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Survey on Communication Methods of Sensory Disabled Persons

[1]Seetharaman K.S, [2]Avenash P, [3]Barath Raj J, [4]Ajay A
[1]Assistant Professor (Guide), [2]Student, [3]Student, [4]Student
[1]Department of Information Technology,
[1]Sri Manakula Vinayagar Engineering College, Madagadipet, Puducherry, India.

Abstract: Human communication is grounded in cooperative and shared intentions. For a normal human it may need a little effort to speak or listen, with another human. But people having sensory issues like blindness, dumbness or deafness will require a helping hand, device or technology to lead their communication with others. There is a spread of techniques and methods of communication support, and there's no standard way of communicating. Communication approaches are likely to vary supported whether an individual has pre-lingual or post-lingual deafblindness, which impairment developed first, and therefore the level of residual hearing or sight. In this survey, different approaches and techniques that exist in Deafblind communication technology from various stakeholder's perspective are presented. Moreover, the survey has been carried out towards the most optimal technique that can be given for any type sensory disabled person with respect to their vision, hearing and speaking abilities. The issues in these techniques were also reported here.

Index Terms **– abilities, blind, communication, deaf, deafblind, dumb, sensory disabled, technology.**

1. INTRODUCTION

On a day to day person, no matter who they're or where they are available from, all participate in interpersonal communication. Often, we are unaware of us participation in an interpersonal communication interaction because these actions have become such an ingrained part of our daily lives. Even though we are being an expert in interpersonal communication, at some point we might experience a difficulty or disturbance during communication with others and that may also lead to end that communication. Now think of people with sensory disabilities, how will they communicate with each other, share their thoughts or ask for their needs. Deafblindness is that the combination of serious auditory and visual impairments during a person. These dual sensory losses vary in severity from person to person and don't necessarily cause total deafness and/or total blindness. It is entirely possible that the person will retain some useful vision and hearing. However, together, these impairments of the distant senses cause serious developmental delays within the child, affecting cognitive development, social development, acquisition of communication and language skills, orientation and mobility. A combination of visual and hearing impairment causes such severe developmental, communication and learning need that the person cannot be educated in special education programs meant for the hearing impaired, for the visually impaired or for severe disabilities. Supplementary assistance would be required to address their unique educational needs consequential to the concurrent impairments of vision and hearing.

A wide range of communication methods exist, including:

- Tactile interpreting (i.e. tactile signing to at least one person with deafblindness) or finger spelling of the finger alphabet
- Close vision interpreting (i.e. visual signing within close proximity to an individual with deafblindness) or visual frame interpreting (i.e. visual signing to quite one person with deafblindness).
- Clear speech interpreting (with or without hearing aids) or speech-to-text interpreting (with certain adaptions and with or without technical equipment, such as a computers, large screens and braille displays).

Depending on the person and therefore the situation, anybody and/or combination of methods could also be required. Furthermore, communication strategies may change over time, particularly if the individual experiences changes within the severity of their hearing and/or visual impairments. Persons with deafblindness can also use assistive technology to support communication. Examples of assistive products include braille displays and writers, hearing aids and loops, and glasses and/or magnifiers. However, it's important to recollect that such assistive products won't meet every individual's needs altogether circumstances, which support could also be required in other areas, such as that provided by an interpreter-guide.

2. LITERATURE SURVEY

Representing between 0.2% to twenty of the population, persons with deafblindness are a really diverse yet hidden group and are, overall, more likely to be poor and unemployed, and with lower educational outcomes. Because deafblindness is less well-known and often misunderstood, people struggle in their communication, to obtain the right support, and are often excluded from both development and disability programmes [1]. There are several technologies both in hardware and software to help these people to get involved in communication and to uplift them in their educational understandings. Teaching and Understanding is the main problem when educating those people with these technologies. The following techniques or approaches helps only a particular type of disability, for example only for blind, or only for deaf people. A good system has to help any kind of disabilities that a person has, where each type of disability is a separate research topic. Therefore, depending upon the disabilities of the person, Communication can be classified into two categories: Physical communication and communication through Assistive device. The following discussion sheds some light on the technology in each category and attempts to give an idea of some of the benefits and drawbacks of the schemes mentioned therein a given schema.

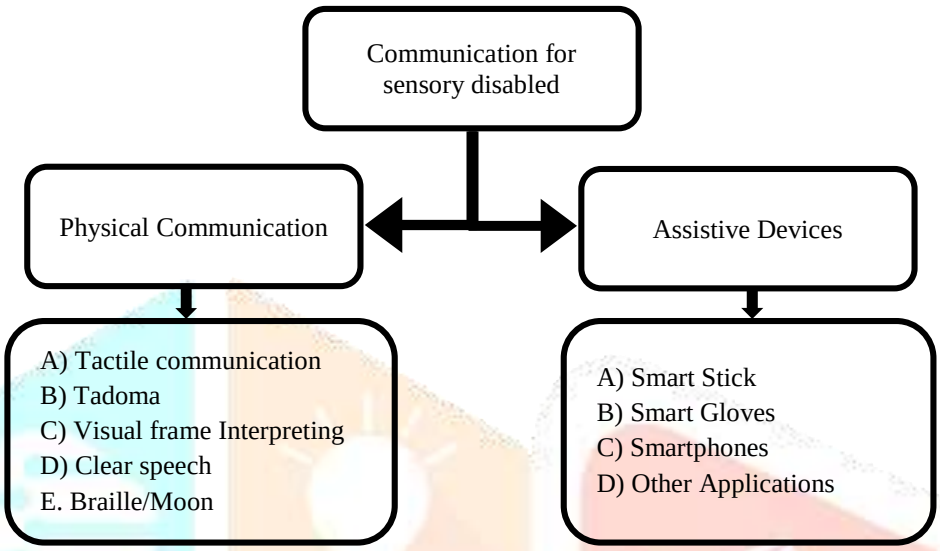

figure 2.1: classification of communication methods

2.1. PHYSICAL COMMUNICATION

Physical communication is the most common, easy and traditional method of communication for sensory disabled people. Here people use their body posture, hands movements, finger gestures and face reactions to share their thoughts and fulfil their necessity. At most of the time these types of people have a professional, who provides communication and mobility support, including guiding and description, which is adapted to the needs of the person. Proper and appropriate communication methods are used at any given time and occasion.

2.1.1. Tactile Communication

- **Tactile sign language**: a common means of communication used by persons with deafblindness. Signs are primarily indicated within the palm of the hand.
- **Tactile fingerspelling**: a variation of tactile sign language using finger-based signs that follow a specific pattern

figure 2.2: sign language using finger spelling

- **Tactile alphabet:** communication based on spelling words, letter by letter, and indicating block letters in the palm of the hand of the individual.

figure 2.3: finger strokes in the palm of hand

2.1.2. Tadoma

Communication through jaw movements, vibrations and the facial expressions of the speaker, achieved by placing a thumb on the speaker's lips and the remaining fingers along the face and neck.

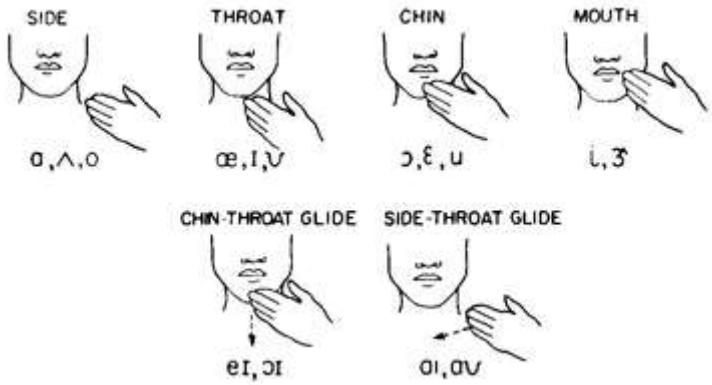

figure 2.4: communication using jaw movements

2.1.3. Visual frame interpreting

Sign language that is adapted to fit a limited field of vision with a person who has some degree of residual sight. Signs are made in a more confined space or box, at upper chest level and between the interpreter's shoulders. The distance from the user depends on the user's preference.

2.1.4. Clear Speech

Clear Speech may be a technique of speaking during which the speaker attempts to precise every word and sentence during a precise, accurate, and fully formed manner. It is not loud, monotone, artificial or exaggerated. An effective and commonly used method of communication for people who have some degree of residual hearing.

2.1.5. Braille / Moon

- **Braille** is a system that uses a series of raised dots (six in two columns of three) to represent letters or groups of letters. Usually these dots are printed and a paper using a special device called Braille device and the user is allowed touch and feel the dots to decrypt the message in it.

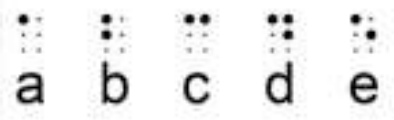

figure 2.5: braille dots

- **Moon** is a tactile alphabet of raised lines and curves that people read by feeling with their fingertips. **Moon** characters are fairly large and many characters have a strong resemblance to their print equivalent.

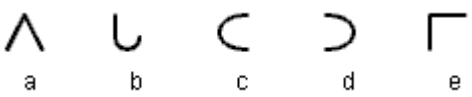

figure 2.6: moon letters

Advantages and Disadvantages

As far as the Physical communication is concerned, we might not depict any disadvantages since they are the basic communication methods, done by a human and it is based on how the user understands those methods. Each and every method has its own advantage by helping at least any one type of disability. In speech, the perception is accomplished with hearing and therefore the reproduction with speaking organs. In sign language perception is haptic in the case of a deafblind person but these people might have issues in both organs therefore teaching these physical communications to them who cannot understand it will be the biggest challenge here. The only disadvantage that can be encountered in this communication is, if a sensory disabled person is also a physically challenged, then these methods cannot help them in any circumstances. Hence using the modern technologies some assistive devices that works based on the software embedded in it will help the sensory disabled persons to overcome their problems in an efficient way.

2.2. ASSISTIVE DEVICES

2.2.1. Smart Stick

Ayat Nada and **Samia Mashelly** [3] have designed a stick in the name Smart Stick to help the visually challenged people in a walking environment. This smart stick contains many devices such as Infrared Sensor, Ultrasonic Sensor, Electronic Travel Aids (ETAs), Audio transmitter, Vibration motor etc. With all these devices attached to a single stick they propose a solution that the stick can identify the environment for obstacles, upward and downward stairs, water ground and other objects in front of that smart stick. The infrared sensors are used to identify the smaller objects in the environment and the ultrasonic sensor is used to detect the closest object or obstacle near the stick. These entities are then converted into speech using ISD 1932 breakout board and the corresponding alert message is spoken loudly or transmitted to the earphones via Bluetooth or any other wireless technology. The Vibration motor is set inside the handle, whenever an obstacle is identified a vibration is made so that the user can be alerted through their hands.

Advantages and Disadvantages

The main advantage of the system is that it helps the blind people in both indoor and outdoor, care-free navigation. The device is placed in the stick makes it comfortable and easy to handle. The smart stick helps in detecting obstacles placed at a distance ahead of the user. The system is suitable for both indoor or outdoor environment. The information regarding the obstacle is given through the voice alerts, eliminates the understanding difficulty of vibrations

The main disadvantage of this system is that it helps only blind people. If a person is deaf-blind then he/she might not hear the voice alerts of the obstacles or even if the speech device fails, though the vibration alert cannot be understood immediately to move further. It may detect water grounds but it is not resistant to water, if exposed to rain or fallen into a water ground it may affect the electrical devices used inside it and cause malfunction. Eventually the devices used inside the stick cannot be assured to function as the same way every time. And lastly the stick may be portable but it should always be kept in hand or kept aside for easy access, it cannot be folded or shrunk to make it always handy.

2.2.2. Smart Gloves

Oliver Ozioko and **Marion Hersh** [5] research resulted in the development of two components, a pair of wearable gloves and a hand held display device with a keypad. The two-way communication gloves were worn by the deaf-blind person and the handheld device will be used by the normal person who support them or their family. Users can send messages using the 14 pairs of pressure sensors embedded in the glove and receive them by means of vibration on the palm. The two components are linked by Bluetooth and therefore the use of Bluetooth to speak with computers, mobile phones and other Bluetooth enabled devices. The gloves will sense the actions, gestures and pressure given by the user and transmits the signal to the hand held device through wirelessly which will display the decoded message on the screen or voiced [6]. Now in turn if the opposite user types a message using the keypad and send it to the user wearing glove, the message will be converted into vibration by using braille code pattern and passed to the user palm and fingers. These Vibration patterns are understood by those people.

Advantages and Disadvantages

This method can help both deaf and blind people which is overcome of the previous method's drawback. The Gloves are lightweight and easy to wear. The message given by the disabled person can be understood very clearly either by text or audio output. Since the users are deaf and blind vibrations are the only input they can get and feel, hence the usage of braille code vibration pattern is a very good advantage for this system.

The main purpose of the gloves is to make communication, therefore handling or holding any objects using these gloves is not possible. If attempted then the pressure sensors will transmit the corresponding signal which is not a message. Hence the user cannot wear it all the time, but only at times when he/she want to communicate something to someone having the handheld device. A separate device for receiving the message is needed for this system which make it more uncomfortable. It may be designed as an android application for better usage. The gloves are not water resistant, sweat may damage the vibrator motor or other sensors to malfunction.

2.2.3. Smartphones

Over the past decade, smartphones have revolutionized our lives in ways that go well beyond how we communicate. Besides calling, texting, and emailing, more than two billion people around the world now use these devices to navigate, to book cab rides, to compare product reviews and prices, to follow the news, to watch movies, to listen to music, to play video games, to memorialize vacations, and, not least of all, to participate in social media. There are apps available for smartphone users to monitor how much they're walking during the day and how well they're sleeping at night. New applications of the technology emerge seemingly daily: Our smartphone can now help the sensory disabled people i.e.) the people who doesn't even know what or how a smartphone look like can use it in order to communicate with the rest of others in the world. The following are some smartphone-based methods that helps in deaf blind communication.

2.2.3.1. Voisee Communicator

It is an android based messaging application proposed by Junar Arciete Landicho that helps in establishing a communication between two disabled persons especially a person with hearing issue and a visually challenged or between a normal person and disabled person [7]. It is a simple application that converts text input into speech output and vice versa using Java's Text to Speech and Speech Recognition APIs. If the user is deaf and not blind then he/she can use the text input and send message to any other users. If the receiver is a normal person then he can choose between any of these two outputs or if the receiver is a blind then the message will be in the form of speech or text if the user in deaf. The reverse is the also the same process if the user gives a speech input, the speech is converted into text and then sent to the respective receiver.

Advantages and Disadvantages

This is considered to be the modern and efficient solution for the communication of deaf and blind people with the normal ones and vice versa. All is needed a smartphone with this application installed in it and we are good to go. The application works on almost all type of android smartphones hence it is easy to afford. Smartphones are portable, small, lightweight and handy, therefore can be used at anytime and anywhere. The initial setup of the application might need a third person's (family member or the person who is with the disabled) help which may not state as a contrast, because it is the sole way this will be done. Then as usual this application cannot be used by a person have two disabilities, but only blind or only deaf.

2.2.3.2. Instant Messenger using Morse Code

Teemu Leppänen, Yoshito Tobe and **Jukka Riekki** [8] has proposed a method that partially overcomes the drawbacks of the Voisee communicator. This is also an android application that uses touch and vibrations in the form of Morse code (a standardized sequence of two symbols called Dots [.] and Dashes [-], it is named for Samuel Morse, the inventor of the telegraph) [9]. This application uses Bluetooth technology for instant messaging. Assume that the sender and receiver is trained in Morse code language, now the sender can enter the Morse code sequence for the message they want to share, a tap to enter a dot and a long press to enter a dash [10]. The app sends the Morse code as vibrations to the receiver. The receiver receives a short vibration for each dot and a long vibration for each dash in the sequence.

Advantages and Disadvantages

This application has proposed a new way of communication through vibrations in the form of Morse code language. The app plays a fantastic role in the communication of deaf-blind but it is not so much recommended to a user who has any one of the disabilities until he/she is well versed in Morse Code language. The same way it needs a helping hand for the initial setup of the application. And the Main disadvantage of this system is that the usage of Bluetooth technology, because the range of Bluetooth is very small so we cannot communicate with the persons at a farther distance and a person who doesn't know about Morse code cannot use this app at any limits.

2.2.4. Other Applications

Be my eyes [13], **Tap to see** [14] are some of the smartphone applications that are designed especially for the Visually impaired people. These apps use the smartphone Camera to identify the real-world objects and tells the user what it is through the headphones attached to the user's ears. **Google's Live Transcribe, AVA** are the applications that picks up spoken text by a phone microphone and delivered to an android phone screen using WIFI or another network connection. This can be useful for people who have hearing problem and attending conferences or lectures, for example. The words spoken will appear on the phone of the one that has the app. But only a few applications are developed for the people who cannot speak to detect hand gestures and convert them into words, since they can express their feeling through their actions or directly through text. Hence these are the existing methods that plays a major role in deaf, blind, dumb communication with their pros and cons stated. The following table shows the overall comparison of all the methods enlisted in this survey.

3. USAGE COMPARISION

table 3.1: comparison based on the users of the surveyed methods

Methods	Technique Used	Users				
		Blind	Deaf	Dumb	Normal	Deaf-Blind
Tactical communication	▪ Finger signs ▪ Hand gestures	✓	✓	✓		✓
Tadoma	▪ Jaw movements ▪ Facial expression	✓	✓	✓		✓
Visual Frame Interpreting	▪ Limited bound hand gesture		✓	✓		
Clear speech	▪ Proper pronunciation of words ▪ Loud volume	✓		✓		
Braille/Moon	▪ touch and feel the braille/moon code printed on a paper	✓	✓	✓		✓
Smart Stick	▪ Walking stick with obstacle detecting sensors ▪ Speech output	✓		✓		
Smart Gloves	▪ A pair of gloves with vibration motors to detect the hand gesture and finger pressure ▪ A display device to decode and send a message	✓	✓	✓	✓	✓
Voisee Communicator	▪ Converts text into speech ▪ Converts speech into text	✓	✓	✓	✓	
Instant messenger using Morse code	▪ Morse code input using Touch and tap ▪ Vibrational output	✓	✓	✓		✓
Be my eyes Tap to see	• Uses video call with a helping volunteer to know about the environment.	✓			✓	

4. CONCLUSION

Each and every approach depicted above are considered to be the best for the type of disability they have been proposed. There are many other methods and technologies that are being used around the world. Since smartphones are the current trending technology with all the features used in this survey. A smartphone contains inbuilt camera, vibration motors, proximity sensors, IR sensors, Gyrometric sensors, pressure sensors etc., which makes it way better device to use all these approaches in it. Already there are plenty of apps available for smartphones to help these types of people. But for a person with more than one disability it gets difficult to find a solution at once. The best approach is said to be that, it should be usable by all type of users' despite of what disability they have or not. Based on this survey made with all these approaches smart gloves, Voisee communicator and Instant messenger are satisfying the best approach limits, but since smart gloves has many drawbacks and it is still not a fully implemented approach, we concluded that by combining Voisee communicator and Instant messenger may result in a better solution for any type of disabled person.

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