A 2-DOF Pneumatic Shoulder Rehabilitation Device Based on Soft Materials

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Motivated by the increase in shoulder-related surgeries and the subsequent shortage in post-operative rehabilitation, an innovative pneumatic shoulder rehabilitation device was designed to mimic the natural movement of the joint and facilitate a dual range of rehabilitation exercises. Powered by individual air pump inflation, which is monitored via an internal pressure sensor, the device contains three modules' spines with seven modules in each spine to enable the 2DOF movement. Currently, the device is capable of completing two basic shoulder rehabilitation movements: vertical abduction and adduction, horizontal extension and flexion. The development of the device began with the creation of a heat-sealing process to allow the air modules to withstand the required air pressure of up to 80 kPa when completing movements. Subsequently, 3D structures and spine designs were assessed to maximize the mutual compression force. Following assembly, the device's control system was programmed using Arduino IDE and integrated with a Bluetooth module for convenient user manipulation via a smartphone. After development, a test-fixture evaluation demonstrated a commendable vertical range of 56.4° and a horizontal range of 109.2°. This range highlights the promising ability of the shoulder rehabilitation device to complete the two 2-DOF predetermined movements as it meets its quantitative benchmarks.

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