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An Approach Using Neural Networks to Estimate Three-dimensional Spinal Curvature Using Inertial Measurement Units

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Introduction

The measurement and analysis of spinal curvature is crucial in diagnosing and treating various musculoskeletal conditions. Traditionally, this process has involved expensive and time-consuming radiographic imaging techniques. However, recent advancements in technology, particularly in Inertial Measurement Units (IMUs) and neural networks, have paved the way for a more efficient and cost-effective approach. In this article, we explore an innovative method that utilizes IMUs and neural networks to estimate three-dimensional spinal curvature accurately [1,2]. Spinal curvature assessment plays a significant role in evaluating and managing spinal deformities such as scoliosis, kyphosis, and lordosis. The conventional method involves using X-ray imaging, which exposes patients to ionizing radiation and can be expensive. Furthermore, it requires professional expertise for accurate interpretation. By leveraging advancements in technology, a more accessible and safer approach can be achieved [3].

Description

IMUs are small, wearable sensors that incorporate accelerometers, gyroscopes, and magnetometers to measure motion and orientation. They have gained popularity in various fields, including sports, gaming, and health monitoring. In the context of spinal curvature estimation, IMUs can be attached to specific anatomical landmarks on the body, such as the vertebrae, to capture movement and posture data. After training, the neural network's performance is evaluated using a separate validation dataset. This allows for an unbiased assessment of the network's ability to generalize to unseen data. If the validation results are satisfactory, the network can be tested on new IMU data to estimate three-dimensional spinal curvature. Comparisons with X-ray measurements can be made to evaluate the accuracy and reliability of the approach [4].

Neural networks, a branch of artificial intelligence, are computational models inspired by the human brain. They consist of interconnected nodes (neurons) that process and transmit information. Neural networks excel at pattern recognition and can learn from large datasets to make accurate predictions. By training neural networks with labelled data, they can effectively estimate complex relationships between input (IMU data) and output (spinal curvature measurements) [5,6]. To train the neural network, a dataset is needed, comprising IMU measurements and corresponding spinal curvature values obtained from traditional methods (e.g., X-ray). The IMU data captures the movement of the spine, while the X-ray data provides ground truth measurements. The data is pre-processed by aligning the IMU and X-ray measurements, ensuring synchronization and accurate correlation.

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Conclusion

The combination of neural networks and IMUs presents a promising approach for estimating three-dimensional spinal curvature. By leveraging the power of neural networks in analysing IMU data, clinicians and researchers can obtain accurate and real-time assessments of spinal deformities. This technology has the potential to revolutionize the field, offering a safer, more cost-effective, and accessible alternative to traditional radiographic imaging methods. Further research and development are needed to refine the approach and address any existing limitations, ultimately leading to improved patient care and outcomes in the management of spinal curvature disorders. The approach of using neural networks and IMUs for estimating spinal curvature offers several advantages. It eliminates the need for ionizing radiation exposure and reduces costs associated with X-ray imaging. Additionally, it provides a more convenient and non-invasive method that can be performed in real-time, allowing for continuous monitoring of spinal curvature. However, challenges remain, such as ensuring the accuracy and reliability of IMU measurements, accounting for individual variations, and addressing limitations in training datasets.

Acknowledgement

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Conflict of Interest

None.

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