

ROBOTIC COMMUNICATIVE TOOL' in Speech and Hearing: A review

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Abstract: In the era of digital world, the technology has been advanced in most of the medical sciences. However, with respect to the field of Speech and hearing sciences there is dearth of research and literature review on 'Robotics' for rehabilitation in Indian context. This article aims to review the existing literature available regarding 'Robotic therapeutic implications' for those with communication disorder. There is also great inproportionate between the client who require therapy for communication problems with that of those with speech therapist and Audiologist. Hence, there is a need to look into the possible changes that could be explored to bridge the gap with 'Robotic technology' in the field of speech and hearing.

Keywords: Robot, Speech therapist, Audiologist, rehabilitation

I. INTRODUCTION

The technological innovation into the field of Robotics has been researched over a period of decades [1]. The robotics is the stepping stone in the medical sciences with respect to therapeutics. The clinical use of interactive robots is a challenging development in communication disorder. A communication disorder is any disorder that affects an individual's ability to comprehend, apply language and speech to engage in conversation effectually with others. The delays and disorders can range from simple sound substitution to the inability to understand or use one's native language. Communication occurs normally through speech. Our articulatory and vocal tract plays an important role for communication. The communication breakdown occurs who have communication disorder like hearing impaired, delayed speech and language, Stuttering, dysarthria, aphasia, misarticulation, autism, cerebral palsy, mental retardation and so on. Medical treatment is of very limited use for those individuals with communication disorder. However, therapeutic rehabilitative options are widely available which are provided by Speech therapist (ST) and an Audiologist [2, 3, 4, 5]. But there are varies evidence based researches which provides clear views about the problems and limitation with these therapeutics approaches. Some of the limitation in the training could be that, a patient is not able to observe his own vocal tract, nor the complex articulations of vocal organs in the mouth, not able to recognize the validity of his articulation and evaluate the achievement of speech training. With regard to children who undergo speech training at school it is not easy to continue the training during vacation and they forget the skill. The most serious problem is that the number of ST is not enough to give speech training to all the individuals with communication impairment [6]. However, the research has lead a path to robotic as a new training system for children with communication problem to make an interactive training and learning of speech articulation. Ricks & Colton [7] reported that non-humanoid robot might be effective, but not emphasized the ways to integrate the robot into therapy sessions. Hence in this review article, we focus on research that has been done with robotics and therapeutics for individuals with communication disorder as well if any available literature input for the ease of training student trainees in the field of speech and hearing.

Speech and listening training by speech Therapist and Audiologist:

Currently, speech and listening training for individuals with communication disorder are provided by speech therapists. Specially and specifically designed training programs to each client are provided by carefully examining the symptoms of impairment. In India, at All India Institute of Speech and Hearing, Mysuru there are about 8101 individuals with auditory and speech related problems who were reported for therapy between 2016 -17. Patients with only speech related problem were about 1401 and with just articulation disorder were about 368. However, 3150 clients are provided with auditory, speech and language training who have hearing impairment. Therapies given to communication disordered patients are very intense and continue. They are provided with 5000 sessions per month approximately by the students and therapist as AIISH

being an institute developing human resource and then imparting clinical services to the needy. Each therapy last for 45 minutes per session. On the contrary, the number of ST is approximately 600, which is far less than the number of the clients. Conventionally the training by a ST is conducted face-to-face by using a mirror to show the articulatory motions of inner mouth for those with speech disorders and listening emphasized training and techniques are taught for those with hearing disorders. However, there is disproportion between the number of sessions and the ST and audiologist available. Hence there is a need to review the literature any other innovation methods that are available to fill in the gap to ease the therapeutic procedure and for the student trainees to learn.

II. PURPOSE OF THE STUDY

The purpose of this study was to critically review the existing literature on the clinical and therapeutic uses of robots for individuals with articulation disorder and also on possible literature available for student trainees in the field of speech and hearing. We focused our review on articles that were published in either peer-reviewed journals or peer-reviewed, published conference proceedings that offered sufficient diagnostic information and clinical outcome data to evaluate the technique. We highlighted important methodological characteristics of therapeutic studies involving participants with ASD, stroke and hearing impaired. The aim of our review article was to understand the current status of empirically-based evidence for this experimental therapeutic technique, which can be of optimal use for the disordered population as well for the student trainees with the innovative technology.

III. METHOD

Various databases, such as PubMed, Google, Google Scholar and Medline, were searched for references related to how robot help in rehabilitation and as a therapeutic tool in medical sciences from 2000 to 2016.

Roadmap of review

1. Robots in Autism spectrum disorder
2. Robots in patients with stroke
3. Robots in hearing impairment
4. Clinical implication

1. Robots in Autism spectrum disorder:

The vision of making robotics [8] to be accessible to all groups, as well as providing tools and materials in developing the scientific temperament in school level is another approach for technological advancement in education. To make robot programming exercises with solutions readily accessible to all students is not economical. This could definitely enhance the knowledge on technology and its applications. Hence when used by the disabled population will not be deprived of the technological advancement in India.

2. Robots in patients with stroke:

Robotic rehabilitation is widely spreading all over the world in the field of motor disorder caused by stroke or spinal cord disease. As the efficacy in implementing Robotics in the field of rehabilitation opens door for many other diversified field of medical sciences, depending on the type of participants or population it could be implemented. Work by [9] emphasizes only on motor and stroke patients as his interest of implementation of Robotics the latest technology advent. Research data in the field is still being worked on and very few well organized comprehensive reviews of robot as assistive therapy should be explored. This gives us an opportunity to use Robotics in the field of speech and hearing as a rehabilitation tool for future.

A review article post stroke patient's rehabilitation for both upper and lower limbs by [10] emphasizes on the usage of Robotics for a long duration span of time for therapy for post stroke patients. Robotics approach gave both kinematics & dynamic parameters during the motion of patient's limbs. The hardware should be different for different prospective of study. The review results give a positive comment on the robotics as therapeutic tool to assist people using ADL's. Once the task is achieved by the participant the therapy can be discontinued. Robots can be used as a tool and not as a replacement for the therapist and manual ability of operators.

3. Robots in hearing impairment

Training the hearing impaired using robotic approach [8] to articulate the words with the use of robot on self organizing map (SOM). With vocal organ and nasal cavity a two dimensional approach mapping of action to a system was considered. Sound of Japanese language was on focus. This mainly focused on auditory impairment. The Robotic machines designed failed to mimic the real human structure. Hence understanding on which part of mouth participated during articulation becomes tedious for the participants to understand. This approach has laid a challenging platform in articulation for hearing impairment to not only generates sound but also mimic human. This will increase the understanding of speech clearly.

Robot used for speaker identification by in helping the especially able population to use customized system for his/her needs. This system is designed only for limited number of commands and orientation. To enable day to day activities on own this system needs to be more advanced and flexible. Robot thus helps needy population to rely on it for few task of importance. This can become a guide for the disable person both with motor or speech intelligently.

Talking robot for speech training system [12] was employed for individual with auditory impairment. The talking robot was also validated by training 19 children from deaf school. The results revealed that the talking robot is expected to intensively teach an auditory impaired the vocalization skill by directing the difference between clear speech and the speech with low clarity.

4. Clinical implication

Robotic head 'Ava' [13] which basically turns head towards the speaker to acknowledge the speech. This is implemented using two microphone placed in both the ears of the Robot that are sensitive to speech and motor are used for the movement of head horizontally towards the speaker. This work proposed which operates real time even in noisy environment. This shows how machines & humans could help in communicative attention that could be used for children who don't have eye contact during speech. Hence these implications show how the technological advancement helps in simple tasks which are complex for certain population.

Hearing robot [14] helps in identifying the location of source from where the signal is generated. This is accomplished by multisensor, multimode, multipurpose for interactive autonomous robot. This navigates in all direction without the necessary of illumination and less affected by obstacles on their way towards source. They perform well indoor but they are less suitable for noisy environment. They can be a guide in an office who can help a new comer to navigate throughout the office premises. Hence robot helps to find the way of the source.

IV. CONCLUSION

Reviewing these recent advances in technology of robotic implementation in the field of communication science, it is evident that there is definitely innovative therapeutic procedures that are widely available, which a speech therapist and audiologist can have a better clinical practices. Though these reviews provide an eye opener for Robotics, it is not available in Indian context. Hence, this article highlights the need for such an innovation recent robotic therapeutic advances in field of speech and hearing in India.

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