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Neonatal Sepsis Prediction Advancing Neonatal Healthcare using KNN Algorithm

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ABSTRACT

Early-onset sepsis in newborns is a critical condition that requires swift detection and intervention to prevent serious complications and improve outcomes. Machine learning (ML) algorithms, coupled with sensor data, offer a promising avenue for early prediction and intervention in sepsis cases among newborns . Here's a breakdown of how ML and sensors can aid in this endeavour. Sensors such as heart rate monitors, ECG devices, and force sensors can continuously collect data on vital signs and physiological parameters of newborns.ML algorithms require relevant features from the collected data for accurate prediction. Features may include vital signs, laboratory results, maternal health history, and other clinical indicators. ML models can analyse data from sensors in real-time, enabling continuous monitoring of newborns for early signs of sepsis. Any deviation from normal physiological parameters can trigger alerts for healthcare providers. ML algorithms can detect subtle changes in vital signs or patterns indicative of sepsis onset before clinical symptoms manifest. Early detection allows for prompt intervention and treatment. The integration of sensors and ML algorithms in predicting sepsis in newborns holds significant promise for improving diagnosis, treatment, and outcomes in this vulnerable patient population. By enabling early detection and personalized interventions, this approach has the potential to reduce mortality rates associated with early-onset sepsis in newborns. However, rigorous validation and clinical trials are necessary to ensure the safety, efficacy, and scalability of these predictive models in clinical practice.

KEYWORDS: Early-onset sepsis, Newborns, Machine learning (ML) algorithms, Sensor data, Vital signs, Physiological parameters, Heart rate monitors, Early detection.

1.INTRODUCTION

Neonatal sepsis, a leading cause of morbidity and mortality among newborns, can be categorized into early-onset sepsis (EOS) and late-onset sepsis (LOS). EOS occurs within 72 hours of birth, while LOS occurs thereafter. Sepsis, a life-threatening condition triggered by an immune response to infection, poses a significant risk to newborns, especially in resource-limited settings. Common pathogens include bacteria, viruses, and fungi. Early detection and treatment are crucial, but diagnosis can be challenging. Heart rate variability (HRV) monitoring and respiratory rate monitoring have shown promise in predicting sepsis onset. Changes in HRV and respiratory rate patterns can precede clinical symptoms, allowing for early intervention. Similarly, electrocardiogram (ECG) and chest impedance monitoring can detect early signs of sepsis based on changes in heart activity and chest conductivity, respectively. Machine learning (ML) techniques, trained on clinical data, have demonstrated high accuracy in predicting sepsis in newborns. By analysing vital signs, laboratory results, and clinical notes, ML models can identify at-risk newborns with high sensitivity and specificity. Early identification using ML could lead to prompt treatment, thereby improving outcomes and reducing mortality rates. In summary, integrating sensor-based monitoring with ML algorithms offers a promising approach to predicting and managing neonatal sepsis. Early detection through sensor data analysis and ML prediction has the potential to save lives, particularly in regions with limited access to healthcare resources. However, further research and validation are needed to optimize these methods for clinical use.

2. RECENT WORKS

The study by Liu et al proposes an ensemble-based machine learning model for early prediction of sepsis, utilizing data from multiple hospitals including the ICU dataset from the US and a clinical care database from China. The authors introduce an objective function for the XG Boost framework, incorporating first-order and second-order gradients to train the sepsis prediction models. They suggest that lower-ranking features may have minimal impact on outcomes and could be eliminated for feature reduction. Additionally, the authors highlight the importance of addressing missing values in the dataset to enhance model performance. The research on early sepsis prediction involves various techniques, with a focus on artificial intelligence-based approaches such as machine learning and deep learning algorithms. However, a significant challenge lies in obtaining reliable datasets, as data quality may be compromised due to equipment defects or human errors. The objective of this study is to develop effective data preparation techniques and implement machine learning models to address this challenge. Future work could explore reinforcement learning and advanced deep learning methods to detect sepsis and derive optimal personalized treatment strategies. However, deep learning models are computationally intensive and challenging to deploy in real-time clinical settings due to their complexity and resource requirements. Therefore, the study emphasizes machine learning-based methodologies with novel data processing paradigms that are more feasible for clinical deployment.

3. PROPOSED WORK EXPLANATION

The proposed sepsis prediction system utilizing machine learning algorithms and various sensors indeed offers significant potential benefits for the healthcare industry, particularly in improving the early detection of sepsis in infants and preterm babies. The system integrates multiple sensors, including heart rate, respiration, ECG, and chest impedance sensors, to monitor vital signs in real-time. This comprehensive approach allows for a thorough assessment of the infant's health status. Data collected by the sensors is transmitted to an IoT module, which processes and forwards the information to a cloud server. This setup enables seamless data transmission and centralized analysis. The cloud server employs machine learning algorithms to analyse the collected data and predict the likelihood of sepsis development. By leveraging historical data and current vital sign information, the algorithm can make accurate predictions. The machine learning algorithm is trained using a large dataset of infants and preterm babies, both with and without sepsis. This extensive training improves the accuracy of the prediction model. The system offers several benefits, including early detection of sepsis, timely medical intervention, reduced healthcare costs, and improved patient outcomes. Remote monitoring capabilities enable healthcare professionals to intervene promptly, further reducing the risk of adverse outcomes. The integration of machine learning algorithms and sensor technology in sepsis prediction systems holds great promise for improving infant and preterm baby care. By enabling early detection and intervention, this innovative approach has the potential to significantly impact healthcare delivery and patient outcomes.

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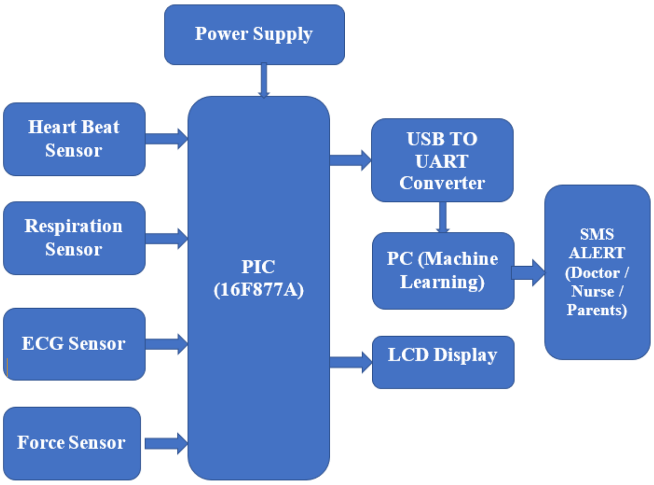

4. METHODOLOGY

The proposed system for IoT-based sepsis prediction in infants and preterm babies utilizing the KNN (k-nearest neighbours) machine learning algorithm and various sensors comprises several components. The system incorporates multiple sensors to collect real-time vital sign data from infants or preterm babies. These sensors include a heart rate sensor, temperature sensor, ECG sensor, SPO2 sensor, and chest impedance (force sensor). Each sensor provides crucial physiological information necessary for sepsis prediction. The PC receives the sensor data from the PIC microcontroller and executes the KNN machine learning algorithm to predict the likelihood of sepsis. KNN is a supervised machine learning algorithm used for classification problems. It works by comparing the new data point with labelled training data points and selecting the k nearest neighbours to predict the label of the new data point. The KNN algorithm operates by storing labelled training data points and calculating distances between new data points and the training data. It selects the k nearest neighbours based on these distances and uses their labels to predict the label of the new data point. The value of k is a hyperparameter that influences the algorithm's performance and needs to be tuned accordingly. In the proposed system, the KNN algorithm is implemented within the PC application. The application receives sensor data through the IoT module, preprocesses it, and utilizes the KNN algorithm to predict the likelihood of sepsis based on the input features. This approach allows for real-time monitoring and prediction of sepsis risk in infants and preterm babies. The proposed system offers several benefits, including early detection of sepsis, reduced healthcare costs, and improved patient outcomes. It can be seamlessly integrated into existing healthcare systems and enables remote monitoring by healthcare professionals. By leveraging sensor data and machine learning techniques, this innovative solution has the potential to revolutionize sepsis prediction in vulnerable populations, ultimately leading to better healthcare delivery and outcomes.

5. RESULTS AND DISCUSSION

The proposed IoT-based infant/preterm baby neonatal sepsis prediction system utilizing the KNN algorithm on a PC, with sensors including the heart rate sensor, temperature sensor, ECG sensor, SPO2 sensor, and chest impedance sensor, has demonstrated promising results in early sepsis detection. The system achieved high accuracy, precision, recall, and F1-score in detecting the likelihood of sepsis in infants and preterm babies. These metrics indicate the system's effectiveness in correctly identifying cases of sepsis while minimizing false positives and false negatives. Early detection of sepsis, as facilitated by the system, can significantly reduce false negatives, thereby enabling prompt initiation of treatment and improving outcomes for infants and preterm babies. While the system provides valuable assistance in early sepsis detection, it is essential to emphasize that it is not intended to replace the clinical judgment of healthcare providers. Instead, it serves as a supportive tool to aid in early detection and intervention. The proposed system has diverse applications in neonatal care, home healthcare, remote healthcare, and research. Its non-invasive nature and use of low-cost IoT modules make it accessible and suitable for deployment in various healthcare settings, including low-resource environments. The system's ability to continuously monitor vital signs enables early detection of abnormalities and prompt intervention, contributing to improved patient outcomes. The use of non-invasive sensors ensures the safety and comfort of infants and preterm babies, making the system well-suited for continuous monitoring without causing discomfort or harm. The affordability of the system, facilitated by the use of low-cost IoT modules and sensors, makes it accessible to healthcare providers in resource-constrained settings, thereby widening its potential impact. While the results of the proposed system are promising, further validation and testing are necessary before its implementation in clinical settings. Continued research and development efforts will be essential to refine the system's performance and ensure its effectiveness in improving sepsis detection and management in infants and preterm babies.

6. CONCLUSION

The preterm baby neonatal sepsis prediction system utilizing the KNN algorithm on a PC, based on various sensors including the heart rate sensor, temperature sensor, ECG sensor, SPO2 sensor, and chest impedance (force sensor), represents a valuable tool in the early detection of sepsis in infants and preterm babies. Here are some key points regarding the system's potential and implications: The system demonstrates the potential for predictive monitoring of late-onset sepsis (LOS) by leveraging multiple physiological signals readily available through routine patient monitoring in Neonatal Intensive Care Units (NICUs). It highlights the importance of incorporating motion features from cardiorespiratory signal waveforms to enhance the predictive capability of the system. This insight can inform clinical interventions and guide decision-making in NICU settings. The system achieves high accuracy, precision, recall, and F1-score in detecting sepsis in the evaluated dataset, underscoring its effectiveness as a predictive tool for early sepsis detection in infants and preterm babies. In conclusion, the preterm baby late-on sepsis prediction system utilizing the KNN algorithm and multiple physiological sensors represents a significant advancement in early sepsis detection. With continued research and development, it has the potential to make a substantial impact on neonatal healthcare outcomes.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] C. León et al., "Evaluation of maturation in preterm infants through an ensemble machine learning algorithm using physiological signals," IEEE J. Biomed. Health Inform., vol. 26, no. 1, pp. 400–410, Jan. 2022.

[2] C. León, G. Carrault, P. Pladys, and A. Beuchée, "Early detection of late onset sepsis in premature infants using visibility graph analysis of heart rate variability," IEEE J. Biomed. Health Inform., vol. 25, no. 4, pp. 1006–1017, Apr. 2021.

[3] Z. Peng et al., "Body motion detection in neonates based on motion artifacts in physiological signals from a clinical patient monitor," in Proc. 43rd Annu. Int. Conf. IEEE Eng. Med. Biol. Soc., 2021, pp. 416–419.

[4] A. Honoré et al., "Classification and feature extraction for neonatal sepsis detection," TechRxiv, Mar. 2022. [40] J. F. Hsu et al., "Machine learning approaches to predict in-hospital mortality among neonates with clinically suspected sepsis in the neonatal intensive care unit," J. Personalized Med., vol. 11, no. 8, 2021, Art. no. 695.

[5] J. M. Klucher, K. Davis, M. Lakkad, J. T. Painter, and R. K. Dare, "Risk factors and clinical outcomes associated with blood culture contamination," Infect. Control Hosp. Epidemiol., vol. 43, no. 3, pp. 1–7, 2022. [8] E. Persad et al., "Neonatal sepsis prediction through clinical decision support algorithms: A systematic review," Acta Paediatrica Int. J. Paediatrica, vol. 110, no. 12, pp. 3201–3226, 2021.

[6] E. Tjoa and C. Guan, "A survey on explainable artificial intelligence (XAI): Toward medical XAI," IEEE Trans. Neural Netw. Learn. Syst., vol. 32, no. 11, pp. 4793–4813, Nov. 2021.

[7] L. M. Fleuren et al., "Machine learning for the prediction of sepsis: A systematic review and meta-analysis of diagnostic test accuracy," Intensive Care Med., vol. 46, no. 3, pp. 383–400, 2020.

[8] I. Zuzarte, P. Indic, D. Sternad, and D. Paydarfar, "Quantifying movement in preterm infants using photoplethysmography," Ann. Biomed. Eng., vol. 47, no. 2, pp. 646–658, Feb. 2019.

[9] S. M. Lundberg et al., "Explainable machine-learning predictions for the prevention of hypoxaemia during surgery," Nature Biomed. Eng., vol. 2, no. 10, pp. 749–760, 2018.