Effects of Bezel Size in Large Tiled Display Gaming

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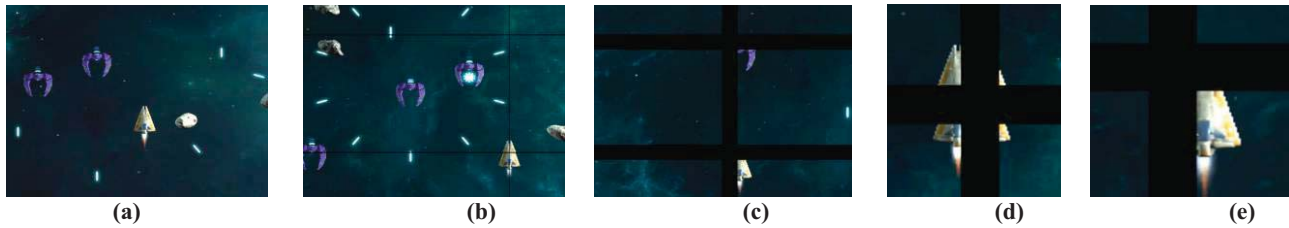{smithgm | teather | lassjw | carette}@mcmaster.ca

Figure 1. Bezel size/compensation conditions. (a) No bezels. (b) 0.25 cm size, compensation off; (c) 4 cm size, compensation on. (d) Close-up of player ship split by un-compensated bezels. (e) Close-up of player ship occluded by compensated bezels.

1. INTRODUCTION

Many spatial UI systems (e.g., VR) rely on large displays. One method of building large high-resolution displays is to use multiple HD monitors as tiles in a single large display. The downside is the presence of monitor borders – bezels – between each tile in such a display. Hardware manufacturers such as NVidia and AMD have developed "bezel compensation" techniques for tiled displays. This treats space behind bezels as part of the coordinate space, hence objects can be occluded behind bezels (Figure 1e). Without bezel compensation, objects break across display borders, and may appear distorted (Figure 1d).

Recent work [1, 2] looked at this problem via static judgment tasks. However games and VR are highly dynamic involving fast-paced reactions and tightly-coupled feedback loops. Previous results may not generalize to interactive scenarios. The effect of bezel compensation is also unclear: consider that "hiding" objects behind bezels could be worse than distorting them!

2. USER STUDY

We compared game performance across different simulated bezel sizes in a 3x3 tile configuration. Twelve gamers took part. We used a 3.4 GHz PC with a 75 in. 1080p TV for the display. Participants sat 10 ft. from the screen and played custom game made in Unity 4.5. Bezels (with compensation) were simulated by drawing black bars over the screen. Without compensation, we used multiple cameras with gaps between their viewing volumes to "break" the coordinate space across the bezels. See Figure 1.

Participants played 4 one-minute trials in each condition. The game involved moving the ship to avoid enemies, asteroids, and projectiles. Enemies moved straight down from the top of the screen and fired bullets either straight down or in an outward pattern. Asteroids moved straight down. The player could destroy these with a single shot (increasing their score).

The study used a 6x2x4 within-subjects design. The independent variables were *bezel size* (0, 0.25, 0.5, 1.0, 2.0, 4.0 cm), *bezel compensation* (on, off), and *trial* (1, 2, 3, 4). Bezel size was counterbalanced with a balanced Latin square. Dependent variables included longest streak duration (in seconds), game score, and the number of times the player died (count) over both all obstacles (enemies, asteroids, bullets) and just bullets.

3. RESULTS AND CONCLUSIONS

The main effects for bezel compensation ($F_{1,11} = 2.8$, $p = 0.12$) and bezel size ($F_{5,11} = 0.68$, ns) on score were not significant. Their interaction was also not significant ($F_{5,55} = 0.4$, ns). For longest streak duration, the main effect for bezel compensation ($F_{1,11} = 0.37$, ns) and bezel size ($F_{5,11} = 1.2$, $p = .34$) were not significant, nor was their interaction ($F_{5,55} = 1.2$, $p = .33$).

For player deaths only trial was significant ($F_{3,11} = 3.1$, $p < .05$). We also analyzed how often players were killed by bullets only - the smallest object that could be occluded by bezels. The bezel size/compensation interaction was significant ($F_{5,55} = 2.4$, $p < .05$). Although we expected the largest bezels to have the strongest impact, the worst condition was bezel compensation with 1 cm bezels. See Figure 2.
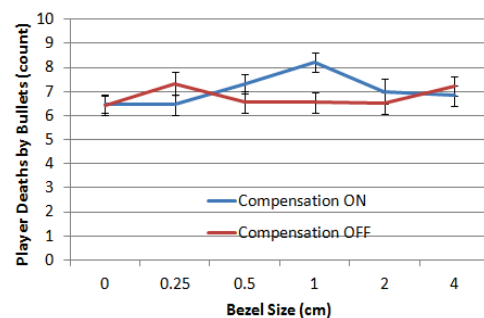

Figure 2. Player deaths due to bullets by bezel size and bezel compensation.

Our current (incomplete) results suggest that the impact of bezel size, or differences due to employing bezel compensation are fairly minimal in games. Future work will focus on different display configurations and using additional participants.

4. REFERENCES

[1] Wallace, J. R., Vogel, D., and Lank, E., Effect of bezel presence and width on visual search, *Pervasive Displays 2014*, 118-123.

[2] Wallace, J. R., Vogel, D., and Lank, E., The effect of interior bezel presence and width on magnitude judgement, *Graphics Interface 2014*, 175-182.