Media Computing Group:

Post Desktop User Interfaces

Fiducials

Kai Höfig, Noriyasu Vontin

Supervisor: Tico Ballagas

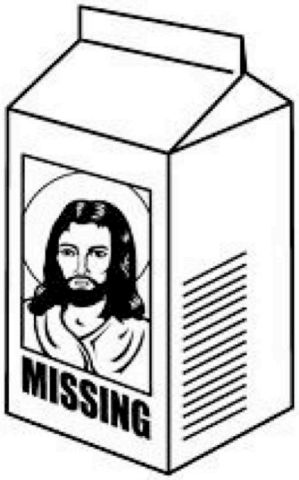
RWTH AACHEN

Overview

- Introduction
- Different Types
- Applications
- Competing Technology RFID
- Conclusion

Fiducials

2/19/07



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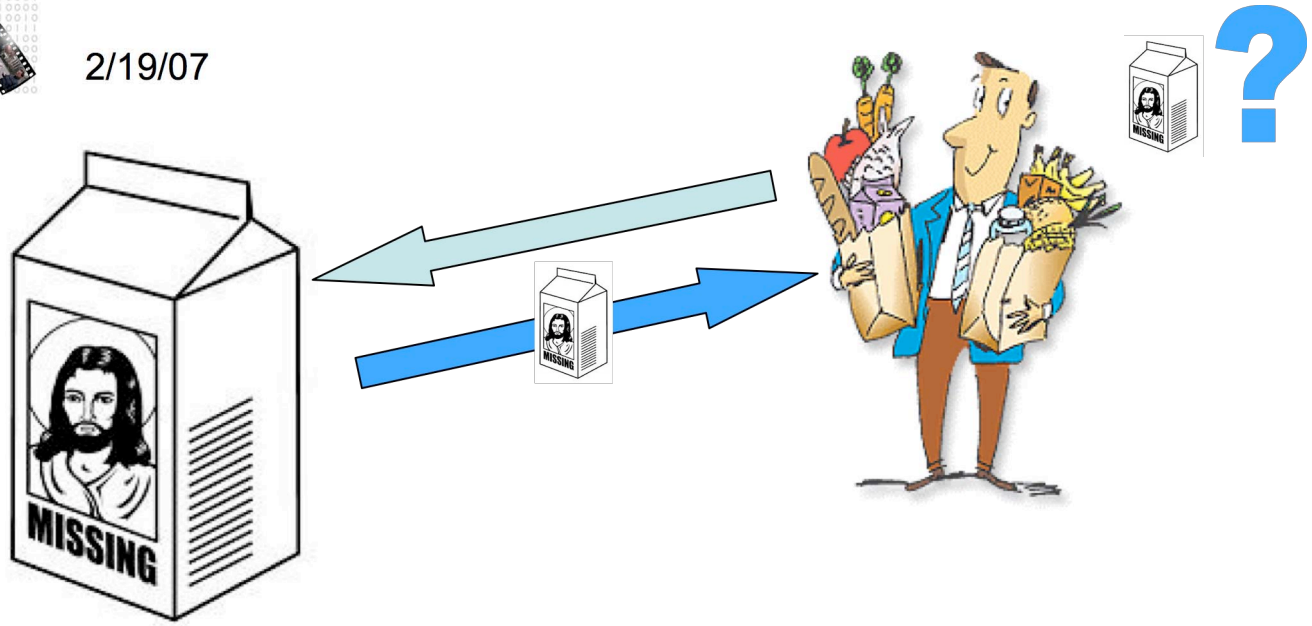

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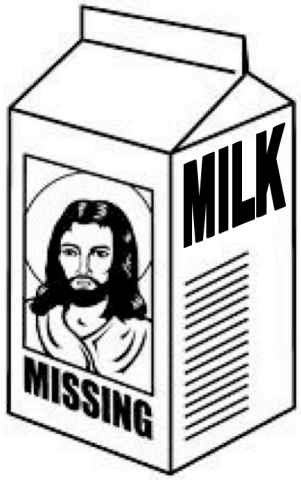

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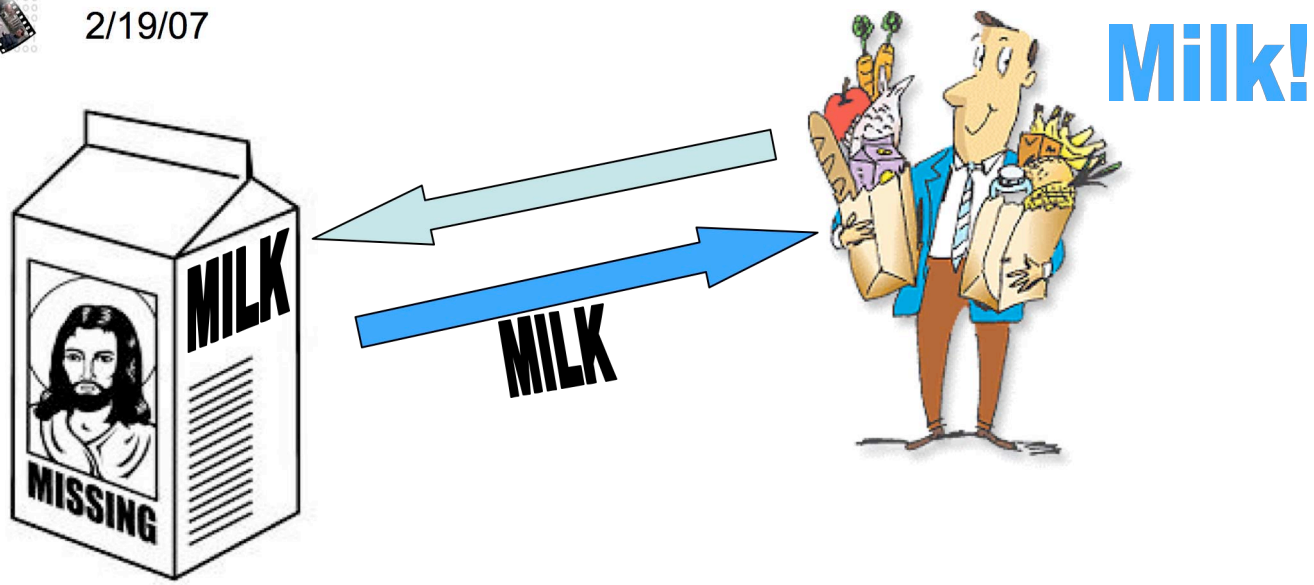

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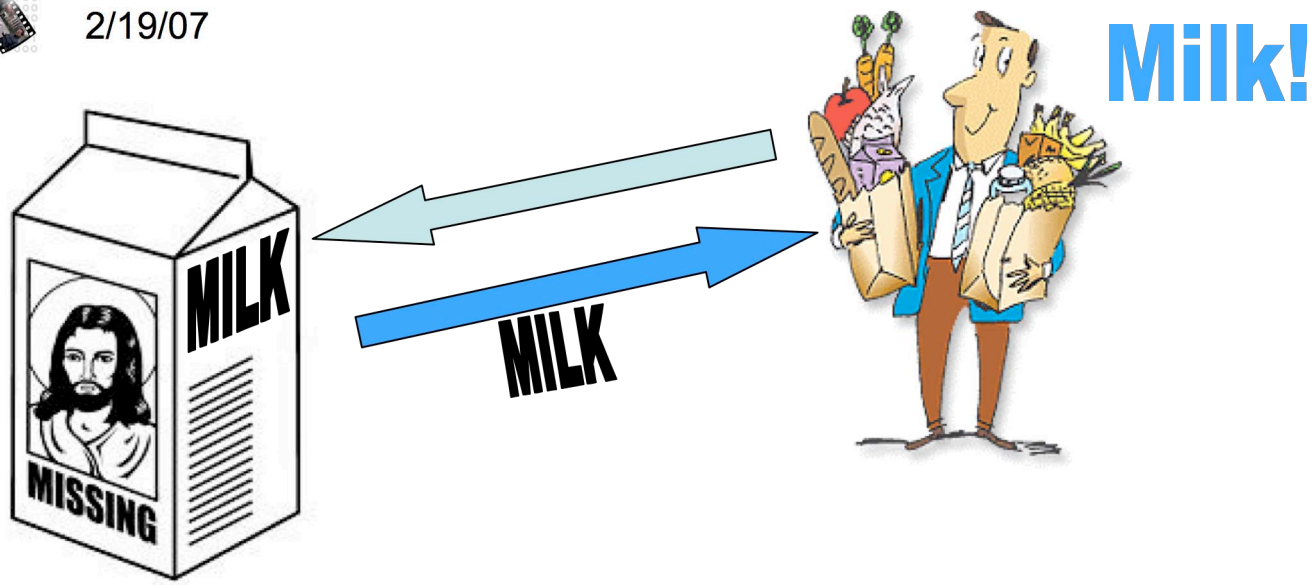

- Labels:

  Easier access to information

Fiducials

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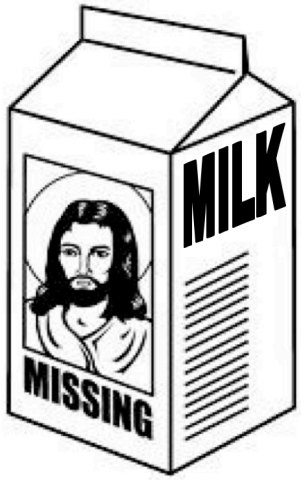

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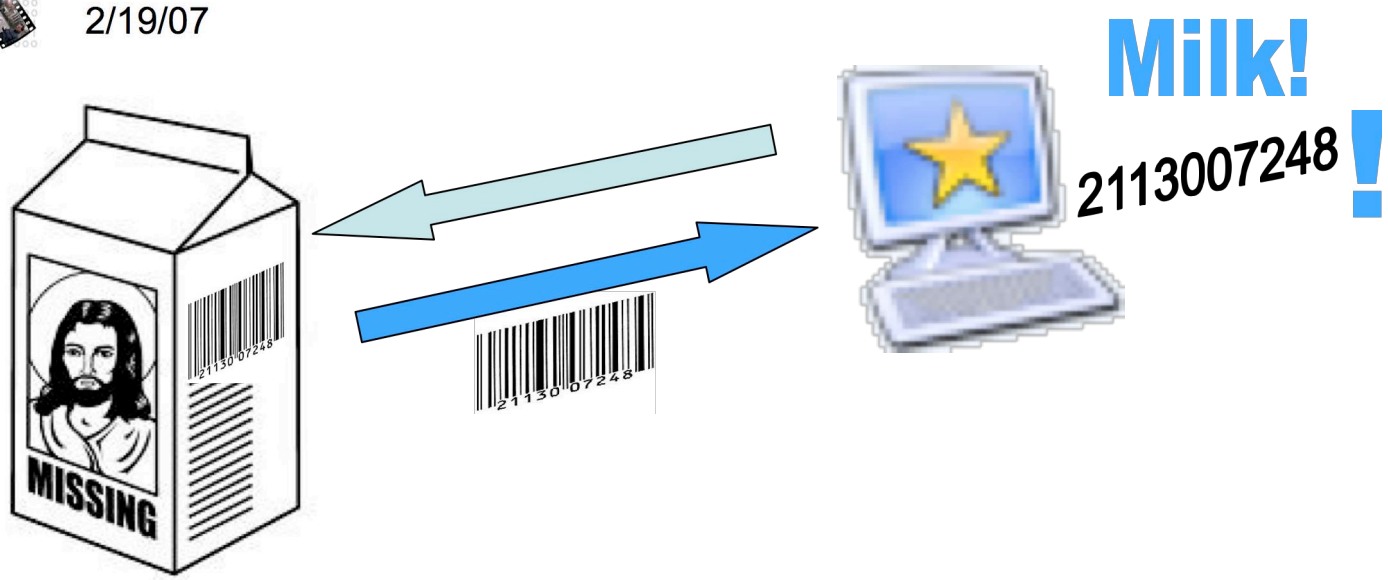

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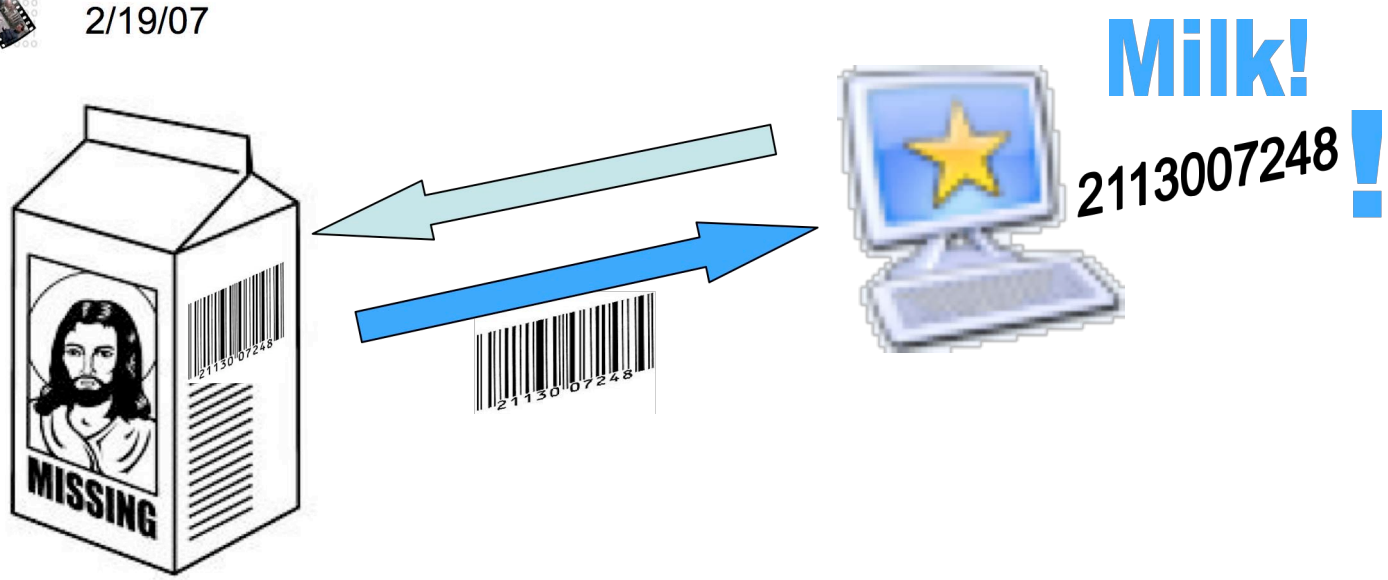

- Labels:

  Easier access to information

- Fiducials:

  Labels for machines

Fiducials

2/19/07

- Link the real world with the virtual world
- Reader
  - Camera equipped computer systems
  - Specialized reader handsets
- New reader class
  - 257 million camera phones sold in 2004
  - Today camera phones have a market share of 48%
  - In Japan 58% want a mobile phone with integrated bar code reader
- Towards ubiquitous computing

Overview

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Familiar?

Fiducials

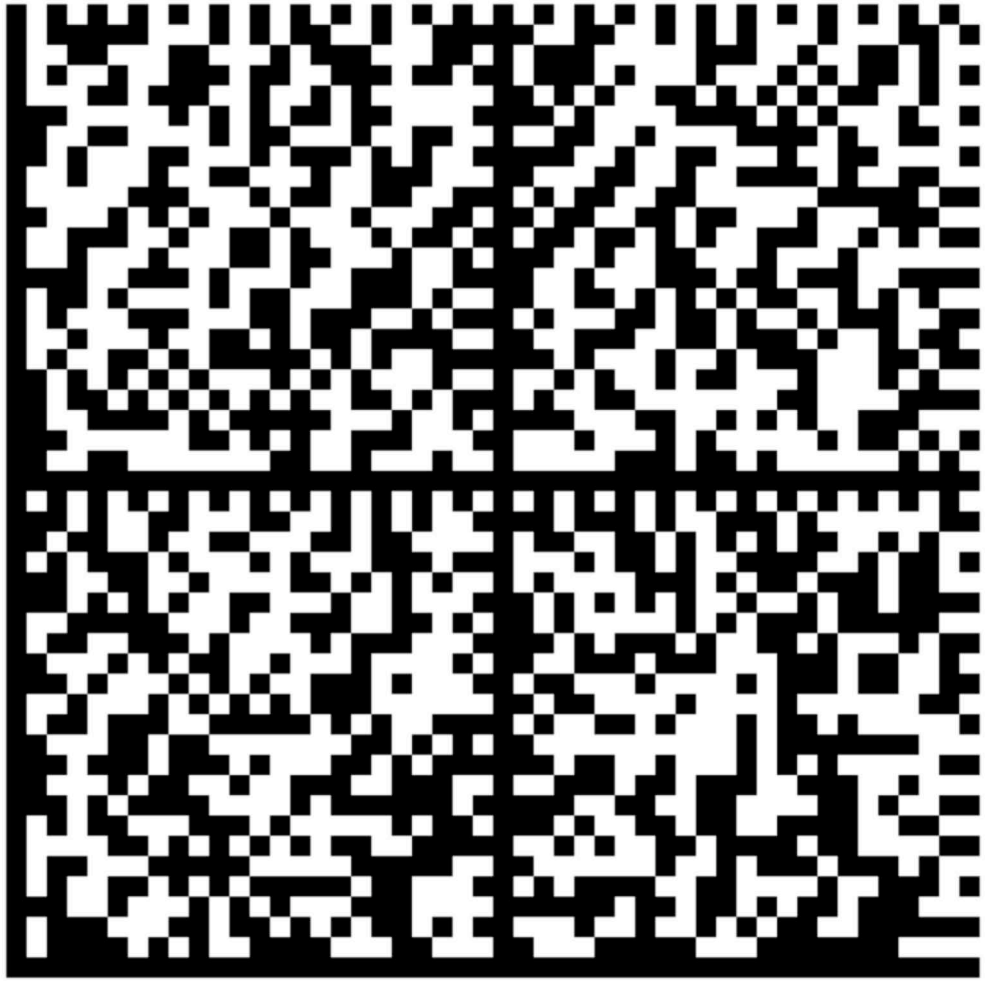
2/19/07

Different Types

Familiar?

There are many more!

Different Types
Datamatrix



Different Types
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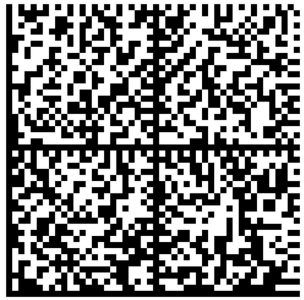

- By RVSI Acuity CiMatrix
- ISO/IEC 16022
- 10x10 ~ 144x144 (8x18 ~ 16x48)
- 1 byte ~ 1,555 bytes
- Up to 60% error correction (Reed-Solomon)
- At least 20% contrast ratio
- One cell orientation lines

- Used by e.g. Deutsche Post, Semapedia

Different Types
Quick Response(QR) Code

Different Types
Quick Response(QR) Code

- By Denso Wave
- ISO/IEC 18004
- 21x21 ~ 177x177
- At least 4 cells margin
- 7 byte ~ 2,953 byte
- Clustering

- Up to 30% error correction (four levels)
- 55% contrast ratio recommended for phones
- Kanji and Kana
- Used by e.g. Japanese mobile phone providers

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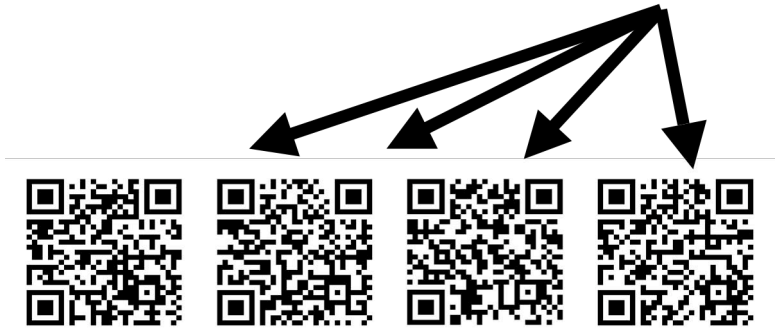

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Different Types
Visual Code
Rohs – UCS '04

Different Types
Visual Code

Rohs – UCS '04

- Designed for mobile devices
- Fixed size of 11x11
- 76bit ~ 83bit
- Error correction (Hamming Code)
- Requires VGA resolution
- Additional output:
  - Tilting, Rotation, Translation
- Code coordinates

Mapping ⇕

Image coordinates

Different Types
Visual Code

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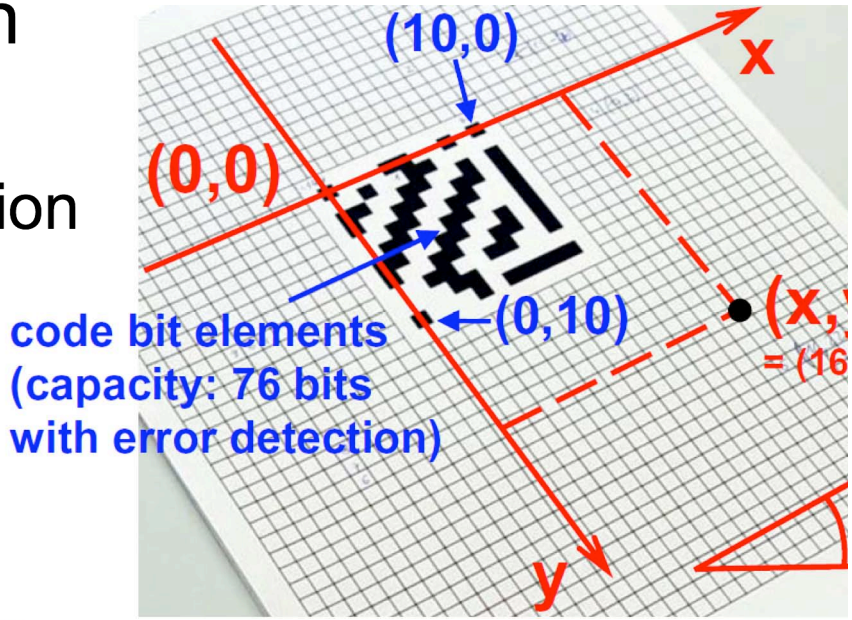
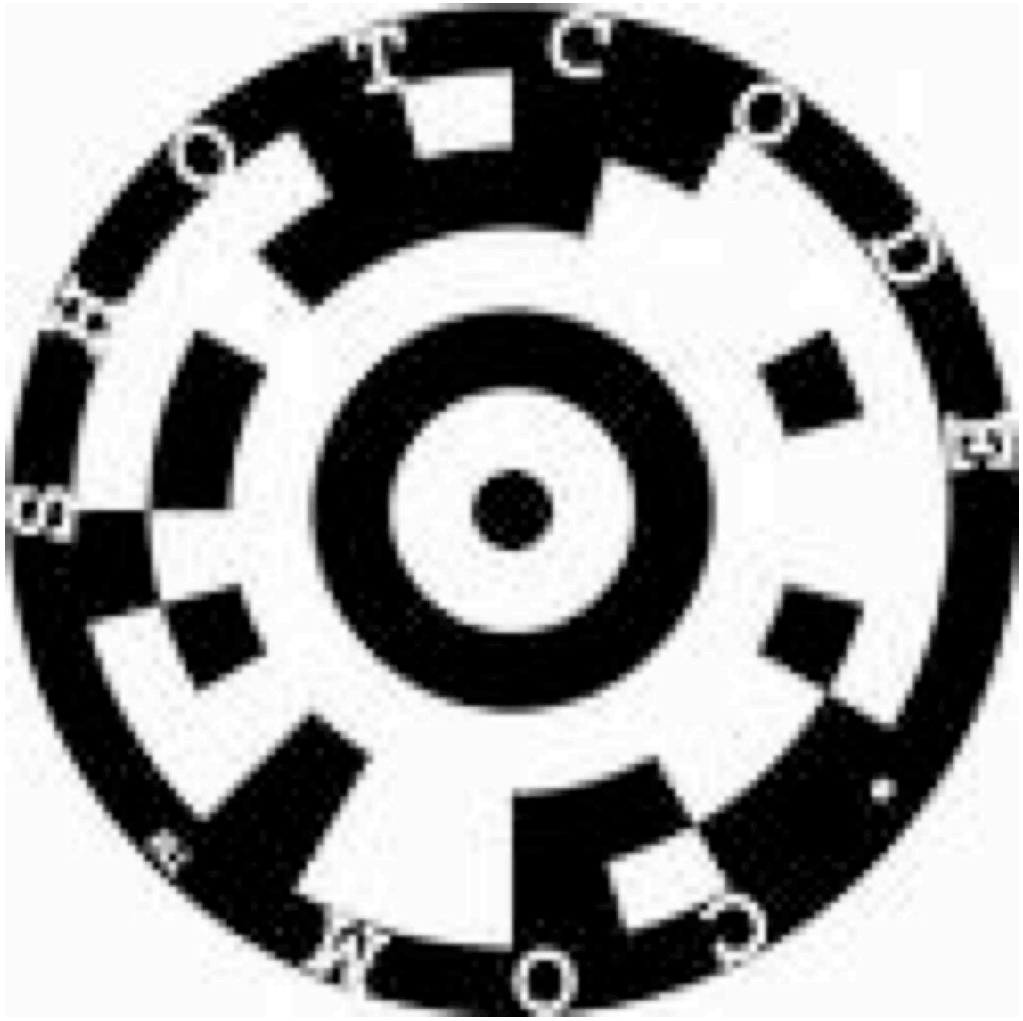
Image coordinates



Different Types
Shot Code

http://www.shotcode.com



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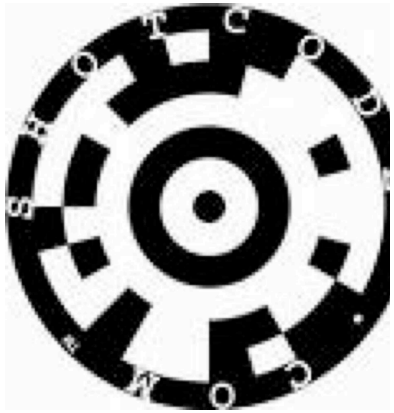
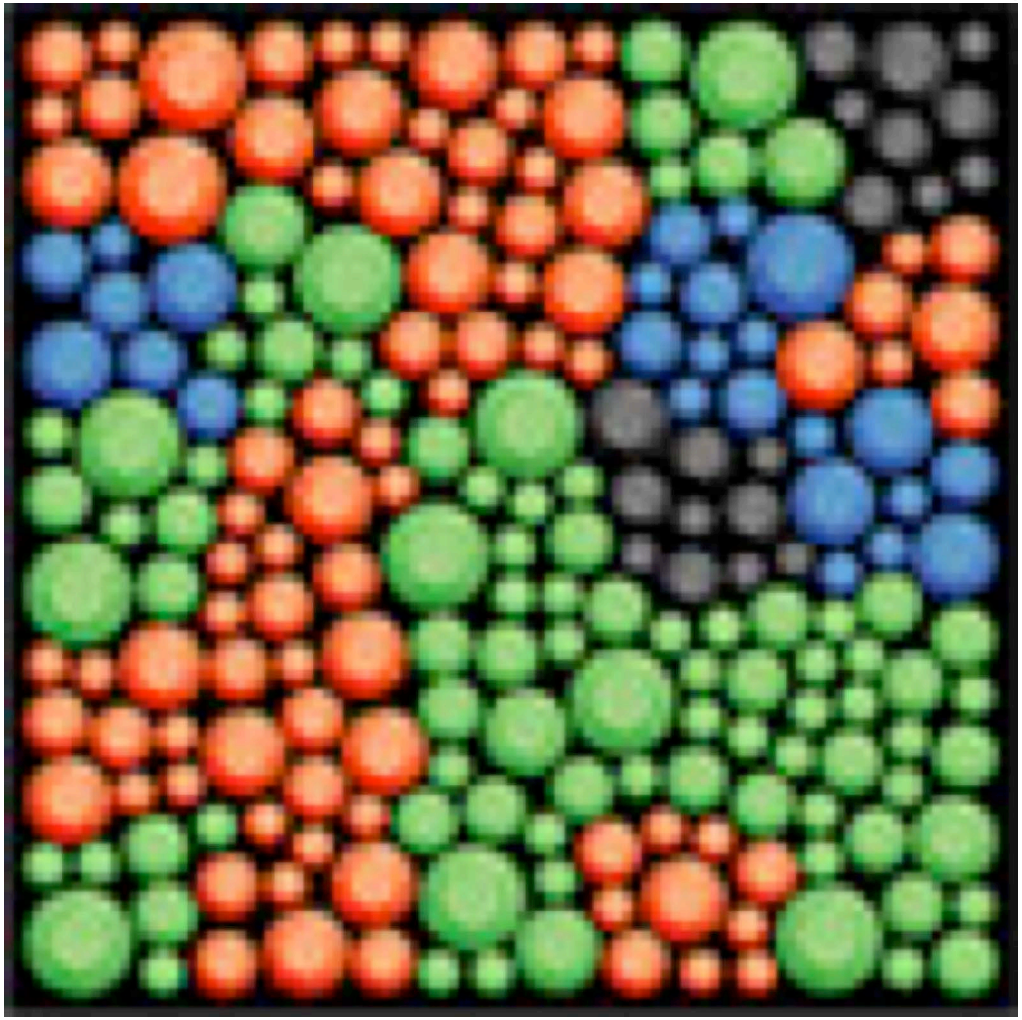


- By High Energy Magic Ltd.
- Formerly known as Spot Code
- Two data rings
- ~42bit
- Designed for mobile devices
  - →Low requirements
- Additional output:
  - Rotation
  - Position
- Commercially used by e.g. Coca Cola (Mexico)

Different Types
Color Code

http://www.colorzip.co.jp/en



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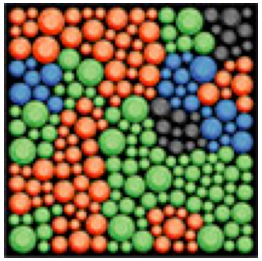

- By ColorZip
- Designed for commercial use
  → Mobile phones
- Standard: 5x5, four colors
  → 17+ billion patterns
- Highly customizable

- High capacity only in theory
- Provided in Japan

Different Types
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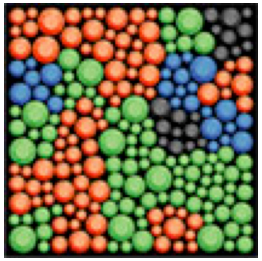

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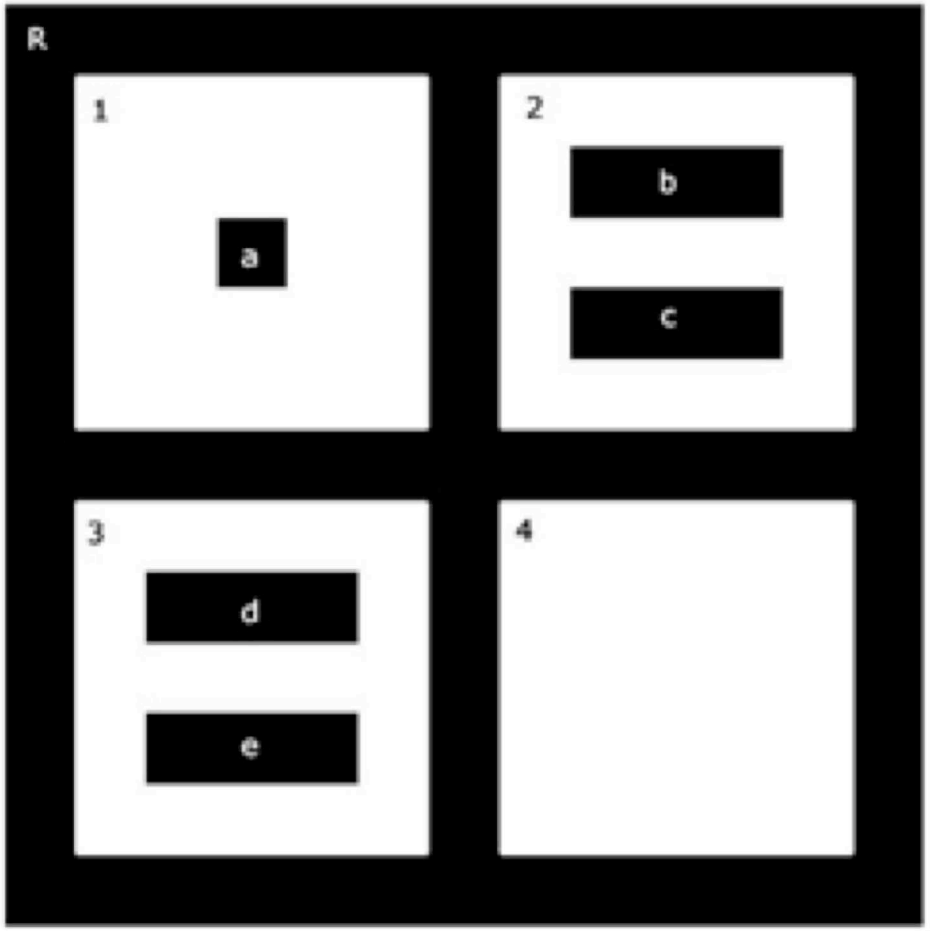
Different Types
d-touch

Constanza, Leinss (University of York) – MIRW '0



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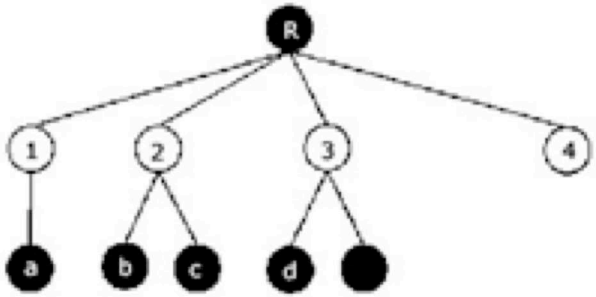

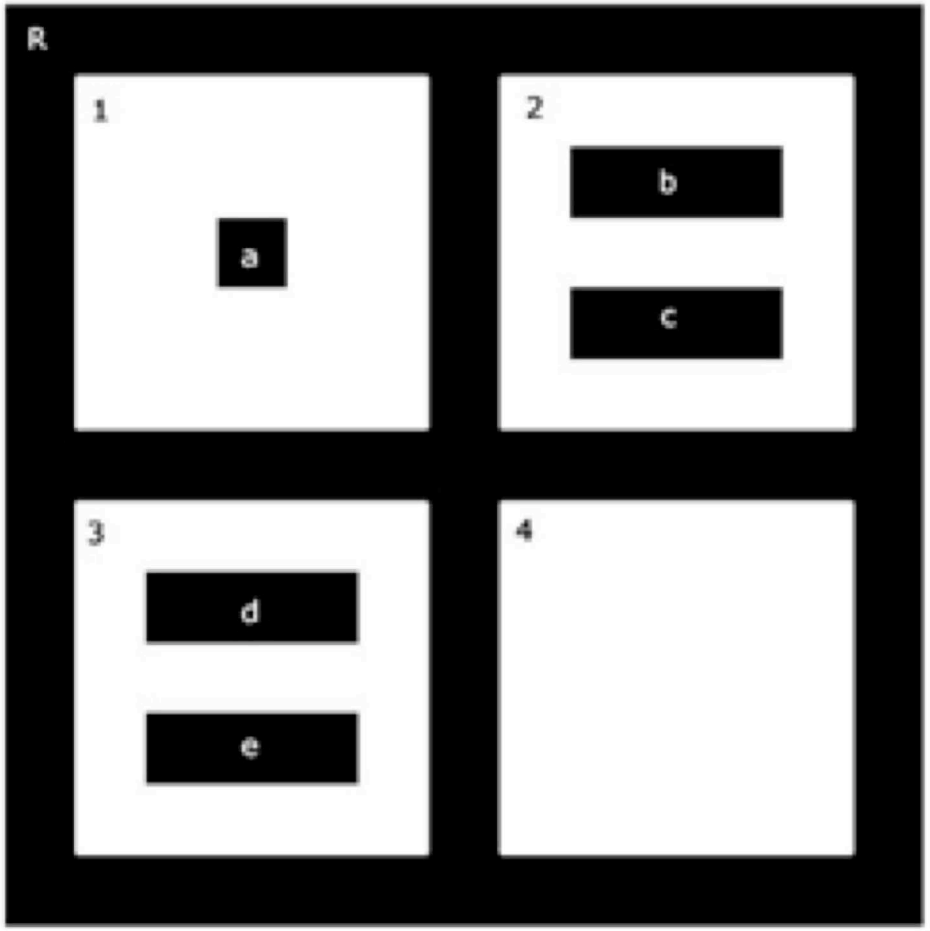

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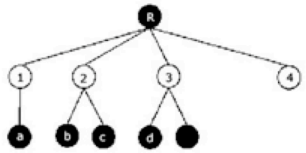

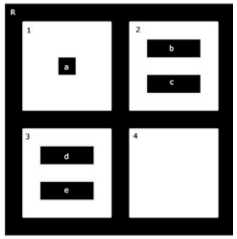

- By Costanza & Robinson
- Topological structure
- Represents trees
- Highly customizable
- Many representations

- Used in the Electronic Lens Project (MIT)

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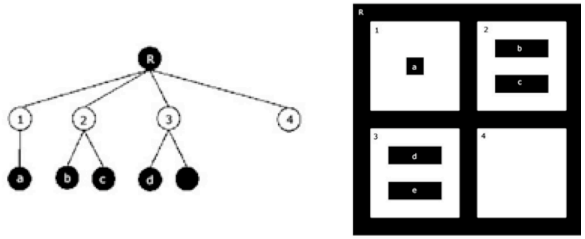

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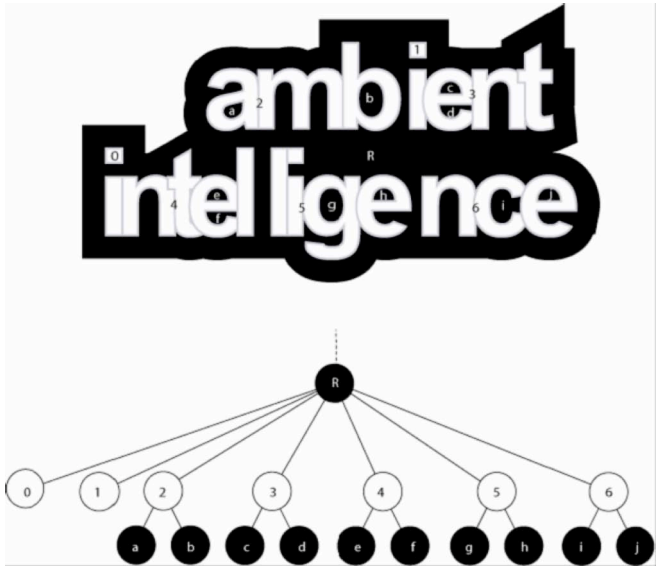

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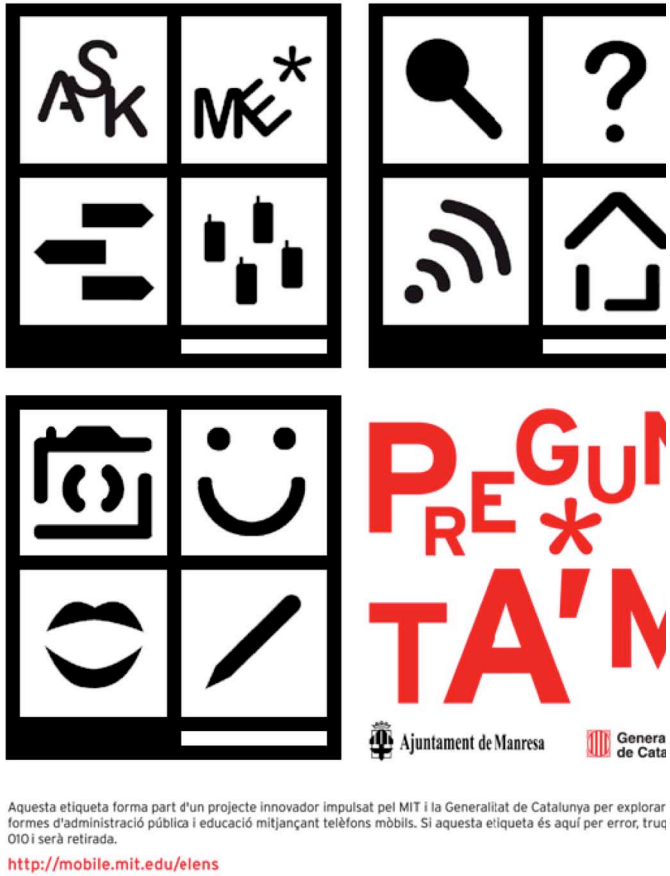

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Different Types
DataGlyphs

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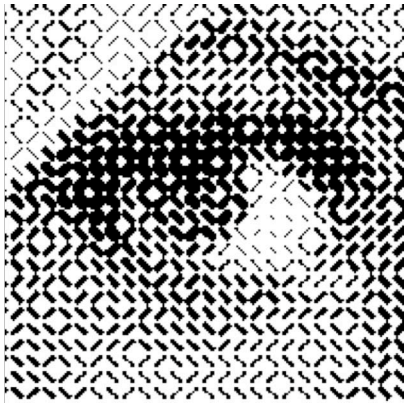

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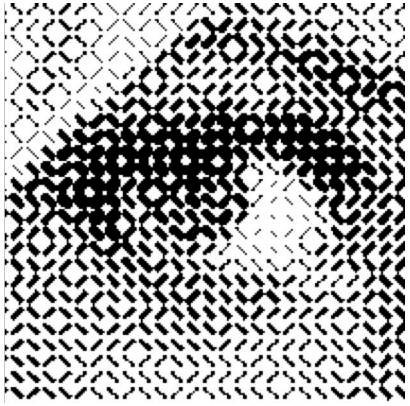
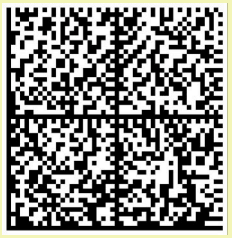


- By Xerox PARC
- Dithering technique (／, ＼)
- 600dpi: 1KB per square inch
- Flexible in shape, size, colour
- Error correction (0~99%)

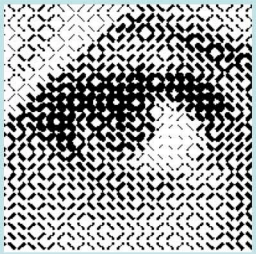
- Used e.g. for watermarking

Different Types
Overview

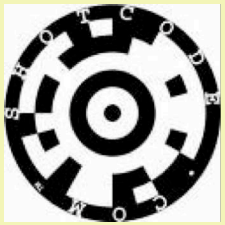
Dotmatrix



Other



Circular



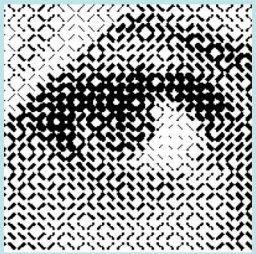
Topological

Different Types
Overview

Dotmatrix

Industrial

Other



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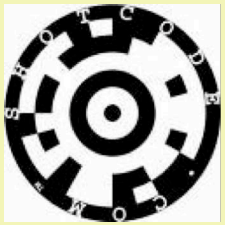

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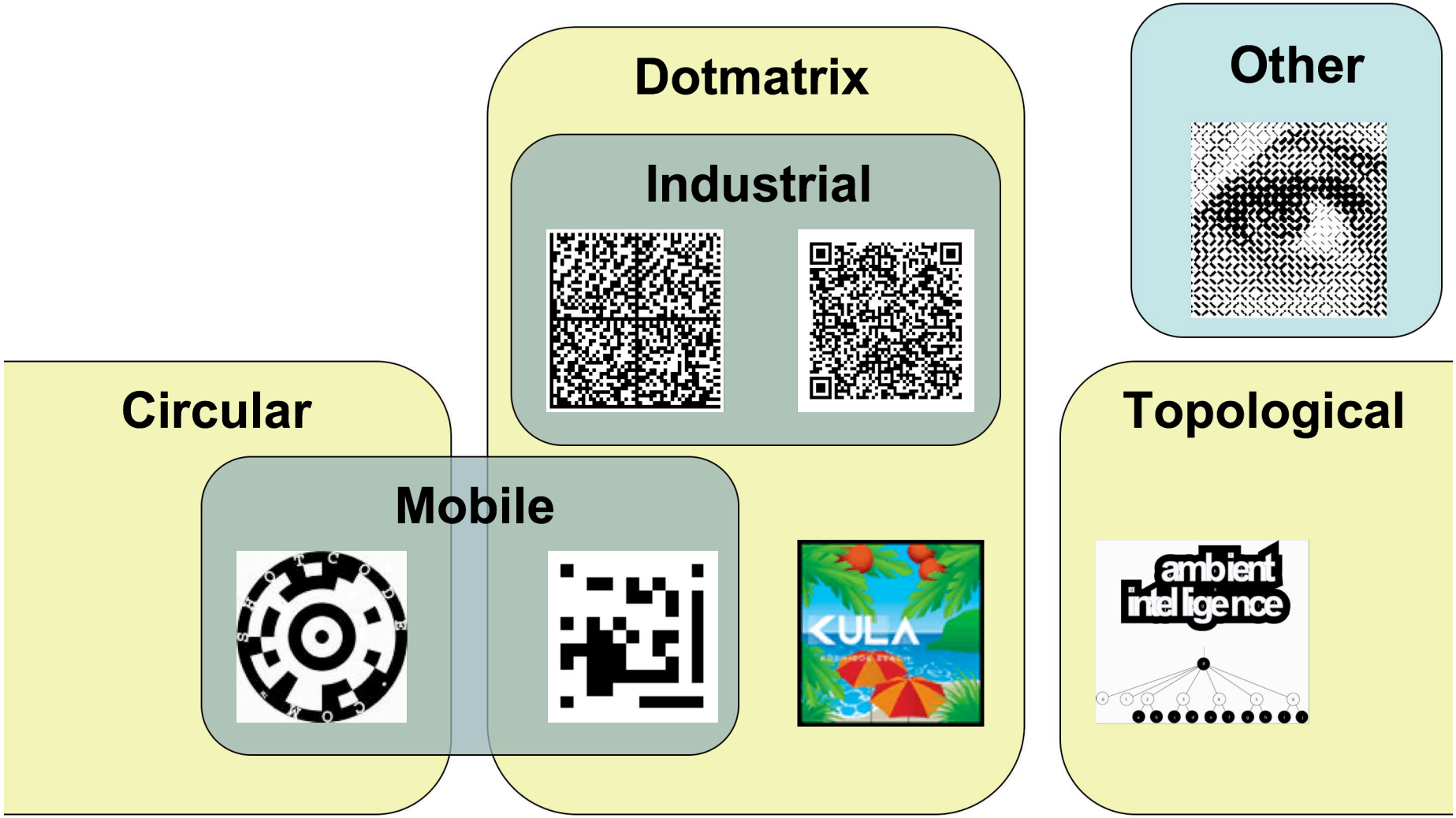

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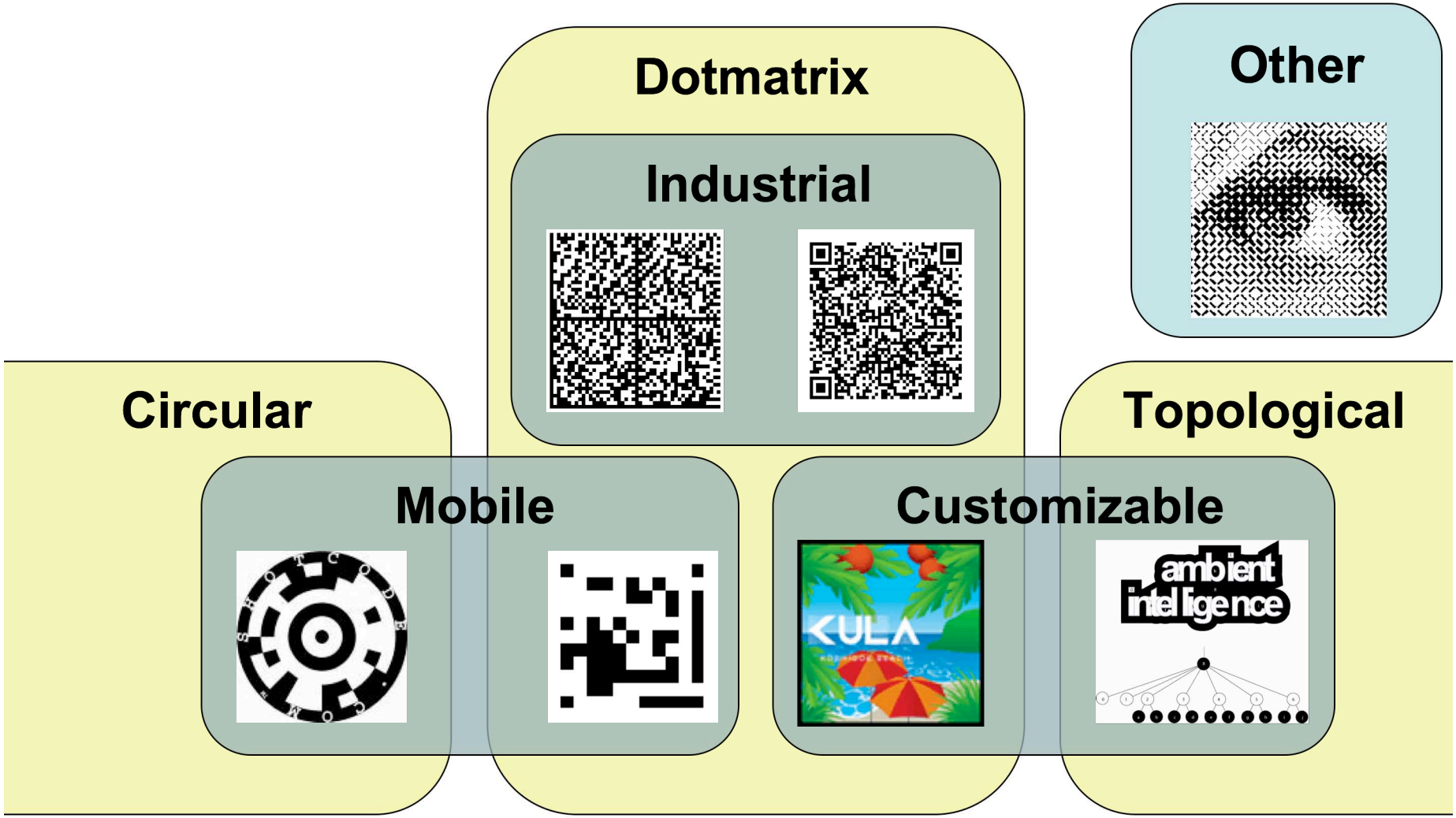

Different Types
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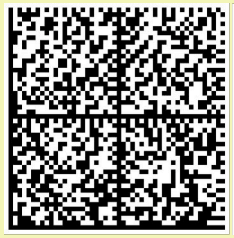
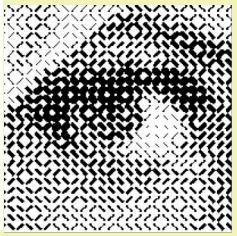
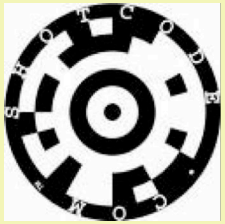
High Capacity





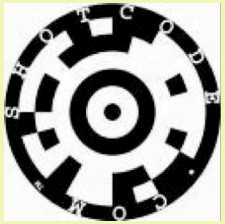
Low Capacity



Different Types
Overview

High Capacity

Any Data



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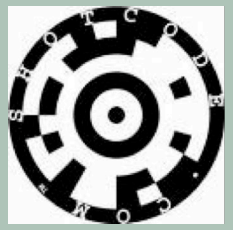
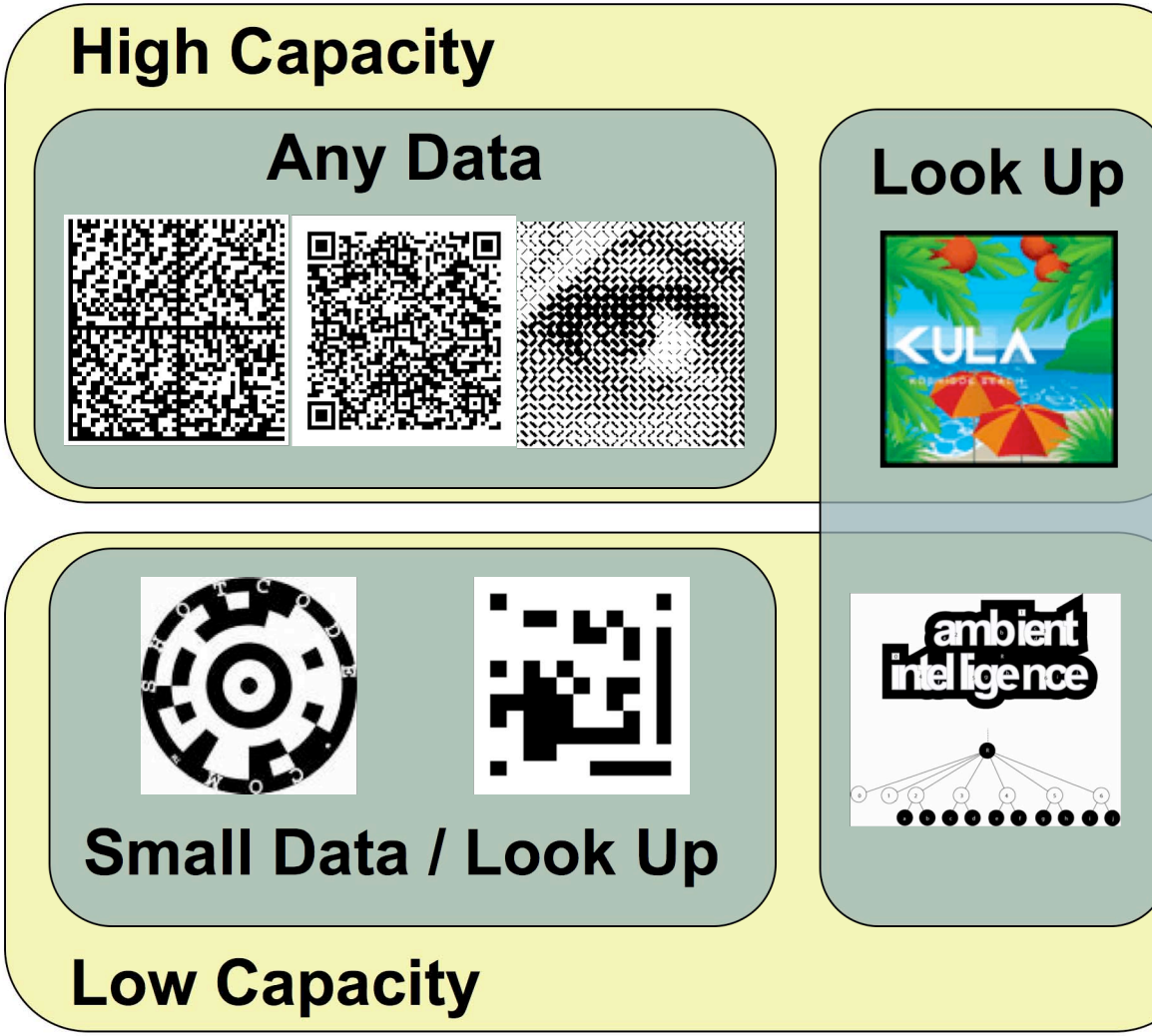


Small Data / Look Up

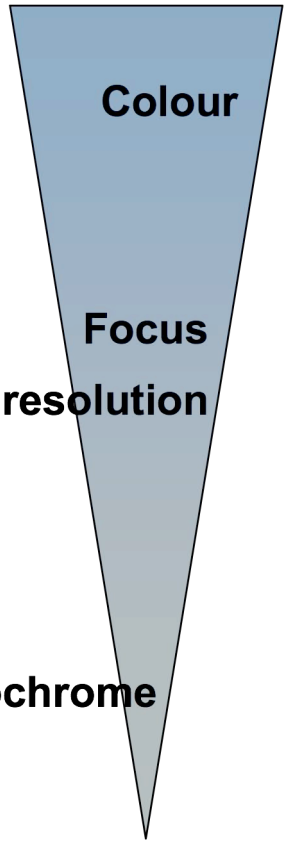
Low Capacity

Different Types
Overview



Different Types
Overview

Requirements



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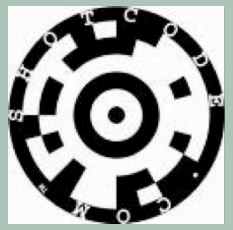

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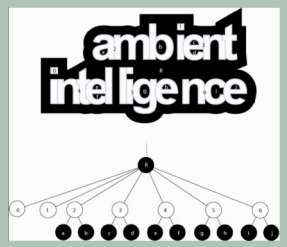

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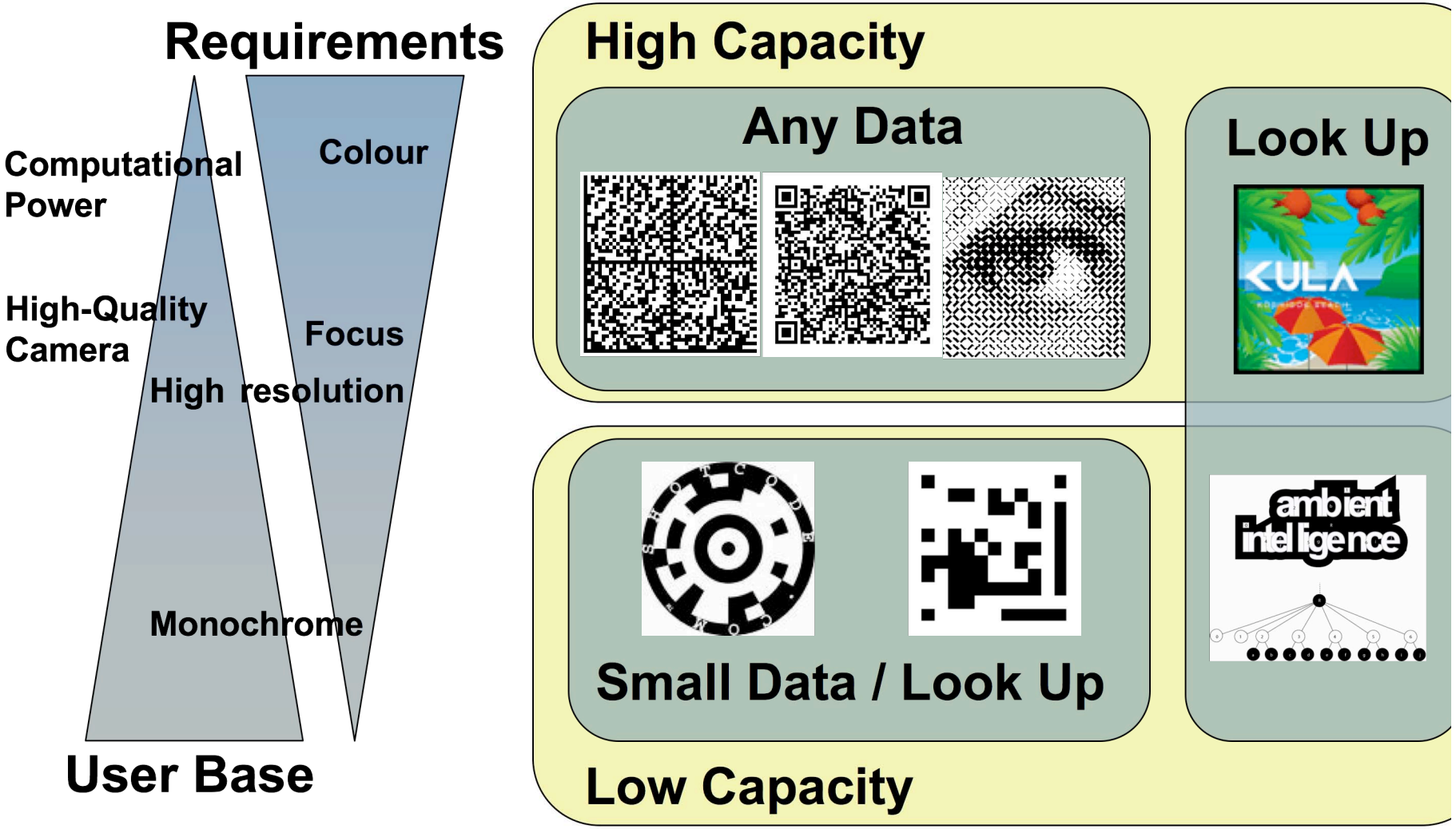
Different Types
Overview



Fiducials

2/19/07

Overview

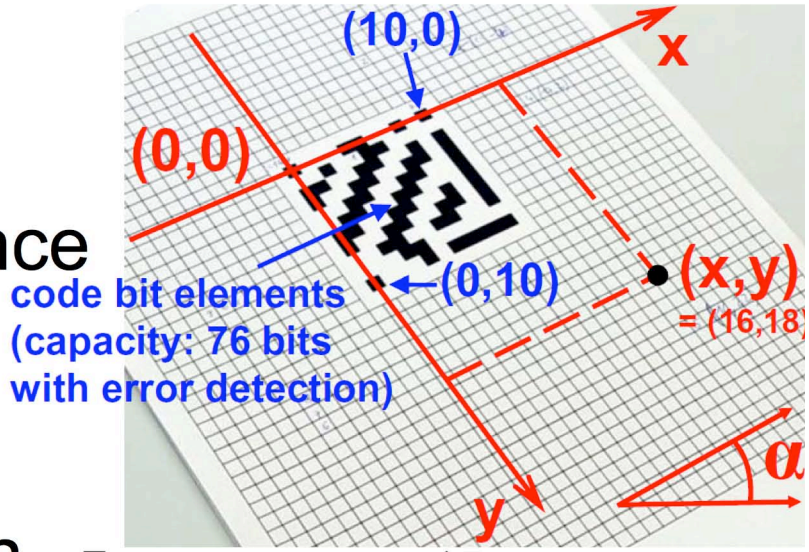
- Introduction
- Different Types
- Applications
- Competing Technology RFID
- Conclusion

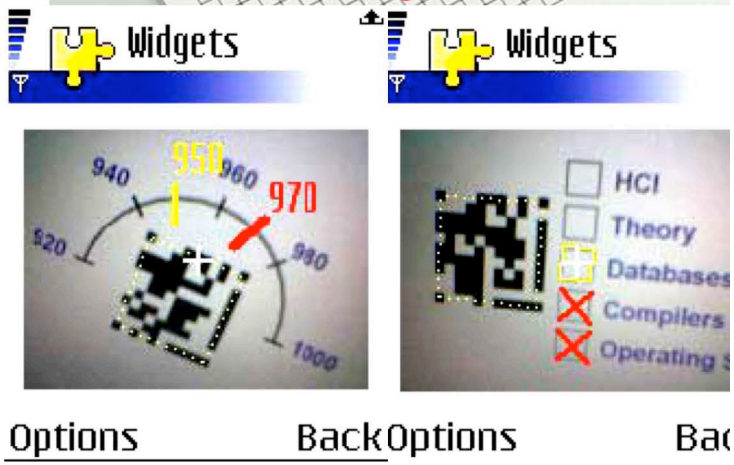
Applications

Real World Interaction

Rohs (ETH Zürich) – IWSAWC '03

- Visual Code
- Additional Parameters
  - Tilting, Rotation, Distance
  - Extended coordinates
- Applications
  - paper-based interaction
- Advantage
  - No initial communication
  - Single interpreter



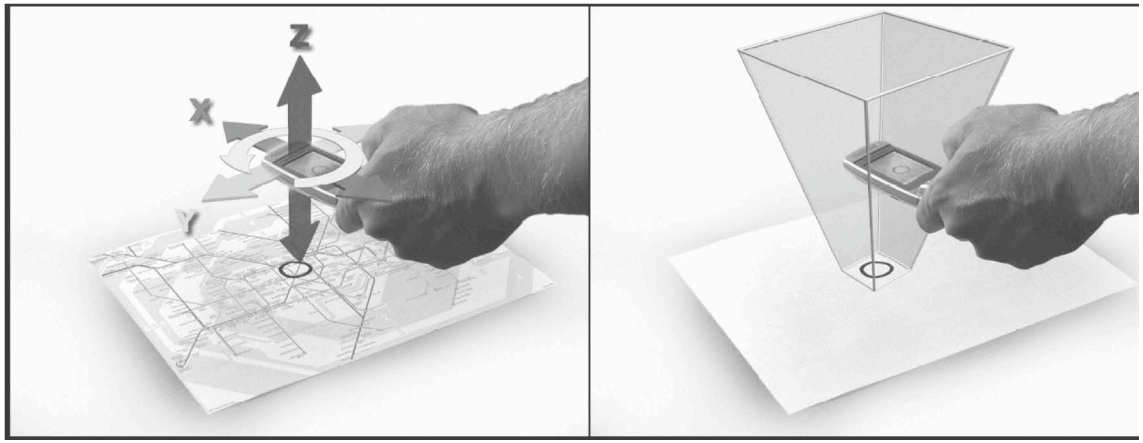


Applications

Mixed Interaction Space

Hansen et al. (University of Aarhus) – CHI '05

- Hand-drawn circle as fiducial
  - Tilting
  - Rotation
  - Translation
  - Identity
- Application



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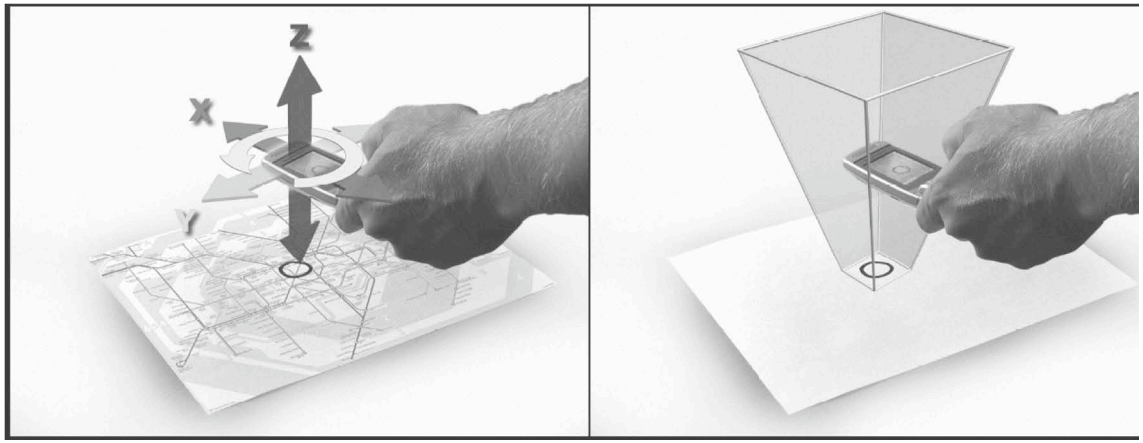
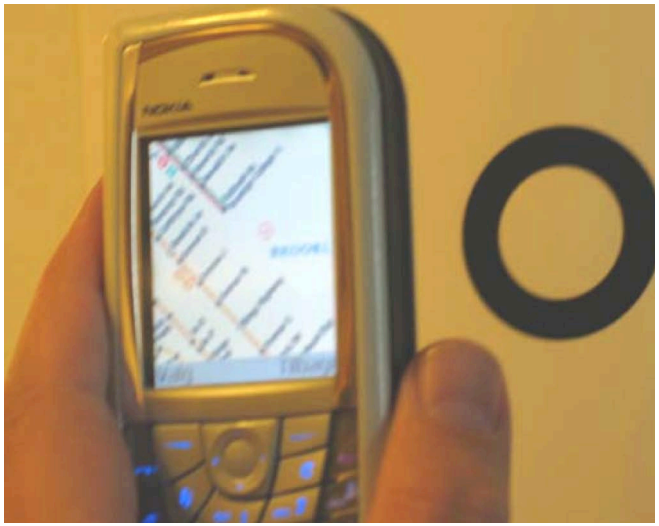


- Application
  - ImageZoomViewer



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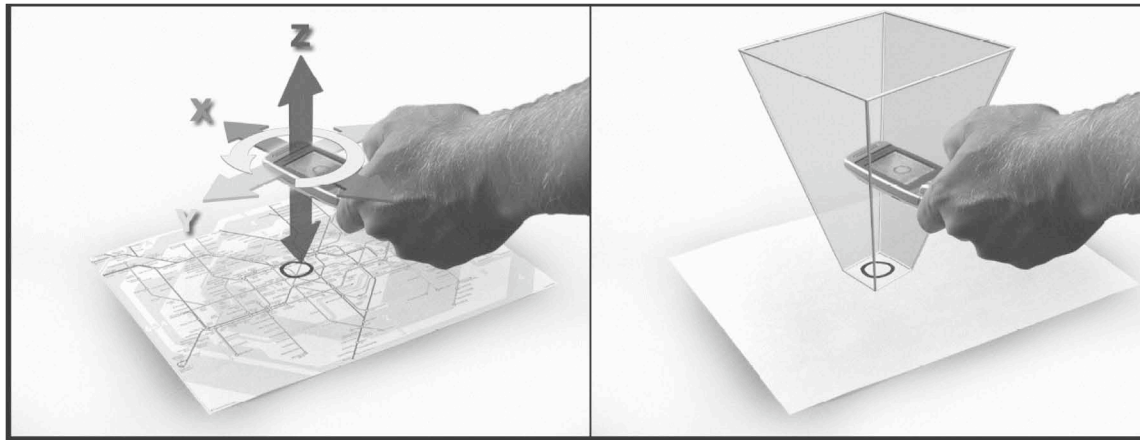
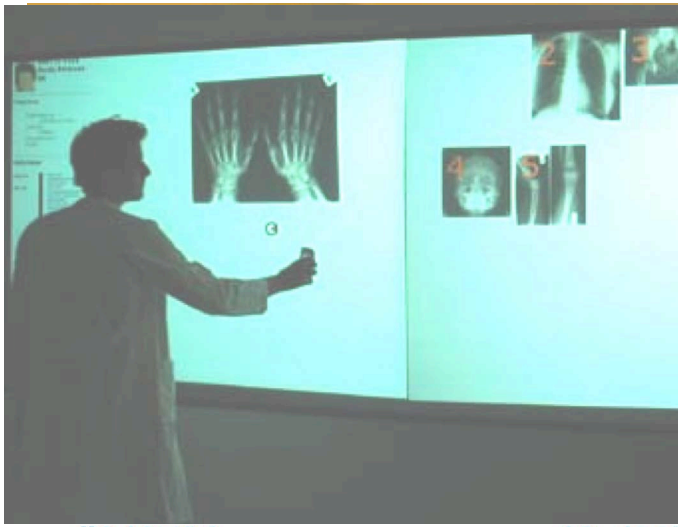


- Application
  - ImageZoomViewer
  - Drozo



Applications

Mixed Interaction Space

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- Hand-drawn circle as fiducial
  - Tilting
  - Rotation
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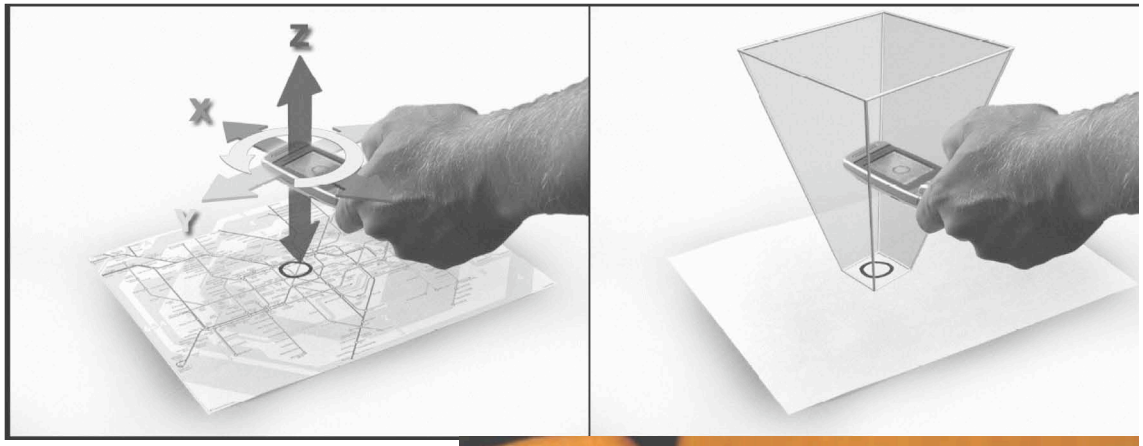
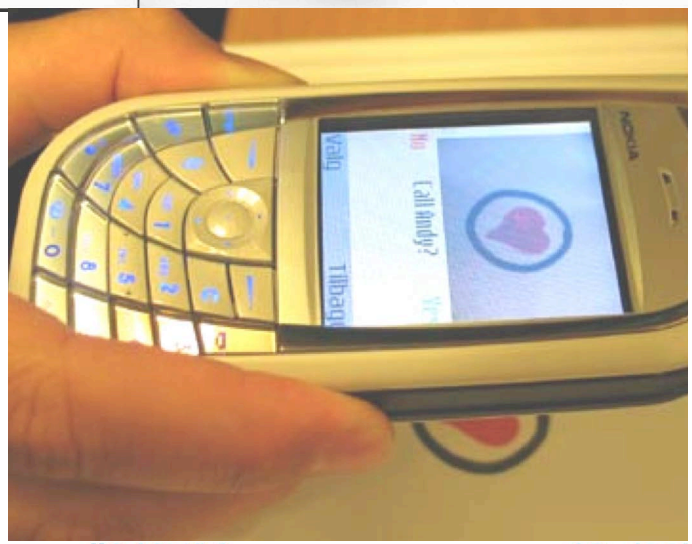
  - Identity

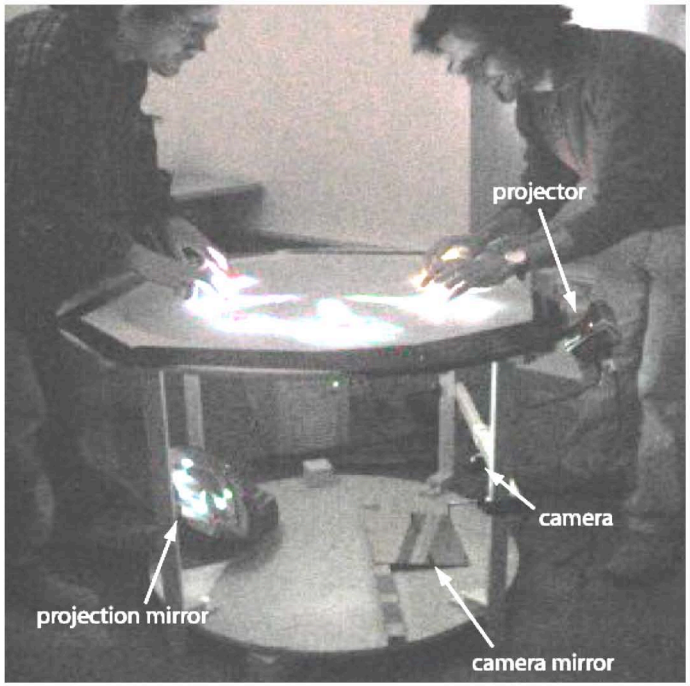


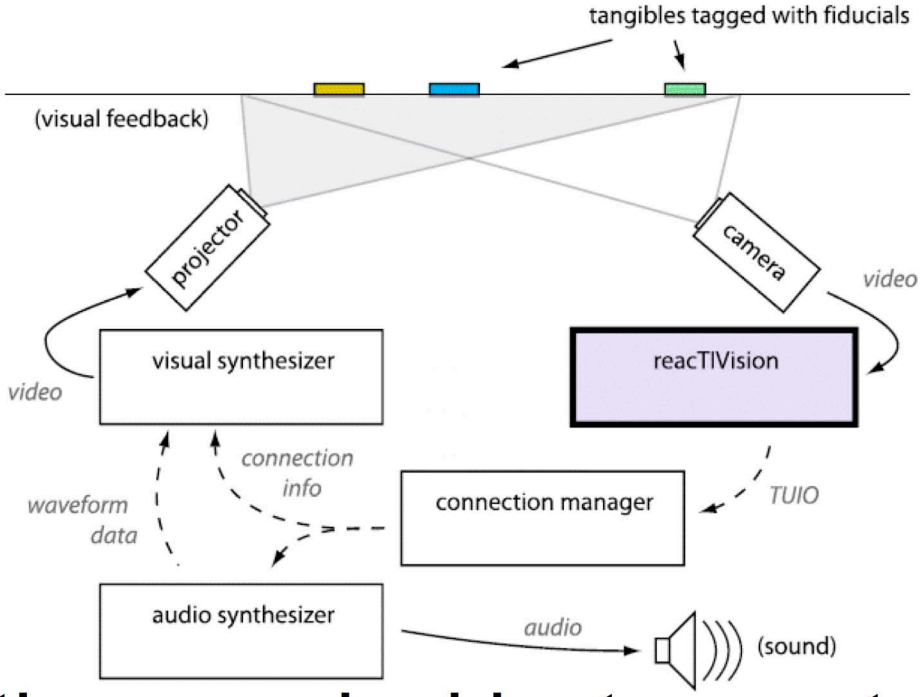
- Application
  - ImageZoomViewer
  - Drozo
  - DrawME



Applications
Reactivision

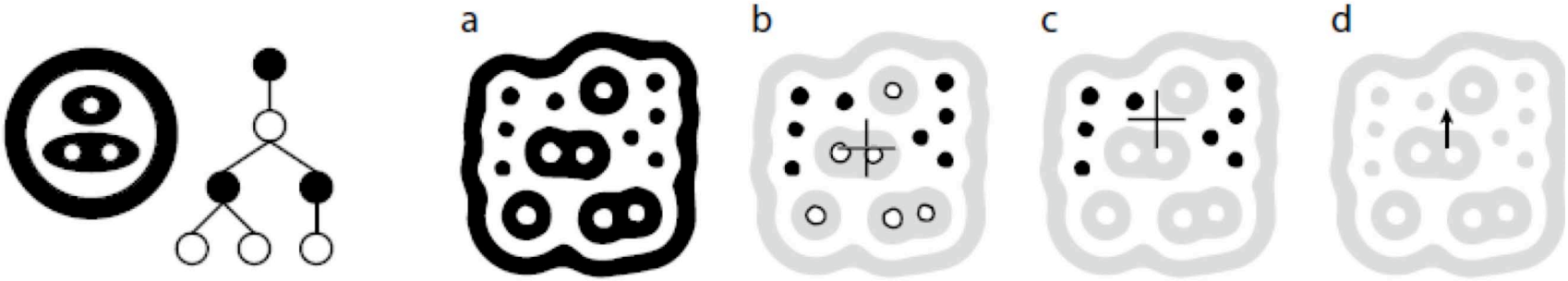
Bencina, Kaltenbrunner (Universitat Pompeu Fabra) – Third Iteration '0





- Synchronous real-time musical instrument
  - Tracking: Location, Orientation, Identity
  - Visual feedback

Applications
Reactivision

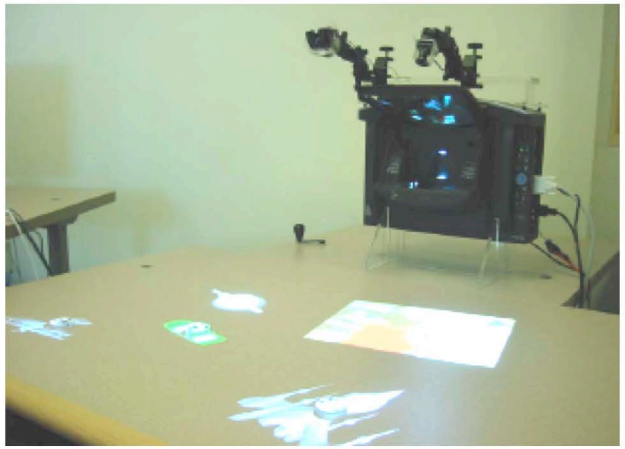


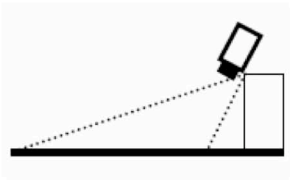
- Improvements over d-touch systems
  - Fiducial: 50% space, any tree depth
  - Tracker: 4 times faster
- Future work
  - More efficient spatial packing
  - Error tolerant tracking

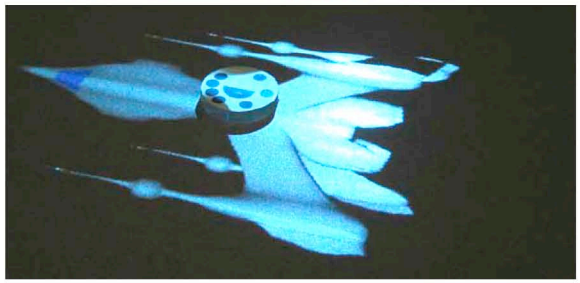
Applications

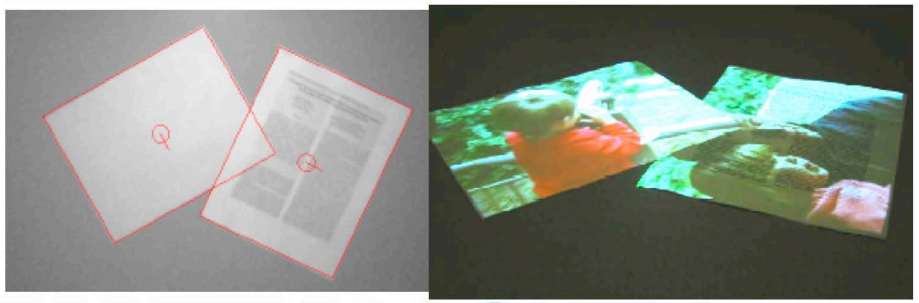
PlayAnywhere

Wilson (Microsoft) – UIST '03









- Tabletop interaction
  - On table projection
  - On table camera
- Fiducial
  - 12bit
  - Orientation
- Application
  - Object placement
  - Video overlay on paper

Applications

Video Conferencing System

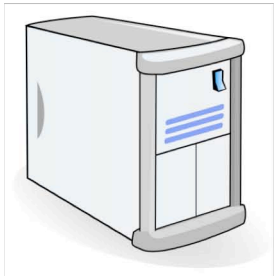
Kato et al. (Hiroshima University, University of Washington) – IWAR '9

- Features
  - Head mounted display
  - Video conferencing
  - Shared workspace
- Benefits
  - No permanent view disturbance
  - Easy rearrangement

Applications

C-Mode

http://www.cmode.jp



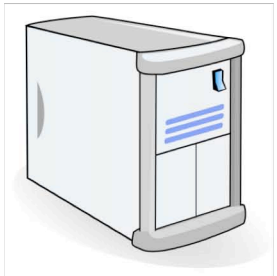
Mobile network

Problem:
How to verify customer and task?

Applications

C-Mode

http://www.cmode.jp



Mobile network

Applications

C-Mode

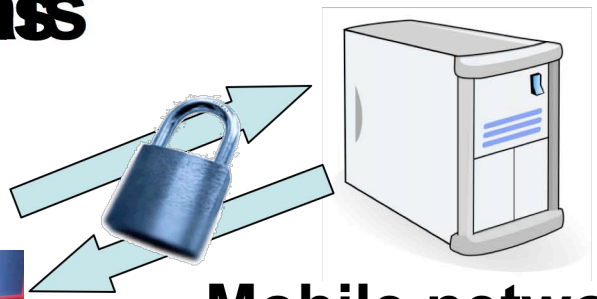
http://www.cmode.jp

- Request purchase ticket
  → Fiducial purchase ticket

Applications

C-Mode

http://www.cmode.jp



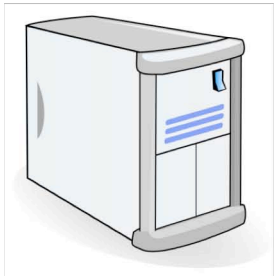
Mobile network

- Request purchase ticket
  → Fiducial purchase ticket
- Customer verification

Applications

C-Mode

http://www.cmode.jp



Mobile network

- Request purchase ticket
  → Fiducial purchase ticket
- Customer verification
- Select drink

Applications

C-Mode

http://www.cmode.jp

Mobile network

- Request purchase ticket
  → Fiducial purchase ticket
- Customer verification
- Select drink

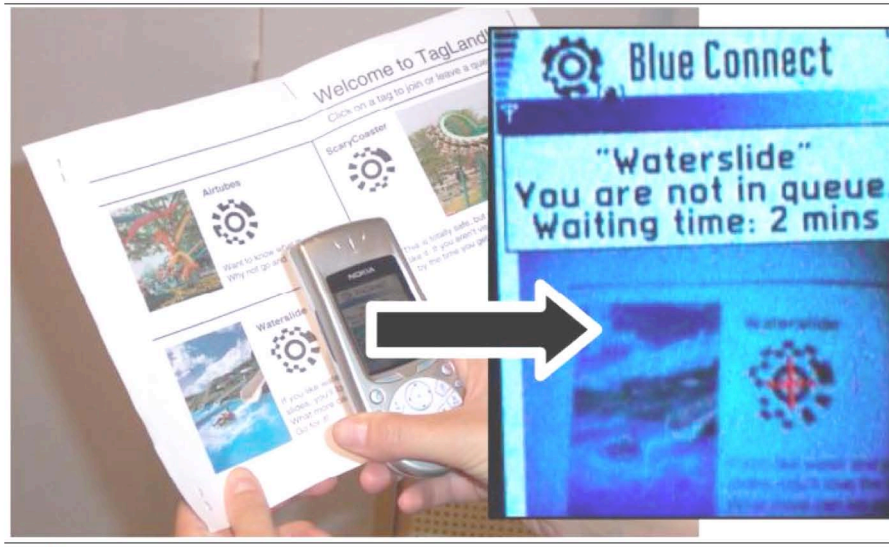
→ Drink, Payment

Applications

Context-aware mobile services

Toye et al. (Oxford University) – 2004

Theme Park Queuing



- Interaction
  - Visual marker
  - Bluetooth
- Advantages
  - Changes anywhere
  - Live information anywhere
- Result
  - Overcome limitations of phones' screen
  - Personalized services through mobile phone

Applications
Context-aware mobile services

Airport Information

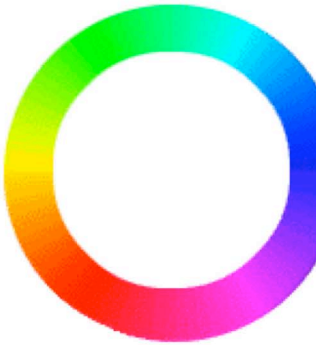
- Interaction
  - Visual marker
  - Bluetooth
- Display
  - Flight information
  - Maps
- Advantages
  - Immediate identification
  - Automatic information access

Applications

C-Blink

Miyaoku, Higashino, Tonomura (NTT Cyber Solutions Laboratories) – UIST '04

0 0 0 1 1
↓ ↓ ↓ ↓ ↓



- Blink signal
  - Hue-difference
  - Constant interval
- Increase data throughput
  - More colors
  - Higher frame rate

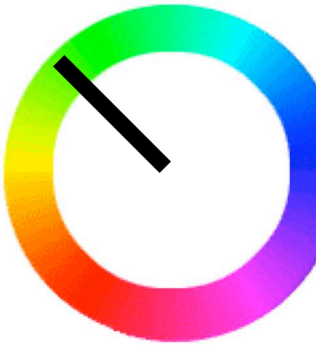
Applications

C-Blink

Miyaoku, Higashino, Tonomura (NTT Cyber Solutions Laboratories) – UIST '04

0 0 0 1 1

↓ ↓ ↓ ↓ ↓



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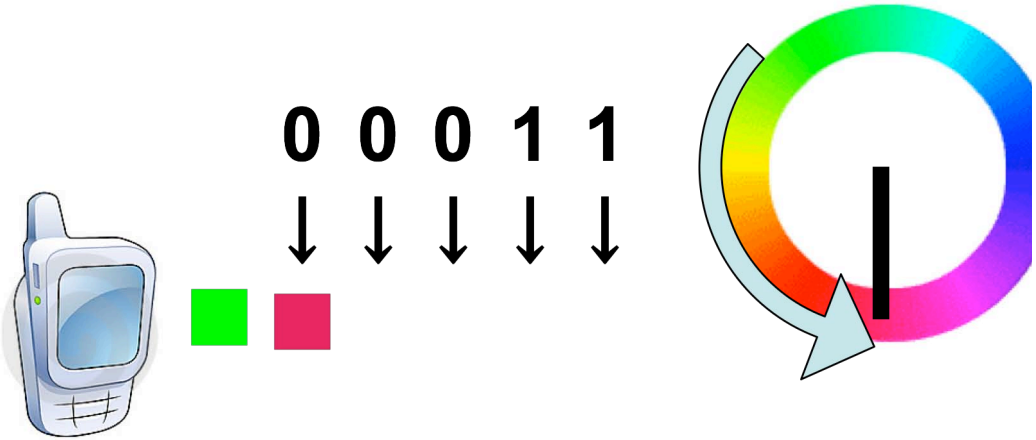

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Applications

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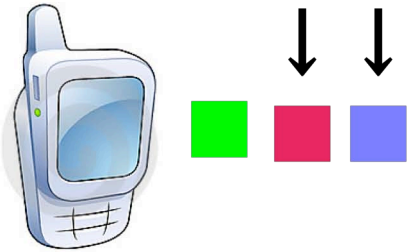

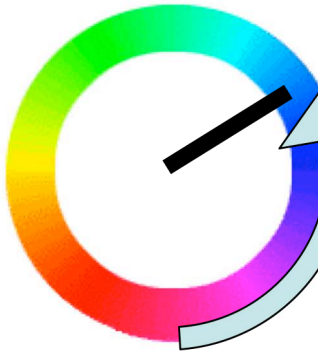

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Applications

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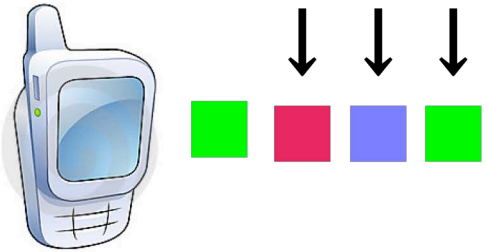

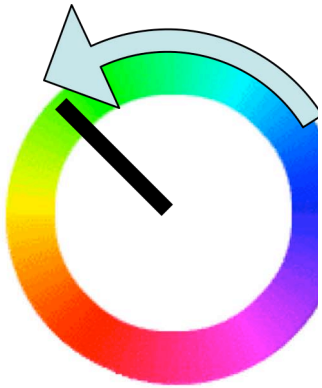

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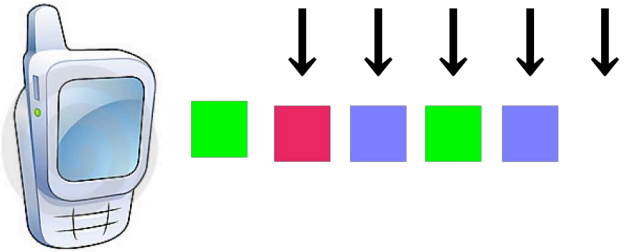

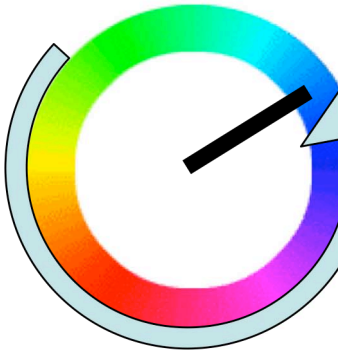

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Applications

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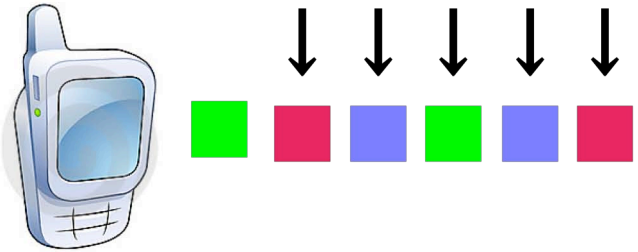

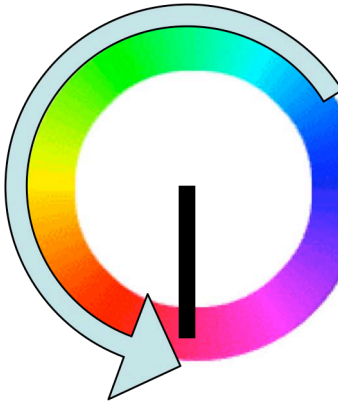

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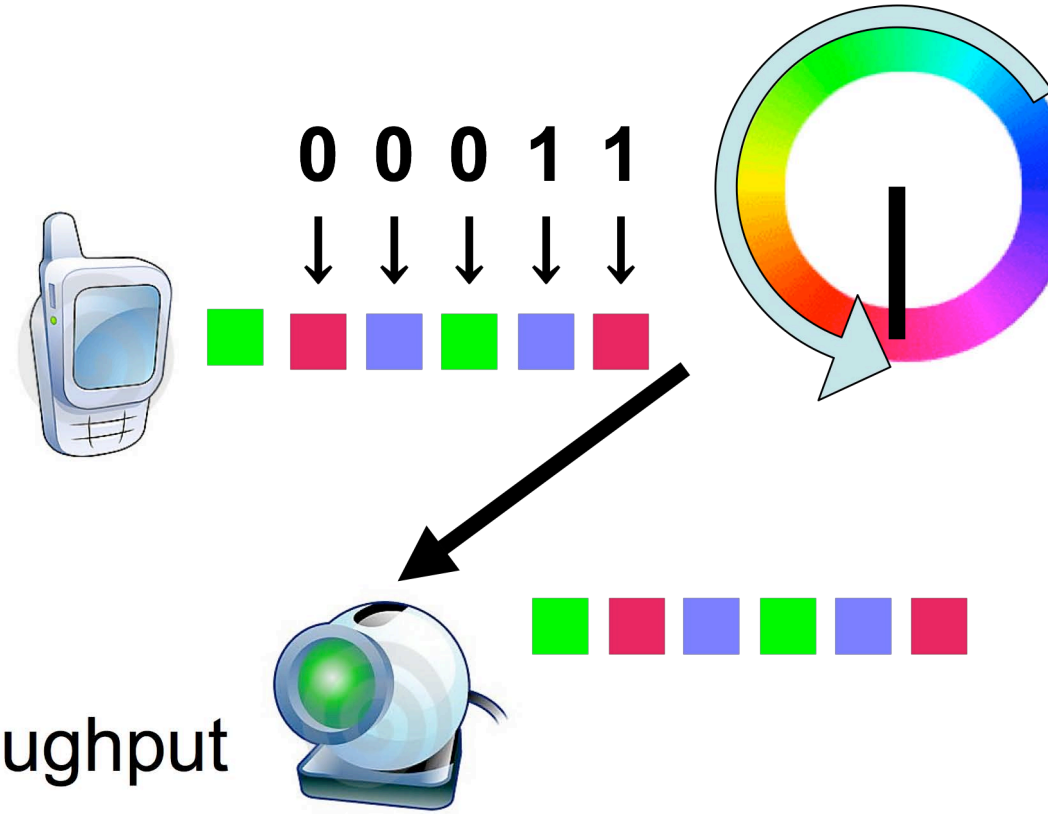
Applications

C-Blink

Miyaoku, Higashino, Tonomura (NTT Cyber Solutions Laboratories) – UIST '04



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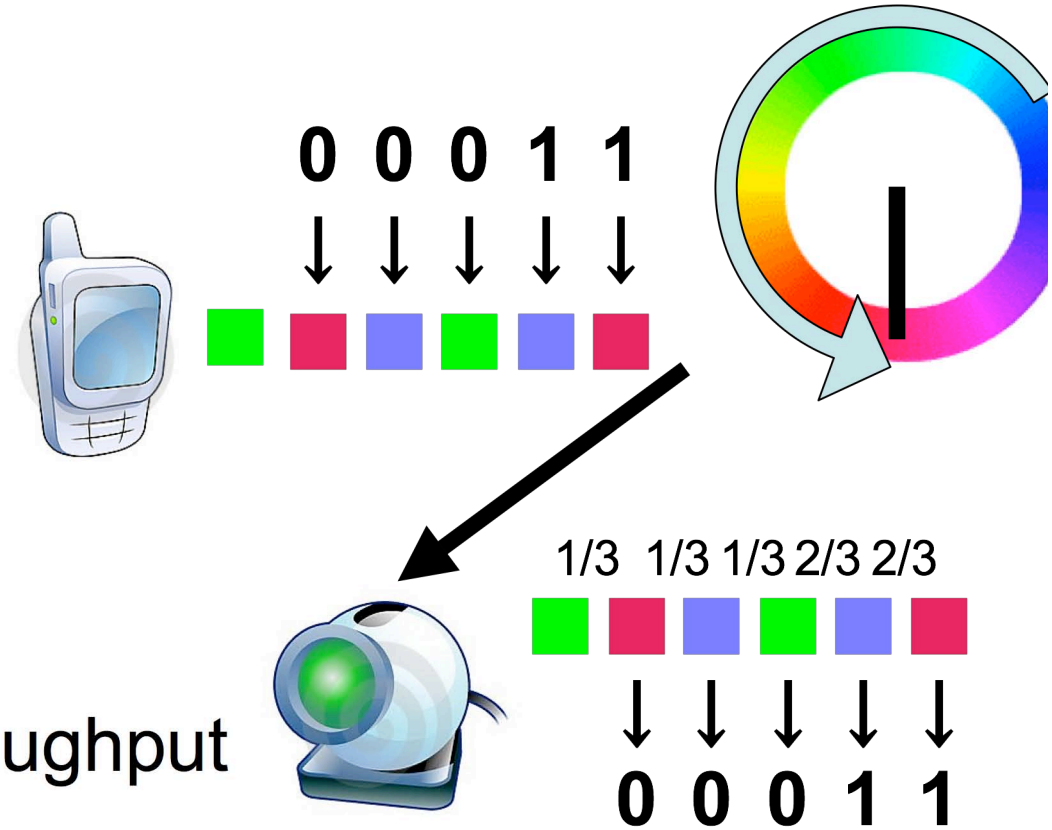
- Increase data throughput
  - More colors
  - Higher frame rate

Applications

C-Blink

Miyaoku, Higashino, Tonomura (NTT Cyber Solutions Laboratories) – UIST '04



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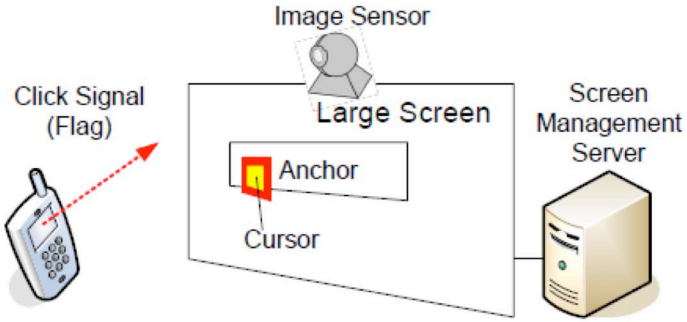
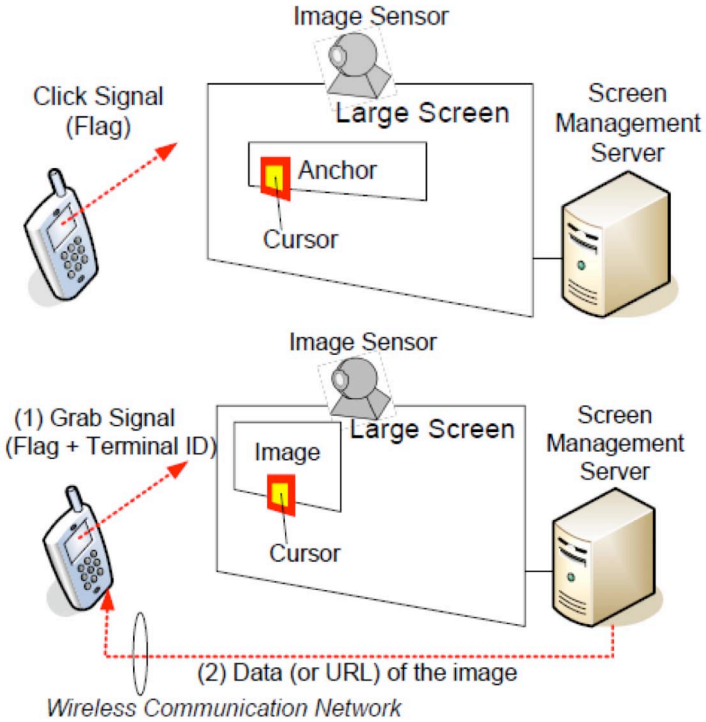
Applications
C-Blink

Applications
C-Blink



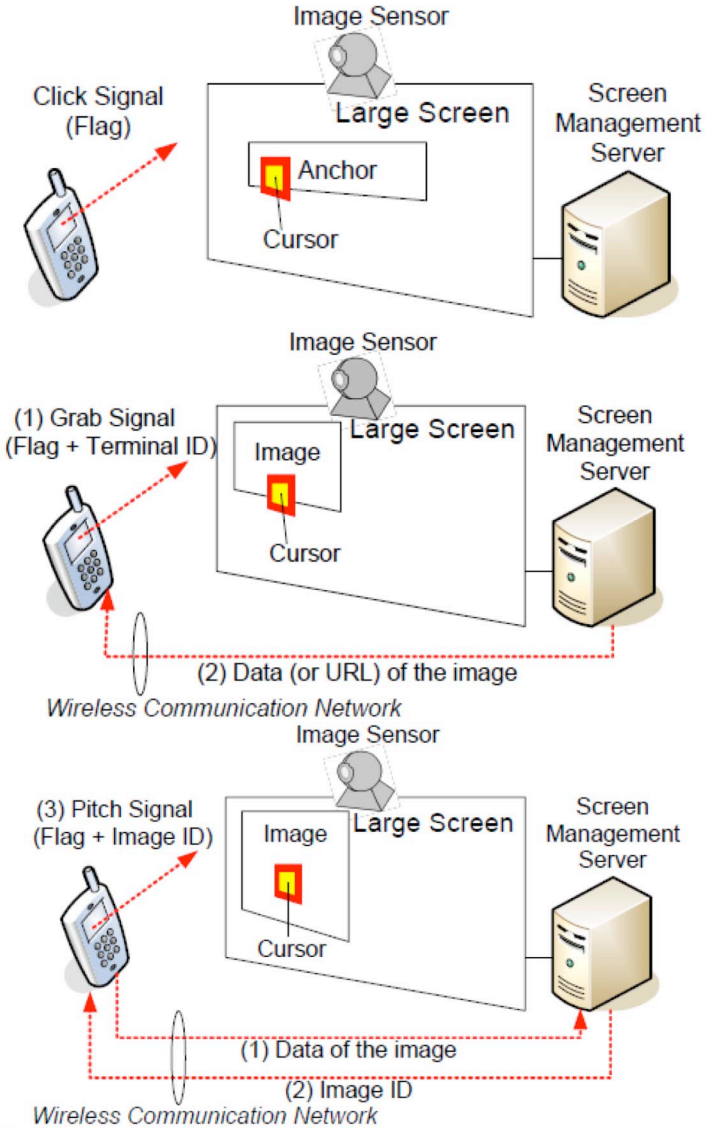
- “Click”
  → Send Click Signal

Applications
C-Blink



- "Click"
  → Send Click Signal
- "Grab"
  → Send Grab Signal
  ← Data (or URL)

Applications
C-Blink

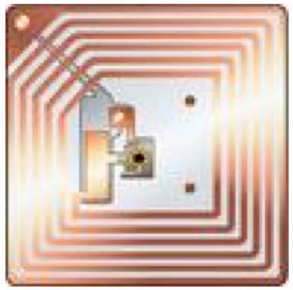


- "Click"
  - → Send Click Signal
- "Grab"
  - → Send Grab Signal
  - ← Data (or URL)
- "Pitch"
  - → Data of the image
  - ← Image ID
  - → Send Pitch Signal

Overview

- Introduction
- Different Types
- Applications
- Competing Technology RFID
- Conclusion

Applications
Competing Technology RFID



Pro RFID

- Bidirectional communication
- Invisible → Secure
- No aiming required

Pro fiducial markers

- Easy to produce
- Easy to attach
- Visible → Affords action, human factor

- Introduction
- Different Types
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Conclusion

- Various fiducial markers
  - Different motivations
    - Industry
    - Mobile phone
    - Commercial
  - Different properties
    - Data capacity
    - Recognition complexity
    - Camera requirements
    - Additional parameters
    - Restrictions

Conclusion

- Various applications
  - Tabletop interaction
  - Conferencing
    → Natural handling / Ease of use
  - Security
    → Reliable verification by machines
  - Large screen interaction
  - Real world interaction
    → New ways interactions
- Several benefits over RFID

- Expecting more fiducial applications in future

Fiducials

2/19/07

RWTH AACHEN

Kai Höfig #242791
Noriyasu Vontin #243715

Media Computing Group:

Post Desktop User Interfaces

Fiducials

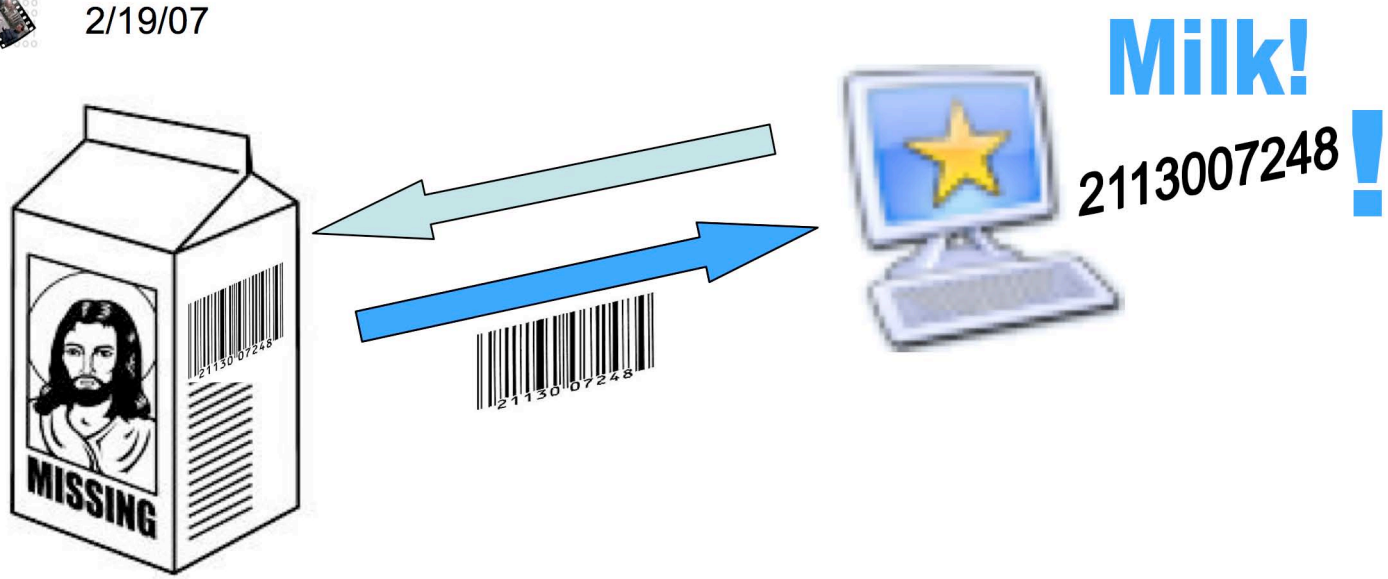
Kai Höfig, Noriyasu Vontin

Supervisor: Tico Ballagas

RWTH AACHEN

Fiducials

2/19/07



- Labels:

  Easier access to information

- Fiducials:

  Labels for machines

Fiducials

2/19/07

- Link the real world with the virtual world
- Reader
  - Camera equipped computer systems
  - Specialized reader handsets
- New reader class
  - 257 million camera phones sold in 2004
  - Today camera phones have a market share of 48%
  - In Japan 58% want a mobile phone with integrated bar code reader
- Towards ubiquitous computing

Familiar?

There are many more!

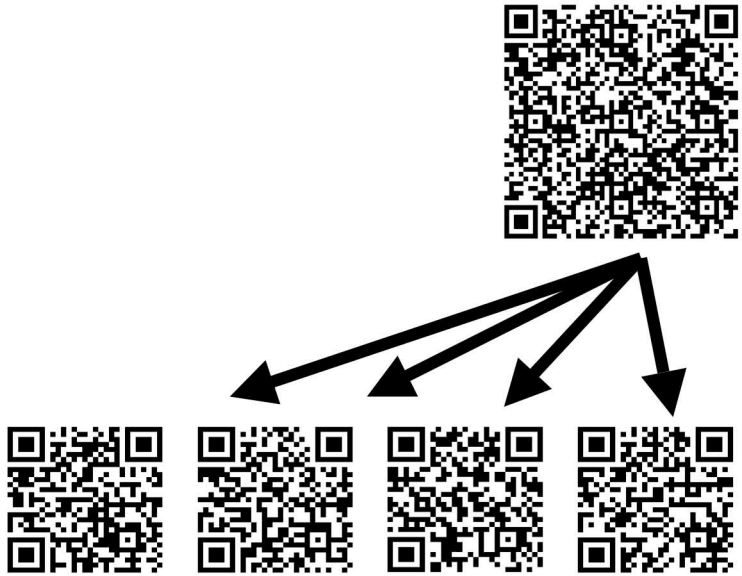
Different Types
Datamatrix

- By RVSI Acuity CiMatrix
- ISO/IEC 16022
- 10x10 ~ 144x144 (8x18 ~ 16x48)
- 1 byte ~ 1,555 bytes
- Up to 60% error correction (Reed-Solomon)
- At least 20% contrast ratio
- One cell orientation lines

- Used by e.g. Deutsche Post, Semapedia

Different Types
Quick Response(QR) Code

- By Denso Wave
- ISO/IEC 18004
- 21x21 ~ 177x177
- At least 4 cells margin
- 7 byte ~ 2,953 byte
- Clustering



- Up to 30% error correction (four levels)
- 55% contrast ratio recommended for phones
- Kanji and Kana
- Used by e.g. Japanese mobile phone providers

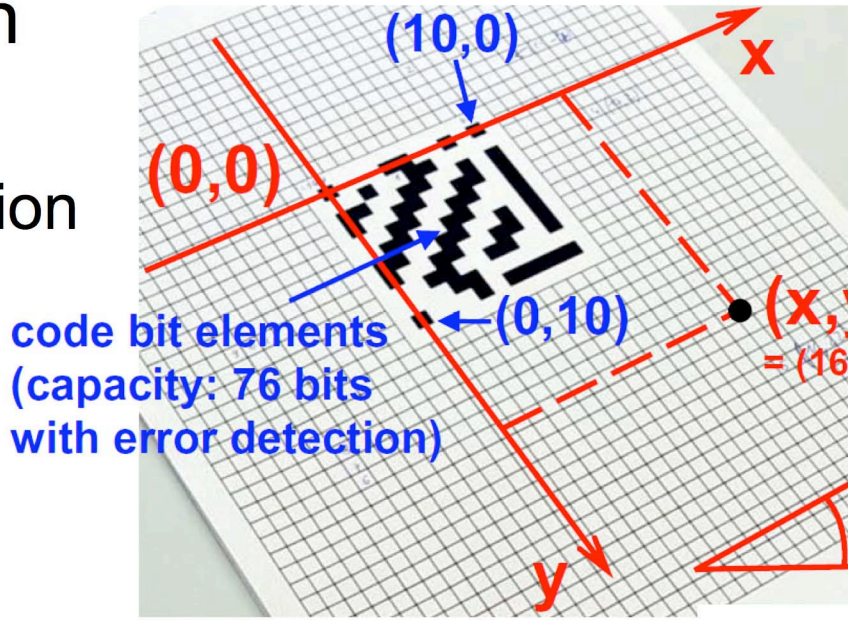
Different Types
Visual Code

Rohs – UCS '04

- Designed for mobile devices
- Fixed size of 11x11
- 76bit ~ 83bit
- Error correction (Hamming Code)
- Requires VGA resolution
- Additional output:
  - Tilting, Rotation, Translation
- Code coordinates

Mapping

Image coordinates



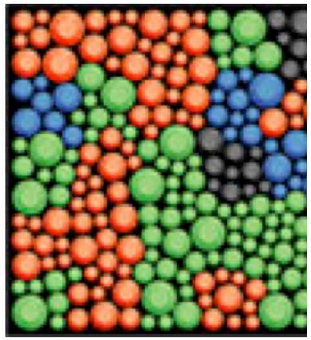
Different Types
Shot Code

http://www.shotcode.com

- By High Energy Magic Ltd.
- Formerly known as Spot Code
- Two data rings
- ~42bit
- Designed for mobile devices
  →Low requirements
- Additional output:
  – Rotation
  – Position
- Commercially used by e.g. Coca Cola (Mexico)

Different Types
Color Code

http://www.colorzip.co.jp/en



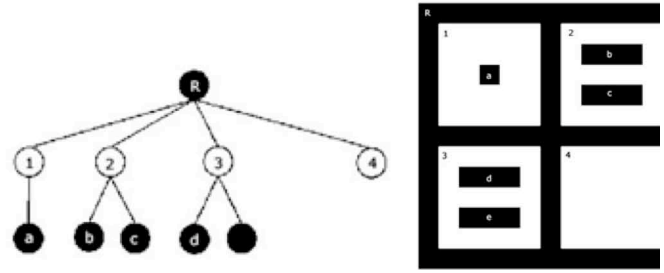
- By ColorZip
- Designed for commercial use
  → Mobile phones
- Standard: 5x5, four colors
  → 17+ billion patterns
- Highly customizable

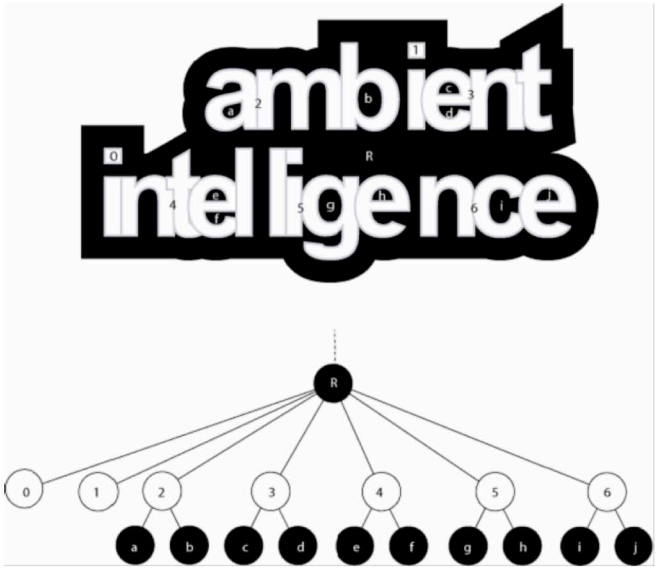
- High capacity only in theory
- Provided in Japan

Different Types
d-touch

Constanza, Leinss (University of York) – MIRW '0

- By Costanza & Robinson
- Topological structure
- Represents trees
- Highly customizable
- Many representations

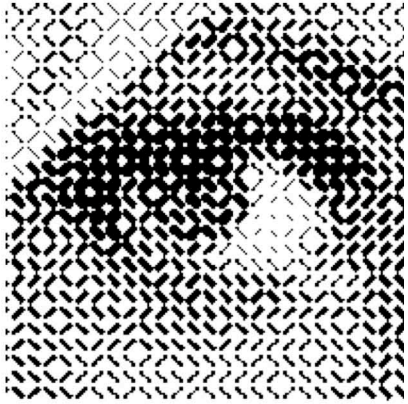




- Used in the Electronic Lens Project (MIT)

Different Types
DataGlyphs

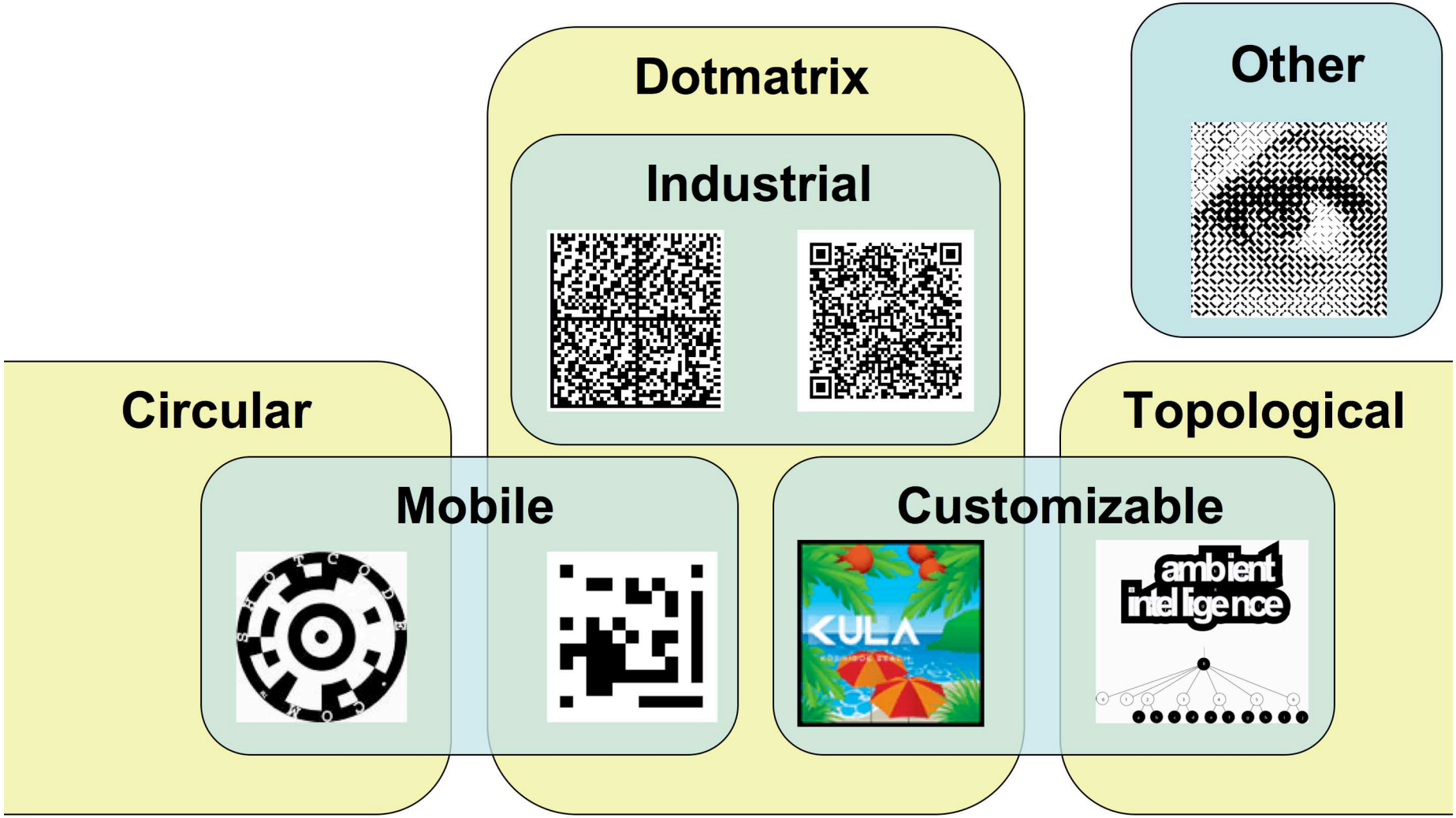
http://www.parc.com/research/projects/dataglyphs



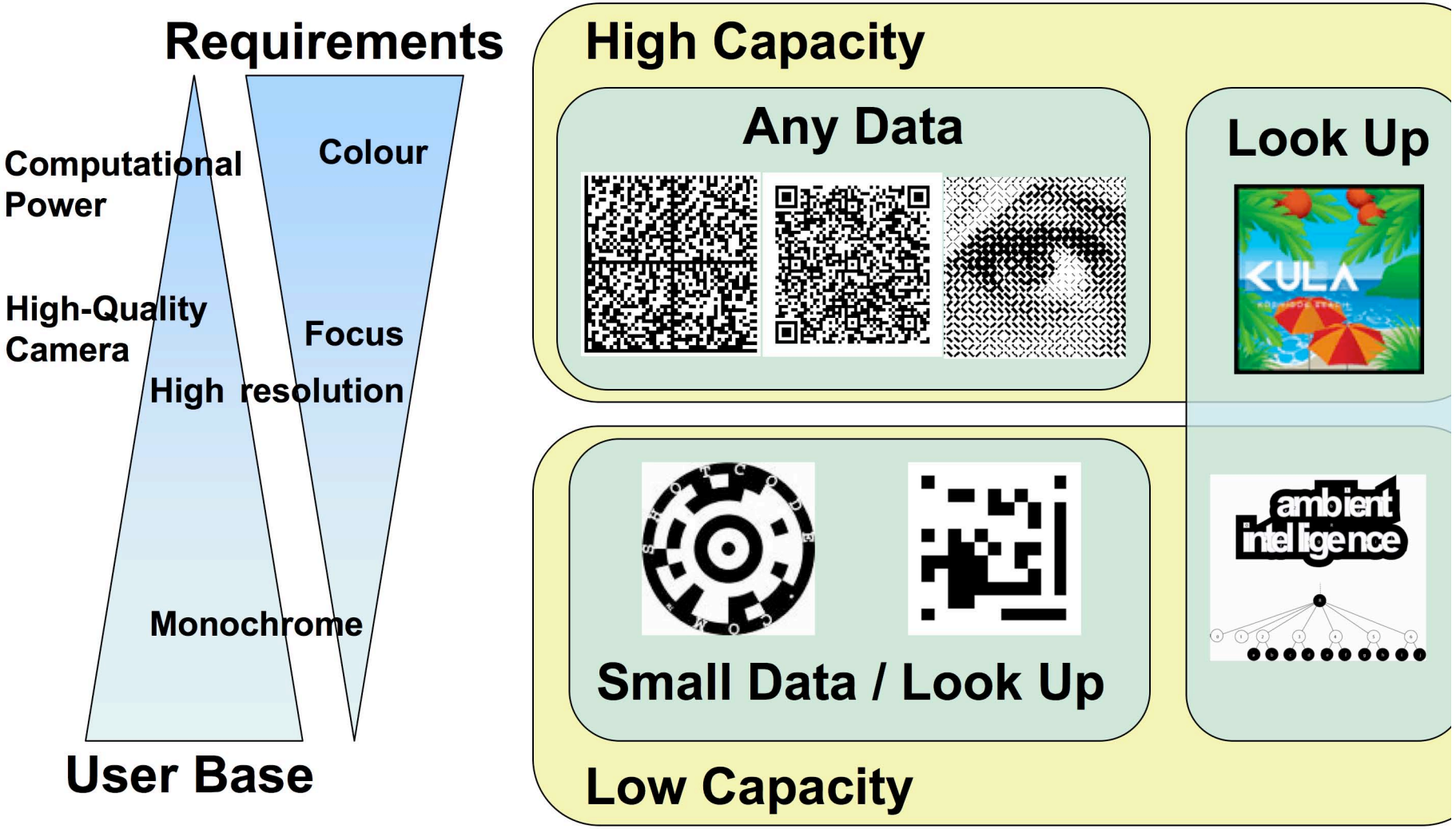
- By Xerox PARC
- Dithering technique (／, ＼)
- 600dpi: 1KB per square inch
- Flexible in shape, size, colour
- Error correction (0~99%)

- Used e.g. for watermarking

Different Types
Overview



Different Types
Overview

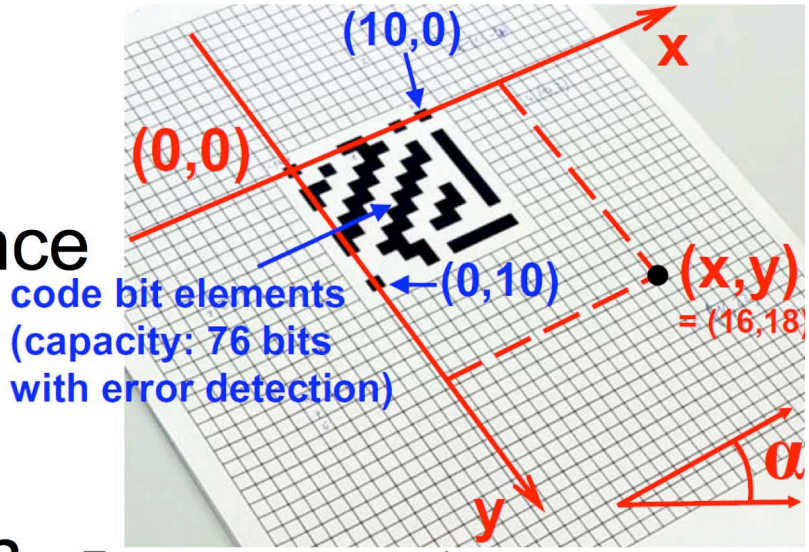


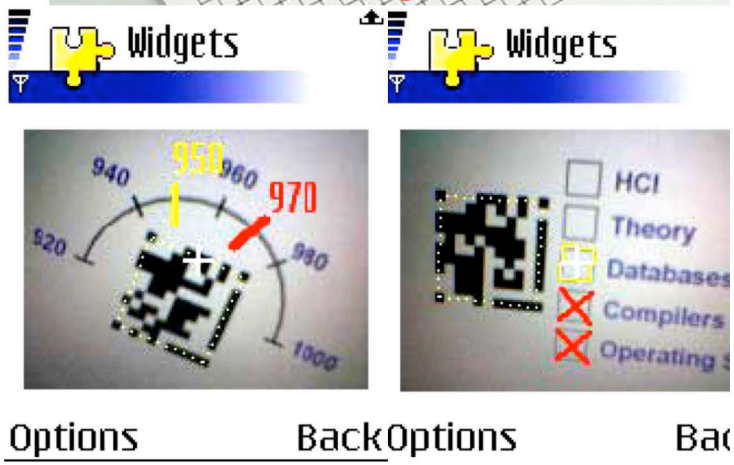
Applications

Real World Interaction

Rohs (ETH Zürich) – IWSAWC '03

- Visual Code
- Additional Parameters
  - Tilting, Rotation, Distance
  - Extended coordinates
- Applications
  - paper-based interaction
- Advantage
  - No initial communication
  - Single interpreter



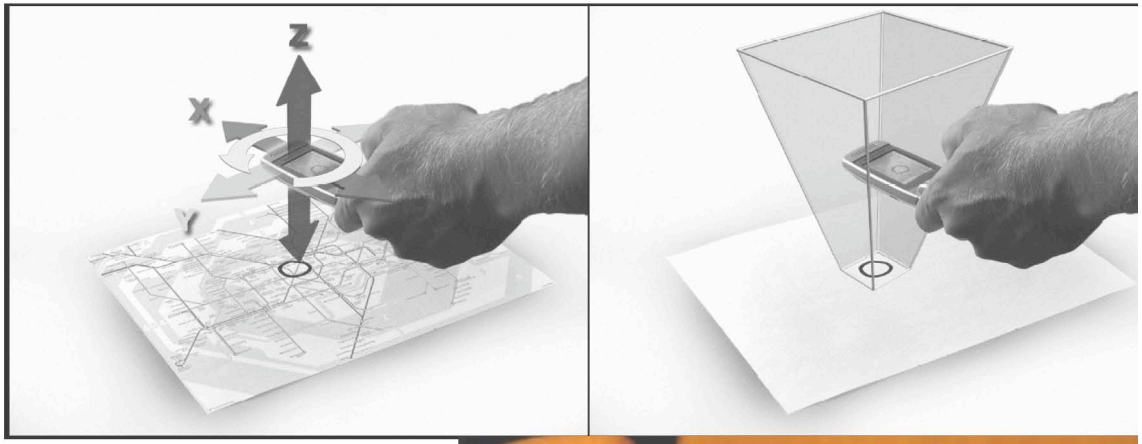


Applications

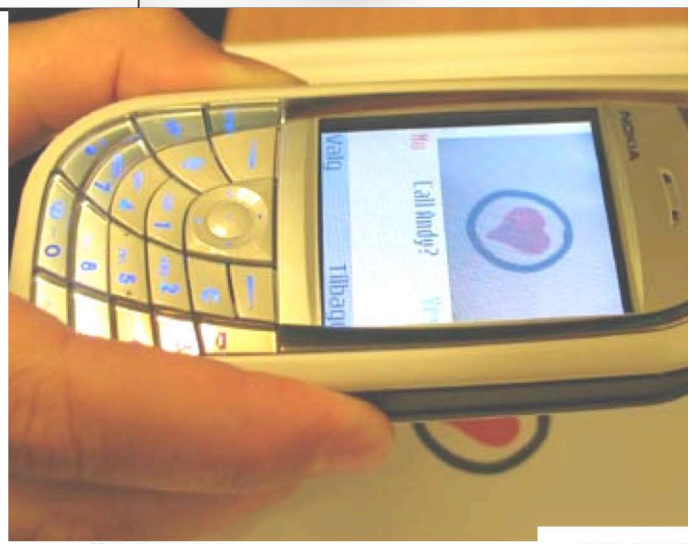
Mixed Interaction Space

Hansen et al. (University of Aarhus) – CHI '05

- Hand-drawn circle as fiducial
  - Tilting
  - Rotation
  - Translation
  - Identity

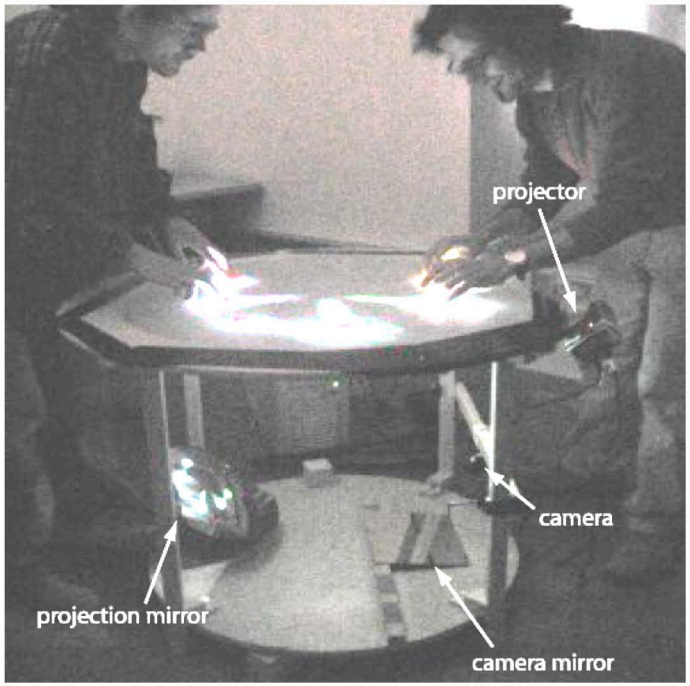


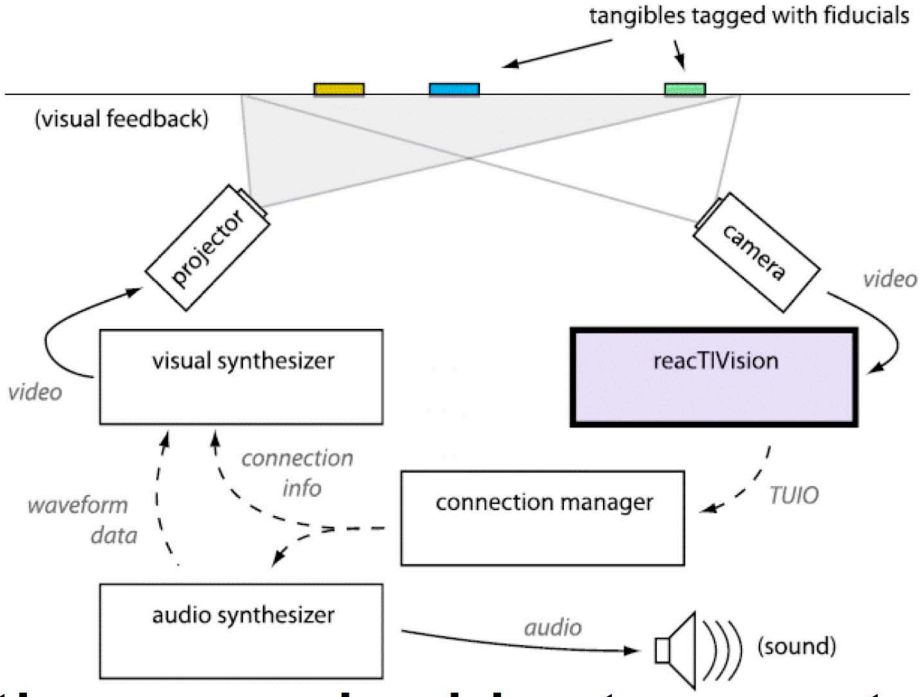
- Application
  - ImageZoomViewer
  - Drozo
  - DrawME



Applications
Reactivision

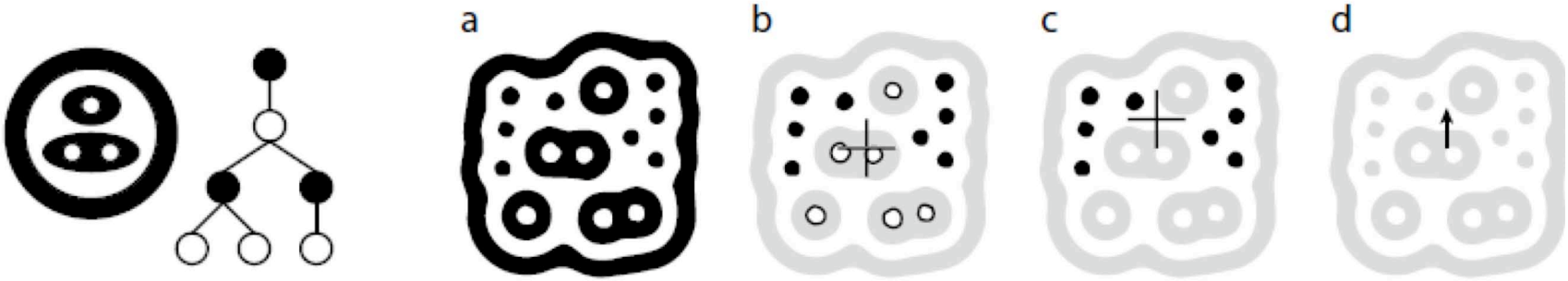
Bencina, Kaltenbrunner (Universitat Pompeu Fabra) – Third Iteration '0





- Synchronous real-time musical instrument
  - Tracking: Location, Orientation, Identity
  - Visual feedback

Applications
Reactivision

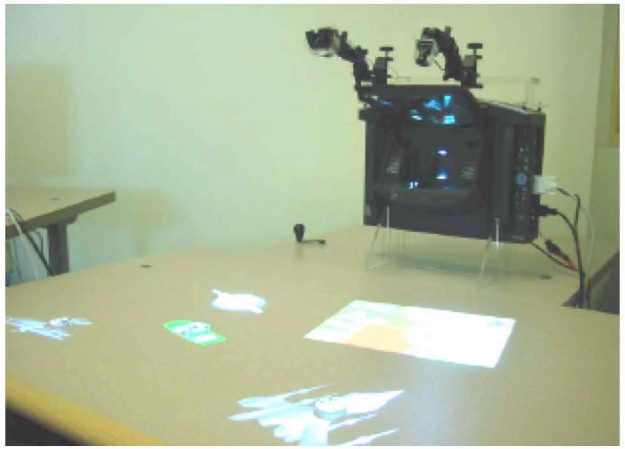


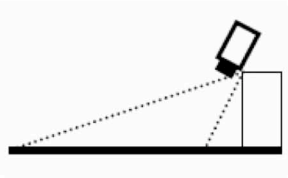
- Improvements over d-touch systems
  - Fiducial: 50% space, any tree depth
  - Tracker: 4 times faster
- Future work
  - More efficient spatial packing
  - Error tolerant tracking

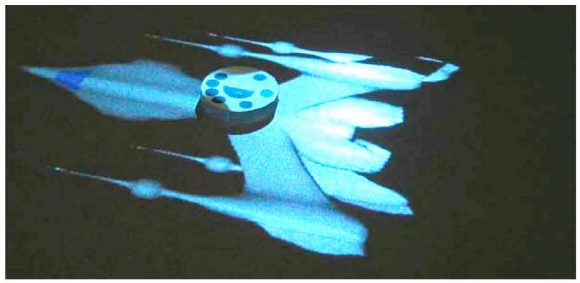
Applications

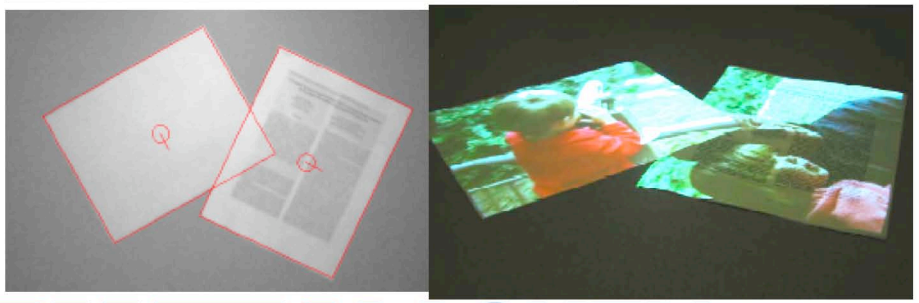
PlayAnywhere

Wilson (Microsoft) – UIST '03









- Tabletop interaction
  - On table projection
  - On table camera
- Fiducial
  - 12bit
  - Orientation
- Application
  - Object placement
  - Video overlay on paper

Applications

Video Conferencing System

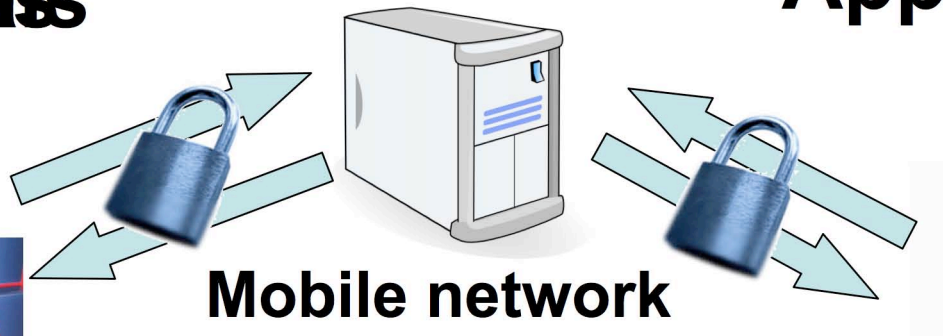
Kato et al. (Hiroshima University, University of Washington) – IWAR '9

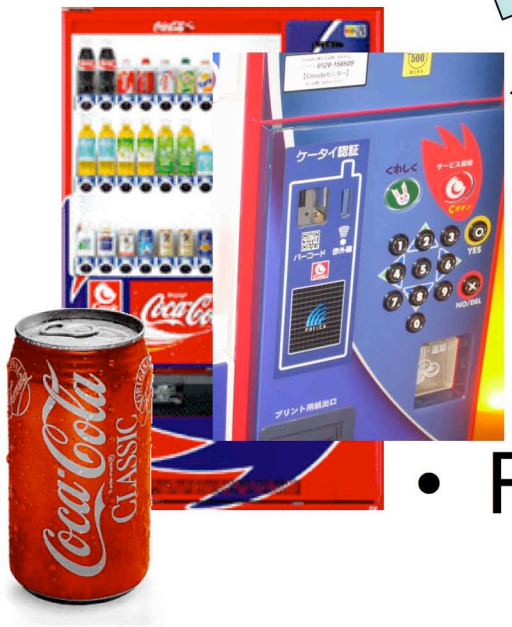
- Features
  - Head mounted display
  - Video conferencing
  - Shared workspace
- Benefits
  - No permanent view disturbance
  - Easy rearrangement

Applications

C-Mode

http://www.cmode.jp





- Request purchase ticket
  → Fiducial purchase ticket
- Customer verification
- Select drink

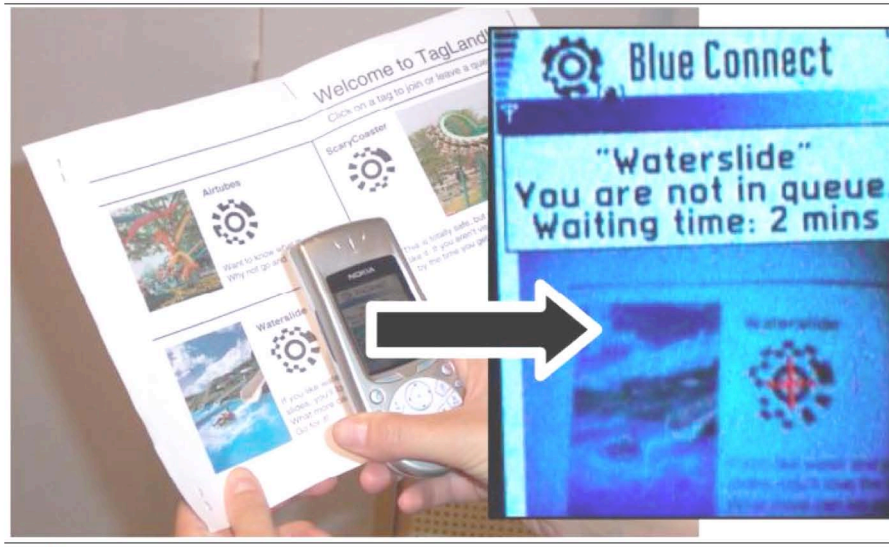
→ Drink, Payment

Applications

Context-aware mobile services

Toye et al. (Oxford University) – 2004

Theme Park Queuing



- Interaction
  - Visual marker
  - Bluetooth
- Advantages
  - Changes anywhere
  - Live information anywhere
- Result
  - Overcome limitations of phones' screen
  - Personalized services through mobile phone

Applications
Context-aware mobile services

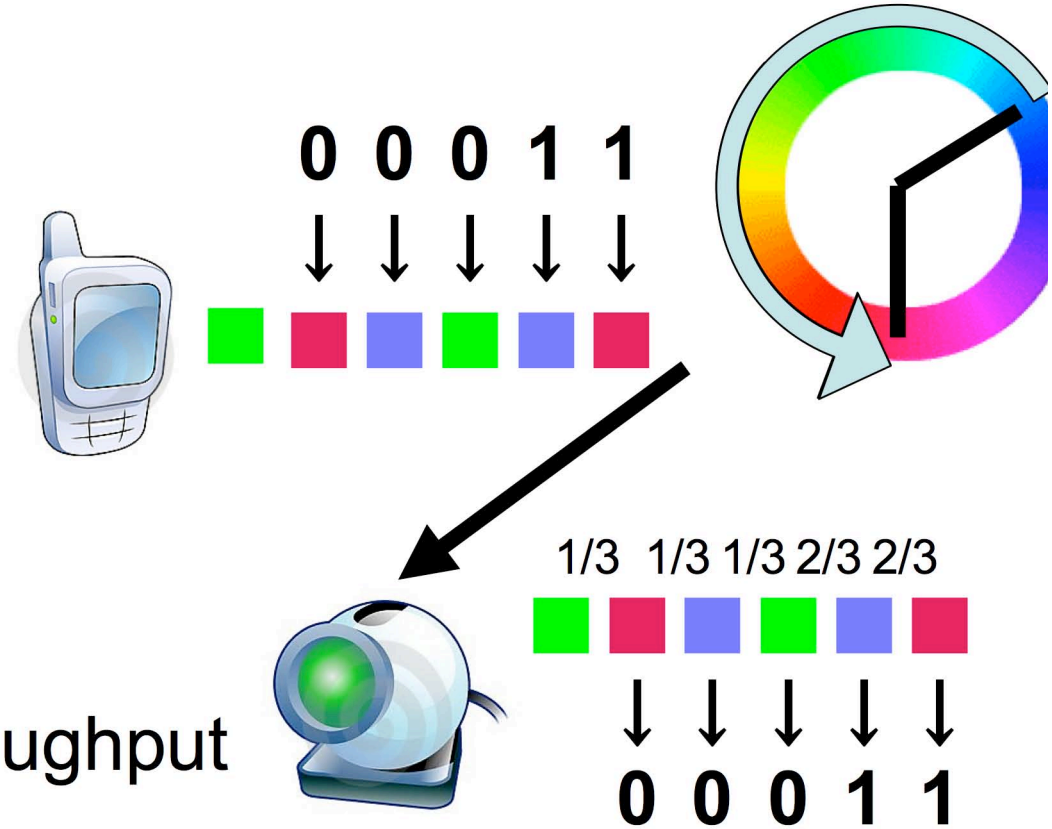
Airport Information

- Interaction
  - Visual marker
  - Bluetooth
- Display
  - Flight information
  - Maps
- Advantages
  - Immediate identification
  - Automatic information access

Applications

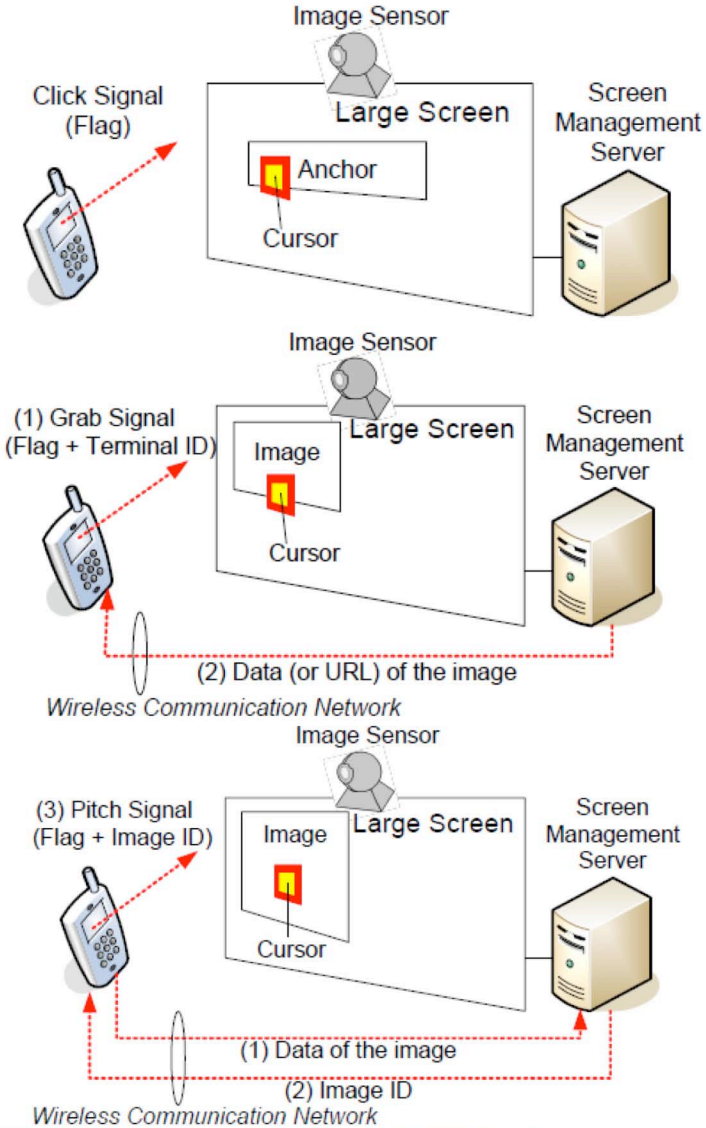
C-Blink

Miyaoku, Higashino, Tonomura (NTT Cyber Solutions Laboratories) – UIST '04



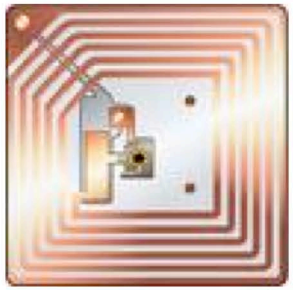
- Blink signal
  - Hue-difference
  - Constant interval
- Increase data throughput
  - More colors
  - Higher frame rate

Applications
C-Blink



- "Click"
  - → Send Click Signal
- "Grab"
  - → Send Grab Signal
  - ← Data (or URL)
- "Pitch"
  - → Data of the image
  - ← Image ID
  - → Send Pitch Signal

Applications
Competing Technology RFID



Pro RFID

- Bidirectional communication
- Invisible → Secure
- No aiming required

Pro fiducial markers

- Easy to produce
- Easy to attach
- Visible → Affords action, human factor

Conclusion

- Various fiducial markers
  - Different motivations
    - Industry
    - Mobile phone
    - Commercial
  - Different properties
    - Data capacity
    - Recognition complexity
    - Camera requirements
    - Additional parameters
    - Restrictions

Conclusion

- Various applications
  - Tabletop interaction
  - Conferencing
    → Natural handling / Ease of use
  - Security
    → Reliable verification by machines
  - Large screen interaction
    → New ways interactions
- Several benefits over RFID

- Expecting more fiducial applications in future