**Detection of speech impairment in children using ML**

**PROJECT SYNOPSIS**

OF MAJOR PROJECT

**BACHELOR OF TECHNOLOGY**

## Computer Science and Engineering

SUBMITTED BY

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## **Introduction**

In the realm of pediatric healthcare, the ability to communicate effectively through speech is a fundamental milestone in a child's developmental journey. However, for a subset of children, this journey is marred by the challenges of speech impairments that cast shadows on their capacity to convey thoughts, feelings, and ideas. These speech disorders come in various forms, including articulation disorders, phonological disorders, and speech sound disorders, collectively presenting a complex array of communication hurdles.

Yet, within these challenges, an opportunity for transformation exists. This project embarks on a path toward change—a change that reimagines how we detect and address speech impairments in children. The "Comprehensive Speech Impairment Detection System for Children" is an ambitious endeavor that stands at the intersection of technology and pediatric speech pathology. It acknowledges the obstacles in the timely identification of speech impairments and seeks to pave a new road to early intervention.

At its core, this project recognizes the multifaceted nature of speech impairments in children, appreciating that each child's journey is unique. With this in mind, it aspires to offer a holistic solution that goes beyond conventional diagnostic techniques. Armed with cutting-edge machine learning models, including Convolutional Neural Networks (CNN) and deep learning, and embracing a multimodal approach that combines speech data with facial expressions and physiological measurements, the project aims to provide precise and diverse assessments.

The objective is clear: to create a diagnostic system that can detect a wide spectrum of speech impairments in children, regardless of their nature and severity. But this is not where the vision ends. It reaches further to offer tailored and data-driven recommendations for early intervention and treatment, recognizing that every child's path to communication success is unique.

For healthcare providers, speech therapists, educators, and, most importantly, the children themselves, this project symbolizes a beacon of hope. It is a promise of timely and effective support, an assurance of enhanced speech and communication outcomes, and a testament to the power of technology in improving the lives of the youngest among us.

As we embark on this journey, we carry with us the belief that through the fusion of innovation and compassion, we can illuminate the paths of children facing speech impairments, enabling them to express their voices, their stories, and their dreams.

**Rationale**

This project is rooted in the profound and pressing need to address the challenges faced by children with speech impairments. Effective communication is an essential milestone in a child's development, a gateway to understanding, expressing thoughts, and connecting with the world. For children grappling with speech impairments, this journey is fraught with obstacles, ranging from articulation difficulties to phonological complexities. Effective communication is a cornerstone of a child's development, influencing their ability to express thoughts, connect with others, and access educational opportunities. However, a significant number of children face speech challenges that impede this crucial journey. Early intervention is consistently recognized as a key factor in addressing speech impairments, improving communication outcomes, and enhancing a child's overall quality of life. Presently, diagnostic processes are marred by subjectivity and delays, hindering the timely support that children need. This project is driven by the belief that technology can bridge this gap, offering precise, data-driven assessments to identify a broad spectrum of speech impairments and facilitate early intervention.

This project stands as a testament to the commitment to improve the lives of children facing speech impairments. It acknowledges the urgency of early intervention, the complexities of speech disorders, and the potential of technology to create a brighter future for these children. Speech disorders manifest in various forms and may co-occur, necessitating a nuanced approach to assessment. By embracing advanced machine learning models and a multimodal approach, which integrates speech data with facial expressions and physiological measurements, the project aims to provide a holistic and accurate analysis of speech impairments. The pursuit of early identification, precise assessments, and tailored recommendations is not only a response to the immediate needs of children but also a long-term investment in their future. It not only unlocks their potential for effective communication but also serves as a beacon of hope for children and their families, promising a brighter and more inclusive future.

**Objective**

**Dataset Development:** Create a diverse and representative dataset of children's speech recordings, encompassing participants from various age groups and a wide spectrum of speech impairments. Ensure the dataset's quality and reliability through rigorous data collection and curation.

**Machine Learning Model Implementation**: Develop, train, and optimize advanced machine learning models, particularly Convolutional Neural Networks (CNN), to analyze speech data accurately. These models should be capable of detecting a comprehensive range of speech impairments in children.

**Diagnostic Assessment**: Create an automated diagnostic system that can analyze speech recordings and provide comprehensive assessments, including identifying the type, severity, and progress of speech impairments. Ensure that the system generates timely and relevant diagnostic reports.

**Early Intervention Recommendations:** Develop a data-driven framework that generates tailored recommendations for early intervention and treatment plans based on the specific speech impairments detected in each child. Ensure that recommendations are continuously updated based on real-time monitoring.

**User-Friendly Interface**: Design an intuitive and user-friendly interface for healthcare providers, speech therapists, and educators to facilitate the use of the diagnostic system and interpretation of results. The interface should also include real-time monitoring dashboards.

**Clinical Validation:** Conduct extensive validation and testing of the diagnostic system's effectiveness and reliability in a clinical setting. Use a diverse cohort of children and assess the real-time monitoring capabilities for dynamic adjustments in intervention plans.

**Expert Collaboration:** Collaborate with speech pathologists, pediatricians, and specialists in the field to ensure that the project aligns with best practices and standards in speech pathology. Gather expert feedback on real-time monitoring features.

**Literature Review**

Table-1: Literature review

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| --- | --- | --- | --- | --- | --- |
| *Sr. No.* | *Journals* | *Year* | *Techniques* | *Findings* | *Shortcomings* |
| 1. | Early Diagnosis of Speech Sound Disorders in Children | 2018 | Research Paper | This study highlights the significance of early diagnosis in improving the outcomes of speech sound disorders in children. Early intervention leads to better communication skills and overall development | The study does not address the potential use of machine learning and real-time monitoring. |
| 2. | Machine Learning Approaches for Speech Impairment Diagnosis in Children | 2019 | Research Paper | The study discusses the application of machine learning algorithms, such as CNN, in diagnosing speech impairments in children. These algorithms have shown promise in automating diagnosis. |  |
| 3. | Real-Time Monitoring of Speech Development in Children with Impairments" | 2021 | Research Paper | This paper emphasizes the importance of real-time monitoring in tracking speech development in children with impairments. It highlights that dynamic adjustments to intervention plans are crucial for improved outcomes | While discussing real-time monitoring, the paper may not thoroughly address the technical challenges and ethical considerations related to continuous data collection. |
| 4. | Speech-Language Impairment: How to Identify the Most Common and Least Diagnosed Disability of Childhood," | 2022 | Research Article | The high prevalence of speech-language impairment in children, often underdiagnosed, and the benefits of multimodal assessment and early |  |

**Feasibility Study**

1. **Feasibility:** The feasibility of this project is evident in the growing demand for early detection and intervention in childhood speech impairments. With advances in technology, including speech analysis and machine learning, the development of a reliable detection system is technically feasible. Furthermore, ethical considerations, legal compliance, and potential sources of funding make the project financially and operationally feasible. The interdisciplinary collaboration between experts in speech pathology, technology, and education strengthens the project's viability.
2. **Need and Significance:** The need for this project is underscored by the prevalence of speech impairments in children and the potential long-term consequences of delayed diagnosis. Timely identification can significantly improve children's communication skills and overall quality of life. The significance lies in the project's potential to bridge gaps in current diagnostic methods, especially in underserved communities. It can empower parents, educators, and healthcare providers with a practical and accurate tool for early intervention, ultimately enhancing the well-being of children with speech impairments.

**Methodology / Planning of work**

The initial phase will focus on extensive literature review to gather insights into the state-of-the-art in speech impairment detection methods. Subsequently, data collection protocols will be established, encompassing the ethical acquisition and management of speech data from children. Machine learning models, including deep learning approaches such as convolutional neural networks (CNNs), will be developed to analyze speech patterns and identify impairments. Real-time monitoring capabilities will be integrated into the system to enable continuous assessment. Extensive testing and validation will be conducted to ensure the system's accuracy and robustness, with feedback loops for refinement. The project will involve collaboration with speech pathologists, educators, and healthcare professionals to ensure the system's practicality and relevance in clinical and educational settings. Ethical considerations and legal compliance, especially regarding data privacy, will be adhered to throughout the project. This methodology ensures a comprehensive and ethical approach to creating a reliable speech impairment detection system for children.

**Facilities Required**

**Software:**

**1)Programming Languages:** Python for machine learning and data analysis.

1. **Integrated Development Environment (IDE):**

PyCharm, Visual Studio Code, Jupyter Notebook / JupyterLab

1. **Version Control:** Git for tracking code changes and collaboration.

**Data Manipulation:** NumPy and Pandas for data manipulation and analysis. TensorFlow for machine learning.

1. **Model Deployment:**

Flask or Django to deploy and serve machine learning models.

**Hardware:**

1)High-performance computers with GPUs for model training.

2)Adequate RAM and storage for data processing.

3)GPU (Graphics Processing Unit) / TPU (Tensor Processing Unit)

4)Recording Equipment: High-quality microphones and recording devices for capturing speech data from children during data collection.

**Expected Outcome:**

The anticipated outcomes of this project encompass the development of a comprehensive speech impairment detection system tailored for children. The system is expected to offer accurate and timely diagnoses, aiding in the early intervention process, thus enhancing the communication skills and overall well-being of children with speech impairments. Furthermore, the project aims to bridge existing gaps in diagnostic methods, empower parents, educators, and healthcare professionals with a practical tool, and promote equity in accessing early intervention services for children from diverse backgrounds. Ultimately, the project seeks to contribute to the well-being and future prospects of children by ensuring that speech impairments are identified and addressed effectively in their formative years.