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Users' Preferences for Map Navigation Gestures

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***Abstract*—**Map is a powerful and convenient tool in helping us to navigate to different places, but the use of indirect devices often makes its usage cumbersome. This study intends to propose a new map navigation dialogue that uses hand gesture. A set of dialogue was developed from users' perspective to provide users complete freedom for panning, zooming, rotate, tilt and find direction operations. A participatory design experiment was involved here where one hand gesture and two hand gesture dialogues had been analysed in the forms of hand gestures to develop a set of usable dialogues. The major finding was that users prefer one-hand gesture compared to two-hand gesture in map navigation.

***Keywords*—**Hand gesture, map navigation, participatory design, intuitive interaction.

I. Introduction

MAPS have become a major part of our lives in helping us to navigate to different locations with ease and reliability. These maps are readily available through websites and applications, but as technology advances, user expectation has also escalated particularly in regards to the abilities of the systems. Traditional input tools, such as keyboard and mouse, are no longer sufficient to meet these demands even with adequate knowledge on the application's functionality [1]-[3]. Research in the field of human-computer interaction has shown that the use of hand gesture improve the intuitive, natural, and ergonomic interface design [4].

Another challenge lies in the physical and conceptual complexity of the map navigation interface. Most systems designed by experts have neglected how difficult the interface is for people who lack these experiences [1]. There are also researchers focusing on algorithms to improve the accuracy, speed, and robustness of the system without considering the human aspect [3]. These algorithms are only improving the aspects of hand gesture recognitions, not ergonomics to enhance user navigation performance. Human factors should be taken into consideration in designing an interface for map navigation.

The appropriate design solutions to design problems of the participatory design in methodologies are one of the concerns in designing hand gesture interface [5]. Nevertheless, it has to be emphasized that there is no perfect design which is able to fulfil each user's requirement [4]; every interface has its own behaviour and needs a custom-designed or standardised dialogue to make it intuitive and easy to use for specific tasks [6].

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Aside from the little studies published on user-centred interfaces map navigation design, there are apparently insufficient investigations on the modalities preferred by users based on delivered performance. It will be interesting to explore the design and operations of the interface on the usage context and map navigation domain [7]. This has been partly retrieved from the encouraging result from semi-structured interviews in this study. With this, a usable user-defined hand gesture dialogue for map navigation applications has been developed using the participatory design. This paper presents investigation on user preferred hand in map navigation interfaces, participatory design methodology of hand gesture interaction in map navigation interfaces, and user-defined dialogue for map navigation.

II. Related Research

A. Interactive Map Navigation

Interactive maps allow users to change the map viewpoint alternatively to meet their personal needs and retrieve further information [8]. As such, the usability of maps navigation interfaces depends heavily on their interaction modality and operation. Map interfaces operations are very important in designing the context of use where the operations directly affect the performance of map navigations. Meng [9] has investigated the possible operations of navigation interfaces as listed in Table I. This operation list is more suitable for advance users in the aspect of complexity and redundancy of the operations. For example, it requires the user to study the different characteristic of the maps so that the visualisation parameter can be altered to perform the action. This intention seldom arises in novice users because they only need to view the map, not study the map's characteristic. Kim et al. [10] proposed another version of operations which covered few simple operations including pan, rotate, zoom, tilt, and play tour. When select the operations, the scope can be narrowed down to reduce complexity and save time. Therefore, it is more suitable for novice users.

B. Study of Participatory Design

Nielsen et al. [4] proposed an approach to determine the human gestures through participatory experiment. The gesture sets were tested and claimed to have improved, though limited discussion and evaluation have been reported regarding its subsequently adapted by other researchers to fulfil the requirements for designing gesture applications. For instance, Wobbrock et al. [11] adopted the participatory design approach and proposed a tabletop hand gesture for surface computing and successfully elicited a set of user-defined gestures. They classified the surface gestures into form, nature, binding, and flow. Besides that, they extended their previous work to formulate an agreement score to determine the degree of consensus for the gesture performed by the participants [12]. Based on the highest agreement score from the participants, a set of hand gesture commands was determined and designed to control the surface computer. The result only showed that the design gestures were better in terms of behavioural aspects with no evaluation reported on the task performance.

TABLE I
THE POSSIBLE OPERATIONS OF INTERACTION BETWEEN THE USER AND MAP

Operation	Explanation
Panning	The user may stepwise move the map towards different directions.
Zoom	The user may enlarge or reduce the display window without content changes.
Zooming with LoD	When the user enlarges or reduces the display window, a new level of detail will be rendered which is either pre-calculated or generated in real time.
Hiding and revealing	The user may visually hide or highlight certain objects or object classes.
Switching	The user may choose different complementary presentation styles.
Focusing	The user may click at a certain object and retrieve its detailed information stored in a database.
Tuning of visualisation parameters	The user may change his viewing angle and graphic variables in terms of colour texture, symbol size, figure-ground contrast, and etc. within the allowable value ranges.
Dialogue	The user may activate a dialogue window and input his personal data.
Query	The user may search for certain object or object classes by giving one or many criteria.

The participatory design aspect also works in three-dimensional gestures of smart-home control. Kühnel et al. [13] enacted extensive work on the human psycho-physiological aspect of smart-home control by adapting the approach of Wobbrock et al. [11] and Nielsen et al. [4] to apply in a mobile device. The smart-home control was able to control television, radio, lighting, and blinds by using seven gestures. The performance test showed that the gesture commands work well, but the commands are only limited to mobile phone users and are not supported in multimodal interfaces.

Several researchers also claimed that the systems using the participatory design approach are more intuitive and natural to users compared with the application design from designer's perspective [14]. Nacenta et al. [14] mainly focused on the comparison between the memorability of the predesigned gesture sets, user-defined gesture sets, and random gesture sets. The predesigned gesture sets were created by designers for a particular application. From the user-centered experiment, the user-defined gesture sets were analysed and designed while random gesture sets were assigned the corresponding action from the database of gestures. In their findings, they discovered that the user-defined gestures are the easiest to remember.

Recent studies showed that the participatory design attracted more research attention in designing the gesture system. Participants who collaborate and contribute in the participatory design process tend to give more articulate and creative process [15], but there are limited researches focusing on designing applications based on the participatory design aspect. It is largely an underexplored domain.

C. Hand Gesture Classification

The use of gesture is a common way of communication in human conversation and is also meaningful during the communication between human and computer. In particular, hand gestures can be classified to compromise the context of use. Poggi [16] and [17] investigated the gestures and it relations with speech. Though not comprehensive, their classification schemes complement each other. For example, Poggi [16] discussed the deictics and iconics that can complement the manipulative, semaphoric, and conversational gesture of Quek et al. [17]. Karam and Schraefel [18] proposed a more comprehensive gesture classification based on human computer interaction that has become the fundamental of researches in the domain of hand gesture analysis. However, as argued by Aigner et al. [19], it still fails to cover the distinction between iconic and pantomimic gesture. Hence, the work has been extended to the semaphoric class of Karam and Schraefel [18] gesture taxonomy. In their gesture classification scheme, they have refined details in gesture types including pointing, semaphoric, pantomimic, iconic, and manipulation; these are the basics of hand gestures classification in this paper. Table II summarizes the classification scheme in this research.

III. Overview of the Proposed Method

A. Interview

The preliminary requirements are to gather the required context of use and operations of the map navigation applications that are adequate as input for multimodal interaction dialogues. In the interview, the interviewees were prompted with questions in a structured manner while their feedbacks were recorded to investigate their favourite functions of using maps. The related operations of the map navigation application were provided after the relevant data had been identified through response analysis to initialise a set of operations. The data were formulated to become meaningful tasks and then assigned to users during the subsequent participative design stage.

B. Participatory Design

This stage uses the participatory design approach to collect hand gesture dialogues, which has been done through conducting user experience design in an inductive approach. A group of participants were tested and guided through scenarios in a set up room (with camera surveillance, monitor, and microphone). They were asked to imagine themselves communicating with the computer that could understand their command when performing the previously identified operations from the previous stage. In order to observe the participants' natural and intuitive behaviour while navigating through the maps, the gaps of technical feedback were removed from the dialogue between user and device to avoid in-depth thinking [11], [20]. This also meant that recognition response was not expected when the participants were demonstrating their hand gesture dialogue. The participants were also advised to assume that the system was able to understand their dialogue.

TABLE II
CLASSIFICATION SCHEME FOR HAND GESTURE ON HUMAN COMPUTER INTERACTIONS

Type	Description
Deictic	Deictic is used to indicate spatial location of an object. It may either be performed by pointing a stretched index finger or with multiple fingers such as the combination of index and middle finger.
Manipulation	Manipulative gestures apply the tight relationship between the movements of the gesturing hand and the object being manipulated to the command object. Visual feedback for controlling the targets is typically shown in manipulation gesture as a guide of being manipulated.
Semaphoric	Semaphoric gestures are signalling systems which convey specific meanings of the gesturing hand poses and movements. The gesture may be any unrelated hand gestures which convey meanings. Semaphoric gestures can be further categorized into static poses, dynamic movements, and strokes. Static poses are static hand poses such as stretching all the fingers to mean "stop". The dynamic movements of semaphoric can refer to information delivered through the temporal. An example would be to twist or turn the wrist like opening a faucet gesture, which means "rotate". Stokes is gestures resembling hand flicks which have similarity with dynamic movements. Stokes gesture may be familiar with slide gestures that are mostly applied in smartphones. For example, a single hand swinging to sideward means "next".
Pantomimic	Pantomimic gestures are actions to depict or imitate the real world objects using hand gesture. Example of pantomimic would be imaginary of capturing photograph using both "L" hand shape. The process can be coded as one pantomimic gesture such as vertical both hand "L" hand shape in the opposite position, then moving closer, and releasing back to the first action.
Iconic	Iconic gestures deliver the information of the objects by performing specific sizes, pattern, and movements. Static iconics are demonstrated by a static hand pose and do not necessarily reflect the real world objects. Dynamic iconics are used to depict the shapes; for instance, drawing a circle may mean "rotate".

C. Participants

Before starting, each participant was asked to fill in a questionnaire on their background and preference on technology devices. Since most participants were young adults (aged 14 to 39), they were expected to possess fundamental cognition knowledge on how to use gesture-based devices and might perform gestures similar to those devices. This age group also has the highest smartphone ownership among all ages [13].

D. Procedures of Experiment

The hand gesture activity perform by participant was recorded by a video recorder. In this experiment, it was used to analyse the hand gestures dialogues. A series of videos that illustrated a scenario of tasks that should be carried out was played to the participants. The experiment was conducted in a private room as in Fig. 1 to avoid any unexpected disturbance. Only the participant and observer were allowed to stay in the room once the experiment started.

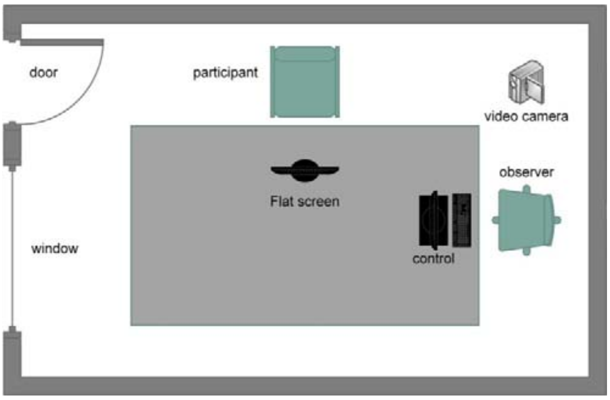


Fig. 1 The layout of the experimental room

The purpose of the study and procedures were explained to the participant beforehand. Within the group, factorial design was applied where each participant was given two conditions that were independent variables. The first involved interaction with hand gesture using one hand and the second was about hand gesture interaction with two hands. They were requested to develop and demonstrate self-dialogue set for map navigation. A total of five tasks were divided into 21 subtasks; think aloud protocol was applied to the participants and video recorded. They were provided subjective preference ratings for each task. The experiment was conducted in the following order:

Step 1. *The researcher briefed and asked the participant to the pre-test questionnaire.*

Step 2. *The participants were given a document and information sheet describing each task listed into two categories.*

Step 3. *The participants were instructed to design their self-defined hand gesture dialogue.*

Step 4. *After designing the overall set of dialogue for every task, the participants were requested to demonstrate each dialogue for five times while thinking aloud to represent each task. For example, when the participant intended to zoom into the map, he or she might say, "I am zooming into the map to view the dept." with a parallel demonstration of the hand gesture.*

Step 5. *After completing each task, the participants were asked to rate the dialogue using a 7-point Likert scale concerning the goodness and ease of use of the hand gesture.*

Step 6. *During the debrief section, the participants were asked to suggest other tasks where the dialogue would be beneficial and rate the number of preferred hand gesture in a post-questionnaire sheet.*

E. Definition of Dialogue Sets

This stage focused on developing usable vocabulary for the operations of map navigations after the multimodal interaction vocabulary had been collected in the previous stage. The usable vocabulary sets denote meaningful commands that can be used to navigate maps.

Based on the agreement score, A, of Wobbrock et al. [11], the match hand gestures of the participants can be translated into reliability. The mathematical equation for agreement score is:

$$At = \sum_{Pm \subseteq Pt} \left(\frac{|Pm|}{|Pt|}\right)^2 \quad (1)$$

where At is the agreement score of a task in a single number and level of consensus among the participants; t is a task in all tasks; Pt is the set of proposed hand gestures for t; and Pm is a subset of matched hand gesture from Pt. The range of A is $[|Pt^{-1}|, 1]$.

IV. Results and Analysis

A. Result of Preliminary Requirements Gathering

There were 12 voluntary participants with average age of 24 (standard deviation, SD = 2.79) who took part in this interview. In the interviewees' satisfaction feedback on the map navigation operations (see Fig. 2), six interviewees were satisfied with the current map navigation operations. The number of interviewees who were slightly satisfied, slightly dissatisfied, and had a neutral stand were two each. Since majority of them were satisfied with the current map navigation operations, no modification was carried out. An interviewee was concerned about the complexity of the map navigation, so slight adjustment on the selection of operations was made. Result showed that most of the operations mentioned were similar with Kim, et al. [10]. The information from the participants was further analysed. With this, the operations that had been tailored for the map navigations were justified (see Table III).

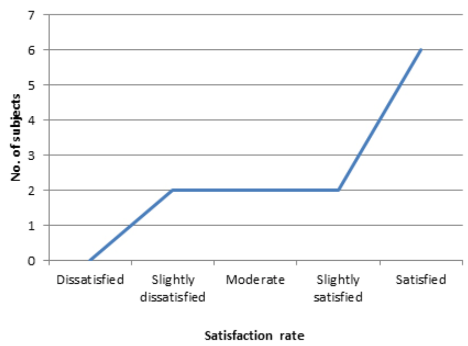


Fig. 2 User satisfaction of the map navigation operations

TABLE III
Summary of Map Navigation Tasks

Operation	Description
Direction	Get the direction from a location to another location.
Zoom in	Zoom the viewer in more details.
Zoom out	Zoom the viewer in less detail.
Pan left	Shifts the viewer to the left.
Pan right	Shifts the viewer to the right.
Pan up	Shifts the viewer to the above.
Pan down	Shifts the viewer to the below.
Rotate left	Rotates the view counter-clockwise.
Rotate right	Rotates the view clockwise.
Tilt up	Incline the view of the map horizontally.
Tilt down	Incline the view of map "top-down"

B. Results Analysis of Participatory Experiment Design

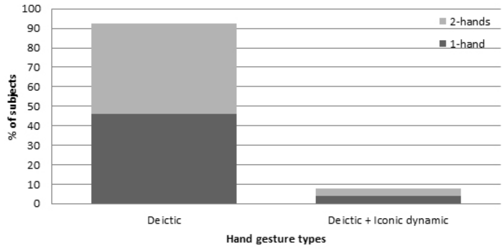
The participatory experiment design had 13 voluntary participants, nine males and four females, with an average age of 28 (SD = 2). Participants with less experience on gesture-based technology devices were included in the experiment. The intention was to balance data collection from the natural and intuitiveness of participants. There were 286 dialogues (13 participants x 11 tasks x 2 x categories) collected from the study. The dialogues were analysed and qualitative observations were used. The observed hand gestures performed by the participants were classified based on the classification scheme in Table II and as depicted in Fig. 3. The combination of more than one type of element was found in each task. For example, it was noticed that participants would first point at the location to zoom and then stretch their hands to further zoom in. The gestures used here were deictic gesture (applied when pointing at the location) then followed by manipulating gesture (when stretching the hand). However, the majority of gestures presented in the tasks were of a single gesture type only since multiple gestures might be confusing and complex.

C. Results Analysis and Defining of Dialogues Sets

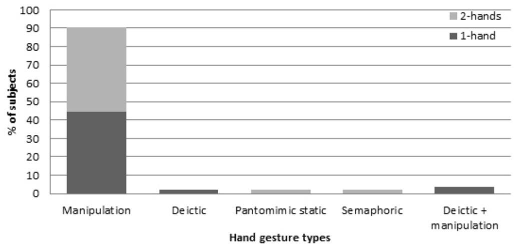
The agreement score for the hand gesture performed by all participants is depicted in Fig. 4. The average agreement score for one-hand gestures and two-hand gestures were 0.41 and 0.26 respectively.

Every time after the participants had expressed the dialogues for each task, they were requested to rate it on two Likert scale for one-hand and two other Likert scales for two-hands. The scales were from strongly disagree (-3) to neutral (0) to strongly agree (3). The major items for rating were: (1) "The hand gesture I chose is a good match for the intended purpose" and (2) "The hand gesture I picked is easy to perform". These subjective ratings were then compared and it was discovered that there was a significantly positive correlation between the good match of the dialogues and its ease to perform ($r_s = 0.791$; $p < 0.01$). Simply to say, the participants felt that the better the dialogue could match the function, the easier it was to perform the hand gesture.

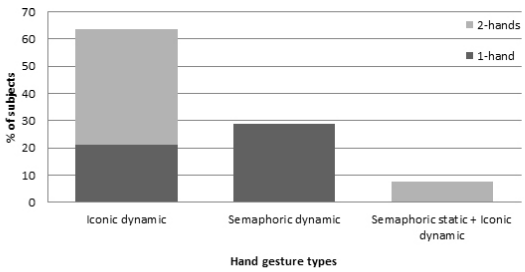
During the debriefing session, the participants were asked for their suggestions on improvement and to rate their personal preference on the number of hand that should be used for map navigation on a 5 point scale from neutral (0) to strongly prefer (5). A Wilcoxon Signed Ranks Test was conducted to compare these subjective ratings, and it was found that one-hand gesture was more preferred ($Z = -2.887$; $p < 0.005$). The participants found it easier to relate and use one-hand gesture. This personal preference has been reflected in the rating of good match ($Z = -4.656$; $p < 0.001$) of vocabulary and its ease to perform ($Z = -4.843$; $p < 0.001$) between the one-hand and two-hand gestures in map navigation.



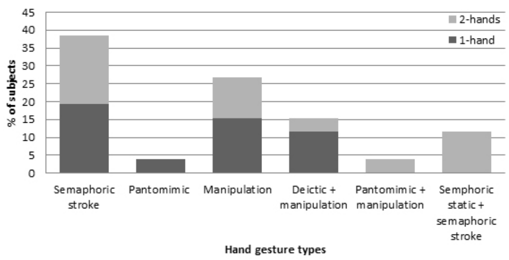
(a) Direction



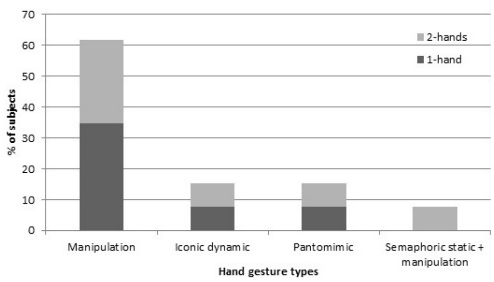
(b) Zoom



(c) Rotate



(d) Pan



(e) Tilt

Fig. 3 The histogram of hand gesture types usage for each of the task

In this experiment, the dichotomous referents including zoom in/zoom out, pan up/pan down, pan left/pan right, rotate left/rotate right, and tilt up/tilt down had fulfilled the reversible gestures [11].

Table IV shows the proposed dialogues. This formalised and consistent set of dialogues has been defined based on all collected hand gesture interactions from the previous stages and the participants' preference on one-hand gesture.

V. Summary and Discussion

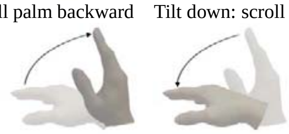
In this paper, the methodology for surface computing interaction from Nielsen, et al. [4] and Wobbrock, et al. [11] and the methodology for air hand gestures from Aigner, et al. [19] were adopted to design the map navigation interface in a user-centered approach. The findings suggested that the usage of one hand gesture interaction is preferable by users compare with two hand gesture for map navigation. The experimental design of this research has outlined the methodology to collect the data from the participants and analysed the attributes from the observation to the independent variable.

The user experience gained from the participatory design is distinct from ordinary interface experts. For example, designers who design the interface based on their expertise go through the iteration process of user testing for their created interface. The user-centered approach which develops the interface from the user can cut down the cost and ineffectiveness of the former approach. However, the experimenters must ensure that the participants' perceptions are held constant across the groups throughout all phases and conditions of the experiments. This step is to lower the risk of human errors that may affect the precision of results collected.

The statistical analysis showed that the users prefer one-hand dialogue that is easy to perform and related to the real world environment. Defining usable dialogue from user-defined is new strategies in design applications. In future, we will examine the effects of the usable dialogue sets on humans' performance. The participatory design not only increases the user experience, it is also beneficial for expert designs. Besides that, cultural differences may be one of the limitations in this study Abadi and Peng [21].

Overall, we have contributed to the development of user-defined dialogue sets for map navigation interface where most other researches are focused on expert designing dialogues sets. We also introduced information about how to extract users define dialogue from user-centered approach under each of processes that we proposed, which can benefits to interfaces design other than map navigation applications. This study leads us toward the future direction of interface design based on user center to suit to the nature of interaction.

TABLE IV
DEFINITION OF USABLE VOCABULARY FOR MAP NAVIGATION INTERFACES

Operation	Description	Dialogue sets sample
Direction	Deictic is selected as the gesture type for direction vocabulary. For example, user pointing at the starting point and then the pointing at the destination point to trigger the direction.	Direction: point at origin, move and point destination 
Zoom	Manipulation gesture is selected to use in zoom task. Pinch fingers to represent “zoom out” and splay fingers to represent “zoom in”.	Zoom in: splay fingers Zoom out: pinch fingers 
Rotate	Semaphorics dynamic gesture is used to design rotating tasks. Twist the wrist to represent rotating.	Rotate left: twist left Rotate right: twist right 
Pan	The semaphoric strokes like flick are applied in designing the pan task.	Pan left: flick to the left Pan right: flick to the right  Pan down: flick downward Pan up: flick upward 
Tilt	The manipulation gesture is adopted to represent tilt. For example, scroll hand backward to tilt up.	Tilt up: scroll palm backward Tilt down: scroll palm forward 

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REFERENCES

[1] R. J. K. Jacob, J. J. Leggett, B. A. Myers, and R. Pausch, "An Agenda for Human-Computer Interaction Research: Interaction Styles and Input/Output Devices," Behaviour and Information Technology, vol. 12, pp. 69-79, 1993.

[2] D. J. Sturman and D. Zeltzer, "A survey of glove-based input," Computer Graphics and Applications, IEEE, vol. 14, pp. 30-39, 1994.

[3] H. I. Stern, J. P. Wachs, and Y. Edan, "Designing Hand Gesture Vocabularies for Natural Interaction by Combining Psycho-Physiological and Recognition Factors," International Journal of Semantic Computing, vol. 2, pp. 137-160, 2008.

[4] M. Nielsen, M. Störring, T. Moeslund, and E. Granum, "A Procedure for Developing Intuitive and Ergonomic Gesture Interfaces for HCI," in Gesture-Based Communication in Human-Computer Interaction. vol. 2915, A. Camurri and G. Volpe, Eds., ed: Springer Berlin Heidelberg, 2004, pp. 409-420.

[5] A. K. Sinha and J. A. Landay, "Embarking on multimodal interface design," in Multimodal Interfaces, 2002. Proceedings. Fourth IEEE International Conference on, 2002, pp. 355-360.

[6] A. Löcken, T. Hesselmann, M. Pielot, N. Henze, and S. Boll, "User-centred process for the definition of free-hand gestures applied to controlling music playback," Multimedia Systems, vol. 18, pp. 15-31, 2012/02/01 2012.

[7] N. Bernsen, "Multimodality in Language and Speech Systems — From Theory to Design Support Tool," in Multimodality in Language and Speech Systems. vol. 19, B. Granström, D. House, and I. Karlsson, Eds., ed: Springer Netherlands, 2002, pp. 93-148.

[8] F. Dickmann, Web-Mapping und Web-GIS: Westermann, 2001.

[9] L. Meng, "The State of the Art of Map-Based Mobile Services," in Map-based Mobile Services, L. Meng, A. Zipf, and S. Winter, Eds., ed: Springer Berlin Heidelberg, 2008, pp. 1-12.

[10] S.-G. Kim, J.-W. Kim, K.-T. Bae, and C.-W. Lee, "Multi-touch Interaction for Table-Top Display," in Advances in Artificial Reality and Tele-Existence. vol. 4282, Z. Pan, A. Cheok, M. Haller, R. H. Lau, H. Saito, and R. Liang, Eds., ed: Springer Berlin Heidelberg, 2006, pp. 1273-1282.

[11] J. O. Wobbrock, M. R. Morris, and A. D. Wilson, "User-defined gestures for surface computing," presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Boston, MA, USA, 2009.

[12] J. O. Wobbrock, H. H. Aung, B. Rothrock, and B. A. Myers, "Maximizing the guessability of symbolic input," presented at the CHI '05 Extended Abstracts on Human Factors in Computing Systems, Portland, OR, USA, 2005.

[13] C. Kühnel, T. Westermann, F. Hemmert, S. Kratz, A. Müller, and S. Möller, "I'm home: Defining and evaluating a gesture set for smart-home control," International Journal of Human-Computer Studies, vol. 69, pp. 693-704, 10// 2011.

[14] M. Nacenta, Y. Kamber, Y. Qiang, and P. O. Kristensson, "Memorability of pre-designed and user-defined gesture sets," in Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Paris, France, 2013, pp. 1099-1108.

[15] E. B. Sanders, "From User-Centered to Participatory Design Approaches," in Design and the Social Sciences, J. Frascara, Ed., ed. New York: Taylor & Francis Books, 2002, pp. 1-8.

[16] I. Poggi, "From a Typology of Gestures to a Procedure for Gesture Production," in Gesture and Sign Language in Human-Computer

Interaction. vol. 2298, I. Wachsmuth and T. Sowa, Eds., ed: Springer Berlin Heidelberg, 2002, pp. 158-168.

[17] F. Quek, D. McNeill, R. Bryll, S. Duncan, X.-F. Ma, C. Kirbas, et al., "Multimodal human discourse: gesture and speech," ACM Trans. Comput.-Hum. Interact., vol. 9, pp. 171-193, 2002.

[18] M. Karam and M. C. Schraefel, "A Taxonomy of Gestures in Human Computer Interactions," University of Southampton, Technical Report2005.

[19] R. Aigner, D. Wigdor, H. Benko, M. Haller, D. Lindbauer, A. Ion, et al., "Understanding Mid-Air Hand Gestures: A Study of Human Preferences in Usage of Gesture Types for HCI," 2012.

[20] J. Ruiz, Y. Li, and E. Lank, "User-defined motion gestures for mobile interaction," presented at the Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Vancouver, BC, Canada, 2011.

[21] H. G. N. Abadi and L. Y. Peng, "Culture as the main source in “User-centered design” Using “user-defined”,“guessability”, and “usability” study in generating gestures for touchscreen mobile devices," in Proceeding of the 2nd International Conference on E-Learning & knowledge Management Technologies, 2012.G. O. Young, “Synthetic structure of industrial plastics (Book style with paper title and editor),” in *Plastics*, 2nd ed. vol. 3, J. Peters, Ed. New York: McGraw-Hill, 1964, pp. 15–64.