) directly to sensors implanted in the brain while non-invasive BCI comprise of external sensors that detect brainwave patterns while in contact with specific areas of the head (Pandarinath et al., 2017).

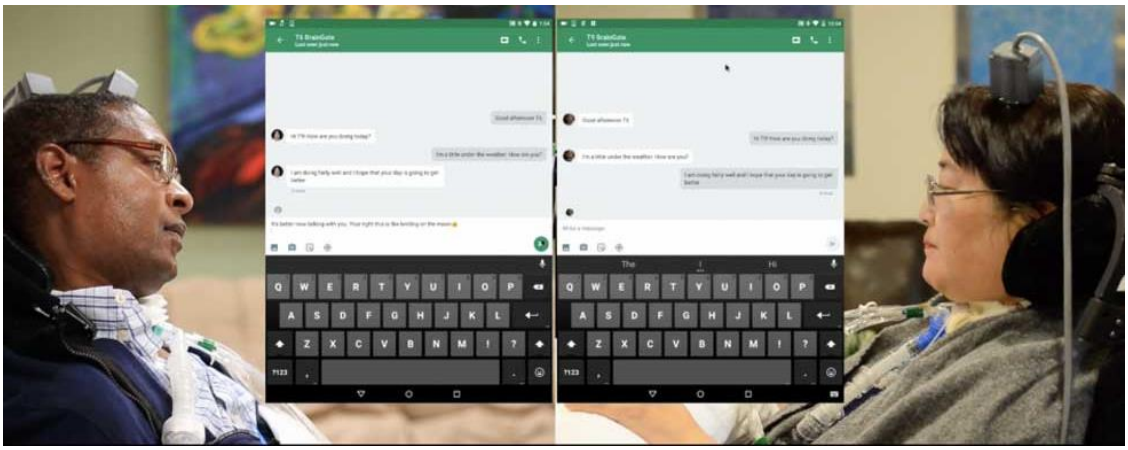

Figure 2. Brain-Computer Interface turns thoughts into a mouse for tablet control (Source: Slash Gear slashgear.com)

BCI applications can be helpful for individuals with various types of disabilities as it can be operated through a direct pathway of communication between the user's brain and the external device being controlled without the need for the user to perform a physical task like pressing a switch or even initiating voice commands. AlterEgo is a non-invasive BCI wearable that allows users to communicate with machines through the medium of neural language without the use of any voice or gesture commands. The solution uses AI and machine learning to interpret commands by processing them internally and provides feedback to the user through bone conduction headset retaining complete privacy for the user. Currently under research and conceptualization in Massachusetts Institute of Technology (MIT), this technology can have significant impact for individuals with physical and communication impairments by reducing the functional barriers to carry out various daily living tasks.

3.3. Exoskeletons and advanced walking aids

Exoskeletons are innovative mechanical structures that humans can wear to increase their strength and endurance. It can be an additional option for the supply of aids if the

structural and functional properties of the neuromuscular and skeletal system are too limited to be able to achieve mobilization with an orthosis. In patients with complete paraplegia (ASIA A), exoskeletons are interesting as an alternative to an orthosis under this criterion for lesion heights above the thoracic vertebra (T12). In patients with incomplete paraplegia (ASIA B-D), orthotics are even suitable for lesion heights above T12 in order to promote the patient's own activity to such an extent that the therapeutical mobilization can be successful. In contrast to an orthosis, an exoskeleton takes on a large part of the active muscle work. In addition powered exoskeletons can improve the quality of life of individuals who have lost the use of their legs by enabling system-assisted walking. Exoskeletons—that may be called "step rehabilitation robots"—may also help with the rehabilitation from stroke, spinal cord injury or during aging. Several prototype exoskeletons are under development. The Ekso GT, made by Ekso Bionics, is the first exoskeleton to be approved by the US Food and Drug Administration (FDA) for stroke patients.

Figure 3. Example of Exoskeletons Technology used by a person with physical disability (Source: International Business Time www.ibtimes.co.uk)

4. Conclusion

Emerging accessibility solutions for users with physical and mobility impairment primarily involve the introduction of advanced innovative features to existing conventional technologies by allowing these solutions to perform far more functions for the user in an automated manner while also enabling the technologies to self-learn about the user's requirements, and behavior to function accordingly. The ultimate goal of all these technologies is to maintain the overall safety of the user and allow him/her to function to the fullest extent possible.

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A review of assistive smart-home technology for people with physical and mobility disabilities

Oussama El Ghoul
Mada Center

1. Introduction

Home automation, through computers, electronics, and telecommunications, is at the service of people with disability in terms of security, comfort, and social bonding. It is based on the ability to interact remotely with the house's equipment, which makes it "Smart". Thus, the fact of being able to activate equipment without moving by utilizing voice or a remote control allows reducing movements and therefore retain a certain autonomy.

Several devices can suit this purpose, allowing disabled persons to, for example, illuminate a room or switch on the heating. These devices can be equipped with a motion or presence sensors, as well as technology that allows for time delay or scenario definition. For instance, turn on the living room at 6 p.m. and then the bedroom at 8 p.m. Adapted remote control allows adapting the equipment to the disability with ergonomic and adapted touch switches or even voice control. Home automation allows the control of existing equipment of the house such as managing the light without moving, controlling the opening and closing of shutters and doors remotely, controlling multimedia devices remotely: TV, music system, etc., control the home alarm remotely, answer the intercom without moving, open the gate (ConnectorSupplier.com, 2019).

All such commands can be carried out in 4 different ways without moving: voice control, mobile and tablet, adapted remote control and adapted switches. Connected switches and plugs simplify daily lives for people with limited mobility. Because they are wireless, they may easily be relocated in another room or at a different height to accommodate the occupants' height. In fact, changing the location of the switch no longer necessitates cutting slots in the walls and removing wires.

Many others smart devices can be used at home by peoples with reduced mobility. In fact, some persons require specific attention, including close surveillance. This is why the remote monitoring bracelet remains one of the most important accessories today given constant and immediate contact with its user. This remote monitoring is also available as a medallion. With a simple pressure user can notify relatives in case of need. It is very useful also in case of emergency for Elderly (Portet et al., 2013).

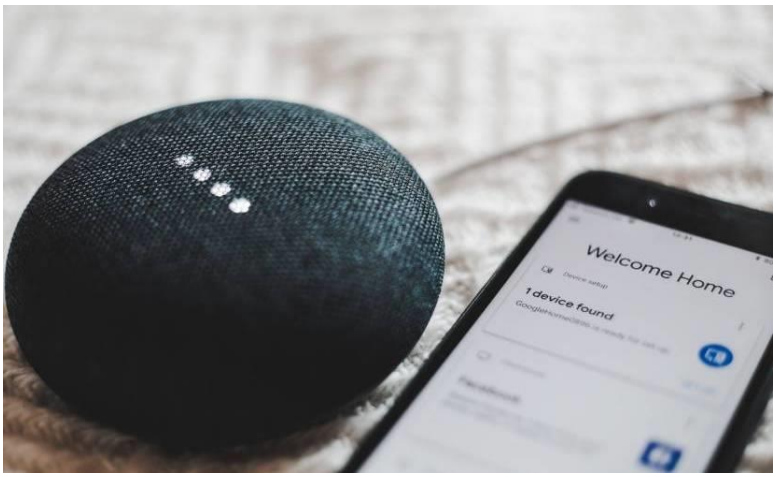

Figure 1. Voice Control using Smart Home and virtual assistant AI technology

These devices and other players in the Internet of Things (IoT) — or, in some cases, the Internet of Medical Things (IoMT) — rely on connectors, sensors, power supplies, signal I/O, Wi-Fi, and Bluetooth connectivity to transmit and receive information at each point. While the functions are accomplished through seemingly invisible means, a very real array of sensors and actuators support every move. The industry's innovations include an M.2 card edge connector, which accepts dual-side modules, allowing for functionality in device-size products. Wireless compatibility is also now possible through wireless module cards, which can deliver BT, WLAN, up to 4G, and GPS solutions to devices.

2. Smart lock

A smart lock is a safer alternative to a keypad, especially to give a housekeeper or nurse access to the home. The Smart Lock is a door lock that can be opened with either a conventional key or a smart phone, allowing the owner to give others a temporary, guest, or admin access. Users can restrict the number of times and days someone has access to their home, while monitoring who has entered in a log. It's Bluetooth- and Wi-Fi-ready,

interfaces with Apple's HomeKit software, and can be controlled whether or not the user is at home. Inside these devices, an array of connectors bring functionality, including battery connectors, control connectors, and REM port connectors.

Figure 2. Smart Lock Technology

3. Smart Doorbells

For those who are confined to bed, or are unable to see out of their windows from their wheelchairs, a smart doorbell is handy. The Ring Smart Doorbell, for instance, comes with a motion-sensor camera and shows who is at the door, allowing users to decide whether or not to answer. The power and signal is managed for the slim PCB through ultra-miniature cables and connectors. A micro-USB may be present for charging or connecting to other devices to move data.

4. Smart Thermostats

Smart thermostats, such as the Nest, keep users house at the exact temperature they want and allow them to change the temperature with their smart phone, even when they're away or via a preprogrammed schedule. A series of sensors deliver information about temperature, humidity, and light. Spring-loaded connectors route signal lines to a home's heating and cooling devices. The Nest features a micro-USB port for charging,

and a proprietary 20-pin connector that locks the devices onto the base unit.

5. Smart Lighting

Smart lighting like Philips Hue Light Bulbs don't just turn on and off; these lights can also change hues and be dimmed to decrease sensory overload, which is a common challenge for many people living with disabilities. Inside these light bulbs, a tiny system includes a circuit board, radio transceiver, AC/DC converter, capacitor, EPROM, and transformer.

6. Smart Curtains, Shades, and Blinds

Operating curtains and shades can be difficult for people with restricted mobility, but smart window coverings can help. My Smart Blinds, for example, can control blinds with audio as well as smart phone commands. A motor is at the heart of these systems, although the most sophisticated versions also include a sensor array to monitor and respond to light conditions.

7. Conclusion

Home automation makes possible not only centralized management of lighting, heating, household appliances, doors, scenario programming, etc. But also, it makes it possible to easily manage entrances and exits using a connected lock. With such a device, the safety and the security of the user is guaranteed. These home automation devices can be controlled remotely using a simple smartphone. Door automation prevents home occupants from moving when knocking, for example. In addition, during visits, they are automatically notified of the visitor's identity from a visual or sound device.

Home automation can be seen as an effective solution for people with disability because it allows, in a simple and intuitive way, to prevent all security risks related to the home. Furthermore, these devices are more than simple devices for comfort. It represents an essential technology that enhances the autonomy of disabled persons and improve the quality of their lives.

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Electrical stimulation of the spinal cord to rejuvenate dormant circuits in people with physical disability

Ahmed Elsheikh
Mada Center

1. Introduction

With the emerging new technology aids such as Spinal Cord Electrical Stimulators, new hope is being found for people who have suffered spinal cord or brain injuries that led to severe mobility issues and sometimes total paralysis. Brains usually are passing message through the spinal cord nerve channels to make muscles move and body parts accordingly. People with physical disabilities, particularly who are suffering from spinal cord injuries have that process of nerve signal communication blocked due to nerves damage.

2. How it works

Nerve pathways in the spinal cord can be repaired by tapping into certain populations of nerve cells, called neural circuits, that are found in the spinal column. These circuits also lead to the target muscles, but their signals aren't blocked by injuries, so some treatments seek to stimulate the ones below the injury site in people with physical disabilities. Research and trails have led to a new trend of emerging neurotechnology which target spinal cord stimulation to enable voluntary control of movement or mobility in individuals with physical disabilities. This neurotechnology helps improving neuroglial and muscular recovery as well as providing support for daily living activities during rehabilitation.

3. Electrical Stimulation Technology

The neurotechnology consist of none-invasive pulse generator devices placed over the

skin with real-time triggering capabilities deliver trains of spatially selective stimulation to the lumbosacral spinal cord with timing that coincided with the intended movement of the body part. Electrical stimulation usually starts reorganizing the spared spinal circuit with the intention of improving sensory and motor functions for the people with physical disabilities. In addition, some of the available technology can be controlled by a mobile app to enable people with spinal cord injuries to control the stimulation in real time using smart phones or tablets with the ability of data gathering and analysis.

Electric stimulators devices are similar to the ones used for neuropathic pain that are placed in the lower back of people with physical disabilities and spinal cord injuries to enable a number of sleeping, but intact spinal cord fibers/nerves to rejuvenate and conduct the signal from the brain to the muscles to initiate mobility or movement such as walking or moving the upper body parts or limbs. In recent studies, this technique was combined with a lot of physical training such as loco-motor training on a treadmill, repeating the walking pattern with the help of therapists and of body-weight support.

The wholistic concept of this neurotechnology is to enhancement spinal networks' impulsiveness via tonic electrical spinal cord stimulation that can impact on the underlying capacity of neural plasticity and can be developed for functional recovery.

Figure 1. examples of spinal cord electrical stimulators

Different types of stimulators, as examples seen above, functioning in similar ways, as they consist of active electrodes and smart digital pre-programed controllers with operational buttons. These devices apply mono-polar pulses of electrical stimulation at increasing intensities through the electrodes that enhances the highest chances of activating the targeted nerve channels. Researchers found that there is a direct relation between electrical stimulation frequency and flexor muscle activity which in the end

leads to improvement in mobility and movement as whole.

Trials and research have suggested that programming the electrical stimulation devices to give the best outcomes requires some time, patience and a careful consideration needs to be put in mind when tuning the intensity of the electrical stimulation. For example, If it is too low, the brain signals will be too weak and still not to be activated while, if it is too high, it can generate involuntary movement of a particular body part.

While some researchers and clinicians continue to have different opinions with regards to the effectiveness of these electrical stimulation technology for people with severe physical disabilities due to spinal cord damage, it has been proven to some extent to be an effective electrotherapeutic modality for a variety of physical disability conditions, and stimulators have much potential for use in muscles and nerves performance improvement.

4. Conclusion

The near future of electrical stimulation technology may include more sophisticated and effective functional electrical stimulation systems used for mobility in partially of fully paralyzed disabled people and also the possibility of manipulation or alteration muscle fiber types in people with spinal cord damage.

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Tawsol Symbols 3D – Towards an innovative Picture Exchange Communication Systems PECS

Achraf Othman
Mada Center

1. Introduction

Pictograms (also called symbols) are widely used in daily life as a type of visual language, such as transportation venue signs (airport, rail station, etc.), road signs, care symbols on clothing, or direction symbols (Tijus et al., 2007). This shows how symbols can communicate information quickly and effectively. Fundamentally, symbols can be understood, regardless of the person's language or literacy skills. Therefore, people with communication difficulties may benefit from using symbols to comprehend what other people are saying, as well as to express themselves. There are many sets of pictograms available online or in the market as printed cards, some of them are free and some must be purchased. Pictogram sets can be considered in several ways including how pictorial, how guessable, how flexible, how consistent, and how visually complex. Each symbol set has strengths and weaknesses, and the choice of a symbol set should be based on the needs and abilities of the person using AAC.

Selecting pictograms for the communication environment is also important, this will include language and culture. Practical issues such as how the symbols are to be used, if software is available to produce printed materials, or which sets are available for a particular AAC device will also influence the pictogram selection. Pictograms or symbols are mostly offered as collections or sets. Most present the symbol together with the word or phrase it stands for.

Typically, the word is printed above the symbol if the focus is on communication as communication partners need to be able to see the words because they may not know what all the symbols mean. When the focus is on literacy, the reader may require seeing the symbols to help decode the written word; as emerging readers often point to words as they read, the symbol is printed above the word.

2. Overview of the Tawasol Symbols

Symbol sets can be considered in several ways including how pictorial, how guessable, how flexible, how consistent, and how visually complex. Each symbol set has strengths and weaknesses, and the choice of a symbol set should be based on the needs and abilities of the person using AAC. Selecting symbols for the communication environment is also important, this will include language and culture preferences. Practical issues such as how the symbols are to be used are software available to produce printed materials, or which are available for a particular AAC device, will also influence any choice. Selecting a symbol set is predominantly based on meeting individual needs within a setting. For example, considering acceptable symbol design and communication environment. AAC users can benefit from choices of globalized, localized, and personalized symbols.

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, linguistically, and environmentally appropriate for AAC users in Qatar and the Arab countries (Tawasol Symbols, 2020) (Figure 1). The Tawasol Symbol dictionary contains until today 1600 localized symbols.

There are many reasons for introducing a new set of localized symbols in the Arab World such as the vast differences in linguistic structures between the Arabic and English languages, which can be confusing and generate fragmented sentences, as illustrated in Figure 1.

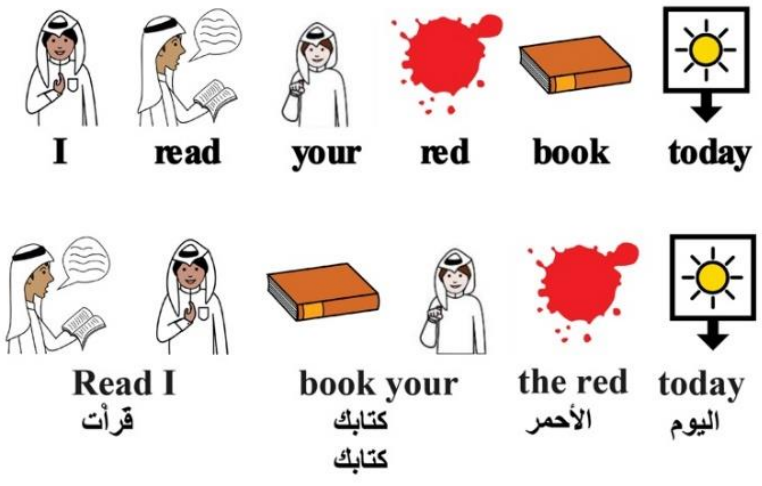

Figure 1. Differences in structure between Arabic and English languages

Moreover, there are always requests by teachers, therapists, and other researchers in the field for symbols not available in other languages, i.e., English, Islamic and culture-related symbols. Non-symbolic, as well as symbolic forms of communication, are culturally dependent. Hence, it is essential to customize AAC resources to meet the Arabic characteristic rubric written system and to address the presence of diglossia and the absence of culturally appropriate vocabulary.

3. 3D Pictograms and Augmented Reality

AR-based apps are used to enhance engagement, motivation, and learning for people with ASD. AR overlays, like 3D videos, figures, and information, can be added to anything and multiple studies have shown that these AR experiences result in increased engagement, enjoyment, motivation, and attention. The study (Yakubova et al., 2021) designed to teach object discrimination revealed a 62% increase in on-task participation and happier, more determined students. A new Google Glass-based AR and artificial-intelligence app motivates and rewards users for social and cognitive learning.

Figure 2.Brain Power using AR to help those with autism to better connect to the world around them. Credit: Rob Michaelson (https://spellboundar.com/)

Researchers used an AR system with foam blocks and a TV screen that acted as a mirror in order to facilitate pretend play. The foam blocks transformed into a 3D car, train, or airplane on the screen and the kids could see themselves playing with the items as toys. Results showed a significant increase in imaginative play frequency and duration with the AR scenario, and a video analysis revealed the children engaged in over 50% more pretend play scenarios per minute than without.

Figure 3. The AR system designed by Zhen Bai to help children with pretend play. Photo: Graphics & Interaction Group/University of Cambridge Computer Laboratory

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.

Figure 4. An example of a 3D Tawasol Symbol from different angles

4. Conclusion

AR allows for interaction with the real world which makes it easier to generalize real-life situations through digital content. The immersive, visual nature of AR capitalizes on a strength largely held by people with ASD and produces more curiosity and engagement. Introducing new technology can also be highly motivating, creating a more in-depth learning experience. In addition, AR can be easily adapted to supplement evidence-based practices, such as picture prompting and video modeling, that are currently being used by clinicians.

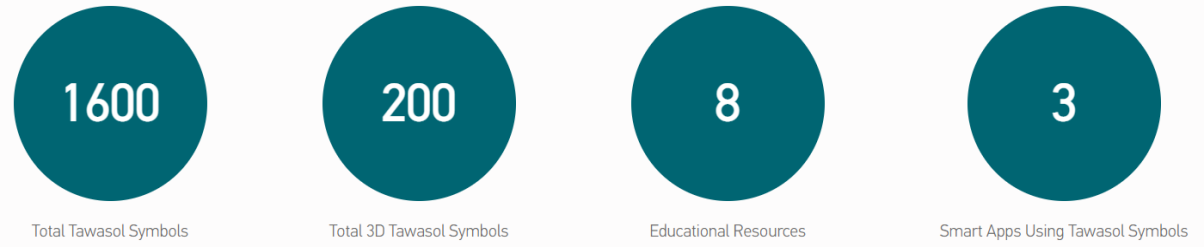

Figure 5.Stats of the Tawasol Symbol Project

The Tawasol Symbols project developed and localized 1600 symbols and 200 3D symbols, however, there are still areas of improvement such and the knowledge around users' priorities and core and fringe vocabulary. More research is encouraged to develop Arabic symbols and to investigate suitable interactive technology devices that use AAC in a bilingual setting. This project opens the door for research opportunities to cultivate a more effective localized and personalized communication system.

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Improving communication for children with ASD using AAC

Soojin Jang
Mada Center

1. Introduction

Autism spectrum disorder (ASD) is a complex developmental condition that involves persistent challenges in social interaction, speech and nonverbal communication, and restricted/repetitive behaviors. The effects of ASD and the severity of symptoms are different in each person. Autism differs from person to person in severity and combinations of symptoms. There is a great range of abilities and characteristics of children with autism spectrum disorder — no two children appear or behave the same way. Symptoms can range from mild to severe and often change over time (Frith et al., 2005 ; Lord et al., 2018).

The present article will present an overview of communication tools from low high technologies that can support the person with ASD with the focus on the project Tawasol Symbols (Tawasol Symbols, 2019; Othman et al., 2021) that provide a localized encyclopedia to reduce social interaction and communication problems improve the restricted and repetitive patterns of behaviors, interests, or activities.

2. Low tech AAC

Low tech Augmentative and alternative communication (AAC) system is simple and easy way to create for a person with ASD yet can be an effective communication means. For example, simple communication board can be created by real photos of family members and places the child likes and the board may be ready to use. Some examples of low-tech communication system include object choice board, visual scene display, topic board, activity board, story board, and communication book. If the child understands simple vocabulary and languages, low-tech communication boards might be a good start. Moreover, this low tech can be a backup option when the high tech AAC is not

working and the environment is not suitable for the use of high tech AAC (i.e., swimming pool or playground).

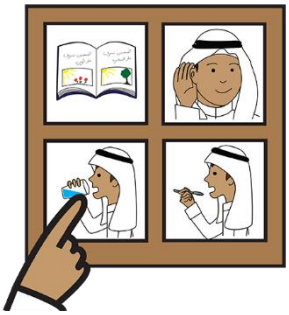

Figure1. Communication symbols from Tawasol Symbols Project

While the simple communication system does not provide auditory feedback, simple speech generating devices (SGDs) provide voice to an autistic child. Having the voice may offer more motivation to learn the communication system for some children with ASD. They range from devices that speak a single message to devices with multiple cells or message options. Usually, simple SGDs are battery operated and use digitized or recorded speech. They are also simple to program with function to customize messages. This can be a good option if the child is in the language development stage and is learning and recognizing the meaning and sounds of the letters, words or phrases. So the child also can develop language and literacy skills. Some examples of simple SGDs are BIGmack, iTalk, Step-by-Step, QuickTalker, and GoTalk.

3. High tech AAC

High-tech AAC devices with a dynamic display are more sophisticated and are similar to tablet computer with touchscreen, requiring a child's ability to navigate the multiple pages of the screen and produce the corresponded messages. Depending on the child's language, cognitive, physical, and visual ability, the overlay (screen) of the high-tech AAC can be programmed with symbols only, symbols with texts, or only texts, as well as numbers of cells on the screen. Also, the screen can range from very simple displays to extremely complex ones to support the child's ability level from emerging communicator to advance. However, high tech AAC are designated, and specialized devices and the cost of the devices may be one of the considerations for the decision-

making process. Some examples of high tech AAC are Tobii Dynabox I-series, Prentke Romich's Accent series, and Satillo's Nova Chats.

Figure 2. Tawasol AAC App (Source: https://mip.qa/solution/tawasol-aac-app/)

One of the localized solutions and supported by Mada Innovation Program is the mobile app "Tawasol AAC App" (Elsheikh et al., 2019). The app gives people with communication difficulties and children with autism spectrum disorder (ASD) the ability to express themselves and build sentences in Arabic through a wide range of symbols. The app allows users to add symbols and vocabulary as they need, making it ideal for a wide range of people with disabilities, including adults such as trauma victims and those who temporarily need a communication tool. This application supports the use of alternative buttons and other access tools for mobile devices, making it easy to use for people with severe physical disabilities to communicate with their family members.

4. Conclusion

As general technology is more accessible to people with disabilities, innovative technologies are available to support the AAC capabilities such as AAC apps on the tablets and computers. This means that those innovative technologies are equipped as AAC devices and can also be used for multi-purposes such as internet navigation, emails, and entertainment. The innovative AAC are cheaper options compared to the specialized high tech AAC as a wide range of apps are available for both free (i.e., GoTalk Now, ChatterBoards AAC, and Bridge Communicate Lite) and affordable such as CoughDrop and LAMP Words for Life.

Although AAC can play a vital role for children with ASD to be effective communicators, having good implementation planning and strategies may directly impact for the success of AAC. Here are some strategies for successful AAC implementation. Firstly, the communication partners should be well trained on how to model of the use of AAC to the child. For example, if you chose the single SGD, start using the SGD to speak with the child. Secondly, once you have shown the child how it works, offer the AAC to the child. So children with ASD have the opportunity to access the same AAC when they are communicating. Thirdly, help the child with appropriate prompts (i.e., physically hand over to the AAC or verbally prompting to use the AAC) when needed. The prompts should be provided consistently (i.e., having the adequate waiting time to respond) and systemically, following the hierarchy of the prompts (physical to visual). Once the child is ok to use it more independently, make sure the prompt is gradually faded out to encourage the child to independently use the AAC. Lastly, once the child masters a word using the AAC, provide and teach new words.

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A Learn App: Mobile augmented reality vocabulary learning application

Supported through Mada Innovation Program

Dena Al-Thani[1], Achraf Othman[2], Al-Dana Mohannadi[2]
[1]Hamad Bin Khalifa University
[2]Mada Center

1. Introduction

In cooperation with its strategic partners, Mada Center works to identify the needs of persons with disabilities for assistive technology and digital access solutions in Arabic. The center has supported start-ups and entrepreneurs to localize technological devices and solutions through the Mada Innovation Program, with the aim of improving digital accessibility for PWDs at the local, regional and international levels. This year, Mada and HBKU worked together to develop a mobile app using augmented reality technology and for the first time three dimensional AAC Symbols for learning purpose. The app is named A-Learn developed by Dr. Kamran Khowaja, Dr. Dena Al-Thani, and Dr. Siti Salwah Salim from Hamad Bin Khalifa University.

2. Ideation

The idea of Al-Learn is to transform the learning of vocabulary through mobile augmented reality. The advantage of using mobile augmented reality is its ubiquity i.e., learning anything supported through an app, anytime, anywhere. The use of mobile augmented reality is expected to dominate the market by 2022 in comparison to virtual reality. A-Learn allows children to learn letters and vocabulary through augmented reality 3D objects.

3. Mada's Support

The 3D models, influenced by Tawasol symbols (Tawasol Symbols, 2018), are specially designed for children with autism by a team of experts in special education, language and speech therapy, and human-computer interaction. To the best of our knowledge, the A-Learn would be the first of its kind for the research community as well as the children with ASD in Qatar, their caregivers, and teachers. This would allow them to become an independent individual and live a better life. The app would support English and Arabic languages.

Each child with ASD is different; it is possible that if one technology-based solution works for one child, it may not work for another child. Therefore, the researchers have started to use different technologies in the interventions for children with ASD to identify the best possible technologies that suites an individual with ASD. Furthermore, the buying cost of each technology may vary drastically; thus evidence-based research on the use of technology can be useful for the parents, caregivers, school, centre among others to decide based on their need and availability of the budget to buy the required quantity of the technology.

4. 3D AAC Pictograms from Tawasol Symbols

Mada provided the 3D Tawasol Symbols for the A-Learn application under the direct grant stream of the Mada Innovation Program (Al-Thani et al., 2019). Tawasol Symbols is a bilingual Arabic / English symbol dictionary of frequently used words in spoken and written communication (in Arabic) represented by images and pictograms . It is a freely available symbol. Symbols are verbal or visual representations of concepts and ideas.

Augmented and Alternative Communication (AAC) methods use visual symbols in the form of graphics such as a picture or object as a tool in A-Learn. When choosing a symbol system, the iconicity of the symbols needs to be considered. Iconicity is the amount that a visual symbol relates to its referent. In other words, it's how much the symbol resembles the intended message in the A-learn application. Iteratively develop and evaluate a mix-reality online interactive learning platform.

5. A-Learn App

A-Learn is an educational augmented reality game. You can use the game to scan letter

cards to show the letters in an augmented reality environment, then you can combine these letters to form words and display 3D representations of these words and interact with them.

Figure 1. QR Code to download the app A-Learn

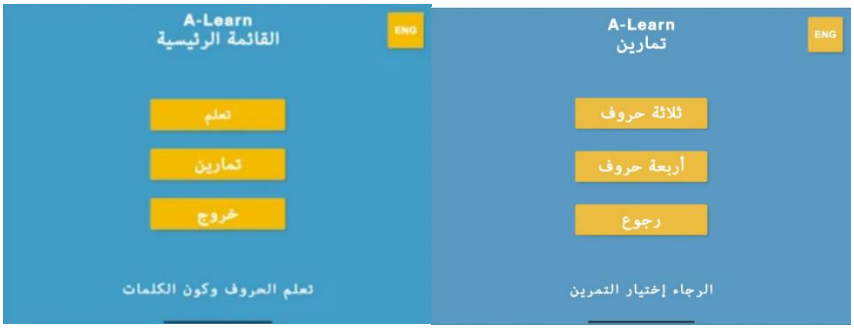

Figure 2. Some UI From the App

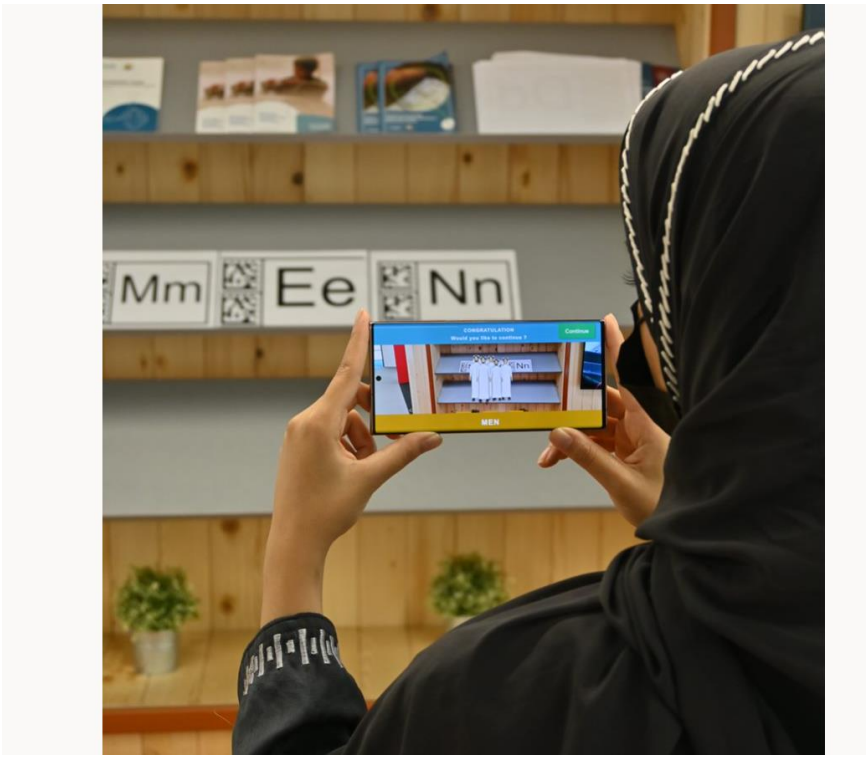

Figure 3. AR Technology displaying a 3D Tawsol Symbol through the app A-Learn

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