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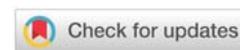
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Mini Review

Attention for the speech of cleft lip and palate in speaker recognition

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Abstract

Artificial Intelligence (AI) has become indispensable to all people, primarily for the purposes of speaker recognition, voice identification, educational purposes, workplace, and health care. Based on a speaker's voice characteristics, identification and recognition of the speaker is accomplished. The voice is affected by both intra- and interspeaker variability. In addition to this, a condition known as structural abnormalities can cause resonance, which can seriously affect voice quality. As a result, speakers may experience difficulties when using AI-based devices. The study aims to investigate the effects of speech with cleft lip and palate on speaker recognition. The review stated that even after surgery, some people with cleft lip and palate exhibit hypernasality and poor speech intelligibility depending on the severity of the cleft. The author discovered that artificial intelligence has been applied to surgical procedures. In children with corrected cleft lip and palate, acoustic analysis revealed poor benchmarking for speaker identification. The most prevalent type of hypernasality also affects speech intelligibility. Thus, more research on speaker recognition using different algorithms and hypernasality is essential. These can help speakers who have CLP to use AI freely and without any issues. Even with its flaws, people with CLP can still learn more about using AI.

Introduction

Cleft lip and palate are examples of craniofacial abnormalities, which are congenital structural deformities brought on by abnormal embryological development. Between the fourth and tenth weeks of the developing embryo or foetus, there is a break in the growth of the embryo, which causes cranial variations [1].

Cleft Lip and Palate are the most congenital craniofacial anomalies that show structural defects in the lip, alveolus, nasal floor, and palates (hard/soft). This occurs due to the lack of fusion of the frontonasal and maxillary processes and palatal shelves which shows cleft in hard/soft palates. These are due to the failure of the facial process of the development.

Orofacial clefts occur at varying rates depending on the demographic. Overall, Indians have reported greater rates (one in 500 births), while people with African ancestry have reported lower rates (one in 2,500 births [2]). The prevalence of isolated cleft palate is 2:1 more common in females than in boys. In contrast, the ratio of men to women who have cleft lips, whether they also have cleft palates, is 2:1 [3].

In the United States, cleft lip with or without cleft palate is the second most frequent birth abnormality, affecting one in every 940 births and leading to 4,437 instances per year [4]. An estimated prevalence of 7.75 to 10.63 per 10,000 live births has been reported [5].

The global prevalence of cleft lip [0.3 (95% CI:0.26-0.34)], cleft palate [0.33 (95% CI: 0.28 - 0.38)], and cleft lip and palate

[0.45 (95% CI: 0.38 - 0.52)] in every 1000 live births, based on the study [6].

Quality of speech depends on the severity of the cleft lip and palate. It also depends on the type of cleft involved. Usually, speech errors such as articulation, and hyper/hypo nasality, will be seen.

In the field of speaker recognition, it is also important to give attention to the cleft lip and palate population due to the increase of technology available in day-to-day life situations. Post-COVID life has become more inclined to virtual and depends on various identification devices at educational institutes, industries/companies, government access, banking systems, entertainment devices, etc. It is also necessary to improve the quality of life of an individual with cleft lip and palate.

According to the scoping review of a study, an attempt was made to pinpoint the many applications of artificial Intelligence (AI) for helping people with cleft lip and/or palate as well as their current state [7]. Artificial intelligence and cleft lip and/or palate were searched for in the Pubmed, Embase, and IEEE Xplore databases. The study was carried out in accordance with PRISMA- ScR Recommendations. 458 items from the initial search were filtered based on title and abstract. 26 publications were added after the screening, duplication removal, and full-text reading of a few papers. They investigated how AI could be used in cases of cleft lip and/or palate to help with diagnosis, treatment-particularly speech therapy-and prediction.

Speech characteristics

Due to pressure loss through the velopharyngeal port or when a youngster lowers their vocal pitch as a coping mechanism to lessen or mask hoarseness, nasal emission, or hypernasality [1].

According to a study, children with cleft lip or palate have articulation disorders (obligatory and compensatory errors) that impair their ability to understand speech [8]. Their survey confirms that in order to improve speech intelligibility in this population, speech therapy is required.

Quality of life with AI in CLP

AI model that can intelligently and consistently identify the anatomy of cleft lip and nasal deformity and automate the placement of nasolabial marks that can serve as a surgical design guide. We used the high-resolution net architecture, a recently developed family of convolutional neural networks-based deep learning architecture, to train an AI model that can recognise and identify the 21 anthropometric points associated with a cleft lip on images and videos of cleft lips. The cleft AI model was put to the test by measuring the Euclidean distance between anthropometric points that were manually indicated by a skilled cleft surgeon and those produced by our model. Each point's Normalized Mean Error (NME) was computed. The range of NME readings was 0.029 to 0.055. The cleft-side Crista Philtri inferior (*cphi*) NME was the largest. Cleft-side *alare* has the lowest NME value. These failures fell well within the bounds of accepted AI standards benchmarks [9].

After reviewing 44 publications, it was concluded that 12 of them stated that AI-enabled computerized programming software for precise landmark detection, rapid digital cephalometric analysis, clinical decision-making, and treatment prediction [10]. Machine learning can assist in identifying cephalometric predictors of the future need for orthognathic surgery in children who have had their unilateral cleft lip and palate corrected.

AI is used to improve the quality of life of an individual with CLP.

Studies on formants, other automatic methods

The obtained benchmark for SPID in children with CLP results showed that for vowel /i:/ it was 75%, this indicates a better benchmark and can be used for further SPID process. A 60% for vowel /a:/ where it states above chance level and 40% for vowel /u:/ which indicates poor benchmarking [11]. The above-said benchmarking was obtained in a small group that consisted of 5 speakers. There is no significant difference between vowels which could be due to anatomical and functional variations. They stated that the SPID is affected as the no. of speakers size increases.

Quality of speech affected

The ability to speak is an essential life skill, and any age can be impacted by cleft-related palatal, dental, and occlusal abnormalities. When velopharyngeal dysfunction is present in certain patients, speech prosthetics are a suitable treatment option that should be administered by a specialized multidisciplinary team [12].

Due to the overlapping or coarticulation and quality effect on the speech of CLP, there are chances of misperception of the voice. Further, it may impact on quality of life.

How speech recognition is important for children/adults

An individual's identity is important at any age and in the current situation, biometrics are essential even for children in school, assistive devices, apps/tools, mobiles, or computers. Voice is one of the biometrics which can be used in assistive devices.

How CLP affects speech recognition

Cleft Lip and Palate is a congenital anomaly where the structures are disturbed and can be rectified through surgeries. Due to the anatomical disturbances, the production of speech may also be affected and the quality of speech is affected due to the disturbance in the nasal quality. In most of the individuals voice of the cleft lip and palate will be hypernasality, where speaker identification can be difficult to identify a particular individual.

Opinion/focus on speech recognition aspects in patients with CLP

According to a study, the most effective tools for assessing hypernasal speech are Machine Learning (ML) algorithms [13].

In instances where machine learning algorithms can quickly and independently identify hypernasality in a manner that is consistent with professional speech–language pathologists and has a high concordance rate. ML algorithms can supplement speech–language pathologists’ gold standard and increase their reach. Long–term outcome monitoring holds significant potential for enhancing treatment outcomes.

Individuals with cleft lip and palate still exhibit a variety of speech problems and hypernasality despite receiving speech therapy and surgical correction. Speech intelligibility is also affected based on the severity of the cleft. These errors could result from the age of identification and management (surgical/speech therapy). AI is being used more and more in modern times, and speaker identification and recognition issues with CLP speech are still present. To enhance the quality of life for a person with CLP, it would therefore be preferable to focus more on speaker verification/identification and develop enhanced AI techniques.

Significance

Speech intelligibility is affected by structural abnormalities in a different condition called cleft lip and palate. AI usage is most common in the modern era. The current study made an attempt to clarify the applications of AI and the speech issues that CLP children face. Errors may endure for a lifetime. Some people may find it difficult to use AI devices because of their hypernasality, speech errors, and intelligibility issues. AI is currently utilized during surgical procedures. In contrast, in a small group of five children, only 75% of the children were able to identify the speaker based on the vowel /i:/. The current study also examined the possibility that people with abnormal speech patterns could have trouble using speaker recognition software.

Conclusion

Finally, since some people may not be successful or entirely satisfied with using AI devices for their purposes, there should be serious attention paid to cleft lip and palate when using these devices. To match their speech quality, further research should be conducted using different algorithms. Additionally, AI can be used in therapeutic management to enhance the speech quality of people who have cleft lip and palate.

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