Integrating Multisensory Information for Modeling Human Dexterous Bimanual Manipulation Skills

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***Abstract*— We propose to make a demonstration of the experimental setup that we have developed to measure human bimanual dexterity in watchmaking. These measurements and their analysis are used to develop robot controllers with similar dexterity. Next we explain the data collection.**

I. INTRODUCTION

The SAHR (Skill Acquisition in Humans and Robots) project aims at a better understanding of the human skill acquisition process with a special focus on bimanual dexterous manipulation tasks (see Fig. 1), so as to develop novel robotic controllers resulting in the same level of precision and robustness (see Fig. 2). We conduct a longitudinal study of the acquisition of dexterous bimanual skills in watchmaking craftsmanship, where precise, coordinated, and directionally compliant control of the hands and fingers motions are required. We model human skills by collecting both tactile and visual information of human during watchmaking manipulations and then use the recorded data to model and analyze human motion, in order to understand the acquisition and evolution of human skills.

This demonstration shows the procedure of watchmaking task and illustrates how the tactile and visual information is collected during manipulation process.

II. DATA COLLECTION

We have established a data recording system that composes of tactile sensing system and motion capture system (see Fig. 1) to record tactile and visual information of human motion, respectively.

A. Tactile Information Collection

Three different types of tactile sensors are used to record tactile information during the manipulation of watchmaking.

1) FingerTPS Sensors: for each hand, 6 FingerTPS sensors are used (12 sensors in total) to cover desired finger phalanges for recording applied pressure.

2) ATI Nano17 Force/Torque Sensor: this miniature force/torque sensor is mounted on the base of the watch to record the interactive force and torque signals applied to the watchface.

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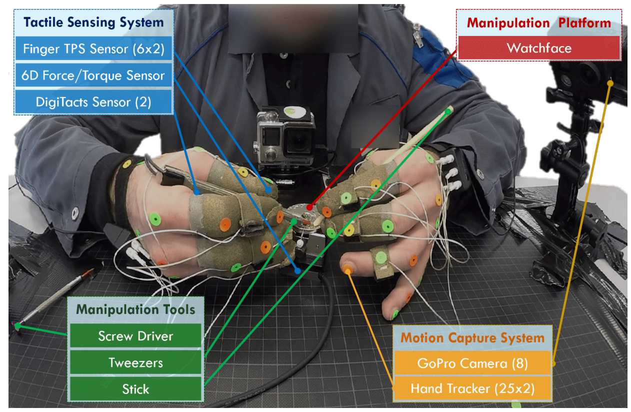

Fig. 1. Experimental setup for human data collection.

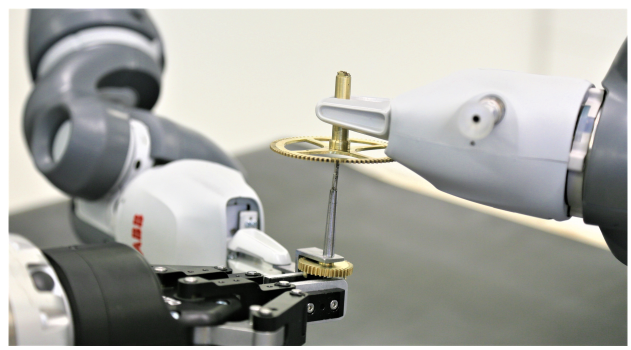

Fig. 2. Illustration of robot learning complex bimanual manipulation skills from human demonstration.

3) DigiTacts Sensing Systems: the DigiTacts systems comprising 24 sensing elements are mounted on both sides of the tweezers (12 sensing elements on each side surface) to record the value and location of the applied pressure.

B. Visual Information Collection

The motion capture system is arranged for the recording of kinematic information of human motion.

A camera array consisting of 8 GoPro cameras are mounted surrounding the workspace to capture the human hand movement at high speed and high resolution from multiple perspectives. Twenty-five trackers are pasted on each hand of human subject to enable the recording of hand pose and positions of finger joints.

The 3D trajectories of these trackers are calculated afterwards, which are used for the reconstruction of hand skeleton models as well as the reproduction of human hand motion. The movements of the manipulation tools (screw driver, tweezers, and stick) are recorded by tracking the markers at their both ends.