Recent Progress on Wearable Augmented Interaction at AIST

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Weavy

The goal of the *Weavy* project team is to create *wearable visual interface* which enables intuitive and direct interaction with real/virtual environments and remote person based on computer vision, multi-sensor fusion, and augmented reality techniques.

In this talk, I will introduce our current investigation in the field of wearable augmented interaction at the National Institute of Advanced Industrial Science and Technology (AIST) in Japan.

http://www.is.aist.go.jp/weavy/movie/2002/Weavy-EngVI.MPG
Contents

This talk covers

• RWCVI-DK: Real World Coupled Visual Interface Development Kit

• Natural feature-based 3D object tracking and its application to wearable AR systems

• Wearable Active Camera/ Laser (WACL) interface for remote collaboration that does not use a head-worn display/camera
RWCVI-DK

We have developed a commercial RWCVI-DK (Real World Coupled Visual Interface Development Kit) in cooperation with Media Drive Corporation that includes:

- Personal Positioning (PP) with self-contained sensors
- Hand-Gesture (HG) Interface
- Real-World OCR (RWOCR) (OCR: Optical Character Recognition)
Goal: Personal positioning for wearable users
- Without external source of information such as GPS and IR/RF/ultrasonic tags
- Light-weight equipments without using expensive highly specialized devices such as Inertial Measurement Unit (IMU).

What are requirements for personal positioning?
- Direction of the user’s head (camera)
  - A wearable camera is attached to the head
- Direction of the user’s body
  - The direction to which the user moves
- Position of the user
Personal Positioning (PP)

- We deal with three types of locomotion that we do frequently.
  - Walking on a flat floor
  - Going up/down the stairs
  - Going up/down in an elevator

- Source of information (self-contained sensors)
  - A wearable camera
  - A 3-DOF attitude sensor (head)
  - A 3-DOF attitude sensor (torso)
    - 3-axis accelerometers
    - 3-axis gyro-sensors
    - 3-axis magnetometers
How does PP work?

Input

Output

Kalman filter update loop

Covariance matrix

State vector

Covariance matrix of measurement error

Update gain

Update covariance

Walking distance estimation module

Magnetic vector

Gravitational vector

Angular velocity (torso)

Attitude angle (head)

Image

Accumulation

Test reliability

Generate measurement

Buffer

Image registration module

Update

DB

Measurement

Input

Output

2004/2/3

Design Computing Lab Lunch Colloquium
Experimental results

Walking on a flat floor

side-forward acceleration while in walking

Speed estimation

Going up the stairs

Going down the stairs

Taking an elevator

2004/2/3

Design Computing Lab Lunch Colloquium
Experimental results

Dead-reckoning trajectories: walking around our office, going down the stairs (3F to 1F), and going up in an elevator (1F to 3F).
Demo Video: PP

http://www.is.aist.go.jp/weavy/movie/2003/robot_exhibition-1VI.MPG
Hand-gesture Interface (HG)

- Sensing for situation awareness is regarded as autonomous input interface and very important to construct AR/situation-aware environments.

- Explicit input interfaces are also essential for interaction with the environment (system).

HG Interface

Especially fits Head Worn Displays (HWDs) in a similar way a touch panel fits ordinary displays.
Related Works on HG (& RWOCR)

- There are numerous works involved with input interfaces for wearable/mobile systems.
- We are aiming to create a novel interface without extra devices on their own hands.

Text typing for cell phones

FingeRing (CHI97)

TR397 (MIT Media Lab.), 1997

2004/2/3
How does HG work?

1. Hand candidate detection based on inter-frame difference with low resolution image
   - Detected
   - Global hand motion tracking using color features
     - Hand posture estimation using contour and color features
       - Yes
       - Hand disappeared?
         - No
         - Hand tracking using particle filter framework
2msec
(Pentium 4-M 2.2GHz)

30msec
Video Demo: HG

http://www.is.aist.go.jp/weavy/movie/2004/hgsampleVI.MPG
Secure PIN Input with HG

http://www.is.aist.go.jp/weavy/movie/2002/passwdVI.MPG
Real world OCR (RWOCR)

Guide (Navigation) service based on doorplates, signboards, and traffic signs

Text translation service when going abroad

The 3rd Conference Room

You are on the second floor of the main building now. You have to go the third floor of the annex.

Room reservation service

Would you like to make a reservation of this room?
Real world OCR (RWOCR)

- Text area detection to make text areas easy to select (Texture analysis based on Neural Network)
- OCR engine developed by Media Drive Corp.

Combining with image registration techniques to get wider/higher definition images including text area
Video Demo: PP & RWOCR

http://www.is.aist.go.jp/weavy/movie/2003/robot_exhibition-2VI.MPG
Video Demo: HG & RWOCR

http://www.is.aist.go.jp/weavy/movie/2003/robot_exhibition-2VI.MPG
Natural feature-based 3D object tracking

**Goal:** To determine geometric relations between a real object and users’ viewing position using vision-based tracking.

**Difficulty:** To keep known points in input images being tracked. To determine accurate camera parameters using the tracking results that usually include classification errors and measurement errors.

Mixed Reality (MR) Applications

- Simulation of sight
- Simulation of the real object
- Display of occluded real objects
- Real Environment
- Edutainment
- 3-D online manual
- Our Target
- 3-D annotation
- CSCW
- X-ray Vision
- Surgery assistance
- MR systems Lab
- GMD
- GMDUNC
- MR systems Lab
- GMD
- GMD UNC
How does 3D Object Tracking work?

- Hybrid Framework of BUA (Bottom-Up Approach) and TDA (Top-Down Approach)
  - BUA: LMedS + P3P (Perspective-Three-Point) solution
  - TDA: Particle Filter (Condensation method)
- Adds new appearance data automatically.
- Orientation sensors is used in the prediction step to select appropriate “Reference Images” from the Database
Output image sequence of Experiment

Wearable Active Camera/ Laser (WACL) : Applications of Wearable Communication Terminals

- Remote Instruction
  - Guidance on how to handle new task
  - Guidance on how to assemble new equipment
  - Medical Guidance in an accident/rescue operation

- Personal Navigation
  - Guidance on how to get to his/her destination

[Kraut 96]

MR-EXPO (ISMAR2003)  
[Kourogi 2003]  
Design Computing Lab Lunch Colloquium  
[Hestnes 01]
Existing Communication Terminals with a Laser Pointer

- Types of Communication Terminal
  - Inside installed Type: GestureLaser [Kuzuoka 98]
  - Portable Type: Cterm [Mikikawa 01]
  - Wearable Type: Telepointer [Mann 00]
How does the WACL look like?

WACL: Supporting Telecommunications by Using a Wearable Active Camera with a Laser Pointer

http://www.is.aist.go.jp/weavy/heteroarcade/movie/remoinstVI.MPG

http://www.is.aist.go.jp/weavy/heteroarcade/movie/waclVI.MPG
Thank You for your attention!

Weavy: http://www.is.aist.go.jp/weavy/
RWCVI: http://adv.mediarive.jp/product/link_visual/index.html