Early Detection of Ankylosing Spondylitis Using Analysis of Breathing Patterns With Neural Networks

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Ankylosing Spondylitis a type of rheumatic autoimmune disorders where normal body cells attack musculoskeletal cells, making bones' weak joints unstable and prone to fractures. This can cause congestion in the rib cage area, changing breathing patterns, and chest expansions in different areas of the torso. The prototype uses 5 internal measurement units around the chest to map chest movement and expansion in all dimensions. The data is used to determine the displacement and angular change of the chest. The IMU data is then transferred wirelessly using wifi for further data processing. To calculate distance traveled/chest expansion, the second integral of acceleration is used, and it is calculated using the trapezoidal integration method twice. The angular velocity data provided by the IMU is also integrated using trapezoidal integration to find the euler angles which are converted to quaternions to avoid gimbal lock. The linear acceleration vector provided by the IMU is rotated to align with the global frame using quaternion multiplication and calibration quaternions, and the angle of rotation is determined by aligning the relative gravity vector with the absolute z axis The aligned quaternion is then obtained and any angular changes in the IMU are also compensated for by rotating the acceleration vector accordingly. After putting the data through a Kalman filter, an LSTM model is trained for early detection of seronegative spondyloarthropathies with the accuracy of approximately 95%.

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