

# User-Defined Game Control with Smart Glasses in Public Space

**1st Author Name**  
Affiliation  
Address  
e-mail address  
Optional phone number

**4rd Author Name**  
Affiliation  
Address  
e-mail address  
Optional phone number

**2nd Author Name**  
Affiliation  
Address  
e-mail address  
Optional phone number

**5rd Author Name**  
Affiliation  
Address  
e-mail address  
Optional phone number

**3rd Author Name**  
Affiliation  
Address  
e-mail address  
Optional phone number

**6rd Author Name**  
Affiliation  
Address  
e-mail address  
Optional phone number

## ABSTRACT

Without specific game controller and direct-touch, game control on Smart Glasses differs with existing console and mobile games. Although current game control set on Smart Glasses is explored by developers based on system limitation, the set is not reflective of user behavior. To create better game control, we presented an user-defined game control study in public space to collect user behavior. In all, 2448 game controls from 24 participants were logged, analyzed, and paired with think-aloud data for 17 commands performed with 3 interaction methods (On-Body, In-Air and Phone) and 2 glasses forms (Google Glass and Epson BT-100). Our findings indicate that users choose area relatively unobtrusive to perform the game control, and glasses form does influence how users creates game control. We also present a complete user-defined game control set with agreement scores and taxonomy. Our results will help designers create better game control sets informed by user behavior.

## Author Keywords

Guides; instructions; author's kit; conference publications; keywords should be separated by a semi-colon.

Optional section to be included in your final version, but strongly encouraged.

## ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

See: <http://www.acm.org/about/class/1998/> for more information and the full list of ACM classifiers and descriptors.

Optional section to be included in your final version, but strongly encouraged. On the submission page only the classifiers letter-number combination will need to be entered.

Paste the appropriate copyright statement here. ACM now supports three different copyright statements:

- ACM copyright: ACM holds the copyright on the work. This is the historical approach.
- License: The author(s) retain copyright, but ACM receives an exclusive publication license.
- Open Access: The author(s) wish to pay for the work to be open access. The additional fee must be paid to ACM.

This text field is large enough to hold the appropriate release statement assuming it is single spaced.

Every submission will be assigned their own unique DOI string to be included here.

## INTRODUCTION

### RELATED WORK

Game Control

Glass Input

Gaming in Public Space

User-Defined Gesture

### DEVELOPING A USER-DEFINED GAME CONTROL SET

#### Overview and Rationale

Playing game is a *user-computer dialogue*[6], a conversation mediated by language of inputs and outputs. As in any dialogue, feedback is essential to conducting this conversation. When something is misunderstood between humans, it may be rephrased. The same is true for user-computer dialogues. Feedback, or lack thereof, either endorses or deters a player's action, causing the player to revise his or her mental model and possibly take a new action.

In Developing a user-defined game control set, we did not want the limitation of input technology to influence users' behavior. Hence, we sought to remove the *gulf of execution*[9] from the dialogue, creating, in seence, a monologue in which the player's behavior is always acceptable. This enables us to observe users' unrevised behavior, and drive system design to accommodate it.

In view of this, we developed a user-defined game control set by having 24 participants perform game control with 2 Smart Glasses (Google Glass and Epson BT-100) in a public cafe. To avoid bias from visual hint[3], no elements specific to Mobile, Console, PC games were shown. Similarly, no specific game title was assumed. Instead, participants acted in a simple blocks world of geometry shapes or basic human avatar. Each participant saw the effect of a game control (e.g., an object moving left and right) and was asked to perform the game control he or she though would cause that effect(e.g. moving the finger tip left and right in front of their chest). In another word, the effect of a game control is the *game task* to which the game control try to complete.

Seven-teen game tasks were presented, and game controls were elicited for three different interaction methods (in-air

#	Description	Used in Famous Game
1	Single select	Clash of Clans, Plague Inc.
2	Vertical menu	Puzzle&Dragon, PeggleHD
3	Horizontal menu	Clash of Clans, PeggleHD
4	Move left and right	Temple Run, Super Mario
5	Move in 4 directions	1943, RaidenX
6	Switch 2 objects	Candy Crush, Bejeweled
7	Move object to position	World of Goo, The Sim
8	Draw a path	Draw Something, P&D
9	Throw an object (in-2D)	Angry Birds, PeggleHD
10	Note highway	RockSmith, Deemo
11	Rotate an object (Z-axis)	Zuma, PeggleHD
12	Rotate an object (Y-axis)	Spore, The Sim
13	Avatar jump	Temple Run, Super Mario
14	Avatar 3D move	Spore, Tintin
15	Avatar attack	Minecraft, Terraria
16	Avatar squat	Temple Run, Minecraft
17	3D Viewport control	The Sim, Spore

**Table 1. Summary of our general casual game task set. We named several famous games which uses these tasks.**

gesture, on-body input, mobile phone interaction). The system did not attempt to sense the users' control input, but we use camera to record the whole control process. Participants used the think-aloud protocol and been interviewed about the control detail. They also supplied subjective preference ratings.

The final user-defined game control set was developed in light of the *agreement* participants exhibited in choosing game control for each command[15]. The more participants that used the same gesture for a given command, the more likely that gesture would be assigned to that command. In the end, our user-defined game control set emerged as a surprisingly consistent collection founded on actual user behavior.

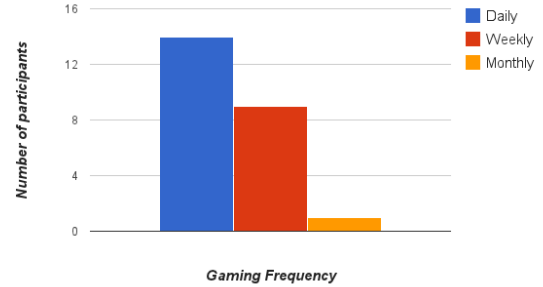
### Game Task Set

Casual game is one of the game categories with most players[5], it is shown high potential in public gaming[10, 11, 2]. We choose top 90 casual games[13] from existing platforms, including PC, console and mobile games (30 games for each) by crawling and analyzing the sale and download count data from famous gaming websites[1, 14, 12, 7]. We invited 3 experienced game developer to review these top 90 casual games. They find out totally 26 game tasks, and removed 9 tasks which only be used once in specific games. At last, we get a general casual game task set with 17 tasks, which can completely support 90% of our top casual games. We describe our general casual game task set in Table 1.

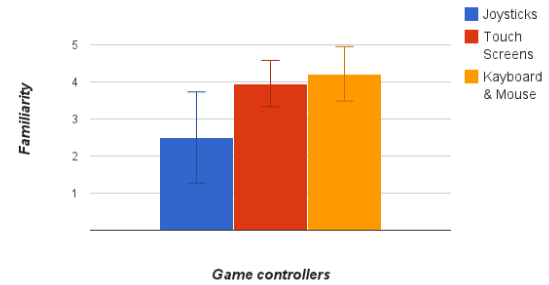
### Participants

We recruited twenty-four participants from the general public for our study. Twelve were female. Average age was 23.2 ( $sd = 2.72$ ). All participants are right-handed and none of them had used a Smart Glasses. About their gaming experience, according to our investigation, most participants play games at least one time per week (see Figure 1). It takes 1.36 hours ( $sd = 0.89$ ) for participants to play games a time. Moreover, 58% of them indicated that their main gaming platforms were

on mobile phones, 38% were on PCs, and only 4% were on consoles. Another important factor of gaming experience is the familiarity of game controllers. The result showed that, compared with joysticks, most of them were more familiar with keyboards, mouses and touch screens (see Figure 2).



**Figure 1. With Caption Below, be sure to have a good resolution image (see item D within the preparation instructions).**



**Figure 2. With Caption Below, be sure to have a good resolution image (see item D within the preparation instructions).**

### Glass Forms

There are many Smart Glasses with different screen sizes and screen placement on the current market. To observe the effect of different display designs upon the study result, our study conducted on two famous Smart Glasses, Epson and Google Glass. The display of Epson BT-100 is located in front of the user's eyes with  $960 \times 540$  resolution (equivalent of a 320" screen from 20 m away)[4]. And Google Glass locates its display above the user's right eye with  $640 \times 360$  resolution (equivalent of a 25" screen from 2.4 m away)[8].

### Interaction Methods

#### Procedure

Users wear two different glasses (BT-100 and Google Glass) and our software randomly presented 17 game tasks (Table 1) to participants. For each game task, participants performed a game control in 3 different interaction methods (in-air gesture, on-body input and phone interaction). Glasses form and interaction method are counter balanced. After each game control, participants were shown a 5-point Likert scales concerning subjective preference. With 24 participants, 17 game

Method	Mean	Std.	L.Bound	U.Bound
In-Air	3.81	0.90	3.75	3.87
On-Body	3.77	0.81	3.72	3.83
Phone	3.68	0.79	3.63	3.74

**Table 2.** Summary of user preference between 3 different interaction methods, it provides mean value, standard deviation, 95% confidence interval for mean(Lower Bound and Upper Bound).

tasks, 2 glasses forms and 3 interaction methods, a total of  $24 \times 17 \times 2 \times 3 = 2448$  game control were made. Of these, 11 were discarded due to participant confusion.

## RESULTS

Our results include game control taxonomies, the user-defined gesture sets, user rating, subjective responses, and qualitative observations for each interaction methods.

### Preference Between Interaction Methods

Table 2 shows the average rating of 3 interaction methods. There is a significant difference across three interaction types ( $F(?,?)=??$ ,  $P = .01$ ). We found the user rating preference for in-air gesture is significant higher than phone interaction ( $P = .009$ ). And We did not find significant difference between in-air and on-body ( $P = .688$ ) or on-body and phone interaction ( $P = .086$ ). According to our interview, we found the general reason from user to give phone lower score. It is because they have to take out their phone from packet, they think it is not always available. And it is not hands-free compared to the other interaction methods in this study. Considering the article length of this paper and user preference mentioned above, our report will focus on the finding for in-air gesture and on-body input.

### Behavior with Different Glasses Forms

#### Classification of Game Controls

##### User-Defined Game Control Sets

*Agreement*

*Conflict and Coverage*

*Properties of the User-defined Gesture Sets*

*Taxonomic Breakdown of User-defined Game Controls*

##### Mental Model Observations

*Social Acceptance and Control Area*

*Metaphor from Existing Game Control*

## DISCUSSION

*Users' and Designers' Gestures*

*Implications for In-Air Gesture Technology*

*Implications for On-Body Input Technology*

*Implications for User Interfaces*

*Limitation and Next Steps*

## CONCLUSION

## ACKNOWLEDGMENTS

## REFERENCES

1. App Annie. <http://www.appannie.com>.

2. Biskupski, A., Fender, A. R., Feuchtnner, T. M., Karsten, M., and Willaredt, J. D. Drunken ed: A balance game for public large screen displays. In *CHI '14 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '14, ACM (New York, NY, USA, 2014), 289–292.
3. Epps, J., Lichman, S., and Wu, M. A study of hand shape use in tabletop gesture interaction. In *CHI '06 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '06, ACM (New York, NY, USA, 2006), 748–753.
4. Epson BT-100 Specs. [http://www.epson.com.au/products/ProjectorAccessories/Moverio\\_BT-100\\_specs.asp](http://www.epson.com.au/products/ProjectorAccessories/Moverio_BT-100_specs.asp).
5. Essential Facts About The Computer And Video Game Industry. [http://www.theesa.com/facts/pdfs/esa\\_ef\\_2014.pdf](http://www.theesa.com/facts/pdfs/esa_ef_2014.pdf).
6. Foley, J.D., v. D. A. F. S. H. J. *The form and content of user-computer dialogues*. In *Computer Graphics: Principles and Practice*. Reading, MA: Addison-Wesley, 1996.
7. GameStop. <http://www.gamestop.com>.
8. Google Glass wiki. [http://en.wikipedia.org/wiki/Google\\_Glass#Features](http://en.wikipedia.org/wiki/Google_Glass#Features).
9. Hutchins, E.L., Hollan, J.D., Norman, D.A. Direct manipulation interfaces. In *Human-Computer Interaction 1* (1985), 311–388.
10. Jurgelionis, A., Nap, H. H., Gajadhar, B. J., Bellotti, F., Wang, A. I., and Berta, R. Player experience and technical performance prospects for distributed 3d gaming in private and public settings. *Comput. Entertain.* 9, 3 (Nov. 2011), 16:1–16:19.
11. Reis, S. Expanding the magic circle in pervasive casual play. In *Proceedings of the 11th International Conference on Entertainment Computing*, ICEC'12, Springer-Verlag (Berlin, Heidelberg, 2012), 486–489.
12. Steam. <http://store.steampowered.com>.
13. Top 90 Casual Games List. <http://ppt.cc/h02j>, Analyzed at 2014-08-14.
14. VGChartz. <http://www.vgchartz.com>.
15. Wobbrock, J. O., Aung, H. H., Rothrock, B., and Myers, B. A. Maximizing the guessability of symbolic input. In *CHI '05 Extended Abstracts on Human Factors in Computing Systems*, CHI EA '05, ACM (New York, NY, USA, 2005), 1869–1872.