Journal of Engineering and Applied Sciences 14 (Special Issue 6): 9232-9238, 2019
ISSN: 1816-949X

Ambient Cueing in Cooker Controls thru Stimulus-Response Compatibililty: Questionnaire Approach

[1]Ku Nurul Fazira Ku Azir, [2]Chris Baber, [1]PhakLen Ehkan and [1]Muzammil Jusoh
[1]School of Computer and Communication Engineering, University Malaysia Perlis, Pauh Putra Kampus, 02600 Arau Perlis, Malaysia
[2]School of Electronic, Electrical and System Engineering, University of Birmingham, Birmingham, United Kingdom

Abstract: Ubiquitous Computing (UbiComp) offers environment in which computers live alongside people and become integrated into their daily activities. Central to this assumption is the seamless integration of digital technologies into the physical environment. This study explores how interactions in UbiComp can be design as natural as it is by using ambient display thru the concept of compatibility. This is a preliminary study of ambient cueing by using a questionnaire approach, probability of linkage are measured. The result show that spatial compatibility enhances response (even when participants have to deal with an increase in information) but non-compatible arrangement led to significantly inferior performance. The suggestion is that ambient displays will be effective in situation in which there is an established fit between task and display (and can be detrimental when such a fit is not established).

Key words: Ubiquitous computing, S-R compatibility, affordance, ambient display, smart, established

INTRODUCTION

The traditional Graphical User Interface (GUI) was designed and serve interaction in an ‘explicit’ way a design which supports the office environment with “Windows, Icons, Menus and Pointer” (WIMP) and requires the user to explicitly request action that should be performed. However, the ubiquitous computing environment provides an ‘implicit’ interaction which is based on the assumption that the computer has a certain understanding of controlling the system by behavioural or psychophysiological aspects of user state (Schmidt, 2000; Zander *et al*., 2014). Selanikio (2008) added that implicit interaction occurs without the explicit behest or awareness of the user and is often considered as an additional input to the computer while doing a task. It is not only concerned with software services but also how the use of physical environment and surroundings help display digital information. This considers the technology as support and provides continuous interaction and natural interface the wall, lamp, fans etc., become interface for controls and communication to the world known as “Seamless integration”.

Seamless integration (Bashir *et al*., 2014) provides continuity with existing work practices and smooth transition between function spaces. The digital interaction between humans and computers will be less like the current WIMP paradigm and more like the way human interact with the physical environment (Ishii and Ullmer, 1997). Information in the digital environment is presented as painted bits (Wisneski *et al*., 1998) that need to be at the foreground of user’s attention to be processed. In order to provide natural interface, digital interactions need to support different actions of human behaviours and expression. One way of considering this issue is to see the technology in term of affording a particular set of responses that the user can readily recognize and act upon (Gaver, 1991; Norman, 1999).

Number of researchers had made an effort in designing prototypes of seamless integration to demonstrate natural interaction such as digital desk (Newman and Wellner, 1992), digital desk calculator (Wellner, 1991), ClearBoard (Ishii and Kobayashi, 1992), Proactive Desk (Noma *et al*., 2004), the enhanced desk (Koike *et al*., 2001) and the reading desk system (Pearson *et al*., 2011). One of development of implicit interaction can be seen in the domestic environment such as kitchen. Advances in devices for kitchens promise to provide new forms of digital interaction. As the concept of the digital kitchen becomes widely discussed, it is worth looking back to the first approaches to understanding perceptions and performance in the

Corresponding Author: Ku Nurul Fazira Ku Azir, School of Computer and Communication Engineering, University Malaysia Perlis, Pauh Putra Kampus, 02600 Arau Perlis, Malaysia

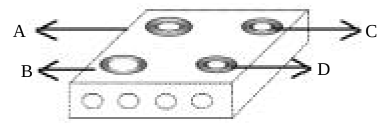
kitchen. In order to relate these developments to Ergonomics, the principles and concepts of Stimulus Response Compatibility (SRC) and its association with cooker-control is explored.

Stimululs-response compatibility with cooker controls: Compatibility refers to the spatial arrangement between Stimulus-Response (S-R) relationship when the relation between displays (stimulus) and controls (response) is direct (compatible), a greater degree of compatibility will result faster learning, shorter response time, fewer errors and less mental workload. This compatible arrangement provides a 'natural mapping' which reduced the need for any information for a user's memory to perform task. Meanwhile, incompatible arrangement occurs when there is no direct relation between stimuli and response which may lead to select wrong control.

A classic example of this natural mapping is four burner stove layout. When both controls and burners are arranged in a rectangle it is obvious which control operates the corresponding burner. However, if the controls are arranged in row there is no obvious spatial relationship between the controls and burners. This may lead to visually frustrating to the inexperienced user and may lead to a period of experimenting with controls to become familiar with the proper usage.

A few numbers of works on cooker-control studies reveal differences in approach that occur in measuring compatibility. These approaches include using a questionnaire approach (paper-pencil test) (Chapanis and Lindenbaum, 1959; Fitts and Seeger, 1953; Shinar and Acton, 1978), sensor lines (Osborne and Ellingstad, 1987; Chapanis and Yoblick, 2001), prototypes of cookers (Chapanis and Lindenbaum, 1959; Wu, 1997; Ray and Ray, 1979) or computer simulation (Chapanis and Lindenbaum, 1959; Wu, 1997; Ray and Ray, 1979; Hsu and Peng, 1993) to explore user's preferences in cooker-control linkages.

The first work exploring preference in cooker-control layout using a paper-based questionnaire was by Shinar and Acton (1978) who presented participants with a drawing similar to Fig. 1 and asked them to label the unmarked controls with the letter which they thought indicated the 'correct' control for each burner. Findings from this study showed at least four commonly expected linkages: linkages 2-5. Linkage 3 were chosen by 31% of the participants while Linkage 2 was chosen by 25%. However, there was not a sufficiently strong preference to be considered as a popular stereotype. Hsu and Peng (1993) preference for cooker-controls linkages through various forms of labels to test whether a suggestion effect existed in the sequential nature. They



Linkage	Control cooker arrangement
2	A B D C
3	A B C D
4	B A D C
5	B A C D

Fig. 1: Control-burner arrangements studies by Shinar and Acton (1978)

showed that linkage 2 was preferred. Wu (1997) reported comparisons of preferences for linkages using two forms of labels: alphabetical and sign. The results showed that linkage 3 was preferred when alphabetical were presented while linkage 2 was preferred with the sign layout.

This selection of studies indicates that there is no clear-cut response from participants in these pencil-and-paper tests. Overall, linkages 2 and 3 appear to be preferred over the other layouts. For some researchers, the problem lies in the ambiguity of the cues that are provided and so have explored other forms of cue to help people make their selection of linkage.

Meanwhile, a number of studies have proposed the use of additional spatial information such as 'sensor line's can be drawn from a control to the burner to which it is linked. Chapanis *et al*. (1965) tested the effectiveness of sensor lines in two different size layouts with compatible and incompatible arrangements. Sensor lines in the compatible arrangement appeared to hinder rather than help and only served a useful function of sensor lines in the large panel if there was an incompatible (Fig. 1).

Osborne and Ellingstad (1987) measured reaction times and errors to examine the utility of sensor lines and showed the displaced burners to be superior in both reaction time and errors. Chapanis and Yoblick (2001) placed "Sensor lines" painted on the stove top to indicate the linkage between cooker and controls. Performance on incompatible panels with sensor lines was significantly poorer on the same panels without sensor lines.

Motivated from previous researchers, it is believed that digital interaction can be achieved when there is compatibility of the projected ambient display in the digital environment. This is the starting point for this research, rather than using sensor lines, this study considers whether the use of such simple ambient displays could provide sufficient cueing to allow people to respond effectively in cooker-burner selection tasks.

The use of projected displays can offer multiple sources of information to users, rather than a single set of sensor lines; for example, it is possible to present several cues to users at the same time. One would hope that additional information ought to improve performance. However, it might be possible for the ambient display to present conflicting information and a further objective is to consider whether confused information can impair performance.

For the purpose of this study, a pencil-paper test was conducted prior to the construction of the physical hardware if participants demonstrated confusion or uncertainty in the test then it might not be sensible with building the physical prototype. While several works have argued that it is not clear if there is a benefit in using paper-pencil test for studying cooker control compatibility, it is believed that a paper-pencil test is still an appropriate approach as the preliminary test in the cooker control compatibility with ambient cueing.

Design and hypothesis: In this study, three coloured circles are used to indicate the different Light Emitting Diodes (LEDs) red, blue and green which are used to indicate cues. These cues differ from previous studies which used letters, numbers or signs to label the controls or sensor lines to show links from control to burner. The LEDs are intended to give a participant a sense of ambient display in the kitchen environment. In this experiment, the LEDs convey three types of cue to the user (Fig. 2-4): Hob LED, represented by a Red circle in this questionnaire, indicates whether a burner is lit. By using red LEDs we capitalize on the user's experience of burners on a hob. In this respect, it would expect the response to be similar to previous studies on SR in cooker controls.

Hob-aligned LED (Blue LEDs) mounted on the underside of the 'hood' (in case there is a pan on the burner). By using blue LEDs we create additional source of information corresponding to the burners that are lit. This ought to simply be a reflection of the preference under Linkage 1. However, the novelty of the positioning of these lights could cause confusion.

Control-aligned LED cueing the control to use represented by green LEDs mounted on the front of the 'hood' in line with the controls. By using green LEDs, its replicate the alignment of control with burner that has been previously achieved through offsetting the controls or by using sensor lines. The idea is that when a burner is on the corresponding control-aligned LED will come on. In order to test spatial compatibility, the questions were

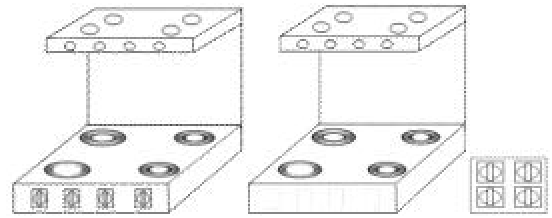


Fig. 2: A schematic representation of the cooker-control arrangement designs used in this study

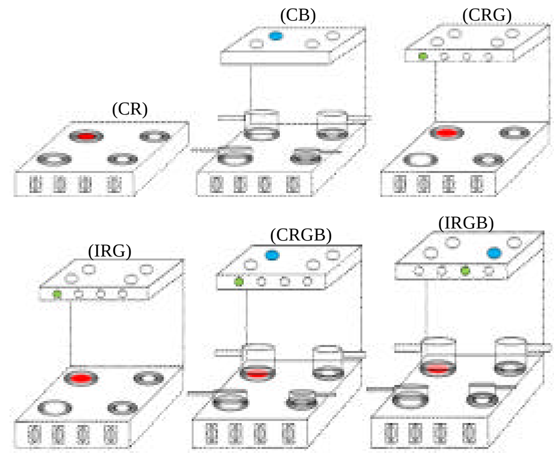


Fig. 3: A schematic representations of linear control burner arrangements in paper-pencil questionnaires

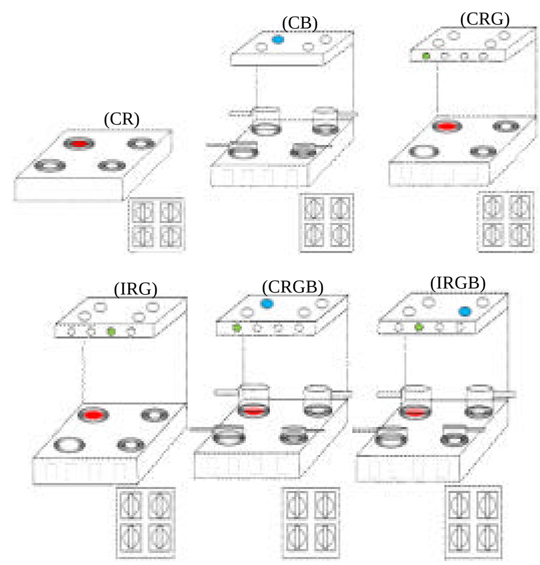


Fig. 4: A schematic representations of quadrant control burner arrangements in paper-pencil questionnaires

designed to present two variations of control-burner arrangement to participants: the response could be from a linear control-burner arrangement or from a quadrant control-burner arrangement. The cooker-burner arrangement layouts of this study are illustrated in Fig. 2.

As stated previously, the Red (R) LEDs are positioned on the hob (to indicate burners switched on), Blue (B) LEDs are positioned in the cooker hood (aligned with the Red LEDs on the hob) and Green (G) LEDs are positioned in a row on the cooker hood (aligned with cooker controls). The three LEDs were then combined with each other to generate six different combinations of ambient lights and questionnaires which defined as below and shown in Fig. 3 and 4 for linear and quadrant arrangement, respectively:

- Compatible Red LEDs (CR)
- Compatible Blue LEDs (CB)
- Compatible Red+Green LEDs (CRG)
- Incompatible Red+Green LEDs (IRG)
- Compatible Red, Blue+Green LEDs (CRGB)
- Incompatible Red, Blue+Green LEDs (IRGB)

While the designs were constructed on the assumptions that linkage 3 was the user's most preferred cooker-control arrangement (because this was the main (although, not only) layout that paper based studies had previously shown), it is not essential that participants get the answer 'correct', rather, the responses are used to determine which of the linkage were most popular and whether there was any consistency in the responses.

Each questionnaire as four cooker-controls in different positions of ambient LEDs. A total of 12 questionnaires are given to participants with six questions are concerning the linear cooker-control arrangement and another six questionnaires on the quadrant cooker-control arrangments. Therefore, each participants answered 24 different cooker-control arrangements with a total of 48 cooker-control layouts shown to participants.

Within these six questionnaries, two presented incompatible and inconsistent, arrangemetns. Compatible arrangements refer to the combination of LEDs and controls that conform to the linkage 3 and inconsistent arrangement indicated that the LEDs create different responsses.

The primary objective of this study is to explore how cueing can affect performnce of simple tasks. One would expect that additional information ought to improve performance. However, it might be possible for the LEDs to present conflicting information and a further objective is to consider whether confused information can impair performance. Further, it assume that as the number of cues increases there is a potential for participants to become confused by the amount of information, particularly in conditions with incosistent cueing. During the experiment, preference linkage choices were measured and the following hypotheses were drawn (Table 1).

Table 1: Linkage responses for quadrant cooker-control arrangement

Linkage		CR	CB	CRG	IRG	CRGB	IRG
2	ABDC	-	-	-	-	-	-
3	ABCD	96% {2}*	88% {4}*	96% {4}*	96% {4}*	96% {4}*	92% {4}*
4	BADC	-	-	-	-	-	-
5	BACD	-	-	-	-	-	-
9	CADB	4%	4%	4%	4%	4%	4%
Redundancy	-	-	8%	-	-	-	4%

*p<0.001, **p<0.05, N.S = Not Significant redundancy is the number of participants who chose the rotary knob twice

- H_1: a consistent reponse of preference linkages can be seen in all the quadrant cooker control arrangement scenarios due to spatial compatibility between cooker and controller
- H_2: the number of responses in the linear cooker control arrangement layouts was varied as number of LEDs increased
- H_3: linkage 3 becomes the predominant preference linkages in the single LEDs compatible linear cooker control arrangements

MATERIALS AND METHODS

Participants and procedure: The 25 university students were involved in the experiment. They were aged between 19-40 years with an average age of 23 years. The 20 participants were male and 5 were female. Participants were recruited from different cultures and came from different degree programs but all had a minimum of one year of experience in the kitchen environment and had used cookers. These experiences include a participant's familiarity to switch the cooker on and off or cook a simple dish such as making an omelette.

By using a frequency or number of participant's responses to particular linkages, a Chi-square statistical analysis was used to compare preferred linkages. Due to the relatively small number of participants used in this study, a likelihood ratio test was used to report the statistical analysis along with effect size (reported in the odds ratio). An odds ratio is used to summarize a focused comparison and a 2×2 contingency table is the categorical data which focused comparison.

To control for order effects in this study, presentations of the questionnaires were randomized across participants using a latin square. Thus, each participant would get a different order of questions. Each questionnaire contained a question "Which rotary knob would you use to switch off the light (s)" the

Table 2: Linkage responses for linear cooker-control arrangement

Linkage		CR	CB	CRG	IRG	CRGB	IRG
2	ABDC	16%	16%	16%	16%	12%	8%
3	ABCD	16%	16%	48%{7, R}*	8%	52% {7, R}*	8%
4	BADC	28%{2, 3, 5,}$^{n.s}${7, R}**	28%{2, 3, 5, O}$^{n.s}${7, R}**	12%	28%{2, 3, 5, 122,R}$^{n.s}${7}**	16%	12%
5	BACD	24%	24%	12%	12%	12%	32% {2, 3, 9, 13, O, R}** {4, 7, 13}$^{n.s}$
7	ACBD	4%	4%	4%	4%	4%	12%
9	BDCA						4%
12	CDAB				24%		4%
13	CDBA						12%
Others		8%	4%				4%
Redundancy		4%	8%	8%	8%	4%	

4%*p<0.001, **p<0.05, N.S = Not Significant; redundancy is the number of participants who chose the rotary knob twice

participants" task was to indicate the answer by marking an 'X' for each cooker-control arrangement and they were instructed to fill in the questionnaires with their first preference response (Table 2).

RESULTS AND DISCUSSION

The result shows that there is a large number of differences in participant responses between linear and quadrant knob arrangements. Summarize the number of responses to each possible control-burner linkage arrange made by participants in the quadrant and linear knob arrangement. From Table 1, it can see the responses were consistent throughout the scenarios in the quadrant control-burner arrangement. Linkage 3 was clearly the most popular and preferred choice in the quadrant control-burner; 96% of participants selected linkage 3 in the single Red LED scenario (CR); 88% participants selected linkage 3 in the single Blue LED (CB) scenario; 96% participants chose Linkage 3 both in the compatible and incompatible Red-Green (CRG and IRG) LEDs scenario the 96% participants selected this linkage in the compatible Red-Green-Blue (CRGB) scenario and 92% participants responded to linkage 3 in the Incompatible Red-Green-Blue LED (IRGB) scenario.

Table 1 also shows the results of Chi-square analysis indicating by letters in the curly brackets which differs for the one in the cell. For example, linkage 3 is more significant to be chosen than linkage 2 in the Compatible Red (CR) scenario with p<0.0001. This demonstrates that linkage 3 is significantly the most preferred linkage compared to any other linkages when the cooker-control was in the quadrant arrangement. Figure 5 illustrates range of responses from quadrant cooker-control arrangement.

In contrast with the consistent response to the quadrant arrangement, the linear control-burner arrangement Table 2 as one might expect, showed more varied results. For single Red and Blue LEDs in the compatible arrangement (CR and CB), a majority of participants selected linkage 4 (28%) followed by linkage 5(24%). Only 16% of participants selected linkage 3 in these scenarios.

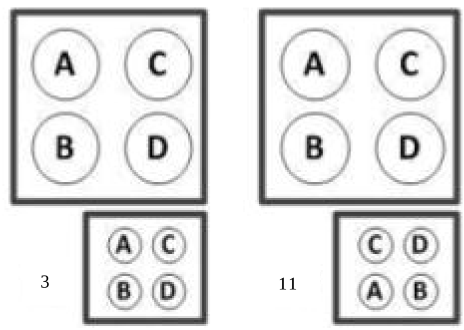


Fig. 5: Type of linkages responses for quadrant cooker-control arrangement

For pairs of LEDs (CRG), linkage 3 was the most preferred for 48% participants. In the Incompatible Red-Green (IRG) scenario, 28% of responses were to linkage 4, followed by 24% participants responding to linkage 12. Linkage 3 was selected by only 8% participants in these scenarios.

For three LEDs, 52% participants chose linkage 3 in the compatible Red-Green-Blue (CRGB) scenario. In the incompatible Red-Green-Blue (IRGB) scenario, linkage 5 was the preferred linkage for 32%. Linkage 3 was selected by 8% participants. Chi-square tests with a likelihood ratio analysis show that in the Incompatible Red-Green (IRG) LEDs scenario, linkage 4 was chosen significantly more often than linkage 7 but with no significant difference to other linkages.

In the Compatible Red-Green-Blue (CRGB) LEDs scenario, likelihood ratio analysis results showed that linkage 3 was chosen significantly more often than Linkages 2, 4, 5, 7 and 'redundancy' linkages. The odds ratio shows that choice of linkage 3 was 7.95 times higher than linkage 2, 5.68 times higher than linkage 4 and 2.6 times higher than linkage 8 and 'redundancy'. In the Incompatible Red-Green-Blue (IRGB) LEDs scenario, linkage 5 was chosen significantly more often than

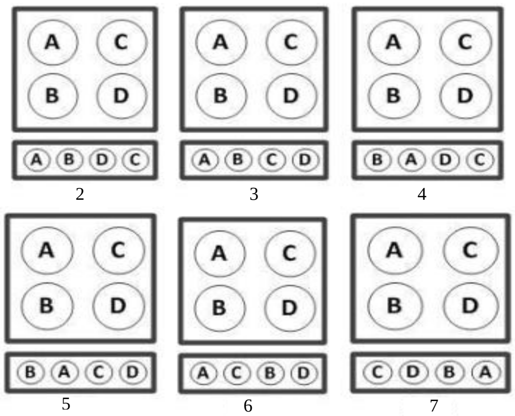


Fig. 6: Type of linkage responses from linear cooker-control arrangement

linkages 2, 3, 9, 12, 'other' and 'redundancy' linkages. The odds ratio shows that the response to linkage 5 was 5.41 times higher than linkage 2 and 3, 3.45 times higher than linkages 4, 7 and 13 and 11.31 times higher than Linkages 9, 13, 'others' and 'redundancy'. Figure 6 illustrates range of responses from linear cooker-control arrangement.

This study describes the preliminary work of designing digital interaction through a classic ergonomics approach using cooker-control layouts. The study tested 25 participants through a series of cooker-control questionnaires which evaluated the concept of ambient cueing using LEDs on the cooker. These questionnaires consisted of two types of cooker-control layout; linear and quadrant and between the layouts there are compatible and incompatible arrangements.

The study examined whether the presence of additional information changed the nature of user's perceptions. Quadrant cooker-control layouts show that regardless of the addition of information given or the combination of two or three LEDs or the arrangement of compatible or incompatible layouts, a high percentage of responses favour linkage 3. This was as expected in Hypothesis 1(H_1). This suggests that additional information does not help or change the nature of user decision-making in high spatial compatibility layouts (although, it suggests that such arrangements need not be detrimental to performance either).

When participants respond to the linear cooker-control arrangement the number of responses varies. This was expected in Hypothesis 2(H_2). It is interesting to note that linkage 3 is not the predominant linkage for the single LEDs. This contradicts Hypothesis 3(H_3). Results show that linkage 4 is the dominant response and this is not consistent with previous findings. Interestingly, the results show that linkage 3 becomes the dominant preference when the number of LEDs increases from 1-2 or 4 LEDs (as long as the arrangement is compatible). These findings suggest that as the number of LEDs increases in the compatible arrangement, the response to linkage 3 increases. A preference for linkage 3 was significantly greater ($p<0.05$) than linkages 2, 4 and 5 and then linkage 7 and 'redundancy' ($p<0.001$) in the compatible two LEDs (CRG) and three LEDs (CRGB) scenarios. However, when LEDs are presented in incompatible arrangements, linkage 3 is less likely to be selected. This result shows that when there are some inconsistencies in the relationship between stimuli then the preference for configurations becomes more confusing; indeed, this confusion is further manifested in the increase in the number of different linkages selected in the incompatible Red-Green-Blue (IRGB) scenario. Therefore, it can be suggested that as the number of LEDs increases in the incompatible arrangement, the consistency of responses reduces. This could indicate that the provision of additional information served not to complement but to confuse the perception of spatial compatibility.

CONCLUSION

The stimulus-response compatibility of four cooker-control layouts with quadrant and linear control-burner arrangement was investigated in this study by using a questionnaire method. This investigation aimed to identify linkage preferences of control-burner arrangements and perceive human perspective when additional information is given. Ambient lights with combinations of single, two or three LEDs are used in this study.

Finding of this study and how linkage 3 is not the dominant preference linkage in the single LEDs in either the red or blue scenarios. But a higher number of responses to linkage 3 can be seen when the number of LEDs increases from one to two or from two to three. There are varied responses when incompatible arrangements are given to participants.

ACKNOWLEDGEMENTS

The researchers would like to thank you for the support given to this research by Ministry of Higher Education (MOHE), Human Computer Interaction (HIT) Research Team, University Of Birmingham, UK and School of Computer and Communication Engineering, University Malaysia Perlis (UniMAP).

REFERENCES

Bashir, R.N., S. Qadri, R.M. Saleem, M. Naeem and Y. Ghafoor, 2014. Human Computer Interaction (HCI) in ubiquitous computing. Intl. J. Innovation Appl. Stud., 9: 534-540.

Chapanis, A. and D.A. Yoblick, 2001. Another test of sensor lines on control panels. Ergon., 44: 1302-1311.

Chapanis, A. and G.R. Lockhead, 1965. A test of the effectiveness of sensor lines showing linkages between displays and controls1. Hum. Factors J. Hum. Factors Ergon. Soc., 7: 219-229.

Chapanis, A. and L.E. Lindenbaum, 1959. A reaction time study of four control-display linkages 1. Hum. Factors J. Hum. Factors Ergon. Soc., 1: 1-7.

Fitts, P.M. and C.M. Seeger, 1953. SR compatibility: Spatial characteristics of stimulus and response codes. J. Exp. Psychol., 46: 199-210.

Gaver, W.W., 1991. Technology affordances. Proceedings of the SIGCHI Conference on human factors in Computing Systems, April 27-May 02, 1991, ACM, New Orleans, Louisiana, ISBN:0-89791-383-3, pp: 79-84.

Hsu, S.H. and Y. Peng, 1993. Control-display relationship of the four-burner stove: A reexamination. Hum. Factors J. Hum. Factors Ergon. Soc., 35: 745-749.

Ishii, H. and B. Ullmer, 1997. Tangible bits: Towards seamless interfaces between people, bits and atoms. Proceedings of the ACM Conference on Human Factors in Computing Systems, March 22-27, 1997, ACM, Atlanta, Georgia, ISBN:0-89791-802-9, pp: 234-241.

Ishii, H. and M. Kobayashi, 1992. Clear Board: A seamless medium for shared drawing and conversation with eye contact. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, May 03-07, 1992, ACM, Monterey, California, ISBN:0-89791-513-5, pp: 525-532.

Koike, H., Y. Sato and Y. Kobayashi, 2001. Integrating paper and digital information on enhanced desk: A method for realtime finger tracking on an augmented desk system. ACM. Trans. Comput. Hum. Interact., 8: 307-322.

Newman, W. and P. Wellner, 1992. A desk supporting computer-based interaction with paper documents. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, May 03-07, 1992, ACM, Monterey, California, ISBN:0-89791-513-5, pp: 587-592.

Noma, H., S. Yoshida, Y. Yanagida and N. Tetsutani, 2004. The proactive desk: A new haptic display system for a digital desk using a 2-DOF linear induction motor. Presence Teleoperators Virtual Environ., 13: 146-163.

Norman, D.A., 1999. The Invisible Computer: Why Good Products Fail, the Personal Computer is so Complex and Information Appliances are the Solution. MIT Press, Cambridge, Massachusetts, USA., ISBN:9780262640411, Page: 302.

Osborne, D.W. and V.S. Ellingstad, 1987. Using sensor lines to show control-display linkages on a four burner stove. Proceedings of the International Conference on Human Factors and Ergonomics Society Annual Meeting, Vol. 31, September 1, 1987, SAGE, Thousand Oaks, California, pp: 581-584.

Pearson, J., G. Buchanan and H. Thimbleby, 2011. The reading desk: Applying physical interactions to digital documents. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, May 07-12, 2011, ACM, Vancouver, BC, Canada, ISBN: 978-1-4503-0228-9, pp: 3199-3202.

Ray, R.D. and W.D. Ray, 1979. An analysis of domestic cooker control design. Ergon., 22: 1243-1248.

Schmidt, A., 2000. Implicit human computer interaction through context. Pers. Technol., 4: 191-199.

Selanikio, J., 2008. The invisible computer revolution. BBC, London, UK., http: //news. bbc. co. uk/2 /hi/ 7106998. stm

Shinar, D. and M.B. Acton, 1978. Control-display relationships on the four-burner range: Population stereotypes versus standards. Hum. Factors J. Hum. Factors Ergon. Soc., 20: 13-17.

Wellner, P., 1991. The digital desk calculator: Tangible manipulation on a desk top display. Proceedings of the 4th Annual ACM Symposium on User Interface Software and Technology, November 11-13, 1991, ACM, Hilton Head, South Carolina, ISBN:0-89791-451-1, pp: 27-33.

Wisneski, C., H. Ishii, A. Dahley, M. Gorbet and S. Brave *et al.*, 1998. Ambient displays: Turning architectural space into an interface between people and digital information. Proceedings of the International Workshop on Cooperative Buildings, February 25-26, 1998, Springer, Berlin, Germany, pp: 22-32.

Wu, S.P., 1997. Further studies on the spatial compatibility of four control-display linkages. Intl. J. Ind. Ergon., 19: 353-360.

Zander, T.O., J. Bronstrup, R. Lorenz and L.R. Krol, 2014. Towards BCI-Based Implicit Control in Human-Computer Interaction. In: Advances in Physiological Computing, Stephen, H.F. and G. Kiel (Eds.). Springer, Berlin, Germany, ISBN:978-1-4471-6391-6, pp: 67-90.