Tap Input as an Embedded Interaction Method for Mobile Devices

By
Sami Ronkainen, Jonna Häkkilä, Saana Kaleva, Ashley Colley & Jukka Linjama (presentation)
Nokia, Finland

Presentation in TEI 07, Conference on Tangible and Embedded Interaction
Baton Rouge, USA, 15-17. Feb 2007

NOKIA
Connecting People

Message, vision

Sensor technologies will
convert mobile devices also into
tangible & embedded interaction artifacts

Content

- Tangible interaction in mobile context,
  social and user experience aspects of gesture interaction
- Minimalist approach: Tap input
- User studies
  with utility value aspect in focus, not fun/creative aspect

NOKIA
Connecting People

Background: Motion gestures as tangible interaction

- Mobile devices as such can be used for tangible interaction
  - Position, orientation, motion, touch of the whole device
  - Limited but easily accessible, and expressive interaction methods

Motion gestures:

- Previous research focused on “position gesture” input
  - Large gestures
  - Precise gestures, tilt control
- Challenges with gesturing
  - How to indicate intention to action (press key while gesturing)
  - Reliability of recognition
  - Attitudes towards gesturing

NOKIA
Connecting People

Motion gestures: minimalist approach

Minimalist approach – tap, shake events

- Fast motion events have benefits:
  - Technology benefit: clear signal & detection with **acceleration sensor**
  - User benefit: feel of control – **device inertia** as force **feedback**
  - -> user intention is clear and continuous recognition of it possible

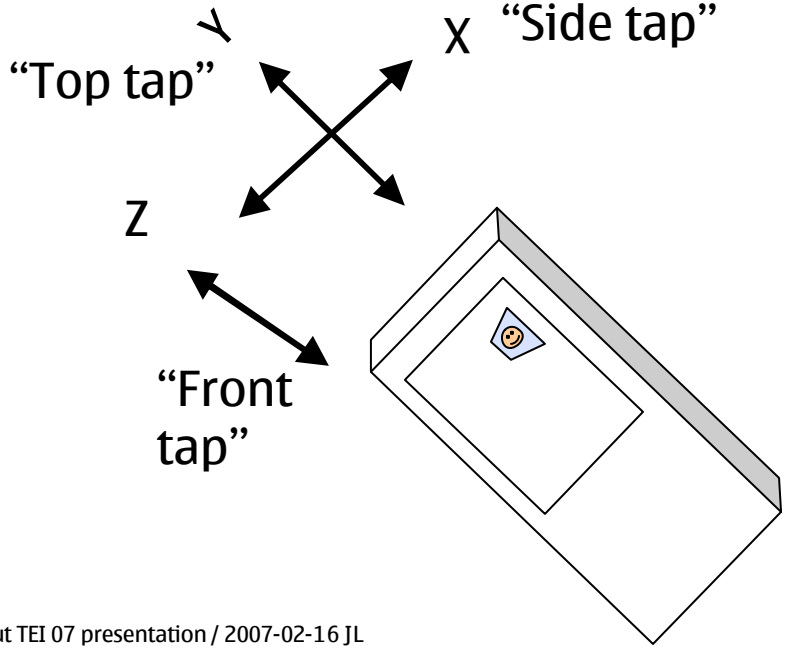
---

- Angela Chang, yesterday: Simplicity sells!

NOKIA
Connecting People

Tapping recognition + interaction

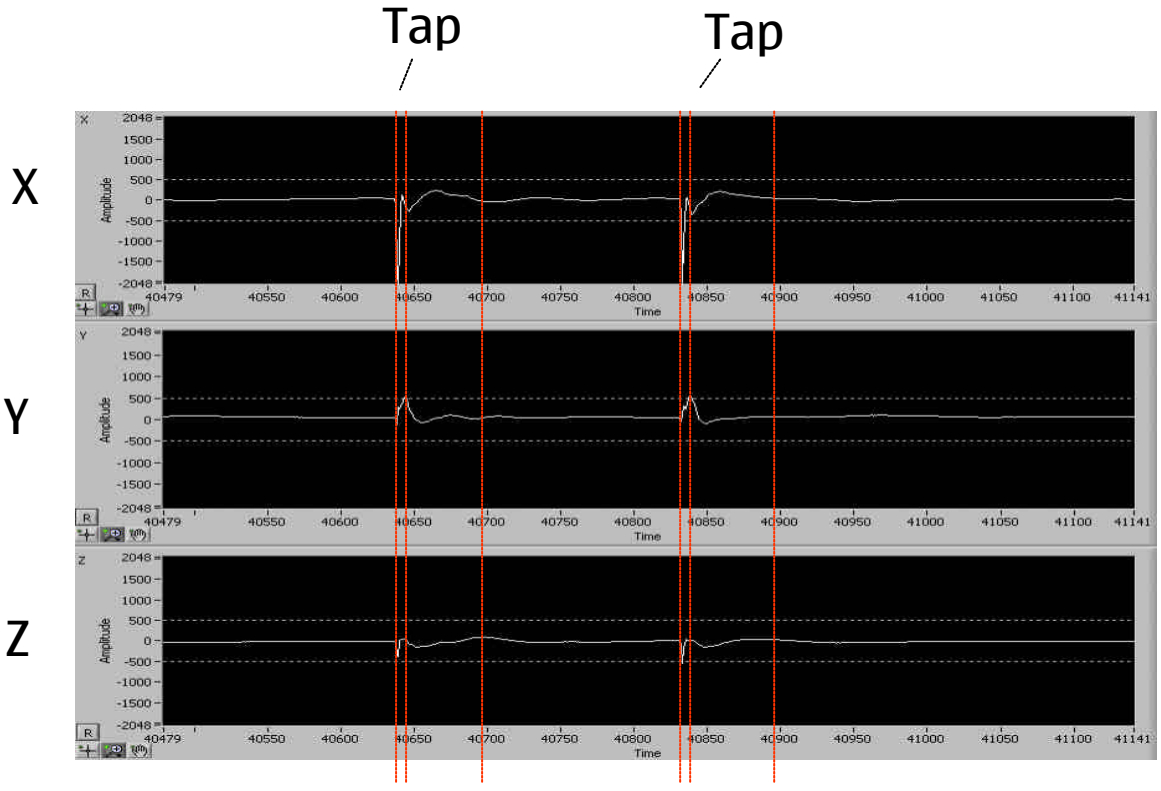
- Tapping is a virtual key input, available also while keys locked -- "Kinetic tap", knock, shake.
  - tap sides of the cover, X Y Z axis sensed by 3-D acceleration sensor inside the device
  - Interaction involves vibra "kick" feedback



NOKIA
Connecting People

Tapping recognition: technology

- Mass production possible
  - Low cost digital 3-D acceleration sensor chip
- The tap recognition algorithm is tuned to look for a clear, short acceleration peaks
- Can be recognized with low energy
  - No complex processing DSP needed



NOKIA
Connecting People

User survey: www study

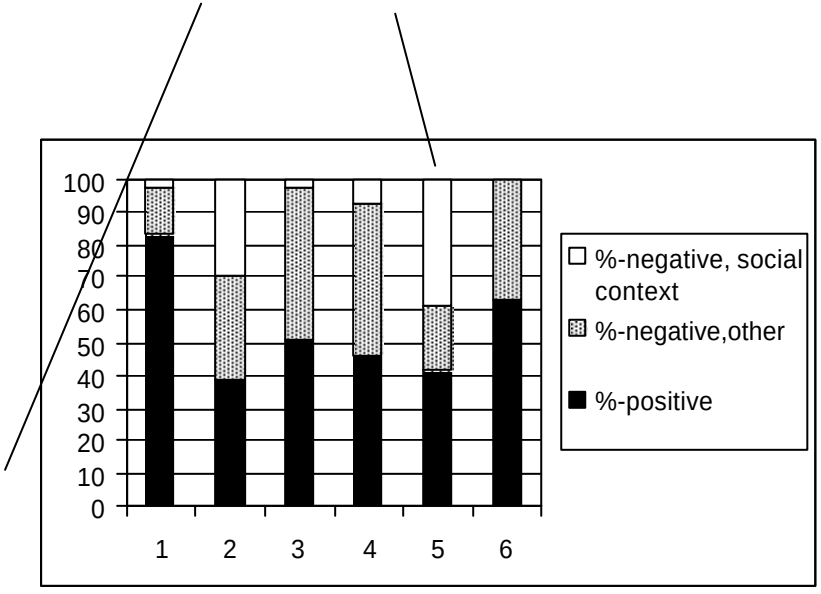
Motivation

- finding overall user perceptions of gesture input in different social contexts
- set of gestures varying from a small tap on a device, to drawing rather large gestures in air.
- 6 Use scenarios in video:
  - E. g. #5: Walking, circle gesture to see calendar. The user is walking on the street. She wants to know what is in her calendar. To find out, she picks the phone out of her pocket and draws a large circle in the air. The phone detects this movement and opens the calendar page on its display.

NOKIA
Connecting People

www study – results

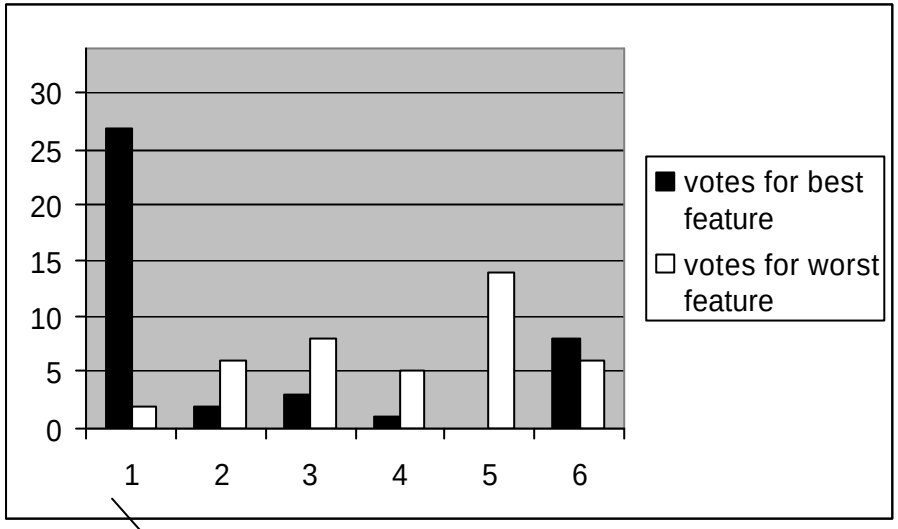
1.Cafe, slap to mute ringtone.	The user enters a cafe, starts discussing with a friend and the phone rings in her pocket. The user slaps the phone with her hand through the pocket, and the ringtone is silenced. Call is not disconnected, but directed to a voice mail box.
2.Library, 'X' gesture to turn silent profile on.	In this scenario, the user enters a library. She wants to turn her phone into a silent profile. In order to do this, she first presses a button to unlock the phone keys and activate motion detection, then draws a large 'X' in the air. The phone detects this gesture and turns the silent mode on.
3. Cycling, shake to initiate call. Movement is detected.	User is riding a bike. He picks the phone out of his pocket and shakes it. The phone then starts making a phone call to a friend. The user has previously selected which number the phone should call when the shaking
4. Walking, swing to read message.	User is walking in the park. She receives a text message. She picks the phone from her pocket and presses a button to open the key lock and activate motion detection. She then swings the phone to right and back, and the phone displays the received message.
5. Walking, circle gesture to see calendar.	User is walking on the street. She wants to know what is in her calendar. To find out, she picks the phone out of her pocket and draws a large circle in the air. The phone detects this movement and opens the calendar page on its display.
6.Talk on phone, tap to change volume.	User is talking on the phone. She taps on the sides of the phone with her fingers. Tapping on one side turns the phone volume up, tapping to the other turns the



NOKIA
Connecting People

www study – findings

- Social aspects matter
- Small gestures acceptable
  - Swing phone from side to side seemed to be a borderline case
- Sometimes difficult to differentiate between attitude towards the controlled **feature**, and towards the **gesture used** for the control



Use case #1 in video survey:
user silencing her mobile phone by tapping it through pocket

NOKIA
Connecting People

User studies

- Tap input as feature
- The aim of both studies was to investigate the perceived usability of tap input among the participants, as well as to gain input to the development of tap recognition algorithms by measuring the number of false detections and on the other hand observing how the users performed their taps.
- Test device Elen as platform
  - Interaction cover: sensor + vibra, sound and LED feedback
- Earlier interaction demo experiences
  - Bouncing ball game (Linjama & Kaaresoja 2004)

ELEN demonstrator with sensor interaction cover.

NOKIA
Connecting People

User study 1

- Elen prototype, 15 participants
- Input gestures
  - Single tap + double tap
- Device held in
  - hand
  - pocket

Tasks performed in the first test

Task description
Phone rings, mute it (double tap)*(device in hands)*
Phone rings, mute it. (double tap) *(device in pocket)*
Alarm clock, snooze it. (double tap) *(device on table)*
Preview received message in idle (double tap) *(device on table)*
Scroll through images in gallery (single tap) *(device held in hand)*
Preview message in gallery (double tap) *(device held in hand)*
Browser, calendar alarm activates, snooze it (double tap) *(device held in hand)*
Lock keys in idle (double tap) *(device held in hand)*
Music player pause/play (double tap), next/prev (method: single tap) *(device held in hand)*
Music player pause/play (double tap), next/prev (method: single tap) *(device in pocket)*
User places phone in pocket and completes sorting task around the office (false double taps are counted)

NOKIA
Connecting People

User study 2

- Elen device & Nokia 5500 prototype
- 10 persons
- Only double taps
- Device held in
  - Hand or belt clip

Device	Task
Nokia 5500 prototype 	Music player pause/play (double tap)
	Music player next/prev (double tap to sides)
	Check received text message in the Gallery view (double tap)
	Music player pause/play (double tap) *(Phone attached to its belt)*
	Music player next/prev song (double tap to sides) *(Phone attached to its belt)*
ELEN demonstrator 	Music player pause/play (double tap)
	Preview message in Gallery view (double tap)

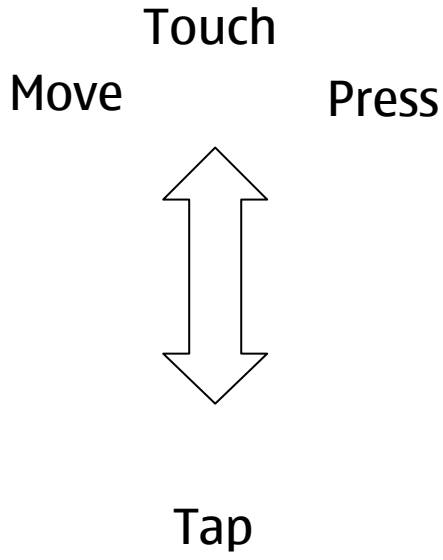
Tasks performed in the second test

User study – results

- Force at which different users tapped the devices varied a lot
- Very strong accelerations were problematic, as the device tends to hit also something else (e.g. the user's palm, depending on how it is held) than just the fingers.
  - -> need for immediate feedback (vibration pulse)
- The cases where the device was carried inside the pocket of a loose jacket proved difficult, as could be expected.
- However, learning how to tap during the test was quick
- The functionalities with most favorable user opinions
  - controlling the music player
  - previewing the text message.

User study – findings & design directions

- Simplicity:
  - Mixing **single** and **double taps** in an application caused problems also due to the users not remembering which kind does what. This is logical, as there are few natural metaphors related to tapping.
- Tapping as an interaction was mixed with touch screen taps
- Feel of control
  - Vibration feedback is needed



NOKIA
Connecting People

Movement gesture input benefits/opportunities

- Benefit: Device and application control possible ”on-the-move” — with keys locked

- Challenges for “continuous motion gestures”
  - unintended activation, social restrictions – no large motions accepted

- Solution: Simple, “event gestures”
  - Tap – intuitive for user, simple to detect for device
  - Turn, Shake – perhaps good alternatives to tap

- Key success factor: proper, immediate, meaningful feedback!

Simplicity

Feel of control

NOKIA
Connecting People

Conclusions

Sensor technologies will
convert mobile devices also into
tangible & embedded interaction artifacts

- A summary of work related to creating and selecting new motion gesture interactions for mobile devices
  - a WWW-based video survey of the social acceptance of different gesture input methods.
  - a simple interaction concept of tapping a mobile device with the hand was selected for further design.
  - an interaction test platform ELEN for actual user test was created.
- The results show that tap input can be a useful interaction method to control a device also when it's worn on the user

Tom Rodden, keynote yesterday:

NOKIA
Connecting People

Thank you!
Demos available

- Bouncing ball game
- Elen interaction test system
- Nokia 5500 Sport phone

NOKIA
Connecting People