

# Automatic Display Zoom for People Suffering from Presbyopia

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Figure 1: Explanation of automatic zoom and its example: (1) Material is displayed as original size when startup, (2) It is zoomed in when moving tablet close to face, (3) It is zoomed out when moving tablet away from face.

## CCS CONCEPTS

• **Human-centered computing** → Human computer interaction (HCI)

## KEYWORDS

Display zoom, Presbyopia

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## 1 INTRODUCTION

Human eyes have an adjustment function to adjust for different distances of seeing. However, it becomes weaker as you get older. When you move paper closer to read small letters, it is not in focus. When you move it away to bring it into focus, it is too small to read. This condition is called Presbyopia. People suffering from presbyopia also suffer from this condition when they use a smartphone or tablet. Although they can magnify the display using the pinch operation, it is a bother. A method for automatic display zoom, to see detail and an overview, was proposed in [Satake et al. 2016]. This method measures the distance between a face and a screen to judge whether you want to see detail or an overview. When you move it close to your

face, it judges you want to see detail and zooms in. When you move it away from your face, it judges that you want to see overview and zooms out. In this paper, we improve and apply this method for presbyopia. First we observe and analyze the behavior of presbyopic people when trying to read small letters. Then we propose a suitable zooming function, for example, a screen is zoomed in also when it is moved away if the person suffers from presbyopia.

## 2 CONVENTIONAL AUTOMATIC DISPLAY ZOOM BASED ON DISTANCE

We have used the front camera of a tablet to measure the distance between a face and a display in our conventional experimental system, instead of a depth sensor. We paid attention to the relation that binocular distance on a screen image captured by a camera (onscreen binocular distance,  $d(t)$  at time  $t$ ) is inversely proportional to the distance between a camera and a face. When onscreen binocular distance increases, it is judged that the screen is moving closer to a face. When it decreases, the screen is moving away. In addition, the change rate of onscreen binocular distance is related to the moving speed of the screen. It is calculated as  $v_T(t) = d(t) / d(t - T)$  at time  $t$  with interval time  $T$ . When a user moves a tablet slowly,  $v_T(t)$  become close to 1. The scale ratio to zoom in/out is proportional to this change rate  $v_T(t)$ . When you move it close to your face to see detail, it is zoomed in. When you move it away from your face to see an overview, it is zoomed out (Fig. 1).

## 3 OBSERVATION EXPERIMENT

We investigated how people move a tablet when they read small letters. Participants read small letters and also several other sizes of letters. Then we analyzed how presbyopic participants and other people move the tablet. As a result, presbyopic participants

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Figure 2: Explanation of presbyopia zoom and its example: (1) Material is displayed as original size when startup, (2) It is zoomed in when moving tablet close to face, (3) It is also zoomed in when moving tablet away from face.

moved the tablet and changed the distance between their face and the screen frequently when it is difficult to see because of presbyopia. In addition, they moved it slowly compared to others. On the other hand, presbyopic participants rarely moved it when there is no presbyopia problem for reading large size letters, and the moving speed is not always the same. We thought that others can focus on it even if they move it quickly.

#### 4 AUTOMATIC DISPLAY ZOOM CORRESPOND TO PRESBYOPIC PEOPLE

We propose an improved automatic display zoom method based on the experimental results. Here, we call the zoom mentioned above as normal zoom, and an additional function of an improved method as presbyopia zoom. This presbyopia zoom works only when you hardly see due to presbyopia. A point system is introduced to judge which type zoom should work, in other words, whether there is a presbyopia symptom, according to a tablet motion. Added and subtracted points are defined as Fig. 3 for each tablet moving speed (not absolute speed), according to the experimental results. Presbyopic people usually moved a tablet at the speed range where a point is added. A total point is added and subtracted at every interval time, then presbyopia zoom works when the point is greater than the predefined threshold. It is subtracted, for example, when a tablet is moved closer and away faster than the presbyopia speed range, and when a tablet has not moved for a while. Fig. 4 shows the

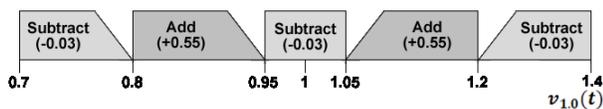


Figure 3: Point addition and subtraction condition for  $v_{1.0}(t)$



Figure 4: Zoom mode, type, and moving speed  $v_{1.0}(t)$

zoom mode (in/out) related to zoom type (normal/presbyopia) and tablet moving speed. The scale ratio to zoom in/out is proportional to this point only for presbyopia zoom. We applied this idea to develop an experimental system, and a presbyopic people and an emmetropia people tried to use it to check how it works (Fig. 5). First, the emmetropia people moved the tablet without presbyopia symptom (Fig. 1), zoom type was not changed from normal zoom to presbyopia one. It was zoomed in when a tablet was moved close to a face (Fig. 1(2)). After that, it was zoomed out when it was moved away (Fig. 1(3)). Next, the presbyopic people moved the tablet with presbyopia symptoms (Fig. 2), and zoom type was changed to presbyopia zoom. It was zoomed in with the scale ratio for presbyopia when it was moved closer (Fig. 2(2)). After that, it was zoomed in again even when it was moved away (Fig. 2(3)).



Figure 5: Trial scene

#### 5 CONCLUSION

In this paper, we proposed automatic display zoom corresponding to presbyopic people. It recognizes a user's situation and provides a suitable zoom function. Although an experimental system worked as we expected, it did not work well when a user did not move the tablet at a supposed speed. In the future, we would like to conduct further experiments to find additional differences between presbyopic people and others. We should develop practical and useful automatic zoom for presbyopic people.

#### REFERENCES

Satake, Y., Funahashi, K., 2016, Automatic Display Zoom Using Face Size Of Camera Image, Proc. ICAT-EGVE 2016 (poster & demo), pp.1-2