Tangible Microscope with Intuitive Stage Control Interface

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Abstract. Control interfaces of microscope stage have been conservative because they historically precede compact mechanisms which can be used in dark rooms with the sense of fingertips. However, there is a trend of expanding frontier in microscope interaction. New kinds of interactions for microscope are proposed and the freedom of stage control increases by hexapod micropositioning. We propose a tangible microscope which has an intuitive stage control interface. The interface combines a tablet device and a hexapod stage. Because a stage is a plane, we virtually assume a stage is on one's palm. It is very intuitive that the stage moves in the same manner of palm's move. As a proof-of-concept, we constructed a prototype by regarding a tablet as a palm. We haven't any quantitative evaluation yet, but it is expected that the concept of tangible microscope bring a new sense of stage control to users.

Keywords: microscope, tangible interaction, gesture by palm metaphor, hexapod stage

1 Introduction

Control interfaces of microscope stage have been conservative because they historically precede compact mechanisms which can be used in dark rooms with the sense of fingertips. One of the traditional stage control interface is coaxial X-knob and Y-knob in the one side and Z-knob in the other side, which are convenient to control X, Y, Z direction with two hands. But it is against one's intuition that X-knob and Y-knob are located in a coaxial relation.

There is a trend of expanding frontier in microscope interaction. Boulanger developed a robotic microscope in cooperation with user's gazes [1]. It is useful when a user does some work such as soldering electric circuit with observing a microscope. However, the application is limited because the interaction is based on gaze angle and it is difficult to use in generic microscopes. On the other hand, the freedom of stage control improves in hexapod micropositioning [2]. By adjusting the length of six legs to support the stage, it has 5 stage movements; x, y, z, pan, and tilt. In order to utilize

such stages, we need a new stage control interface as an alternative of traditional stage control interfaces.

We focus how users feel a stage as an extension of the body. Because a stage is a plane, we virtually assume a stage is on one's palm. It is very intuitive that the stage moves in the same manner of palm's move. We constructed a prototype as a proof-of-concept and confirmed that such an interface brings new user experience to users in microscope imaging.

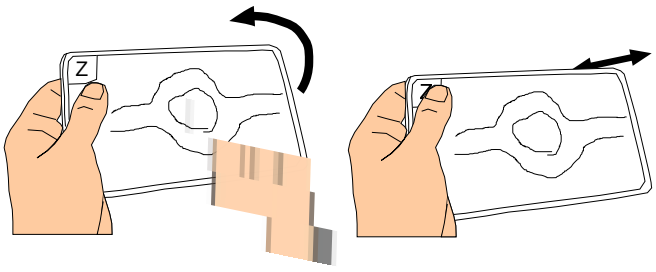
2 Tangible Interaction for Microscope

As for tangible interaction in microscopes, Lee and et al. proposed tangible interaction from the viewpoint of subjects [4]. In the system, a user can interact euglena with light controlled by one's finger. Though their viewpoint is on subjects, our viewpoint is on view control in micro world.

In order to control the view of microscope, we employ a palm-based metaphor for the stage. We assume a stage is virtually on users's palm. As for palm-based metaphors, there are some researches on palm-based gestures. Dezfuli and et al. proposed an interaction method to use palm as imaginary remote control for TV set, air conditioner, and so on [3]. They focus on convenience that users don't need to search any remote control devices. However, the reason we employ the palm is its intuitiveness. If one can move stage on one's palm, this can be said as tangible interaction for microscope.

In this research, we employ a small size tablet as a proxy of a palm instead of using palm directly. It is effective that we can deal with tablet just as a palm and we can utilize display and sensor at the same time.

The variations of tangible interactions are XY move, Z move, rotate, and tilt. They are so sensitive that user must push mode switch on the tablet screen. Fig. 1 shows operations of tilt control and z control. In tilt control gesture, user must specify a pivot point which is the center of tilt movement.



(a) tilt control (b) z control

Fig. 1. Stage Control by Palm-Metaphor Gesture

3 Prototype

Our prototype consists of PI H811 (hexapod stage), Nikon SMZ25 (microscope), Prosillica GE1660 (camera), HP620 (computer), and Sony Xperia Z3 Tablet Compact (user interface). Fig. 2 shows the partial appearance of the prototype; PI H811 and Nikon SMZ25. PI H811 and HP620 are connected by serial interface. Sony Xperia Z3 and HP620 are connected by WiFi. Prosillica GE1660 and HP620 are connected by ethernet.

A host program is working on HP620 and communicates with Sony Xperia using WebSocket. User interface program is written in HTML5. Motion sensors in Sony Xperia detects the movement of the tablet and then sends control commands to HP620, which controls the hexapod stage.

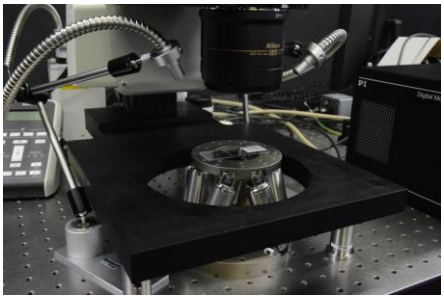


Fig. 2. Stage Control by Palm-Metaphor Gesture

4 User Experience

As for horizontal moves, a user can move the stage using strokes on the touch panel of the tablet. As for pan and tilt moves, the user can move the stage using tilting tablet with touching the surface. The stage moves quickly enough responding these gestures.

Examples of result images are shown in Fig. 3. Fig. 3(a) shows the image captured in a initial position. If the user wants to observe the subject (a fruit fly) from the direction over the head of the fruit fly, the user moves the tablet to the side of the user. Then the desired image is captured as shown in Fig. 3(b).

As for image display, the current prototype shows poor performance in speed (5 FPS). If a user moves the tablet quickly, the images don't follow the move. The weak point of the hexapod is that working area is not so large. If the stage is located apart from the center, it is impossible to control pan and tilt of the stage. In such a case, the tablet notifies the user of the limitation with vibration.

From this prototype, we identified the advantage and the disadvantage of intuitive stage control using gestures based on palm metaphor. The advantages are as follows.

- It is very intuitive to control stage by a tablet. This is a clear metaphor.
- By changing view angle, it is easy to understand 3D shape of a subject.
- It is so enjoyable to control a microscope just like a game.

The disadvantage is that the movement is sometimes very awkward because the range of working area is limited in the hexapod stage.

(a) Fruit Fly in the Initial Position (b) Fruit Fly after Moving the Tablet

Fig. 3. Stage Control by Palm-Metaphor Gesture

5 Conclusion

We proposed an intuitive stage controller for microscope and constructed a prototype as a proof-of-concept. Our contribution is the proposal of a novel gesture; tilt gesture with specifying a pivot point. This should enable new experience of imaging from the angle controlled in an intuitive and flexible manner.

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