



# Gestural Interaction with mobile devices

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# Outline

- Introduction
- Quickening
- Sonification
- Some experiments in Model-based target sonification
- Speed zooming in mobile devices
- Future works

# Disadvantages of Mobile devices

- A limited amount of screen space on which to display information
- Low graphics resolution and few colours
- May lead to visual overload especially in mobile situations
- Limited input: small keyboards, handwriting or speech recognition

# Advantages of Gestures

- Potential for more natural, multimodal interaction
- Do not need to look at the screen, use the keyboard or handwriting or speech recognition methods
- Browsing long documents, large web pages, images and playing games
- User is in continuous interaction with the mobile device.

# Quickening

Quickening in general is a prediction of the future state of the system based on the current state (for example position, velocity, acceleration, and so on) .

- Presenting a rate or acceleration as a position allows the control order to be reduced by an order or two
- The derivative may be easier to understand than the controlled variable.

# Sonification

Mapping data onto appropriate sound features like time stamp, volume, pitch, timbre.

# First Experiment

- Mobile device with gestural input
  - PocketPC (hp5450), an accelerometer (Xsens P3C, 3 degree-of-freedom) and built-in vibertactile unit, stereo headphone.
- Goal was exploration, navigation and selection
- Conditions
  - No Doppler effect, no vibration feedback,
  - No Doppler effect, but vibration feedback,
  - Doppler effect, no vibration feedback and
  - Doppler effect, vibration feedback .

- Task to locate and select the 7 audio sources
- 12 participants performed all conditions in a counterbalanced order
- Initial condition used for training
- Visible cursor and invisible targets
- Accuracy emphasised over speed

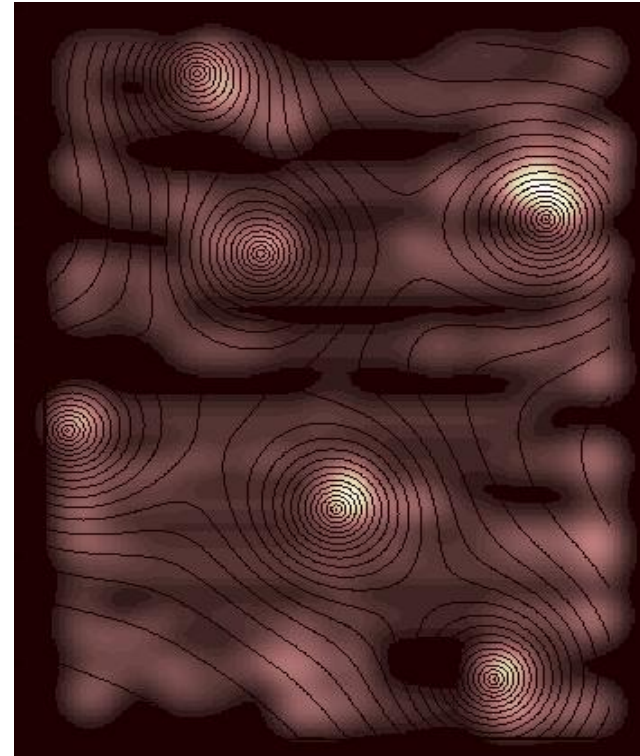
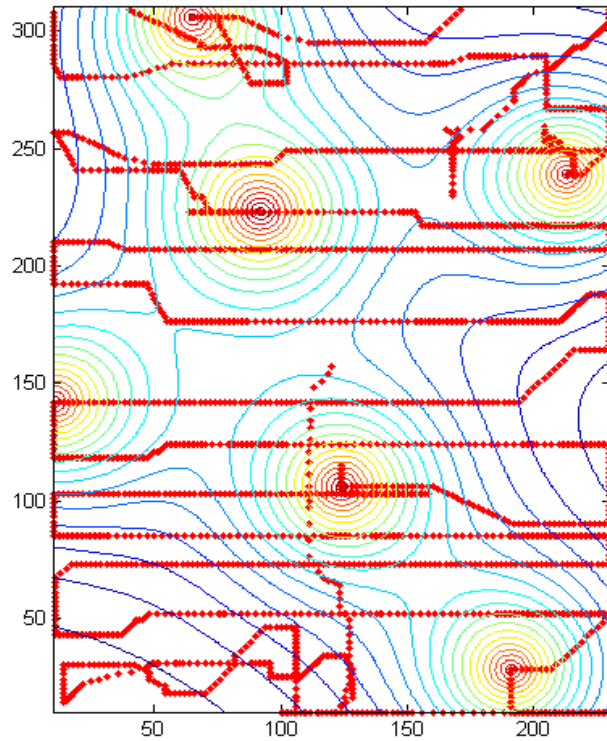


# Metrics and Visualisations

- Targets found
- Accuracy
- Time taken
- Extra clicks
- Space covered

## Feedback

- Audio feedback
  1. Seven target sounds selected to be distinct (Hip hop, Celtic, Arabic, Country, Jazz, Traditional Farsi, Opera).
  2. Volume proportional to the distance of the cursor from the target
  3. Pitch shift proportional to moving toward/backward the target horizontally
- Vibrotactile feedback
  1. Identical for every target
  2. Binary On/Off. Set to on within 5 pixel radius of the target and off otherwise.



**The traces of the cursor for participant 12 in no Doppler with vibration experiment (left) and its exploration density plot (right)**

# Conclusions for experiment 1

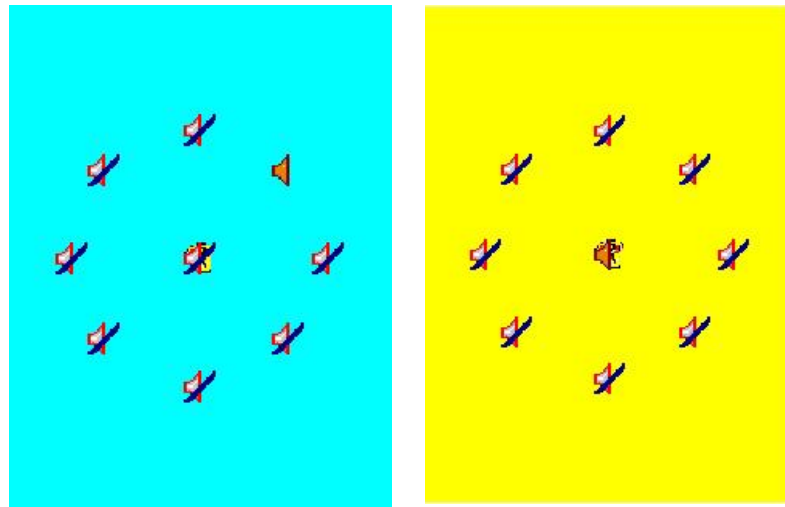
- Provided useful exploratory information of users' navigations,
- Visible cursor affected the method of exploration ,
- Doppler effects affect perceived errors in horizontal and vertical dimensions differently,
- Vibration was clearly perceived by users, but led to them spending more time circling around targets.
- Results did not suggest that the use of Doppler or vibration brought consistently improved performance.
- More focused experiments are now needed to investigate users' responses to individual features of the quickened displays used and development of HCI model.

# Second Experiment

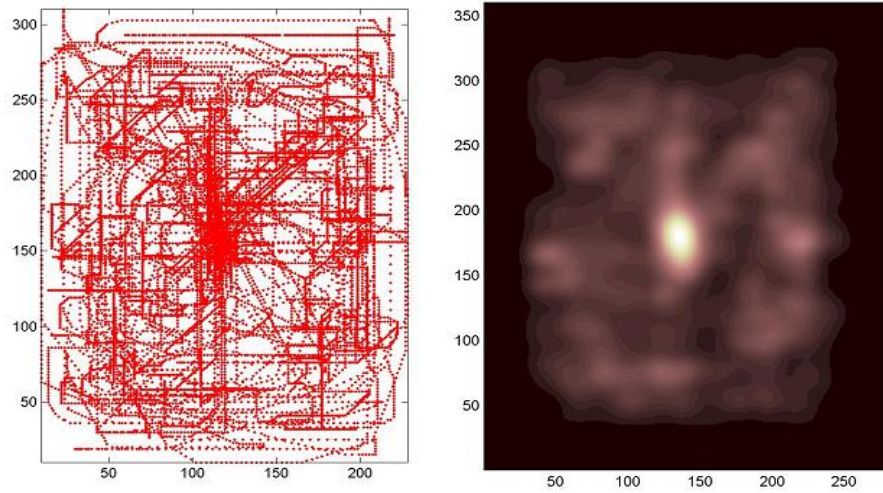
This experiment was a collaboration between department of psychology in University of Glasgow and Hamilton Inst.

- Mobile device with gestural input
  - PocketPC (hp3X), an accelerometer (Xsens P3C, 3 degree-of-freedom) and ,stereo headphone.
- Goal was exploration, navigation and selection
- Conditions
  - Doppler effect,
  - Derivative,
  - No quickening

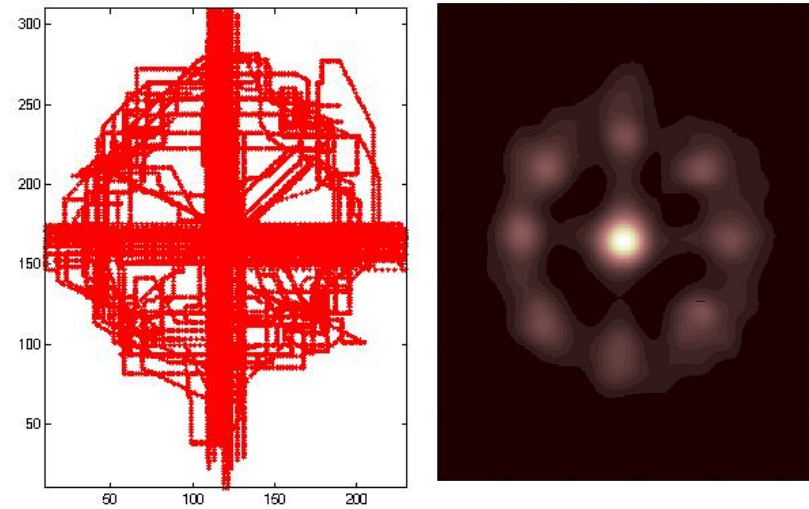
- Task to locate and select the 8 audio sources around the center, in 5 trails for each target.
- 8 participants performed each conditions (in general 24 participants).
- A training application had graphic feedback for participants.
- Accuracy emphasised over speed



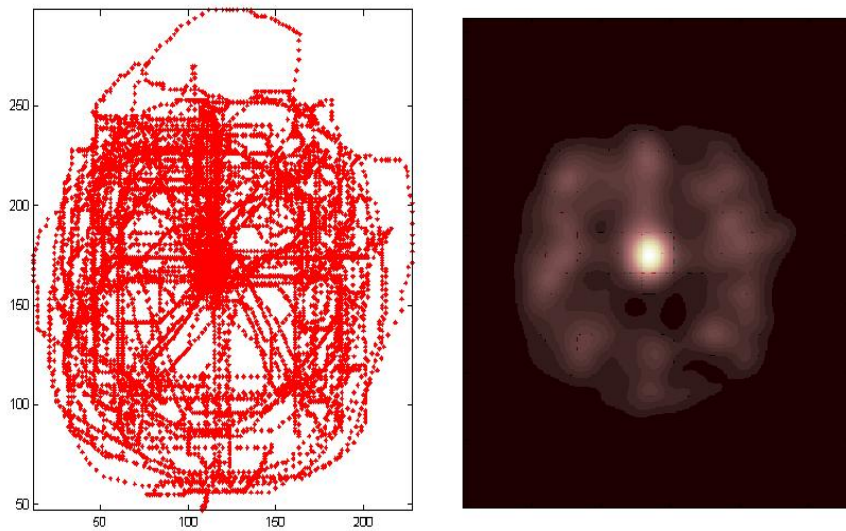
Training application, the screen before pressing button(left)  
The screen after pressing button(right)



Participant 7's movement in Doppler condition



Participant 22's movement in no-quickenning condition



Participant 13's movement in Derivative condition

# Primary conclusions for experiment2

- Provided useful exploratory information of users' navigations for just audio,
- Doppler effect affects perceived errors in horizontal and vertical dimensions differently,
- Both 45 and 90 degree directions have less error position and timing value in 3 conditions.
- No-Quickening has been the most accurate application in selecting targets, but its timing data is bigger than others.
- Doppler one has the minimum timing data among others but its position error is bigger than two others.
- Psychological results will be discussed later!

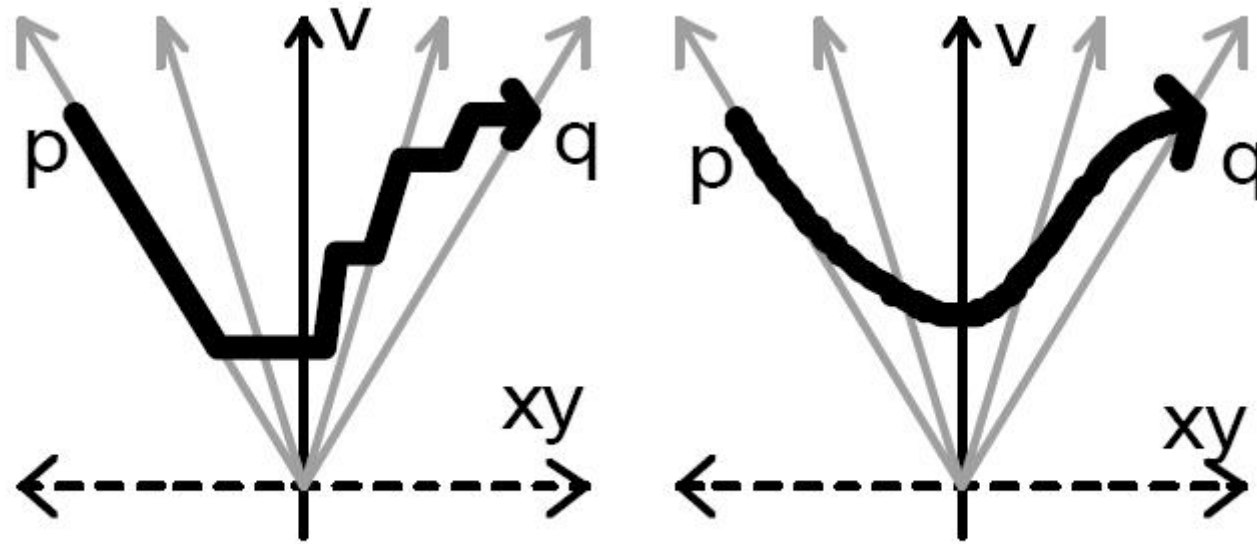
# Speed dependent Automatic Zooming

Traditional scroll bars are not useful for mobiles; because

- The user must move back and forth between the picture/document and scroll bar and it increases the operational time,
- May cause significant attentional overload ,
- It may cause a sudden jump to a distant location, resulting in disorientation and confusion.

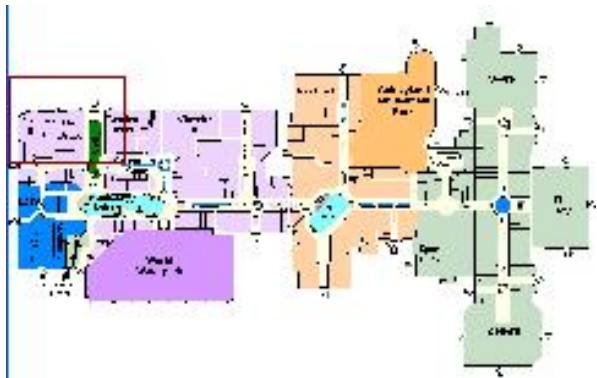
Solutions in mobile devices:

- Multiple window zooming,
- Speed-dependent automatic zooming,



a) Manual zooming/panning. b) Automatic zooming.

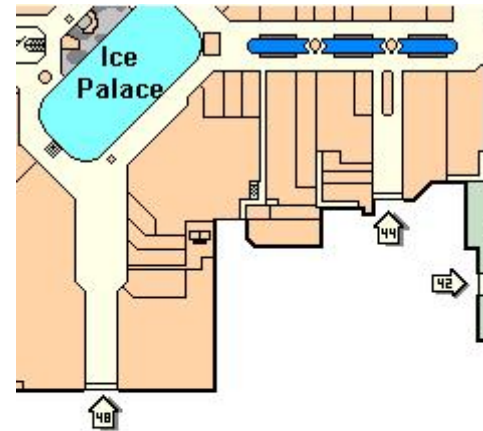
The efficiency of the navigation using automatic zooming and traditional manual zooming (Igarashi, Hinckely, 2000).



SDAZ (Zoomed-out map)



Multiple window zooming



SDAZ (Zoomed-in map)

SDAZ and multiple window zooming in PDAs

# Design & Implementation

SDAZ **couples** the user's rate of motion through an information space with the zoom level—the faster the user moves the 'higher' they fly above the work surface.

## State space modeling,

- Present differential equations describing a dynamic system,
- Computers can easily manipulate matrices, calculate stability, controllability, observability and many other useful attributes of a system.
- Models the internal dynamics of the system, as well as the overall input/output relationship as in transfer functions.

## Coupling user's motion with the zoom level

$$x_1(t) = x$$

*position*

$$x_2(t) = V$$

*Velocity*

$$x_3(t) = A$$

*Acceleration*

$$x_4(t) = Z$$

*Zoom - level*

$$x_2(t) = V = (x - x_t)$$

$$x_3(t) = A = (V - V_t) = \dot{x} - V_t$$

$$x_4(t) = Z = k_1 V + k_2 A + k_3$$

$$\dot{x}_1(t) = V = (x - x_t)$$

$$\dot{x}_2(t) = A = (V - V_t)$$

$$\dot{x}_3(t) = \dot{A} = (A - A_t) = \ddot{x} - A_t$$

$$\dot{x}_4(t) = \dot{Z} = k_1 \dot{V} + k_2 \dot{A}_3 = k_1 \ddot{x} + k_2 (\ddot{x} - A_t) = \ddot{x}(k_1 + k_2) - k_2 A_t$$

$$\begin{matrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \\ \dot{x}_4 \\ x \end{matrix} \begin{pmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & -1 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & k_1 + k_2 & 0 & 0 & 0 \end{pmatrix} \begin{matrix} x \\ V \\ A \\ Z \\ x_t \end{matrix}$$

$$Z = f(x, y, V, A)$$

# SDAZ in browsing a long document in PDAs

In long documents most of the time one dimensional browsing is enough (in y axis). So the zoom is a function of:

$$Z = f(y, V, A)$$



Zoomed-in window



**Granular Synthesis**

**r Synthesis**

entary sonic particles, of sonic quanta" -

a to the representation and generation of musical  
anular method of sonic analysis may have been  
: Quantifying Music (Cohen). This late  
organization of music into "corpuscles of sound".  
not investigated further for quite some time.  
w interest in granular synthesis around 1946  
d be synthesized with the correct combination of  
i particularly apt and flexible representation for  
ain information (starting time, duration,  
ency domain information (the frequency of the  
fore magnetic tape recorders became readily  
omposition was through extremely sophisticated

# Future Works

- Evaluating efficiency of SDAZ with traditional methods in mobile devices,
- Combining SDAZ with audio and evaluating its efficiency,
  - assigning different sounds to some parts of map or document
  - How will it make easier to find goals on maps or important titles in documents?
- Combining sonification idea with Body-Space project,
  - Assigning different clusters and sub-clusters of audio to different parts of body

- Gestural interaction between two mobile devices through GPS or wireless communication,
  - Using audio/vibration feedback to measure the distance between two mobiles
  - Playing games between two mobiles
- Adding audio/vibration feedback to city maps got from GPS
  - This application will be helpful for drivers, and blind people
  - Do we need to involve in image processing?