VizWear-Active: Towards a Functionally-Distributed Architecture for Real-Time Visual Tracking and Context-Aware UI

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Abstract

VizWear-Active is a wearable active vision system for distributed computing environments. It consists of wearable and infrastructure-side modules that autonomously and co-operatively work together. The wearable-side modules include a wearable active camera module for actively acquiring information existing around the wearer in his/her daily life and a wristwatch UI module to provide a context-aware user interface (UI). We have implemented and demonstrated a visual augmented memory application based on real-time visual tracking by the wearable active camera module and arm gesture recognition by the wristwatch UI module.

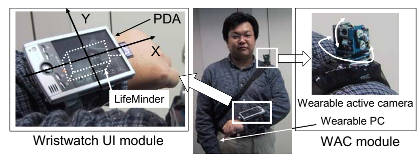

Figure 1. A prototype *VizWear-Active* **system.**

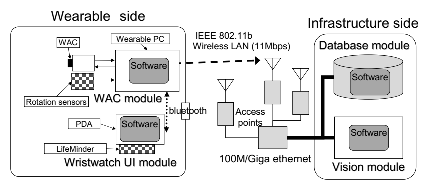

Figure 2. Overview of *VizWear-Active***.**

1. Introduction

Visual augmented memory [2] is a promising application of wearable systems that assists the wearer to recall previously experienced episodes related to people that the wearer met in his/her daily life. To realize visual augmented memory, it is important to collect information existing around the wearer and to recognize the wearer's requirements.

We have developed the *VizWear-Active* system [1, 4] for visual augmented memory. It is a wearable assistant with a wearable active camera [6]. This paper describes an implementation of real-time visual person tracking, which collects visual information about the people around the wearer, and a context-aware UI, which recognizes the wearer's requirements. It also shows an example of a visual augmented memory application.

2. *VizWear-Active*

Figure 1 shows a prototype of the *VizWear-Active* system. It has a wearable active camera (WAC) module, which can observe the wearer's surrounding with elevation and panning, and a wristwatch UI module, which consists of a PDA and a LifeMinder [7]. LifeMinder is a wearable healthcare assistant that can potentially grasp the wearer's conditions for the context-aware UI.

The vision tasks for visual augmented memory are often computationally intensive for stand-alone wearable systems. To solve this problem, we introduce a functionally-distributed architecture that integrates the infrastructure-side resources with the wearable systems. Our system has a vision module and a database module on the infrastructure-side, as shown in Figure 2. The wearable and infrastructure-side modules are connected via a wireless LAN (IEEE801.11b).

To achieve real-time visual tracking in the *VizWear-Active* system, we have proposed Distributed Monte Carlo (DMC) tracking [5], which is an extension of the ConDensation algorithm [3] for distributed architectures. The DMC tracking method provides coarse but rapid person tracking with the smallest possible number of samples on the WAC module and accurate estimation of the face posture with a sufficient number of samples on the vision module. Using it, the WAC module continues to track the person on a stand-alone basis even when it is unable to communicate with the

Proceedings of the 6th International Symposium on Wearable Computers (ISWC'02)
0-7695-1816-8/02 $17.00 © 2002 IEEE

vision module. This is because the stand-alone WAC module can also complete the tracking process. More accurate results can be obtained when it can communicate with the vision modules. Figure 3 shows DMC tracking results. The broken ellipses indicate states tracked by the stand-alone WAC module, and solid ellipses indicate states estimated by the vision module. Figure 4 shows the delays in visual tracking. The solid line indicates feedback delays for the camera control in the DMC tracking. The broken line indicates delays when the visual tracking was processed by only the vision module, and the tracking results were fedback via a wireless LAN. We can see that the vision module estimated the head posture accurately, while the WAC module fed back the head position rapidly.

The wristwatch UI module presents information about episodes that the wearer wants to recall. The wearer's requirements are recognized by using the *LifeMinder*. This has accelerometers for two axes, which are set to match the display plane of the PDA and cross each other at right angles as shown in Figure 1. The accelerometers can measure the pose of the wearer's arm with respect to the direction of gravitational acceleration. The wearer looks on the display at the wristwatch PDA when he/she wants to recall an episode. The wristwatch UI module recognizes this arm gesture, the wearer is looking at the display. Figure 5 shows an example of the X- and Y-axes components of acceleration. We can see that these values clearly change when the wearer is looking at the display. The arm gesture can be recognized by thresholds of the accelerometers.

3. Visual Augmented Memory Application

We implemented a visual augmented memory application on the *VizWear-Active* system. The database module has an "episode database" that stores episodes, including time-stamps and video logs displaying previously met people and their environments. The face dictionary indexes all episodes in the episode database to enable the necessary episodes to be retrieved. The database module retrieves episodes of a tracked person by using a face recognition engine (VISIONICS corp. FaceIt), and the episodes are sent to the wristwatch UI module in response to the recognized arm gesture.

Figure 6 shows an example of the visual augmented memory. The left(right) parts shows processes on the wearable-side (infrastructure-side) modules. The left lower part shows an episode being presented to the wearer.

Acknowledgments

LifeMinder was provided by Multimedia Laboratory Corporate Research & Development Center TOSHIBA Corporation. This work was supported by Special Coordination Funds for Promoting Science and Technology of MEXT of the Japanese Government.

Figure 3. Results of DMC tracking.

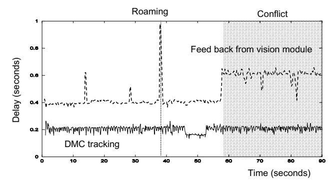

Figure 4. Delays in DMC tracking.

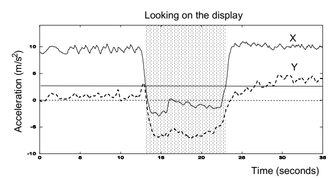

Figure 5. Results of arm gesture recognition.

Figure 6. Visual augmented memory.

References

[1] http://www.is.aist.go.jp/vizwear/.

[2] J. Farringdon and V. Oni. Visual augmented memory. In *4th International Symposium on Wearable Computers (ISWC2000)*, pages 167–168, 2000.

[3] M. Isard and A. Blake. Condensation – condentional density propagation for visual tracking. *International Journal of Conputer Vision*, 29(1):5–28, 1998.

[4] T. Kato, T. Kurata, and K. Sakaue. Face registration using wearable active vision systems for augmented memory. In *DICTA2002*, pages 252–257, Jan. 2002.

[5] T. Kato, T. Kurata, and K. Sakaue. VizWear-Active: Distributed Monte Carlo face tracking for wearable active cameras. In *ICPR2002*, Aug. 2002. (to appear).

[6] W. Mayol, B. Tordoff, and D. Murray. Wearable visual robots. In *4th International Symposium on Wearable Computers (ISWC2000)*, pages 95–102, 2000.

[7] T. Suzuki and M. Doi. LifeMinder: An evidence-based wearable healthcare assistant. In *CHI2001 Extended Abstracts*, pages 127–128, 2001.