Soft Wearable Glove for Hand Rehabilitation

Abstract

There are 15 million people worldwide who suffers stroke each year. According to the World Health Organization, stroke kills someone every six seconds. One in six people worldwide faces stroke in their lifetime. In Malaysia alone, six new stroke cases occur every hour. Apart from 15% of the patient that died within 30 days after encountering stroke, they suffer a minor to severe disability and require constant rehabilitation. Tasks often taken for granted by the able-bodied such as buttoning a shirt, picking up a telephone, using cooking and eating utensils, become frustrating, nearly impossible feats due to reduced gripping strength and motor control. This is where the Soft Wearable Glove for Hand Rehabilitation, an air-controlled soft-robotics rehabilitation glove comes into play. The glove allows people with limited hand mobility to grasp and pick up objects. The actuator unit is made of soft silicone which will be controlled by inflating air and can perform bending and twisting movements. It can provide the power to assist hand gesture movements while at the same time eliminating the need to make use of heavy and hard robotic and mechanical materials. The glove will be made lightweight and has a low manufacturing cost comparatively with typical robotic gloves. It will also be designed to reduce pressure points on the wearer's hand as the silicon soft actuators naturally distribute the power by fitting the patient finger contour. This device could help those who have hand mobility issues, whether from a degenerative condition, stroke, or old age.

The burden of stroke now disproportionately affects individuals of poor resource simply due to the fact that successful rehabilitation depends on amount of damage to the brain, skill of rehabilitation team, cooperation of family and friends and the timing of rehabilitation. Generally, the earlier it begins the more likely survivors are to regain lost abilities and skills. Low and medium income stroke patients have to rely on tight resources of general hospitals and often lack support for a long and continuous professional rehabilitation program. Notwithstanding, there is much more that can be done to improve the quality of life for people who have suffered from stroke. Initial stage of physical rehabilitation involves a repetitive guided exercise, especially on the fingers, which conventionally requires a physiotherapist. It is a growing consensus that existing technology can shift the paradigm granting more patients access to the treatment. However due to the implementation of mechanical system it can cost up to thousands of U.S dollars for a pair of glove.

This is where the Soft Wearable Glove for Hand Rehabilitation should come into play where its main objective is not only to become a low cost solution for these issues but also generally be accepted as a new technology that can also be implemented in many other medical areas. While existing robots with hard exoskeletons can act as assistive devices and guide patients through rehabilitation exercises, the soft robotic glove should align more flexibly with a patient’s joints, plays nice with soft tissues like human skin, and, since it is much lighter, should eventually be taken home instead of being limited to use in a clinic. The emerging

field of soft robotics holds great promises for bringing robots into all aspects of our daily lives, especially areas previously forbidden to rigid robots.

The basis of these systems is an elastomeric actuation element powered by direct mechanical energy in the form of pressurized fluids. Fluidic elastomer actuators are fast and inexpensive to fabricate and offer safety and adaptability to robotic systems. Arrangements of these units can yield arbitrarily complex motions and achieve various functionalities. Actuation power can be generated on-board by a pneumatic battery for mobile implementations. The actuator unit is made of soft silicone which will be controlled by inflating air and can perform bending and twisting movements. It can provide the power to assist hand gesture movements while at the same time eliminating the need to make use of heavy and hard robotic and mechanical materials. The glove will be made lightweight and has a low manufacturing cost comparatively with typical robotic gloves. It will also be designed to reduce pressure points on the wearer's hand as the silicon soft actuators naturally distribute the power by fitting the patient finger contour. Sensors can be incorporated on the glove to interact with patient and to monitor the progress. The modular nature of these robots enable distributed sensing and computation elements. Naturally, it should be a portable, assistive, soft robotic glove designed to augment hand rehabilitation for individuals with functional grasp pathologies. Ultimately, patients have to be comfortable with wearing the glove.

Project team: Chew Cheng Hoon, Gobinath A/L Tamil Vanan, Yap Yih Shan, Jasher Tan Si-Ming, Ronald Lim Ong Cheng Siew