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Gravity Balancing Conditions for an Upper Arm Exoskeleton

Venketesh Dubey
Bournemouth University

Sunil Agrawal
University of Delaware

An upper-arm wearable exoskeleton has been designed for assistance and functional training of humans. One of the goals of this design is to provide passive assistance to a user by gravity balancing, while keeping the transmitted forces to the shoulder joints at a minimum. Consistent with this goal, this paper addresses the following questions: (i) an analytical study of gravity balancing design conditions for the structure of the human arm, (ii) minimization of transmitted shoulder joint forces while satisfying the gravity balancing conditions, and (iii) possible implementation of these conditions into practical designs using zero-free length springs.

The Evolution of the External Left Ventricular Assist Device

Harry Soroff
Stony Brook University

Jahangir Rastegar
Omnitek Partners, LLC

External counterpulsation is a noninvasive method of applying external pressures to vascular beds of the lower extremities synchronous with the cardiac cycle. Numerous animal experiments and a number of clinical trials have been conducted over the years in patients with various forms of cardiac disease to evaluate the effectiveness of external counterpulsation. The external counterpulsation machines (known as ECP and EECP machines) are currently widely available for use in the treatment of angina by applying positive pressure to the lower extremities during cardiac diastole to increase coronary flow. External counterpulsation has also been shown to be capable of perfusing the ischemic myocardium following an AMI and of assisting the failing left ventricle in patients with CHF. In these applications, positive pressure is applied externally to the lower extremities during cardiac diastole and negative pressure during cardiac systole so as to increase coronary flow and reduce the work of the heart. This paper provides a review of the developments in the area of external counterpulsation and the related devices. The paper also reviews the experimental evidence that provides the scientific basis for the design of a device now under development and called external left ventricular assist device (XLVAD) that should provide effective support of the left ventricle of a patient in congestive heart failure or following an AMI. The evolutionary development of the external counterpulsation devices into the XLVAD is presented in detail. The clinical and mechanical advantages as well as the shortcomings of each device are described.

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