Abstract

The knee joint has essential functions to support the body weight and maintain normal walking. Neurological diseases like stroke and musculoskeletal disorders like osteoarthritis can cause the knee joint to lose its function. Along with physical therapy, robot-assisted therapy using wearable exoskeletons and exosuits has shown the potential as an efficient therapy that helps patients restore their limbs’ functions. Exoskeletons and exosuits are being developed for either human performance augmentation or medical purposes like rehabilitation. However, the research on exoskeletons started early before exosuits, the research and development on exosuits have recently grown rapidly for their advantages that exoskeletons lack. The objective of this research is to develop a soft exosuit for knee flexion assistance and validate its ability to reduce the EMG activity of the knee flexor muscles. The exosuit has a novel soft fabric actuator and novel 3D printed adjustable braces for attaching the actuator aligned with the knee. An analytical model has been derived and validated experimentally to model the output torque of the actuator. In addition to that, the actuator’s deflation and inflation time has been experimentally characterized and a controller has been implemented and the experiment has been tested on a human subject. It is found that the analytical torque model succeeded to predict the torque output in flexion angle range from 0° to 60° more precisely than analytical models in the literature. In addition to that, human Experiments showed that, for the human subject tested, the exosuit gave the best performance when the controller was tuned to inflate at 31.9% of the gait cycle. The biceps femoris, the semitendinosus and the vastus lateralis muscles showed average EMG reduction of -32.02 %, -23.05 % and -2.85 % respectively. Finally, it is concluded that the developed exosuit can assist the knee flexion and it can be used in the future in human performance augmentation and rehabilitation.