Engage In-Museum Services

This page is a repository of draft thinking for the kinds of services Fluid plans to deliver within the institution itself. These centre around some form of mobile device carried around by the visitor - our initial project plan calls for initial targetting for the Apple iPhone - alternative platforms include Google Android, Blackberry, and the J2ME platform represented by Nokia phones and others.

Location awareness

A key affordance for our services is to become aware of the location of the user. This might enable

- Way-finding - helping the visitor find and plan routes to items of interest
- Triggered resources - playing audio or video that is appropriate to the visitor's context
- Physical bookmarking - allowing the user to store references to places or items of interest, or share them via social networking
- "Contextual inquiry" - presenting information and an exploration path for information resources both inside and outside the institution relating to the visitor's context

This information could be acquired by a number of modalities.

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Radio positioning systems

WiFi positioning

Technologies based on assessing position relative to a number of "beacons" formed by routers and hubs using standard WiFi technologies. A particularly lightweight and innovative approach from the SCYP project makes use of purely signal strength information from unauthenticated beacons. Commercially, Nokia has been working on this technology, demo video here, useful for illustrating the concept.

Pluses of this scheme:

- WiFi antennae are common and will become even more widespread amongst personal mobile devices - no need to distribute additional sensors
- Very low cost to deploying beacon grid - may even be part of an existing WiFi provision
- Fairly cheap requirements for calibration - a few sweeps of the area suffice - FAQ

Minuses

- Accuracy is relatively low - it is not feasible to locate a user to finer resolution than 5m. This is not sufficient to be able to generally identify an individual exhibit, or even to localise to the right side of a lightweight wall
- Time to fix may take several seconds

Bluetooth positioning

Dedicated Bluetooth "beacons" may be attached to key points within the museum space, and recognised by special hardware in the phone.

Advantages:

- Relatively precise positioning is possible
- Beacons are relatively cheap

Disadvantages:

- Many phones do not possess BlueTooth hardware, and handing out small "dongle" receivers creates risk of loss or theft.
- APIs are not very stable across the platforms

RFID positioning

Advantages and disadvantages largely as for Bluetooth - however, an interesting "inverse" system run by the Exploratorium instead tagged visitors rather than exhibits. In this way, the cheap "passive" receivers could be given out, and the more expensive active sensors retained as part of the museum infrastructure.
An interesting extension of this model would be to associate the identity of the tag with a cookie, etc. for the duration of a visit, providing a "round-the-back" connection enabling a traditional mobile device owner to gain access to location-awareness via detection of their passive tag.

It is unclear the number of RFID masts would be required to give a decent granularity of location coverage across an institution, or the cost of such a solution. The "Mojix eLocation Solution" is a recent commercial system which insists that it is the "market's first UHF passive RFID Real Time Location System" - which suggests that affordances for any form of fine-grained location over RFID (above simple "swipes" at specially positioned kiosks) may be crude and/or expensive. However, another promising report of passive RFID in a museum context (Skyetek sensors - 1m range) is by Baldwin & Kuriakose at Melbourne.

Hybrid RFID and WiFI positioning

This is a commercial system for location of objects, which seems to be used most in hospitals at the present time. Here's a video demonstration of the tech.

UWB positioning

A recent publication on Local positioning systems (Google books link - Kolodziej & Hjelm) surveys the overall accuracies possible with the radio technologies. The following verdict: (p.121) "Most systems using radio technologies such as Bluetooth or Wi-Fi can only pinpoint an item within about 10 to 16 ft (3 ft with site surveying) in an indoor environment. With UWB, Ubisense is able to track to an accuracy of 6in."

UWB, "ultra-wide band" is another radio modality which achieves higher accuracy due to its wide bandwidth, solving the problem of multipath in an indoor environment. UWB works in the unlicenced frequency of the RF spectrum commonly used for garage door openers, portable telephones and baby monitors. Since UWB is built around sending short (~ 1ns) discrete pulses, positioning can be more accurate than other technologies. The Ubisense system referred to in the text is available as a Research Package - overall cost is unknown, but one estimate puts tag costs at between $50 and $100.

This system could be useful for making an "initial survey" of a museum space using one or more cameras taking a large number of images with a UWB sensor attached – for later use via an image recognition based visitor system (see below).

Visual positioning systems

2d barcodes

A variety of 2-dimensional barcode systems are prevalent - some front-runners are

- Datamatrix - arbitrarily scalable, popular in US and Europe (perhaps some IP concerns)
- QR Codes - popular in Japan, reasonably attractive design, widespread reader code and public domain
- Blotcodes - proprietary but visually amusing design, currently read only by 2dsense
- ShotCodes - encodes 40 bits of data, amusing visual design, probably has good behaviour under poor visuals

Advantages:

- Low cost to deploying labels
- Uses camera, present in every phone, libraries accessible even in iPhone
- Low CPU cost for decoding, software widespread

Disadvantages:

- Still requires custom labelling on every exhibit, can be visually intrusive
- Typically small range of viewpoints from which code can be read
    - May lead to contention in more crowded spaces
    - Creates problems for unsighted and limited mobility users

A useful software platform reading a variety of codes is 2dsense, however this is delivered for the iPhone environment only.

Scene recognition systems

These attempt direct recognition of either objects present in the scene or else entire scenes.

A front-running research group in this area is the Media Faculty at the Bauhaus-University, Weimar. In particular, a live system, PhoneGuide has been demonstrated running live in two museums (Senckenburg Museum of Natural History, Frankfurt and Weimar Museum of Ancient and Early History) during working hours, delivering fairly fast recognition performance on the Nokia J2ME platform. In particular, the PhoneGuide publication reports an interesting range of user testing as well as some more details of the platform. In terms of recognition/location times, "11 percent of all subjects would prefer a recognition time of less than 1 second,
50 percent of 1 to 2 seconds, 33 percent of 2 to 4 seconds, and 1 subject would accept 4 to 6 seconds"

Advantages:

- Zero cost to deploying labels and zero intrusion - many institutions may forbid barcoding/labelling of any kind
- Uses camera, in every phone and libraries easily accessible
- Also allows recognition/integration of "inaccessible" artefacts - those which are extremely large/not below head height.

- As well as determining position, this solution can also determine **orientation** - essential for guides which describe physical relations such as "visible to your left, is ..."

Disadvantages:

- Moderately expensive training phase
- For high quality solution, will rely on algorithms and systems still in research

A particularly valuable affordance of recognition systems are for vision-impaired users. This may allow them to "see"/register exhibits that otherwise might be completely imperceptible.

Other positioning systems

Ultrasound

Ultrasound positioning systems work in a similar way to radio-based positioning, except that the communication channel is one-way (as opposed to two-way on Bluetooth or WiFi). A device on the individual (or object whose position is being tracked) emits a unique high frequency ultrasound which is picked up by a network of strategically placed microphones.

Because the device itself has no knowledge of its position (only the system behind the microphones does), one would need a seperate companion device (e.g. PDA, iPhone, etc.) connected to the backend system and query it for the ultrasound device's position.

SciAm has an article (A Positioning System That Goes Where GPS Can't) on the topic, and Sonitor Technologies (based out of Norway) appears to be a forerunner in the field.

Notes on ultrasound, as well as a survey of all other positioning technologies, is in Global Positioning: Technologies and Performance (covers indoor, despite the title).

Advantages:

- Significantly higher resolution than radio-based location technologies (room-level accuracy or better, according to Sonitor Technologies)
- Avoids problems associated with radio interference (metal objects bouncing the signal, other radio signals causing interference, etc.)
- Device emitting the ultrasound is very small (~1"x0.5") and light (~4g)
- Ultrasound devices themselves are relatively cheap

Disadvantages:

- Technology appears to be propreitary, and not widely available
- Would need a seperate companion device (e.g. PDA, iPhone) to query the system on the device's location