Design and Development of Pneumatic Elbow Exoskeleton with Fatigue Alert

Authors: Theresa James, Ann Maria George

Affiliation: St. Joseph's College of Engineering and Technology, Palai (APJ Abdul Kalam Technological University)

Corresponding author email: theresajamesv@gmail.com Ph. 7902377140
.   annmariageorge2004@gmail.com Ph. 9539690324

It has been reported from numerous studies that, the work-related musculoskeletal disorders (WMSDs) have emerged as a critical global public health concern, affecting around 57-83% of workers across diverse occupational sectors. Forceful exertions, unergonomic postures and sustained muscle contractions results in biomechanical overloading which in turn affects the health of musculotendinous structures. Though there are various Exoskeleton systems which mitigate these effects, there are various limitations such as minimal biomimetic characteristics followed by safety concerns regarding human-robot interface due to the use of rigid actuators. This paper aims to address the research gap by the systematic fabrication of Pneumatic Artificial Muscle (PAM) prototype for the exoskeleton assisting human movements which reduces the human fatigue.

In this research, a pneumatic elbow exoskeleton with fatigue alert is developed which operates on the integration of electromechanical and pneumatic subsystems to assist upper limb motion and monitor operator fatigue. The major components of the system include EMG sensors, ESP32 microcontroller, relay-driven actuation circuits, and a pneumatic muscle actuator. The Pneumatic Artificial Muscle (PAM) expands radially by the introduction of pressurized air which is regulated at 150-200 kPa.
The expected results of this project in the area of AI-Driven Generative Design & Development of Ergonomic Exoskeleton Arms for Industrial and Defense Applications are: high specific strength and ergonomic advantages during performance of industrial operations like welding and associated material handling. The outcomes of this research paper are in congruence with the conference sub theme "Industry 4.0, Robotics, Automation and AI".

Keywords: Exoskeleton, Air Muscle, Pneumatic Artificial Muscle, Automation, AI, Ergonomics