ユビキタスシステムアーキテクチャ

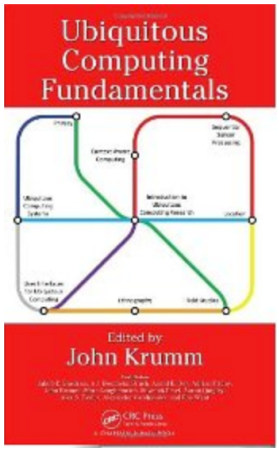
第6回 Context Awareness

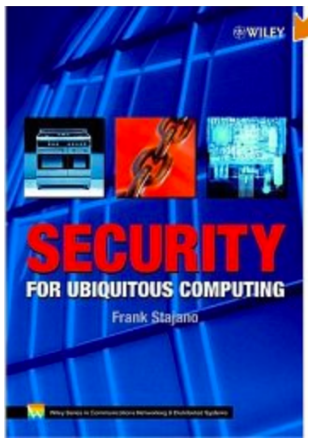
慶應義塾大学環境情報学部
徳田英幸

タームプロジェクトについて

- 5/28（木）の授業で中間発表を行います!
  - 11時10分～　@τ12
    - 1グループ5分程度でどのようなシステムを構築するか説明する
    - 5枚程度の発表資料の準備をする
    - 出席できない場合は、TA/SAに相談してください
    - 別途対応します
- 質問、相談があればTA/SAまで
  - wataru, drgnman@ht.sfc.keio.ac.jp
  - デルタ棟S213に来てもらってもOKです

Textbook？

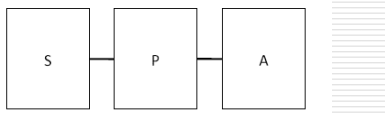




back to the last lecture…
ちょっと復習。。。

HOT-SPA Architecture

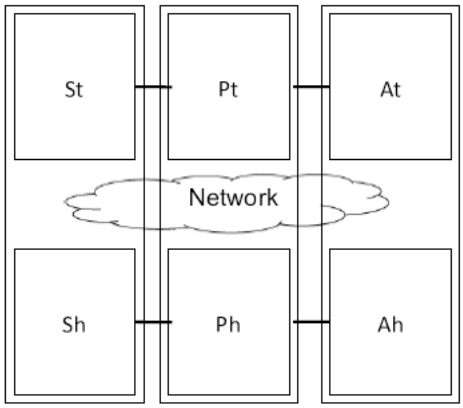
HOT-SPA Architecture Model



SPA Model

HOT-SPA Model

There



Here

Context-awareness in Ubiquitous Services

- Personal Context
  - e.g. sleeping, eating, standing, running, walking, moving, stopping, … etc.
- Group Context
  - e.g. group meeting, discussion, sports, ad hoc chatting, lecture, … etc.
- Urban Context
  - e.g. City-wide context
    - blackout area, rain, hot spots, traffic jam, train accident, social events, … etc
- Nation-wide Context
  - e.g. population distribution, power distribution, … etc

Personal and Global Enablers:
Sensor enabled Smart Devices & Cars

- Internal Sensors
  - GPS
  - Camera
  - Accelerometers
  - Light Sensors
  - Microphone
  - Cellular radio signal strength
  - Bluetooth
  - WiFi
  - Smart Cards (Osaifu Keitai)
  - NFC, Active/Passive Tags
- Soft Sensors/Open Big Data
  - Twitter, Foursquare, Facebook, etc
- External Sensors
  - Biosensors
  - Alcohol sensor
  - Pressure sensor
  - Mote Sensor
  - Zigbee sensor

Context Capturing

Context-awareness in Ubiquitous Services

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- Nation-wide Context
  - e.g. population distribution, power distribution, … etc

Simple Examples

Visualizing Status of a Shower Room with Sensors

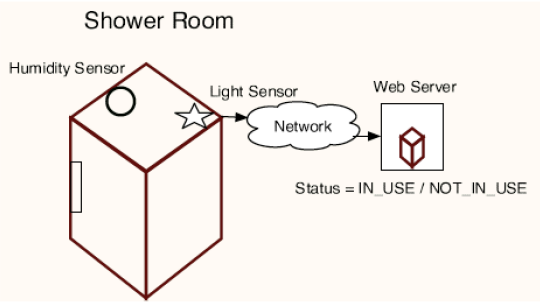


Figure 1.2: シャワールーム管理システムの構成モデル

S: Sensing Module

```
#define PERIOD 10 /* check every 10 sec */
sensing_module()
{
  SENSOR_RAW_DATA da;

  while(TRUE) {
   da = read_sensor_data();  /* reading sensor raw data */
                             /* sending data to processing module */
   send_sensor_data(sensor_data_proc, da);
  }
}
```

P: Processing Module

```
processing_module()
{
  SENSOR_RAW_DATA da;
  SENSOR_NORMALIZED_DATA nda;
  EVENT_DATA ed:
  CONTEXT ctx;

  while(TRUE) {
   nda = sensor_data_proc(da); /* receive sensor data */
   ea = event_proc(nda);       /* convert data to an event */
   ctx = context_capture_proc (ea);
    actuation_module(ctx);
  }
}
```


C: Context Capturing

```
CONTEXT context_capture_proc(ea)
EVENT_DATA ea;
{
   CONTEXT ctx:

   /* simple contex capturing */
   ctx.time = get_current_time();
   if ((ea.wet == WET) \&\& (ea.light == ON)){
     ctx.status = IN_USE;
   }else{
     ctx.status = NOT_IN_USE;
   }
   return(ctx);
}
```

A: Actuation

```
actuation_module(ctx)
CONTEXT ctx;
{
    /* setting a web page with the current context */
    set_web_page(current_time, ctx);
}
```


Context Capturing

- Rule-based Capturing/ルール指向型状況認識
  - If R1then do S1
  - If R2 then do S2
  - …
  - If Rk then do Sk
- Machine Learning-based Capturing/機械学習型状況認識
  - 機械学習：アルゴリズムとして明示的に解が与えられていないタスクに対して、そのタスクを遂行するためのモデルを学習データから構築
  - Probabilistic analysis
  - ML with Learning data
  - ML without Learning data

機械学習プログラムが学習するとは？

- 与えられたあるタスクに対して
- 与えられたある学習データによって
- モデルの性能測定基準の値が向上すること

- 機械学習とは、単にモデルを構築をするだけでなく、その性能基準の値が向上するということ
- 機械学習のタスク
  - 推論、認識、予測、適応などを伴う人間の知的活動の様々な分野がその対象

ML-based Capturing

ML-based Capturing

Zoograph
(2006-)

contact: namachan@ht.sfc.keio.ac.jp

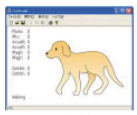
小型センサを使用したペットの行動推測システム

―いつでも，どこでも自分のペットの行動が確認できたら―
本研究ではユビキタスセンサ技術で，このペット好きの夢を実現します．
ペットの飼い主はオフィスでも，スーパーでも，いつでも，どこでもペットの行動を確認できるようになりました．行動の確認だけではなく，ある特定の行動をとった場合に飼い主に自動的に知らせるなど，行動コンテクストを応用した実用アプリケーションの実現も研究課題の1つです．

Behavior Context Extraction System for Dogs with a Small Sensor

"Being close to your pet, any where and any time."
Using Ubiquitous Sensor Technology, we meet this needs of the pet lovers. Now, pet owners can know what their pet is doing from an office, a school, or a shopping mall. We are working on not only context extraction but also context aware service, for example calling the pet owner when his/her pet takes a certain behavior.

sensor data



sensor data

センサー <sensor>
無線センサが組み込まれた首輪をペットに装着し，環境情報を取得します．
Taking environmental information using a collar with sensor implemented.

コンテクスト解析 <context>
コンピュータでセンサデータを受信し，データを解析します．
Analyzing the sensor data and extract a behavior context of the pet.

表示・通知 <visualize>
携帯電話上で動くアプリを利用し，リアルタイムにペットの行動状況を表す．
Using cell-phone, the viewer application shows the behavior of the pet.

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コンテクストアウェアアプリケーション
What is Context-aware Applications

コンテクストアウェアアプリケーションとは？
What is a Context-aware Application?

- コンテクストとは？/ Context?
  - 場所、時間、その他いろいろな状況・環境・人の嗜好など（文脈）
  - Context may indicates Location, Time, Situation, Environment or even person's preference
- コンテクストアウェアアプリケーションとは？

  Context-aware applications?
  - 状況を認識し、それに適した形でプログラムの挙動を適応できるアプリケーション
  - Based on captured context information, the behavior of the program may change dynamically.

Context-awareness in UbiComp

- Personal Context
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Personal Context:
基本的なチェック項目/ Check Items

- 誰(who)が利用するのか？
- 何(what)をセンスするのか？
  - プライバシに関して問題ないか？
- 何(what)のアクションをするのか？
  - 自然なアクションか?
- どんな支援をするのか？
- いつ(when)有効か？
- どこで(where) 有効か？

Context-aware Applications and Taxonomy

by J. I. Hong, UC Berkeley

Potential Examples	Context Types	Human Concern
Auto Cell Phone Off In Meetings	Identity	Convenience
Tag Photos	Time	Finding Info
Proximal Reminders	Location Proximity	Memory
Health Alert	Activity History	Safety
Service Fleet Dispatching	...	Efficiency

Context-aware Applications and Taxonomy

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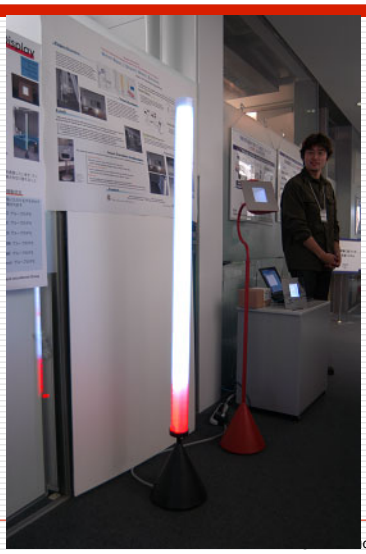
SF-2a: Smart Lamp



状況認識用センサ:

e-code spider

RFID tag

状況:

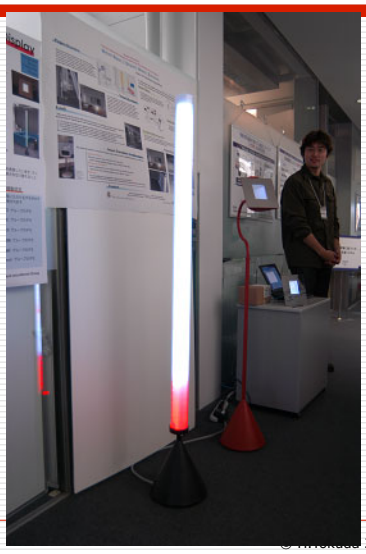
会場内の人数

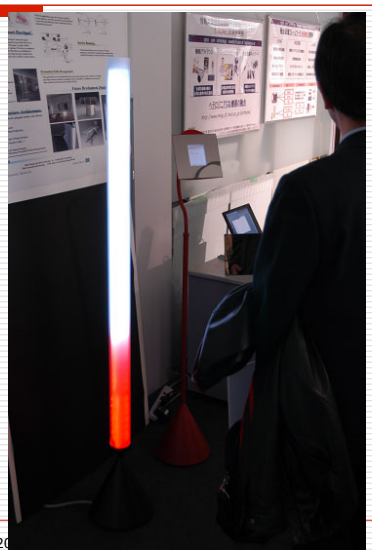
会場のデモ状態

適応動作:

光による表示

SF-2a: Smart Lamp



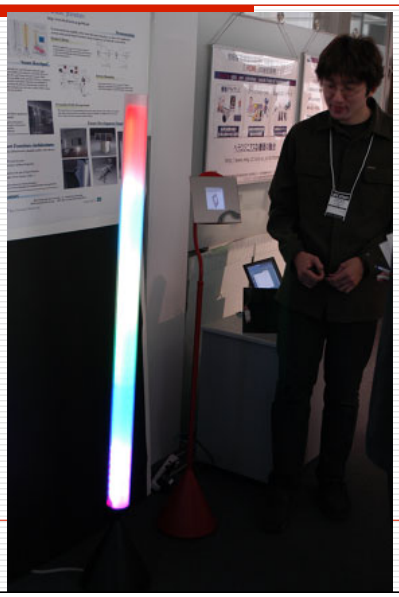


Environmental Monitor

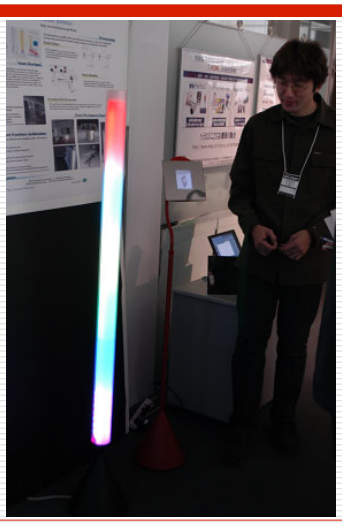
- Intuitive Indication
  - Encode Value of Sensors to Colors
- Coordination with Sensors in Surroundings
  - Number of People
  - Weather Information
  - Network traffic

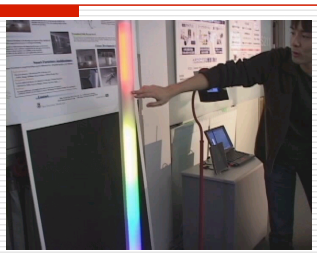
RF-ID

Event Monitor



Event Monitor (2): Demo status





Red: Demo1 up/down

Light Blue: Demo2

Yellow: Demo3

Green: Demo4

Blue: Demo5

Pink: Demo6

Personalized Message Board

状況認識用センサ:

RFID tag +e-code spider

PDA+無線LAN

状況:

個人の年齢、性別

適応動作:

年齢に応じた広告を表示

2012

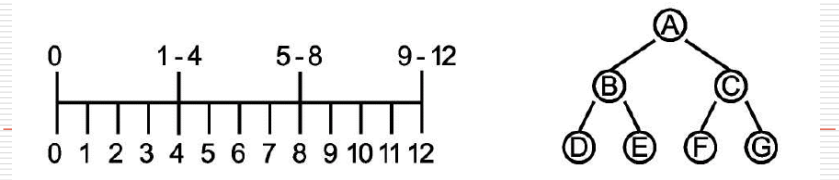
Personalized Message Board

PPNP (Privacy Profile Negotiation Protocol)

- Adjusting Data granularity
  - Protecting private information against public servers
- P3P/APPEL (W3C)
  - Platform for Privacy Preference Project
  - A P3P Preference Exchange Language
  - Service Level
    - L3: do_service(A, B, C)
    - L2: do_service(A, B)
    - L1: do_service(A)

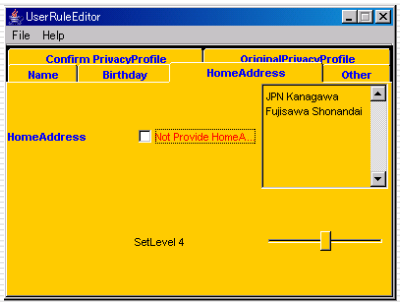
PPNP: Data Granulation

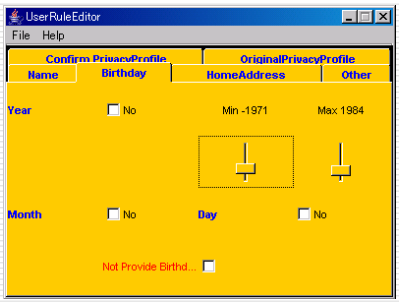
- Continuous vales
  - Eg.
    - age
  - granularity
    - default…2 groups
    - mid….1～4
    - high…1～8
- Hierarchical vales
  - Eg.
    - Address, organization
  - granularity
    - default…A
    - mid….A-B
    - high…A-B-D



User Rule Editor in a uMobile

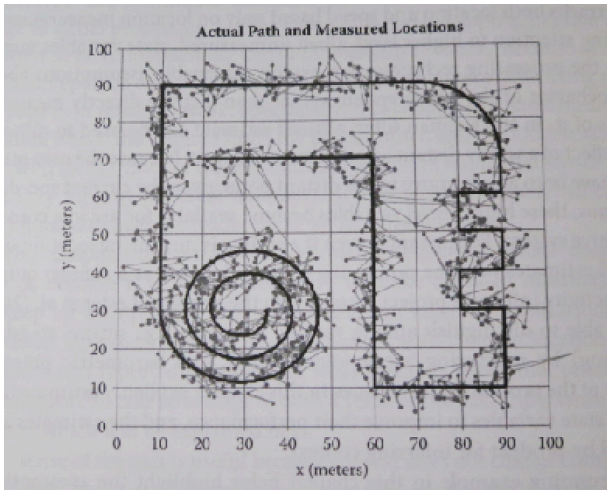
- Address
- Date of birth



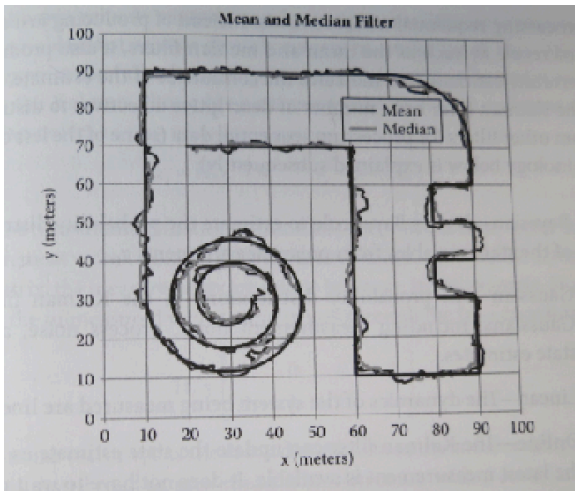


Location Context Capturing

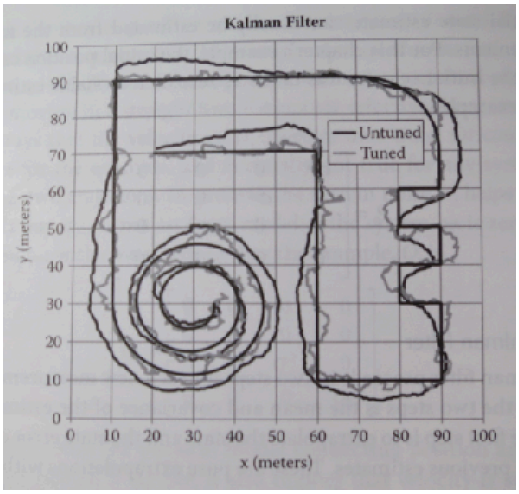
Actual Path and Measured Locations
(by John Krumm)



Mean and Median Filter

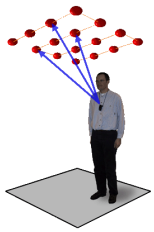


Kalman Filter

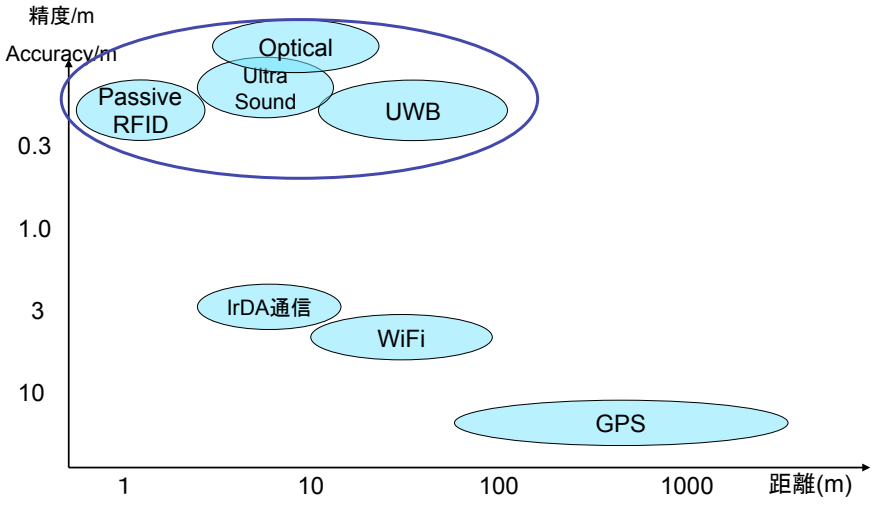


室内位置情報システム(Indoor Location Systems)

- GPS利用不可
  - 自己センス型 (GPS, Criket)
  - 環境センス型 (3D Bat)
- 超音波方式
  - 3D Bat
  - Criket
- 電子タグ(RFID)
  - Active vs. Passive
- 画像処理
  - EasyLiving

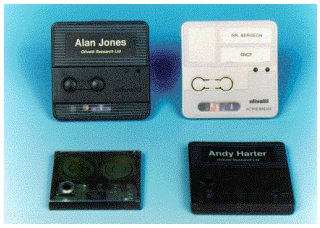


位置情報システム (Location Systems)

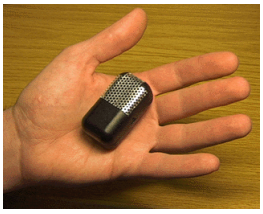


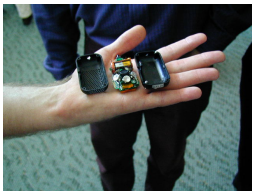
Active Badge

- 2次元位置情報システム
- IrDA
- 個人認証
- Follow-me アプリケーション



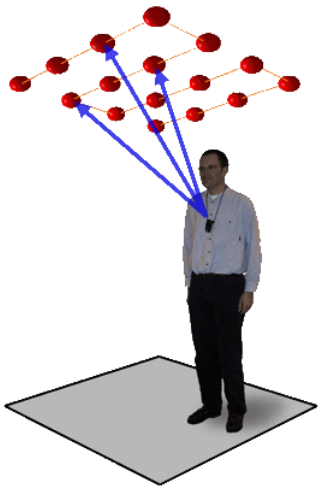
3-D Active Bat （初期モデル）



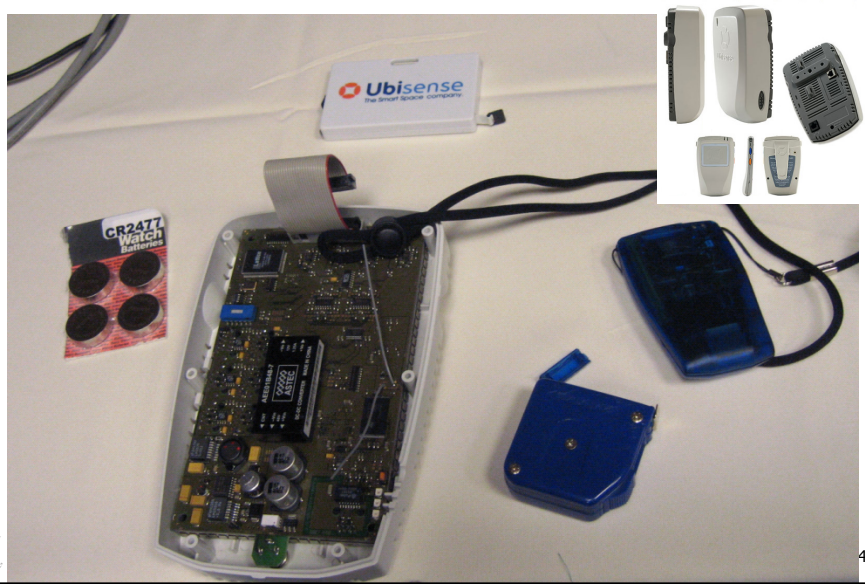


3-D Bat System

- 環境センス型センサ



Ubisense: Base unit + tag



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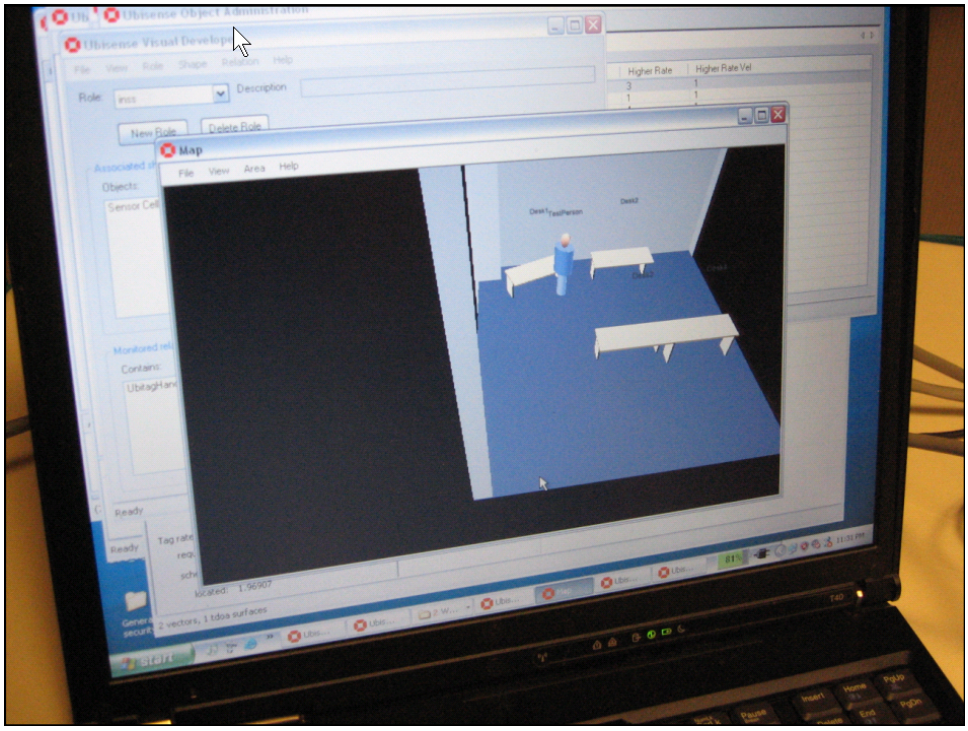
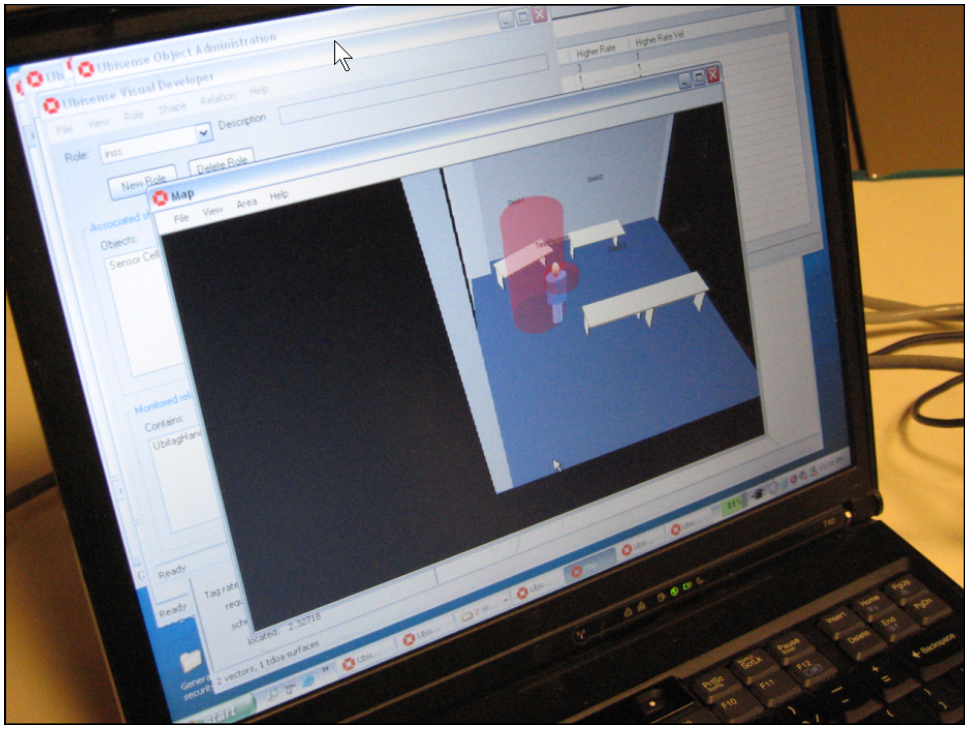
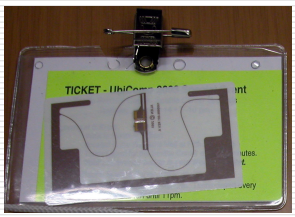
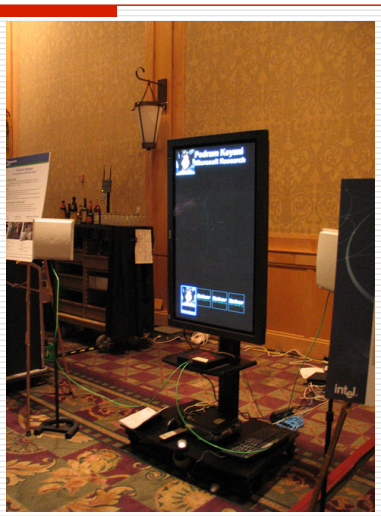




Sensor Network in SS Lab.

Passive Tag (Ubicomp2003)



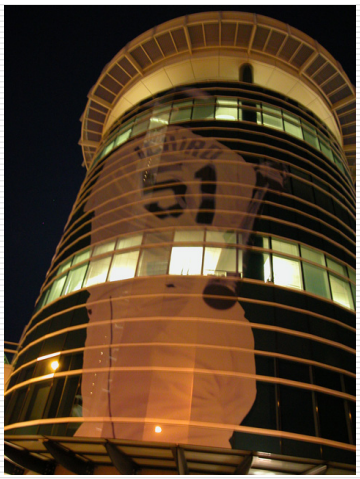


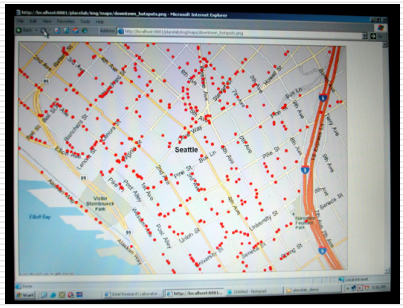
Active Tag: R-Click@六本木ヒルズ

- ここだけクリック
- みてとるクリック
- ぷらっとキャッチ

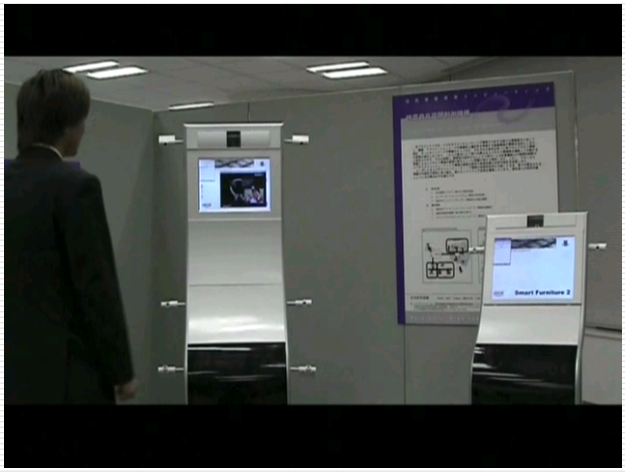
R-Clickの実証実験@六本木ヒルズ

Ubicomp2003@Seattle 10/12-15

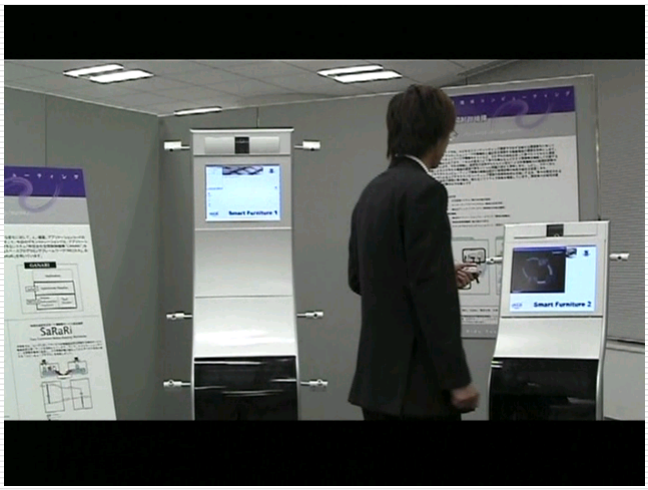




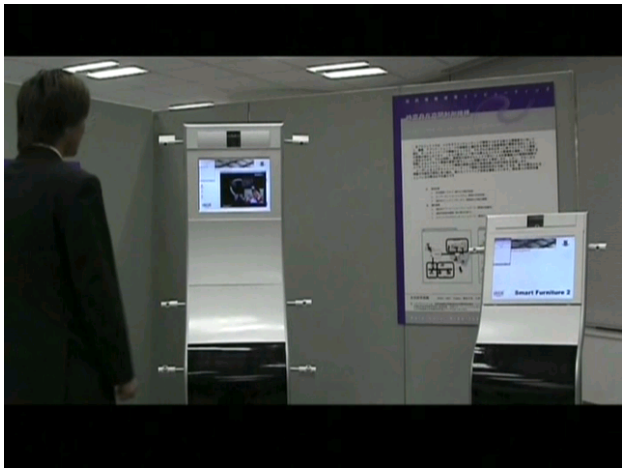
SF-2 with a Location System



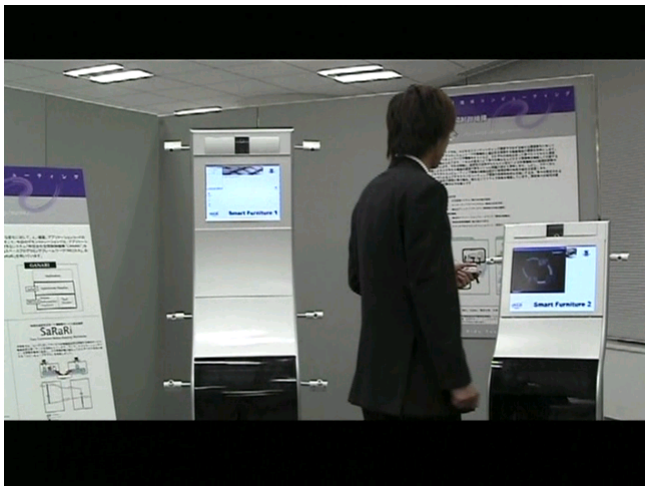
SF-2 with a Location System



SF-2 with a Location System



SF-2 with a Location System

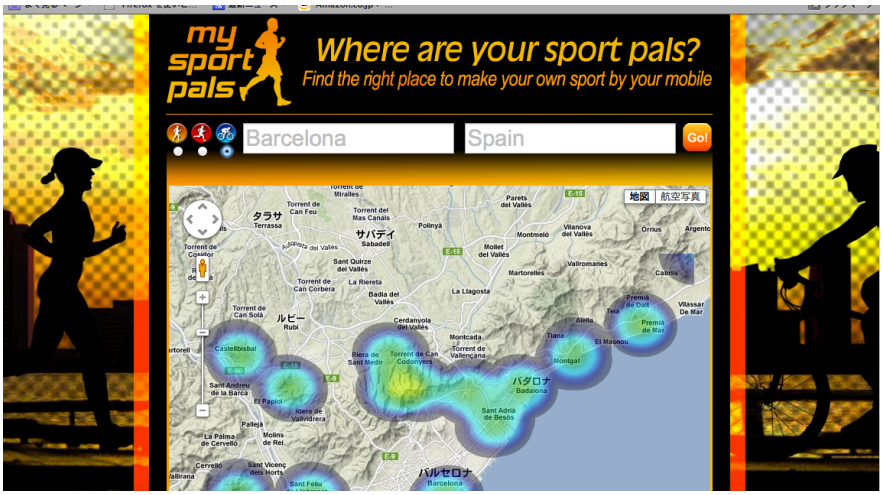


Urban Context Capturing
Limitations: Useful and Harmful

Context-awareness in Ubiquitous Services

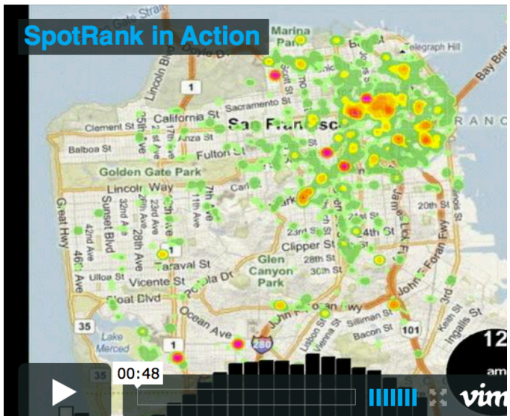
- Personal Context
  - e.g. sleeping, eating, standing, running, walking, moving, stopping, … etc.
- Group Context
  - e.g. group meeting, discussion, sports, ad hoc chatting, lecture, … etc.
- Urban Context
  - e.g. City-wide context
    - blackout area, rain, hot spots, traffic jam, train accident, social events, … etc
- Nation-wide Context
  - e.g. population distribution, power distribution, … etc

My Sports Pals (www.mysportspals.com)

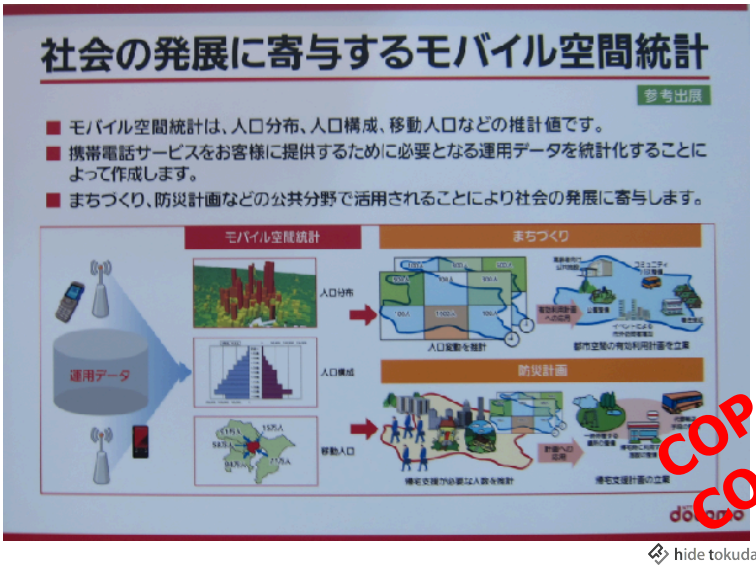


SkyHook's SpotRank (http://www.skyhookwireless.com)

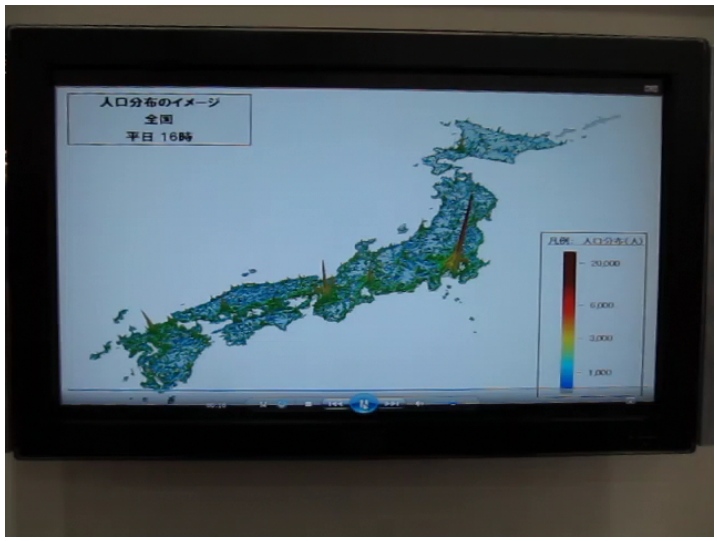
SpotRank In Action



NTT DoCoMo (Mobile Space Statistics(2010))



Mobile Space Statistics (2010)



Limitations: Useful and Harmful

- Anonymity Set and Privacy Enhancement
  - Visualization Problem: Density vs. Actual Data
    - Sport Pals: No cycling path
  - Small Anonymity Set Problem
- Data Accuracy
  - Mobile Statistics/Skyhook
- Real-Time Sensing/Processing/Actuation
  - Mobile Statistics
- Target Users
  - City Planner vs. Individual