ThirdHand: Wearing a Robotic Arm to Experience Rich Force Feedback

Yi-Chi Liao* Shun-Yao Yang* Rong-Hao Liang* Liwei Chan*† Bing-Yu Chen*
*National Taiwan University †Keio University

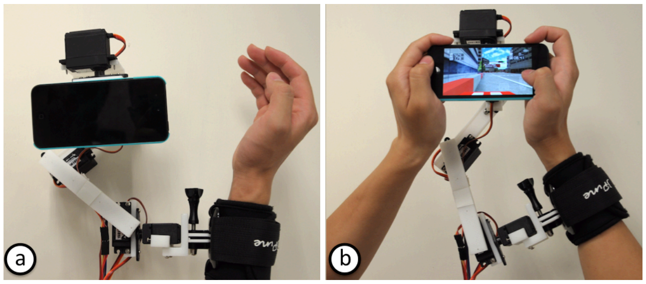

Figure 1: *(a) The ThirdHand is a robot arm that is allowed for attaching to users' wrist, serving as an addition support for a mobile device and (b) providing versatile force feedback to mobile game.*

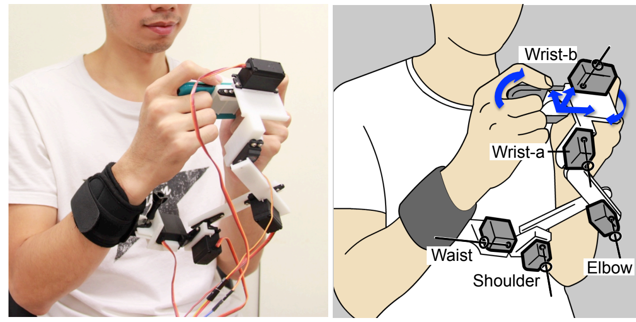

Figure 2: *The prototype device consists of five motors to provide directional forces at three axes and the rotational forces at pan and roll rotations.*

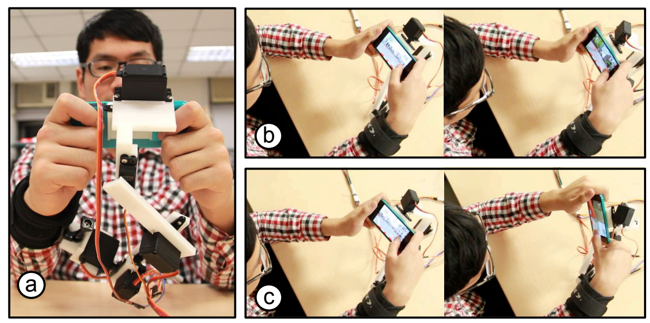

Figure 3: *(a) Car racing with ThirdHand. (b) ThirdHand pushes the screen away from the user when he is pressing the throttle button, and pulls the screen toward the user when he is pressing the brake button. (c) When the car hits a barrier on the road, the screen tilts correspondingly.*

1 INTRODUCTION

Mobile devices such as smartphones become prevalent gaming platforms. To enrich the gaming experiences, researchers are increasingly interested in bringing various haptic feedback to the mobile games. Traditional haptic devices such as phantom [1], a robotic arm that generates force on fingers in precise 6 DOF (Degree Of Freedom), can provide accurate and rich force feedback. However, since the devices need to be grounded on a fixed surface, they are not mobile. Therefore, recent research also explored haptic interaction on mobile devices with self-contain mechanisms. GyroTab [Badshah et al. 2012] demonstrated the potential of ungrounded devices using gyro effect to generate torque feedback. Muscle-propelled force feedback [Lopes and Baudisch 2013] eliminated motors and instead actuating the users muscle for creating feedback. However, these devices provide only 1-DOF force feedback, therefore limit the possible expressions and applications. Hence, this work presents *ThirdHand* (Figure 1), a wearable robotic arm which provide 5-DOF force feedback to enrich gaming experiences.

2 SYSTEM DESCRIPTION

Figure 2 shows our prototype device. The robot arm comprises five motors to provide five degrees of freedom. The motor Wrist-a and Wrist-b are to control pan and roll of the screen. As a result, the prototype is capable of delivering directional forces along the devices three axes, and rotation forces at pan and roll rotations. All the motors except the motor Wrist-a adopted high torque Servo 1501MG. The motor Wrist-a studiedly adopted Coreless Servo BB (25g) with torque at 2.8 kg/cm, because the motor has notably small friction comparing to other motors. We purposely used this small motor to allow users the freedom to take control of the degree-of-freedom, so that users can freely steer the screen in hand without affecting by the primitive friction of the motor. To strengthen the structure while reducing the weight, arms that connect motors were embedded with carbon fiber. The weight of the prototype is 504g.

3 APPLICATION: Car Racing Game

To deliver engaging gaming experience, the *ThirdHand* generates force feedback to the mobile phone in response to the game context. Figure 3 demonstrates an example of a car racing game. When the user presses the throttle button, the screen is pushed away; when the user presses the brake button, the screen is pulled toward his face. When the car hit anything on the road, e.g. a barrier, the phone tilts regarding to the collision.

References

BADSHAH, A., GUPTA, S., MORRIS, D., PATEL, S., AND TAN, D. 2012. Gyrotab: A handheld device that provides reactive torque feedback. In *Proc. ACM CHI '12*, 3153–3156.

LOPES, P., AND BAUDISCH, P. 2013. Muscle-propelled force feedback: Bringing force feedback to mobile devices. In *Proc. ACM CHI '13*, 2577–2580.

SA'15 Emerging Technologies, November 02-06, 2015, Kobe, Japan
ACM 978-1-4503-3925-4/15/11.
http://dx.doi.org/10.1145/2818466.2818487

[1] http://www.dentsable.com/haptic-phantom-omni.htm