# Motion and Compliance Control of Robotic Fingers by EMG Interface

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## Abstract

To manage the motion and joint compliance of an extra robotic finger, an unique Electromyographic (EMG) control interface was developed. A new class of wearable robotics known as "supernumerary robotic fingers" gives users extra robotic limbs to compensate for or enhance the capabilities of their native limbs without actually replacing them. Since extra robotic fingers are intended to work in concert with human limbs and intimately interact with them, they should exhibit similar behaviour to that of human beings, including the capacity to manage compliance. In order to implement stiffness regulation control strategies, it is crucial to present a control interface and take into account the actuators and sensing capabilities of the robotic additional finger. We provide an EMG interface and a control strategy to adjust the device's compliance using servo actuators. In particular, we employ a surface one channel EMG electrodes interface to control the compliance of the robotic device and a commercial EMG armband for gesture detection to be coupled with the motion control of the robotic device. With the help of two sets of tests on compensation and augmentation, we have validated the suggested interface. Since this cutting-edge wearable technology can be utilised to compensate for the absent grasping abilities in chronic stroke patients, several bimanual activities have been completed in the first set of studies using the robotic device and imitating a paretic hand. The robotic additional finger is utilised in the second set to increase the workspace and manipulation power of healthy hands. The identical EMG control interface has been used to both sets.

## Introduction

Wearable robotic technologies, such as exoskeletons, have mostly been utilised to replace amputated limbs or to rehabilitate human limbs. In addition to more conventional wearable robotic structures, a particularly promising research line focuses on augmenting human limbs with robotic limbs rather than replacing or improving them. The use of wearable robotic prosthetic limbs has two benefits. On the one hand, this augmentation gives humans the opportunity to improve their capacities. On the other hand, extra limbs can make up for defective limbs' lost functions, for example in the case of chronic stroke patients.

Recently, we began looking into how a second robotic finger might work in tandem with a human hand. We primarily concentrate on two potential applications: augmenting the human healthy hand to increase its capabilities and compensating the missing abilities of stroke patients with a paretic hand. Regarding grasp compensation in stroke patients, it should be mentioned that numerous wearable gadgets, particularly for hand rehabilitation and functional recovery, have been developed over the p. A supernumerary robotic finger with an EMG control interface that can be used to regulate motion and joint stiffness. The goals are to compensate for grasping in chronic stroke patients and augment the healthy human hand to improve its workspace and grasping abilities.

The robotic finger's compliance is managed by changes in EMG signal amplitude, and its mobility is controlled by gesture recognition. Through a servo motor-based control strategy, the robotic device's compliance can be modulated using an EMG one channel electrode interface. We created a five-degree-of-freedom device that the user may wear around their wrist with an elastic band. We verified the effectiveness of using a technology to improve and compensate for human grasping capabilities. We specifically demonstrated how the extra robotic finger may act as an extra thumb, expanding the human hand's workspace and hand dexterity, and how it can make up for the non-functional hand's lost talents in stroke patients. Through tests, we show that both patients and healthy subjects can control various flexion trajectories and modify grasp tension using the same interface past ten years.

The primary concept was to use the paretic arm and robotic finger as the two components of a gripper to hold an object. The robotic finger's flexion and extension could be controlled by the human user, who also received vibrotactile input on the forces the robotic finger was applying to the object it was holding. Finger flexion and extension are controlled by the frontalis muscle, which is recorded via an EMG interface. An EMG interface built into a cap and an underactuated, compliant additional finger. With regard to enhancing the healthy human hand, we demonstrated a prototype robotic additional finger, demonstrating how this wearable device might improve healthy participants' grasping and dexterity. An object-based mapping algorithm that allows users to manipulate robotic prosthetic limbs implicitly. The primary goal of the mapping was to follow the human hand with a dataglove and replicate the hand's primary movements on the extra finger. Even while the earlier efforts on extra-robotic fingers showed the impact of the research quite clearly, the robotic devices and their control interfaces shown today are not sufficiently general. In actuality, the suggested systems could only handle a limited number of inputs, and no methods for adjusting the robotic finger's compliance to regulate the force applied to the object being clutched have been suggested.

Since extra robotic fingers are intended to work in concert with human limbs and intimately interact with them, they should behave similarly to human fingers in terms of control. Depending on the situation and the actions being carried out, humans have the ability to dynamically adjust the stiffness of their arms. For instance, when we wish to achieve a perfect positioning or while we are holding big loads, muscular constriction might increase stiffness. Making the robotic additional finger's actuators and sensing capabilities compatible with stiffness regulation control approaches is therefore of utmost significance. Second, we think that the stiffness of robotic fingers should be directly controlled by the user through an interface.

The primary contribution of this work is the creation of a novel EMG interface that can be used to regulate both the motion and compliance of the extra robotic finger, so affecting how tightly the grasp is achieved. We specifically link various finger motions to various hand gestures made by people. For hand gesture recognition, we made use of an industrial EMG interface. The user's biceps signal was read using a special Surface One bipolar EMG channel for the compliance control. The user can more effectively manage separately grasp tension and device motion thanks to the separation of the two EMG readings. We also exhibit a newer iteration of the robotic additional finger prototype, whose ball bearing and spur gear system permits adduction and abduction action. The suggested approach can be employed by both healthy subjects and patients for grasp augmentation and compensation.

We conducted a pilot research to show the approach's viability with a healthy hand for enhancing its capabilities and a simulated paretic hand to make up for losing grasp abilities. In order to conduct two distinct sets of tests involving the augmentation of a healthy hand or the compensation of a simulated paretic hand, we used four healthy individuals. In both instances, the interface produced enough of a result to successfully control the additional robotic finger and carry out the suggested task. All of the studies involved wearing the wearable device on one arm and the control interface on the other. In fact, patients cannot correctly regulate hand motion and muscle contraction in their paretic upper limbs, whereas healthy participants may be able to wear the interface on the same arm as the device.

One alternative is to use the healthy arm, which also delocalizes the EMG reading to another area of the body. Keep in mind that the hand motions are only required to choose one of the device's predetermined behaviours; they do not need to be maintained for an extended period of time. This is crucial for bimanual tasks that require the use of both hands.

## Conclusion

In patients with hypertensive nephropathy, the combination of HQI and antihypertensive medications is more important in improving the associated indexes than taking antihypertensive medications alone, and an evidence dose of HQI may be more beneficial. In individuals with hypertensive nephropathy, HQI in combination with antihypertensive medications significantly improves renal function and blood pressure control. The methodology's poor quality and the study's small sample size mean that further rigorous randomised controlled trials are required to corroborate the findings.

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