Exo-Balancer: Design Method of Personalized Stabilizers for Shooting Actions

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ABSTRACT

In photography and videography, it is a huge challenge to align sight towards a moving target continuously and steadily, often requiring considerable practice and experience. Blurry photos are often taken by camera users who lack requisite skills. To address this problem, stabilizers have been designed. Conventional stabilizers introduce a steep learning curve, because they are designed to be mass-produced and not tailored to the individual. Therefore, we present a design method of personalized stabilizers for shooting actions. Our system requires users to input their body data. Then, the system proposes the suitable position of the camera to be harnessed to the user considering the moments of force of both the user and camera.

CCS CONCEPTS

•**Human-centered computing** → *Human computer interaction (HCI);* •**Information systems** → **Personalization;**

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1 INTRODUCTION

In recent years, the spread of image-sharing applications has led to an increase in the number of camera users. Unfortunately, the camera user's hands shake slightly, regardless of their conscious behavior. Shaky phenomena occur mainly because of the movement of the photoelectric surface in a camera during exposure. This problem can be solved to some extent by shortening exposure time. However, this generates another issue: lack of light quantity. Studies aiming to reduce shaking have been conducted for many years. However, most aim at removing camera shake after a photo is taken [1, 2]. Modern cameras have mechanisms to correct calculated image data using photodetectors and either record them or conduct real-time processing to physically adjust the optical axis. Indeed, these functions reduce camera shake to a certain degree; however, they cannot remove it completely.

Thus, the occurrence of camera shake and operable time depend on user skill. To address the issue further, tools have been developed, such as the tripod and the gimbal. A tripod can be expensive to install, and can only shoot from one point at a time. Meanwhile, a gimbal is more controllable than a tripod. There are two main types: hand-held and attached gimbals. The hand-held gimbal's weight is often a burden to users. Thus, its operability cannot be guaranteed. Alternatively, the controllability of an attached gimbal is also contingent upon user skill, because it is not a personalized device.

Therefore, we present a new design method for a personalized stabilizer, which is expected to allow all users to perform well, regardless of skill; to improve the operability and performance of stabilization, thus enhancing the quality of photos and movies; and to extend the operable time over existing non-personalized stabilizers. Figure 1 center shows an example of a shooting situation using our instrument. Personalization maximizes user's ability and combined with our system, it enables users to focus on their subject instead of stabilization, thus yielding desirable result.

2 IMPLEMENTATION

Exo-Balancer is divided into two broad components: the calculation component, which considers moments of force between the user and instruments to determine a suitable fixed position; and the personalized fabrication component, which uses the calculated result. The latter includes one harness, one monopod, one camera, two bungee cords, and four connectors, generated by a 3D printer. Figure 2 left depicts a model of the components connecting the harness to the monopod.

To reduce user stress when taking a photo, our method calculates a suitable position for the user using the balance relation between force and moment, according to the user's body data, and the fixed angles of an object. The user first inputs the distance from their shoulder to their lumbus (value = n, as shown in Figure 1 right)

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Figure 1: Left: our instrument assembly. Some parts consist of ready-made goods and components printed with a 3D printer. Center: an example of a shooting situation using our instrument. Right: simple configuration of our instrument. This image includes the applied forces, the masses of a few components, and the angles when the user is equipped with our instrument.

Figure 2: Left: all parts we prepared, consisting of a monopod, harness, bungee code, and 3D-printed components. Right: the user equipped with our instrument. The monopod is equipped with a movable panhead, therefore users can move a camera attached to the panhead freely.

as basic body data. Next, the user holds a camera in front-capture position, and measures the distance from the camera position to the harness position (value = l, as shown in Figure 1 right).

From equations of horizontal and vertical force equilibrium and the moment of forces around C, we obtain an equation about x, as follows.

$$x = \frac{(2m_c + m_f)L}{2(m_c + m_f)}$$

We define the equation, $F = F'$, as the requirement to calculate and minimize the forces on a user's body. Then, we obtain the equation for l, as follows.

$$2l^3 + nl^2 - 2l(n^2 + x^2) - n(x^2 - n^2) = 0$$

Our system optimizes the two equations by incorporating x and l, which are based on specific user values. Thus, we obtain a personalized optimal fixed camera position. After the calculation phase, users externalize the data to their physical world. First, we attach the harness to the user's body. It has a mounting plate, and we fix the monopod to the mount (see Figure 2 right).

3 CONCLUSION AND FUTURE WORK

In this paper, we presented Exo-Balancer, a design method for personalized stabilizers. We assembled prototypes, combined ready-made goods (e.g., one monopod, one harness, and two bungee cords) with four components, printed with a 3D printer (see Figure 1 left). For the harness we used, the part attached to user's body is made of rubber. Due to the rubber property of lightweight and elastic, it can be stretched easily when weights are applied. Therefore, the harness can be a less burdened on user's body, however it is not suitable for binding tightly to the user's body. We will consider using the harness made of materials which can tighten the gap between the harness and the user's body without burdening it.

Exo-Balancer presents one of the best fixed-position devices for users to operate comfortably with reduced stresses, because it is based on the user's own physical data. The optimal position considers the moment of forces between a user and equipment, including the camera. Our method needs to enhance the ability as a stabilizer, however, in terms of reducing impacts on the device caused by changing its fixed position. Nevertheless, our method has the potential to enhance usability more than holding a camera merely by hand.

In the future, automatic optimization of parameters, based on users' body data, will be required. It is difficult to prepare 3D-scanned parts because of the high cost. Thus, the challenge will be to automatically parameterize data for manufacture, based on crowdsourcing like Koyama et al. [3]. Future work could also scan the user's pose as they take a photo to evolve the current system to one that considers muscular movements.

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