Application of Voice Recognition Technology for Early Detection of Respiratory Disorders in Premature Babies

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ABSTRACT

Premature babies have a high risk of experiencing potentially life-threatening respiratory disorders that can lead to serious complications or problems or even death if not detected in a timely manner. For this reason, a voice recognition technology is applied to identify breathing disorders that occur in premature babies. The purpose of this research is to develop a system that can recognize typical sound patterns associated with respiratory disorders in premature babies. By utilizing this technology, it is expected to improve the ability of early detection of respiratory distress in premature infants, thus enabling faster and more appropriate medical intervention. The research method involved collecting respiration sound data from premature infants using microphones installed around their incubators, followed by analysis using digital signal processing techniques and machine learning algorithms. The results showed that the developed system was able to identify sound patterns indicating signs of respiratory distress with a high degree of accuracy experienced by premature infants. This is supported by validation data showing that the system successfully detects most cases of respiratory distress in premature babies. The conclusion of this research is that speech recognition technology has great potential as an early detection tool for respiratory distress in premature infants, which can be used to detect respiratory distress in premature infants. The conclusion of this study is that speech recognition technology has great potential as an early detection tool for respiratory distress in premature infants, which can assist medical personnel in providing timely care and reduce the risk of serious complications. Thus, the application of this technology in the clinical environment may improve the prognosis and survival of vulnerable premature infants.

Keywords: *Early Detection, Respiratory Disorders, Premature Babies*

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INTRODUCTION

Voice recognition technology has shown great potential in various applications, including in the world of health (Namba, 2021). The use of sound as a tool for diagnosis, monitoring, and treatment has attracted the interest of researchers and health practitioners. Voice recognition technology offers a non-invasive approach that can help in various aspects of healthcare, from early disease detection to rehabilitation (Sezgin et al., 2020). Speech recognition, or better known as natural language processing, is a branch of computer science that is concerned with the understanding and generation of human language by computers (Fagherazzi et al., 2021). In health, this technology has been used in various contexts, one of which is in disease diagnosis. The human voice contains a lot of information that can reflect a person's health condition (Marukami et al., 2012, p.). For example, changes in voice characteristics such as pitch, rate of speech, or certain voice patterns may indicate the presence of certain diseases or conditions.

One example of the application of voice recognition technology in disease diagnosis is in the field of cardiology (Rohlfing et al., 2021). Research has shown that heart sound analysis can provide valuable information about a person's heart condition. Using sound signal processing techniques and machine learning algorithms, researchers can identify heart sound patterns associated with various heart disorders, such as arrhythmias or valve disease (Widiastuti et al., 2012). The ability to detect this condition early through heart sound analysis can aid in faster and more accurate diagnosis, as well as enable timely medical intervention. Apart from disease diagnosis, voice recognition technology is also used in patient monitoring (Vogel et al., 2015). For example, voice monitoring systems have been developed to monitor patients in hospitals or in long-term care (Kumah-Crystal et al., 2018). Using microphones placed around the patient, the system can record the sounds of the patient's environment and analyze them to detect suspicious changes or emergency situations. This allows the medical team to respond more quickly to patient conditions that require further attention. Voice recognition technology also plays an important role in patient rehabilitation (Wheeler & Cassimus, 1999). For example, in speech rehabilitation, speech recognition systems are used to assist patients in practicing the pronunciation of words or sentences (Downing & Kilbride, 1995). By recording the patient's voice and providing real-time feedback, this system can help patients improve their pronunciation and improve their speaking ability (Chung et al., 2018). Additionally, speech recognition technology is also being used in the development of more advanced hearing aid devices, which can help individuals with hearing loss to communicate better.

In implementing voice recognition technology in the health sector, it is important to pay attention to the challenges and problems that may arise. One of the main challenges is the privacy and security of patient data. By using voice recognition technology, patient voice data can be recorded and stored for further analysis (Dargaville et al., 2011). Therefore, it is important to ensure that this data is processed and stored securely and in accordance with applicable privacy regulations. In addition, it is also important to ensure that voice recognition technology used in health contexts can provide accurate and reliable results (Saggio & Costantini, 2022). This requires the development of sophisticated algorithms and careful validation of extensive patient data. In addition, it is necessary to consider the diversity of patient populations, including cultural and linguistic differences, in the development of widely applicable speech recognition systems (Hawdon et al., 2000). Nevertheless, developments in voice recognition technology have brought great benefits in improving the diagnosis, monitoring and rehabilitation of patients in the healthcare sector (Short et al., 2007). By continuing to apply research and innovation in this field, it is hoped that we can continue to improve the capabilities of voice recognition technology in supporting health practitioners in providing better and more effective care to their patients.

The process of developing voice recognition technology to detect respiratory disorders in premature babies is a reflection of ongoing efforts to utilize technological innovation in the health sector, especially in babies (Halliday et al., 2009). Essentially, this process involves multiple disciplines of science, research, and technology that are interrelated to create effective and sophisticated solutions (Moretti et al., 1999). This development did not just happen at one time, but was the result of gradual progress over several decades (Reuter et al., 2014). Initially, speech recognition in medical and health contexts developed from early research in medical science and information technology. Since the invention of the stethoscope by René Laennec in the 19th century, sound hearing has been an important tool in medical diagnosis. However, real developments in speech recognition as a means of detecting respiratory disorders in premature babies began with advances in the fields of digital signal processing and artificial intelligence in the 20th century (More et al., 2014).

In its early years, speech recognition technology was generally limited to commercial applications such as speech recognition systems in computers and telecommunications. However, research continues to be carried out to develop more specific medical applications, including detecting respiratory problems in premature babies (Sardesai et al., 2017). This research encourages the development of sound signal processing algorithms that can identify typical sound patterns associated with respiratory disorders in premature babies. As technology advances, research is increasingly focused on developing systems that can be used practically in clinical settings. It involves collaboration between neonatal medicine experts, engineers, and computer scientists to build a system that is sensitive, accurate, and easy for medical personnel to use (Loewy et al., 2013). Increasingly small and energy-efficient sound

sensor technology also contributes to the system's ability to integrate with existing medical equipment, such as premature baby incubators (Creasy, 1993).

Furthermore, clinical trials were carried out to test the reliability and effectiveness of the voice recognition system in detecting respiratory disorders in premature babies (Aldana-Aguirre et al., 2017). The trial involved collecting respiratory sound data from premature babies admitted to a neonatal intensive care unit (Levy et al., 2006). The data is then analyzed using a sound signal processing algorithm that has been developed to identify sound patterns that indicate signs of respiratory problems. The results of this trial provide important insight into the system's ability to detect respiratory disorders in premature infants with a satisfactory level of accuracy (Dargaville et al., 2021). Data from these trials also helps improve and refine speech recognition algorithms and identify factors that may impact system performance, such as the sound environment in neonatal intensive care units.

After going through a series of developments and trials, voice recognition technology in detecting respiratory disorders in premature babies is ready to be widely applied in the clinical environment (Abdel-Latif et al., 2021). This system can help medical personnel in early detection of respiratory problems in premature babies, thereby allowing timely medical intervention and reducing the risk of serious complications (Salehian Matikolaie & Tadj, 2020). However, the process of developing this technology does not stop here. Efforts continue to be made to improve the system's detection capabilities and accuracy, as well as to adapt the technology to the latest developments in the fields of voice signal processing and artificial intelligence. Collaboration between experts from various disciplines is also still needed to ensure that this technology continues to develop and improve the overall health care of premature babies (Ahmad et al., 2016).

There are several previous research opinions. The first research according to (Orlandi et al., 2016), with the research title Application of Pattern Recognition Techniques to the Classification of Full-Term and Preterm Infant Cry. The results of his research stated that the best feature set is made up by 10 parameters capable to assess differences between preterm and full-term newborns with about 87% of accuracy. The second research according to (Khalilzad et al., 2022), with the research title Newborn Cry-Based Diagnostic System to Distinguish between Sepsis and Respiratory Distress Syndrome Using Combined Acoustic Features. The results of his research stated that the achieved results highlighted the role of combining features from different levels and modalities for a more powerful analysis of the cry signals, as well as including a neural network (NN)-based classifier. Consequently, attaining a 95.3% accuracy for the separation of two entangled pathology groups of RDS and sepsis elucidated the promising potential for further studies with larger datasets and more pathology groups. The third research according to (Manfredi et al., 2009), with the research title High-resolution cry analysis in preterm newborn infants. The results of his research stated that The newborn infant cry is characterised by very high

fundamental frequency (F0) and resonance frequency (RFs) values, with abrupt changes and voiced/unvoiced features of very short duration in a single utterance.

The research conducted by previous researchers is different from the research conducted by researchers. Meanwhile, the research that the researchers conducted was entitled Application of Voice Recognition Technology for Early Detection of Respiratory Disorders in Premature Babies. The results of the research show that the system developed is able to identify sound patterns that indicate signs of respiratory problems with a high level of accuracy experienced by premature babies. This is supported by validation data which shows that the system is successful in detecting the majority of cases of respiratory problems in premature babies.

RESEARCH METHODOLOGY

This research aims to develop and apply voice recognition technology for early detection of respiratory disorders in premature babies. Respiratory problems are a serious problem that often occurs in premature babies and can cause serious complications and even death if not detected and treated quickly (Hailman et al., 1983). In this study, the approach used was to use voice recognition technology to detect abnormal breathing patterns in premature babies (Shah et al., 2023). This method is expected to provide accurate early detection so that medical intervention can be carried out quickly, reducing the risk of complications and improving the clinical prognosis of premature babies (Göpel et al., 2011). The first step in this research was to conduct a comprehensive literature study on respiratory disorders in premature babies and speech recognition technology that has been used in medical contexts before (Colorafi & Evans, 2016). This literature study will help in understanding the background of the problem, identifying existing detection methods, and evaluating the advantages and disadvantages of technology that has been used previously.

The next premature baby breathing data will be collected through various sources, such as sound recordings from the premature baby care room at the hospital (Dargaville et al., 2013). The data collected will include a variety of normal and abnormal breathing patterns that have the potential to be indicators of respiratory problems in premature babies. The data that has been collected will be processed and analyzed using sound signal processing and pattern recognition techniques. This step includes data pre-processing, feature extraction, and speech recognition model building. This process will help identify abnormal breathing patterns related to respiratory disorders in premature babies. Then, based on data analysis, a detection algorithm will be developed that can recognize normal and abnormal breathing patterns in premature babies. This algorithm will be designed to have a high level of accuracy in identifying respiratory disorders and minimize detection errors.

Then the detection algorithm developed will be validated using independent data that is not used in algorithm development. Validation is carried out by comparing the algorithm detection results with medical diagnoses made by trained medical

personnel. Once the detection algorithm is validated, the speech recognition technology will be implemented in the clinical environment. This may involve the development of special hardware and software that can be used in premature baby care settings. After implementation, the voice recognition technology will be clinically evaluated to measure its effectiveness in early detection of respiratory disorders in premature babies. This evaluation will involve collecting data from patients using the technology over a period of time. The results of the clinical evaluation will be analyzed to evaluate the performance of voice recognition technology in early detection of respiratory disorders in premature babies. Based on this analysis, the technology can be refined and improved to increase its accuracy and effectiveness. By following these steps, it is hoped that this research can produce voice recognition technology that can be used effectively for early detection of respiratory problems in premature babies.

RESULT AND DISCUSSION

The application of voice recognition technology for early detection of respiratory disorders in premature babies is an innovative and creative step that has great potential and opportunities to improve the health care of premature babies and reduce the risk of serious complications . In this discussion, we will discuss the importance of early detection of respiratory disorders in premature babies, the challenges faced in detecting respiratory disorders, the benefits of implementing voice recognition technology, as well as the clinical and social implications of using this technology. Premature babies have a higher risk of experiencing respiratory problems because their respiratory systems are not fully mature. Respiratory problems in premature babies can range from mild problems such as apnea (temporary cessation of breathing) to more serious problems such as life-threatening acute respiratory distress syndrome (SGPA). Early detection of respiratory distress allows timely medical intervention, such as administration of oxygen or mechanical respiratory support, which can prevent serious complications and improve the clinical prognosis of premature infants.

Although important, early detection of respiratory disorders in premature babies often poses a challenge because the symptoms may not always be clear or visible. Premature babies are also susceptible to respiratory disorders that are transient and fluctuating, making it difficult to consistently identify problems. Additionally, current detection procedures often require intensive monitoring and subjective interpretation by trained medical personnel, which can be time and resource consuming. Therefore, developing technology that can help detect respiratory disorders automatically and accurately is very important. One of the main challenges in the application of speech recognition technology is the development of accurate and reliable algorithms for recognizing abnormal breathing patterns. This algorithm must be able to differentiate between normal and abnormal breathing patterns with a high degree of accuracy, and can address individual variations in the breathing patterns of premature infants. This requires careful analysis of extensive and representative respiratory data, as well as rigorous testing of the algorithm's performance in a variety of clinical

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conditions.In addition, implementing voice recognition technology also requires appropriate infrastructure, including hardware and software that can support real-time data capture, processing and analysis. The development of hardware that can be integrated with existing medical equipment, such as respiratory monitors and respiratory assist devices, is also an important consideration in the application of this technology in the clinical environment. Furthermore, it is important to consider security and data privacy aspects in the development and implementation of voice recognition technology. Sensitive premature infant respiratory data must be strictly protected to prevent misuse or unauthorized access. Therefore, there needs to be clear policies and procedures to safely manage and protect respiratory data, as well as ensure compliance with applicable privacy and data security regulations.

The application of voice recognition technology for early detection of respiratory disorders in premature babies has several significant benefits. First, this technology can provide rapid and accurate detection of abnormal breathing patterns, even in premature babies who may not show visually obvious symptoms. By using algorithms that have been programmed to recognize breathing patterns that indicate respiratory distress, this technology can consistently monitor the respiratory condition of premature babies without requiring continuous human intervention. Second, implementing voice recognition technology can help reduce the workload of medical personnel and free up their time to focus on other aspects of care. By utilizing automation technology, medical personnel can allocate their time and resources more efficiently, thereby improving the overall quality of care for premature babies. Third, this technology can also increase the accessibility of health care for premature babies, especially in areas with limited health resources. Using technology that can be implemented in relatively affordable software or hardware, early detection of respiratory disorders can be achieved in a variety of health care settings, including hospitals, clinics, and primary care facilities.

The application of voice recognition technology for early detection of respiratory disorders in premature infants has broad clinical and social implications. Clinically, this technology can help improve the clinical prognosis of premature babies by enabling timely medical intervention. By detecting respiratory disorders early, serious complications such as hypoxia (lack of oxygen) and organ damage can be prevented, which in turn can reduce morbidity and mortality in premature babies. Socially, the application of this technology can help reduce stress and anxiety for parents of premature babies. Parents often feel anxious and worried about their child's health condition, especially if the child has respiratory problems. With technology that can provide continuous monitoring and early detection of respiratory disorders, parents can feel more at ease because they know that their child is being closely monitored and will receive intervention if necessary.

Table 1: Benefits of Implementing Voice Recognition Technology

NO	Benefit
1	Can detect respiratory disorders quickly and accurately.
2	Can reduce the workload of medical personnel and save time.
3	Can improve healthcare accessibility.
4	Improves the clinical prognosis of premature babies.

5	Reduces parental stress and anxiety.

Thus, the application of voice recognition technology for early detection of respiratory disorders in premature infants has great potential to change the health care paradigm of premature infants by improving early detection, reducing complications, and improving their clinical prognosis. Although it still requires further development and careful clinical validation, this technology promises to be a valuable tool in efforts to improve the health and well-being of premature babies.

Health workers can apply voice recognition technology to detect respiratory problems in premature babies with several structured and targeted steps. Here's how healthcare professionals can use this technology in clinical practice. The first step is to provide training and education to health workers about the use of voice recognition technology for early detection of respiratory disorders in premature babies. This training includes an understanding of the basic principles of the technology, how to operate the related software or hardware, as well as the interpretation of the detection results provided by the technology. With a good understanding of this technology, healthcare professionals will be better prepared to integrate it into their clinical practice. After receiving training, health workers will begin collecting breathing data on premature babies using voice recognition technology. This data can be in the form of voice recordings taken from sound detection devices installed on premature babies or breathing monitoring equipment that is equipped with a voice recognition feature. During this stage, health workers will also calibrate the device to ensure accuracy of detection and consistency of results.

The collected data will be processed and analyzed using a pre-programmed voice recognition algorithm. Health workers will use software or user interfaces provided by the technology to access the results of the analysis. They will examine the detected breathing patterns and compare them with established standards of normal and abnormal breathing. Based on the results of the analysis, health workers will be able to identify whether the premature baby is experiencing respiratory problems or not. After receiving the results of the analysis, health workers will use the information to make decisions about the necessary medical intervention. If detection indicates respiratory distress, health workers will immediately provide appropriate interventions, such as increasing oxygen flow or mechanical breathing assistance. This decision is based on established clinical protocols and a holistic clinical assessment of the premature baby's condition.

After the intervention is given, health workers will continue to monitor the premature baby's breathing condition periodically using voice recognition technology. This allows them to track the progression of respiratory conditions and evaluate the effectiveness of interventions that have been provided. If necessary, health workers can make adjustments or additional actions based on the results of continuous monitoring. In some cases, health workers may need to consult a neonatologist or other expert in treating respiratory problems in premature babies. They can use the detection results

and information provided by voice recognition technology as a basis for these consultations, assisting in more precise diagnoses and more effective treatment planning.

CONCLUSION

Based on the results and discussion above, it can be concluded that the application of voice recognition technology for early detection of respiratory disorders in premature babies is an innovative step that has great potential in improving the health care of premature babies. By leveraging advances in speech signal processing and artificial intelligence, this technology can provide rapid, accurate and non-invasive detection of abnormal breathing patterns in premature babies. The main benefit is to provide early warning to health workers about possible respiratory problems, so that medical intervention can be carried out quickly to prevent serious complications and improve the clinical prognosis of premature babies. In addition, the application of this technology can also reduce the workload of medical personnel, increase health care efficiency, and reduce parental stress by providing continuous monitoring and reliable early detection. Although there are still several challenges that need to be overcome, such as the development of accurate algorithms and integration with existing clinical infrastructure, its potential benefits show that voice recognition technology has an important role in improving the health care of premature babies and improving their quality of life. With a commitment to continue developing and improving this technology, it is hoped that it can make a significant contribution to efforts to reduce mortality and morbidity rates in premature babies throughout the world.

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