Mobile Interfaces Using Body Worn Projector and Camera

Nobuchika Sakata, Teppei Konishi, and Shogo Nishida

Division of Systems Science and Applied Informatics Graduate
School of Engineering Science, Osaka University,
Machikaneyama-cho 1-3, Toyonaka city, Osaka 560-8531 Japan
{sakata,konishi,nishida}@nishilab.sys.es.osaka-u.ac.jp

Abstract. Unlike most desktop computer and laptop, mobile interface are designed to facilitate user operating the information easily with various situations that is standing, walking, and moving. However, almost mobile devices such like cell phones have a small key pad and small display because those devices should keep compact and light weight for bringing and pocketing. Therefore, they impose a lot of burdens to users in terms of watching a small display and typing with a small keyboard. Such devices do not focus to provide implicit and awareness information. In this paper, we describe features of body worn projector, which has capability for projecting information to user's peripheral vision, and body worn camera, which has capability for recognizing user's posture and estimating user's behavior, is suitable interface for providing awareness, implicit, and even explicit information. Finally, we propose two mobile interfaces which are "Palm top display for glance information" and "Floor projection from Lumbar mounted projector".

Keywords: Mobile AR, Wearable Computer, Mobile Interface, Mobile Projector, and Procams.

1 Introduction

Unlike most desktop computer and laptop, mobile interface are designed to facilitate user operating the information easily with various user's situations that is standing, walking, and moving. However, almost mobile devices such like cell phones have a small key pad and small display because those devices should keep compact and light weight for bringing and pocketing. Therefore, they impose a lot of burdens to users in terms of watching a small display and typing with a small keyboard. Also, they are designed for providing explicit information such like "search result of user's input" and "mail for you", needs user's deeply attention. For example, when user supposes to get restaurant information, user push a small button for inputting the restaurant name and gaze a small display for confirming the search results. Existent those devices do not focus to provide implicit and awareness information. For example, if the current cell phones provide "Good restaurant around you" via character information with the small display when user walks around the good cuisine and the user storages the cell phone in user's pocket, the cell phone should vibrate itself, ring or flash for awaking to the explicit information, and then, user should take the device

R. Shumaker (Ed.): Virtual and Mixed Reality, LNCS 5622, pp. 106–113, 2009.

from user's pocket to confirm the information. However, in case of user does not suppose to get restaurant information, it bothers the user. In this paper, we report that a combination of body worn projector, which has capability for projecting information to user's peripheral vision, and body worn camera, which has capability for recognizing user's posture and estimating user's behavior, is suitable interface for providing awareness, implicit, and even explicit information.

2 Related Works

Real world based interface, which aim to provide information based on user's behavior and circumtance around a user in real world, has been researched as good piece of supporting IT usability[1-8][10][13][15]. In the fields of wearable and mobile computer such like cell phones, providing information based on the place, pose and circumstances of mobile user, real world based interface has a possibility to boost usability dramatically. Also estimating user's purpose and circumstance by means of multimodal interface, several researches[3][4][5][6][8-12][16][17][19-21] provide information corresponding to the estimated purpose and circumstance. In those researches, some works adopted projector as display interface. Projecting information to various place and parts of human body, user can obtain the projected information with various postures such like standing, walking, running and crouching. Following paragraph introduce some details of above relate works.

Assaf Feldman presents "ReachMedia"[5], a system for seamlessly providing just-in-time information for everyday objects, built around a wireless wristband with an RFID reader to detect objects that the user is interacting with. It enables hands and eyes- free interaction with relevant information using a unique combination of audio output and gestural input, allowing socially acceptable, on-the-move interaction. Toolstone[8], the system applies only the information of object poses. However, these researches do not apply 3D spatial relation between the held object and a user. One of ways of recognizing user's condition and situation is identifying a held object and using it as input to a system. Tsukubu[7] proposed that a system comprised from a visible and an infrared camera estimates user's status with a held object and offers a teaching video. Ueoka [6] presented "I'm here" to support a user's memory where he placed an object by displaying the last video scene of the object he handled. The system enables users to retrieve certain information from a video database that has recorded a set of the latest scenes of target objects which were held by the user and observed from the user's viewpoint. As mentioned above, those researches recognize just a held object. 'SIXth Sense'[22][23] bridges these digital devices and interaction with the physical world by augmenting the physical world around us with digital information and proposing natural hand gestures as the mechanism to interact with that information. 'SIXth Sense' projects information to any surface, walls, and the objects around us, and to interact with the information through natural hand gestures, arm movements, or with the object itself. However, 'SIXth Sense' treates explict information by explicit gesture mainly.

Those works indicated providing a information based on user's posture and gesture is good way to boost IT usability. However, those works mainly focused to explicit information based on explicit user's gesture and posture.

3 Mobile Interface by Body Worn Projector and Camera

Commercial projector such like mobile LED projector become small enough to attach a human body, recently. One big feature of body worn projector is projecting to various places, such as floor and wall, and even human body parts which are arms, palms, fingers and back of the hands. It enables to provide information via any surface around a user. In section 3.1, we suggest “Palmtop display for glance information” for mobile interface of shoulder or breast worn projector and camera. In section 3.2, we suggest “Floor Projection from lumbar worn projector” for mobile interface of lumbar worn projector and stabilization method for lumbar mounted projector using internal inertial Sensor.

3.1 Palmtop Display for Glance Information

With attaching a projector on user body, it causes occlusion problem by user’s own body. Mayol[18] conducts the simulation to measure a level of decoupling of camera movement from the wearer's posture and motions by a combination of inertial, visual sensor feedback and active control. In terms of field of view of the handling space and amount of camera motion during walking, around a breast and shoulder is suitable place for deploying wearable visual robot which has 2-axis actuator, some sensors and a camera. We assume that cell phone installed a projector module is attached to user’s shoulder. In that situation, we suggest “Palmtop display for glance information”. We define information which needs short time to view and understand as the glance information. For example, when getting a spam mail on cell phone, in case of using current cell phone, user should bring out a cell phone from own pocket or bag, and then user watch small display. Finally, user recognizes the information is no worth to browse. However, using a palm top display, user just holds up own palm to certain position, and then the cell phone projects header information to user’s palm. Consequently, user can cut out motion of bringing out cell phone from own pocket and bag. This way of viewing information is suitable for time, short message, mail subject, and memo information (fig.1). Note that in case of that the projected information is worth for replying and operating, user just takes a cell phone from shoulder, and then, user operates by old fashion ways such like pushing buttons. Therefore, this mobile interface just boosts ease of viewing information and cuts out bothersome motions to bring out a cell phone from own pocket and bag, it does not deny current operating of cell phone.

We conduct a user study to assess performance of "Palmtop display for glance information" with qualitative and quantitative analysis. We set "on shoulder condition" and "in pocket condition" as comparative conditions. "Palmtop display condition" is that user just hold up own palm to certain position and view the projected information on user’s own palm under wizard-oz-way. "On shoulder condition" is that user detach semi-fixed cell phone from own shoulder and view a display of the cell phone. "In pocket condition" is that user brings out cell phone from shoulder and view a display of the cell phone. Ten males served as subjects (age:21-24).

The sampling data are completion time of viewing and completion time of motion. Completion time of viewing is time through a signal of starting, viewing the information on cell phone display or user's palm and telling the information to observer.

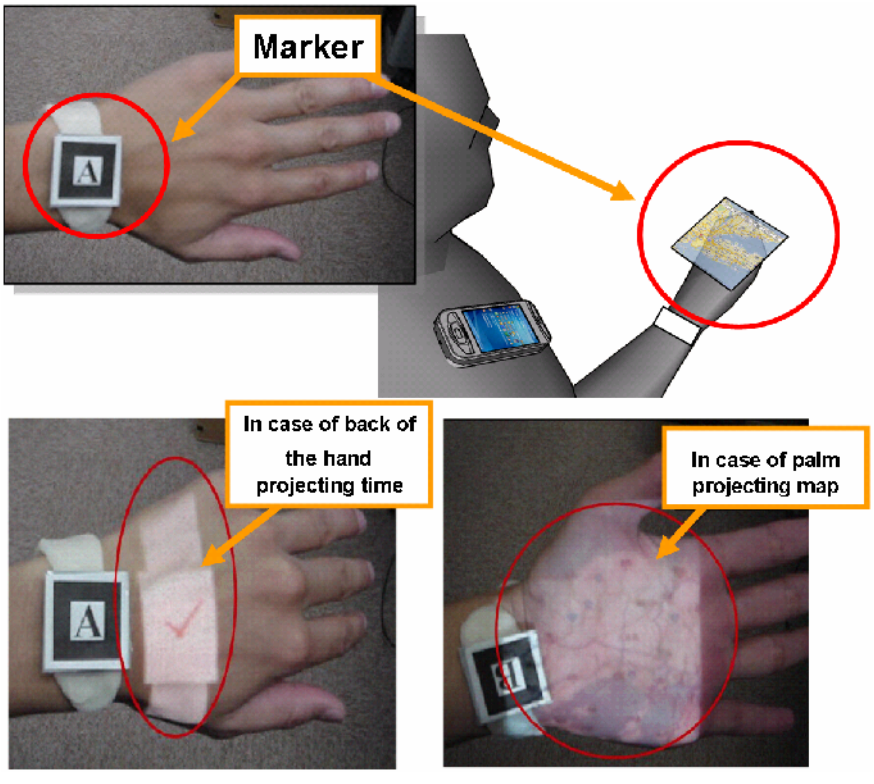

Fig. 1. Palm top display for glace

Completion time of motion is time through a signal of starting, viewing the information on cell phone display or user's palm, telling the information to observer, fixing cell phone to pocket or shoulder (in case of palmtop display, putting back own palm to original position). Also, to measure the performance of palm top display purely, we conduct Wizard-of-OZ test in "Palmtop display condition". Actually, in "Palmtop display condition", to compensate a problem of stability of projected information by user's motion, we fixed camera and projector with tripod instead of attaching to user's body. Note that we do not disrespect the stabilize problem. We believe that it is necessary to solve the problem for realizing palmtop display. We put ARToolkit[21] Marker to user's wrist (fig.3) for recognizing 3D posture and position of user's palm by the camera. After the user test, we conduct questioners to subjects.

Fig 3 shows a result of the user test. In case of "Palmtop Display condition", completion time of viewing and completion time of motion mark shortest time as shown in the upper side of fig. 3. Lower side of fig. 3 shows a result of questionnaire. "Palmtop display condition" marks less bothers. In this result, we can confirm possibility that palmtop display realize ease of viewing information and reduce bothers to bring out a cell phone from own pocket and bag.

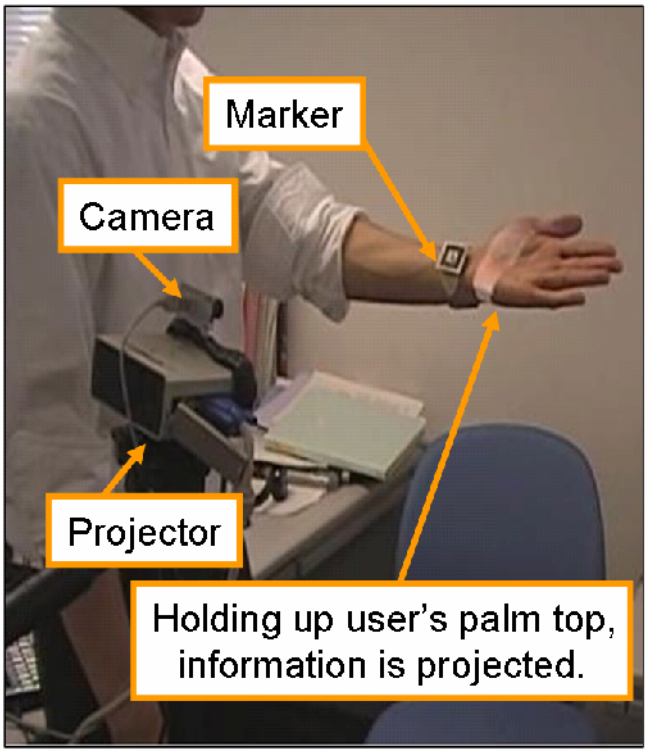

Fig. 2. Palmtop display condition (Wizard-of-Oz)

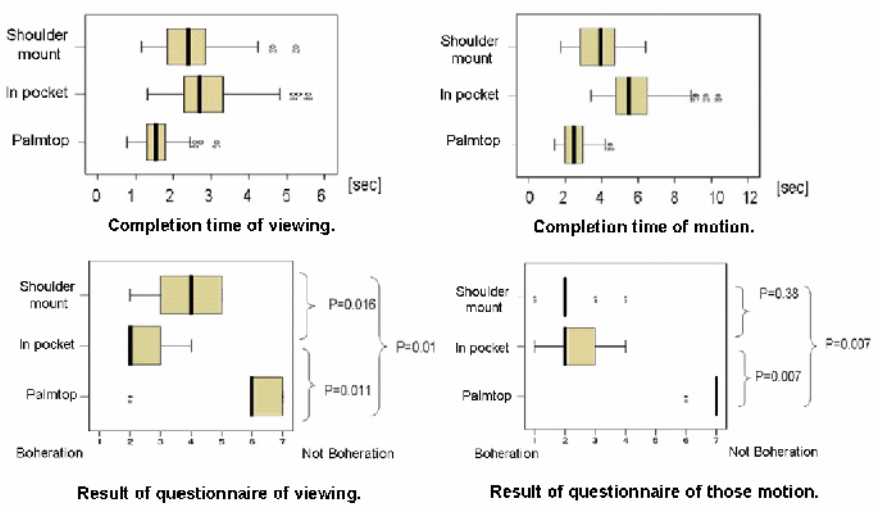

Fig. 3. Result of user test of palm top display for glance

3.2 Floor Projection Using Internal Inertia Sensor

Almost mobile device provide information to user via small own LCD. To use such mobile device, user must hold the device by one-handed and gaze installed small display even while user walking and running. However, risks of collision and falling are increased with gazing and holding the device by one-hand. Furthermore, it is difficult to provide the information based on real-world situation such like AR information. Also, the devices are designed for providing explicit information such like "search result of user's input" and "mail for you". Such style information needs user's deeply attention. Those devices have no focus to provide implicit and awareness information. Therefore, we propose “Floor projection” from lumbar mounted projector. This projecting way realizes hands, eye, and head free interface with current social acceptance. In section 3.1, we assume that cell phone installed a small projector and a camera are attached to user’s shoulder. However, considering social acceptance, we assume that people storage the cell phone in a pocket or fix the cell phone to own belt such like current mobile style in early age of spreading cell phone with projection capability. The common feature of body worn projector enables to provide information via any surface around a user. With using body worn projector, implicit and awareness information are projected to on a part of floor where user watches by user’s peripheral vision. Explicit information is projected to a part of floor where user watches by user’s central vision (Fig. 4).

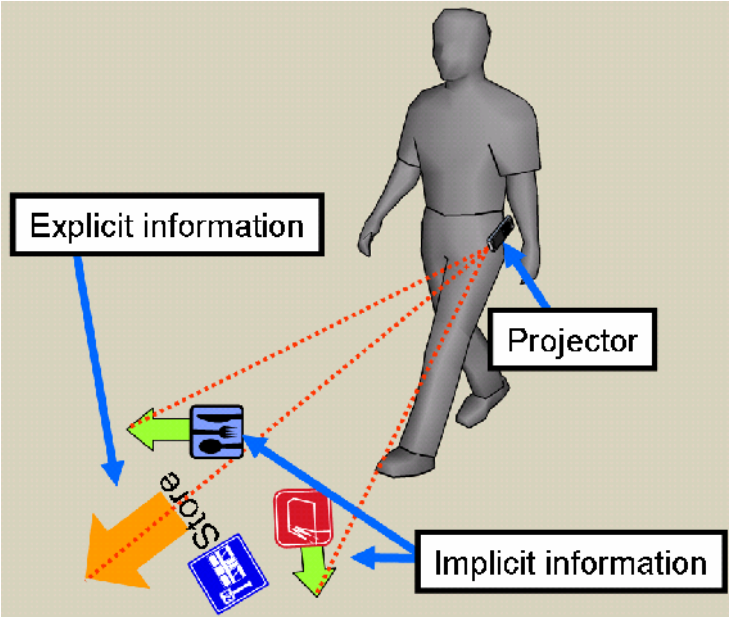

Fig. 4. Projecting explicit and implicit information from lumbar mounted projector

However, lumbar as mounting position loses a stability of projection comparing to shoulder, breast and head mounting. In particular, during walking and running, the projected information becomes unstable extremely. Therefore, we propose stabilization method for lumbar mounted projector using internal sensor. Actually, accelerometer and attitude sensor which be installed to a lumbar mounted projector measure translation and rotation of the lumbar mounted projector. Also we focus to periodicity of walking for applying compensations of time and spatial displacement by means of active noise cancel (ANC). Finally, according to measured translation and rotation, the projected information is moved on pixel of projector coordinate to cancel motion of lumbar mounted projector. Currently, we implement canceling a projector rotation. As a result, we can prevent that the projected information drop from user's peripheral while walking. However, it still involves stabilization problems. We should implement canceling translation by means of ANC.

4 Conclusion

In this paper, we describe features of body worn projector, which has capability for projecting information to user's peripheral vision, and body worn camera, which has capability for recognizing user's posture and estimating user's behavior, are suitable interface for providing awareness, implicit, and even explicit information. Finally, we propose two mobile interfaces which are “Palmtop display for glance information” and “Floor projection from Lumbar mounted projector”.

Conducting a user study of “Palmtop display for glance information”, we can confirm possibility that palmtop display realize ease of viewing information and reduce bothers to bring out a cell phone from own pocket and bag. Also we propose a stabilization method for lumbar mounted projector using internal accelerometer and attitude sensor and implement canceling rotation.

In future work, we suppose to realize palmtop display with real wearable condition while waling and even running. Also, we suppose to implement canceling translation of stabilization method for lumbar mounted projector.

References

1. Kourogi, M., Kurata, T.: Personal positioning based on walking locomotion analysis with self-contained sensors and a wearable camera. In: ISMAR 2003, pp. 103–112 (2003)
2. Rekimoto, J.: GestureWrist and GesturePad: Unobtrusive wearable interaction devices. In: ISWC 2001, pp. 21–27 (2001)
3. Kurata, T., Okuma, T., Kourogi, M., Sakaue, K.: The hand-mouse: A human interface suitable for augmentedreality environment enabled by visual wearables. TechnicalReport of IEICE (PRMU), pp. 69–76 (2000)
4. Feldman, A., Tapia, E.M., Sadi, S., Maes, P., Schmandt, C.: ReachMedia: On-the-move interaction with everyday objects. In: ISWC 2005, pp. 52–59, (2005)
5. Ueoka, T., Kawamura, T., Kono, Y., Kidode, M.: I’m Here!: a Wearable bject Remembrance Support System. In: MobileHCI 2003, Fifth International Symposium on Human Computer Interaction with obile Devices and Services, pp. 422–427 (2003)

6. Tsukubu, Y., Kosaka, T., Kameda, Y., Nakamura, Y., Ohta, Y.: Video-Based Media for Gently Giving Instructions: Object change detection and working process identification. In: PRMU 2004, pp. 13–18 (2004)
7. Rekimoto, J., Sciammarella, E.: ToolStone: Effective Use of the Physical Manipulation Vocabularies of Input Devices. In: Proc. of UIST 2000, pp. 109–117 (2000)
8. Kourogi, M., Sakata, N., Okuma, T., Kurata, T.: Indoor/Outdoor pedestrian navigation with an embedded gPS/RFID/Self-contained sensor system. In: Pan, Z., Cheok, D.A.D., Haller, M., Lau, R., Saito, H., Liang, R. (eds.) ICAT 2006. LNCS, vol. 4282, pp. 1310–1321. Springer, Heidelberg (2006)
9. Sakata, N., Kurata, T., Kato, T., Kourogi, M., Kuzuoka, H.: WACL: Supporting Telecommunications Using Wearable Active Camera with Laser Pointer. In: ISWC 2003, NY, USA, pp. 53–56 (2003)
10. Yamamoto, G., Xu, H., Sato, K.: PALMbit-Silhouette. In: Interaction 2008, pp. 109–116 (2008) (in Japanese)
11. Yamamoto, G., Nanbu, S., Xu, H., Sato, K.: PALMbit-Shadow: Accessing by Virtual Shadow. In: The 6th IEEE and ACM International Symposium on Mixed and Augmented Reality, Nara, Japan (2007)
12. Starner, T., Weaver, J., Pentland, A.: Real-time American SignLanguage recognition using desk and wearable computer-based video. IEEE Trans. Patt. Analy. and Mach. Intell. 20(12) (1998)
13. Mann, S.: Smart Clothing: TheWearable Computer and WearCam. Personal Technologies 1(1) (1997)
14. Starner, T., Auxier, J., Ashbrook, D., Gandy, M.: The gesture pendant: A self-illuminating, wearable, infrared computer vision system for home automation control and medical monitoring. In: The Fourth International Symposium on Wearable Computers, ISWC 2000 (2000)
15. Kolsch, M., Beall, A., Turk, M.: Postural comfort zone for reaching gestures. In: Human Factors and Ergonomics Society Annual Meeting (2003)
16. Kolsch, M., Beall, A., Turk, M.: An objective measure for postural comfort. In: Human Factors and Ergonomics Society Annual Meeting (2003)
17. Wither, J., DiVerdi, S., Hollerer, T.: Evaluating Display Types for AR Selection and Annotation. In: International Symposium on Mixed and Augmented Reality (2007)
18. Mayol, W.W., Tordoff, B., Murray, D.W.: Designing a miniature wearable visual robot. In: ICRA, pp. 3725–3730 (2002)
19. Chaffin, D.B.: Localized Muscle Fatigue Definition and Measurement. Journal of Occupational Medicine 15(4), 346–354 (1973)
20. Wither, J., Di Verdi, S., Hollerer, T.: Evaluating Display Types for AR Selection and Annotation. In: International Symposium on Mixed and Augmented Reality 2007, pp. 95–98 (2007)
21. ARToolkit Website, `http://www.hitl.washington.edu/artoolkit/`
22. Mistry, P., Maes, P., Chang, L.: WUW: Wear Ur World - A Wearable Gestural Interface. In: CHI 2009 extended abstracts on Human factors in computing systems, Boston, USA (to appear, 2009)
23. Maes, P., Mistry, P.: The Sixth Sense. TED talk in Reframe session. In: TED 2009, Long Beach, CA, USA (2009)