Goals and objectives of the Chiru Project

13.06.2013 The Chiru Result Seminar

Seamus Hickey
3 years ago...

- "Great 3D User Experience"
- Social media
- Networked Mobile gaming was still in its infancy
- First commercially successful tablet (iPad) was released 04/2010
- Open Source
3D as a hype or a trend?

Interest over time
The number 100 represents the peak search interest

3D Interest
(Google Trends – Web searches, Worldwide)
What is a 3D?

3D Internet

• Creation, transmission, storage, access, interaction of 3D information

3D User Interface (UI)

• Human-Computer Interaction (HCI) in which the user's tasks are performed directly in a 3D spatial context (Bowman et al. 2006)

3D User Experience (UX)

• UX: “person's perceptions and responses that results from the use and/or anticipated use of a product, system or service“ (ISO 9241-210, 2010)

• 3D UX: Users’ perceptions and experiences of 3Dness depends on a 3D context, e.g. 3D user interface, application, virtual environment, visual appearance, meaning of use, device context, interaction
Research objectives of the Chiru project

1. Develop 3D user interaction mechanisms for tablet devices
   - Understanding users’ perceptions of 3D UIs
   - New interaction paradigms, user input mechanisms
   - Visual Design

2. Design Network Virtual Environments (NVE) for the mobile context
   - Latency, Asset transmission
   - Incorporate 3rd party data sources in the virtual environment
   - New form of protocol traffic, low frequency data, exploring use cases

3. Support the Open Source community (realXtend)
Designing UX for 3D services on touch screen devices

13.06.2013 The Chiru Result Seminar
Seamus Hickey
Leena Arhippainen, Minna Pakanen
Antti Karhu, Juha Hyvärinen
From a Traditional 3D UI Definition Towards New 3D UIs

” 3D UIs support: object manipulation, viewpoint control and application control“

New 3D UIs:

Designing a 3D UI from scratch utilizing:
• 3D Space, Service Multitasking, Objectifying data

User interaction Mechanisms
• Eye tracking, Natural interaction
• Object manipulation by gaze and sensor controls

Form factor
• Touch screen, Tablet size screens
3D Desktop UI Concept: 3D Conference Call Use Case

- Blog posts of the people in the conference call
- Recent web searches
- Ongoing conference voice call
- Apps/files

Center for Internet Excellence
Next step to internet

Intel and Nokia Joint Innovation Center
Intel Labs Europe
A Context-Aware Map Based 3D UI: 3D News Use Case

• Use multiple services to achieve a user task: Service Fusion
• Utilize the ‘geographical space’ context and ‘News’ context
Implementation of the Service Fusion prototype

Separate the data from the operations

• Data is pulled from a data-source
• Split the data and define them as RDF data structures
• Each RDF file is represented by a 3D object
• Agents (i.e. scripts) are attached to the map
• When the object is dropped on the map, the agent checks if it has a script which can handle the object
3D Map UI: Cinema and Music Use Case

Expanded the previous 3D News service

Implemented several services in Oulu 3D model:

• Calendar
• Cinema
• Purchasing
• Music (bars, stores)
• News (Kaleva, Oulu Events)

Uses cases

• Movie payment and calendar
• Music listening and searching
Service Fusion: Cinema Service (1/3)

Select a movie

Sing up to the system by dragging a ID card
Service Fusion: Cinema Service (2/3)

ID information goes automatically backward and the cinema hall appears

Select the seat
Drag the visa card for payment

After payment, a ticket appears on the screen and the calendar updates automatically
Service Fusion: drag a music object to the service (radio icon)
Service Fusion: drag a music object to the search (on the map)
Service Fusion:
3D Office and Music Club UIs

• Changed architecture to contain a service discovery method

• Visual indication for actions
  • When an object is selected, the destination services are highlighted

• Uses cases
  • Music listening, News
  • Search: Web browser, Twitter, YouTube
  • Calendar events, Power Point slide
Service Fusion 3D UI vs. Service Fusion 2D UI

Service Fusion 3D UI
- Depth
- Navigation (Zooming, camera controls)

Service Fusion 2D UI
- No depth (components’ z axis = 0)
- No navigation
Service Fusion 3D UI vs. Grooveshark 2D UI

Music listening

select from the playlist and drag & drop to the music service

![Service Fusion 3D UI](image1)

![Grooveshark 2D UI](image2)

Intel and Nokia Joint Innovation Center
Intel Labs Europe
Service Fusion 3D UI vs. Grooveshark 2D UI

Information searching

The same use case in the both UIs: Drag and drop to the service for searching

Twitter  YouTube  Web browsers

Twitter  Google Chrome  YouTube

Service Fusion 3D UI

Grooveshark 2D UI

Center for Internet Excellence
Next step to internet

Intel and Nokia Joint Innovation Center
Intel Labs Europe
AR Service Fusion: Movie payment

- A user can browse movies and then book and pay tickets by drag & drop interaction (e.g. movie selection, ID card, seats, Visa payment)
AR (Augmented Reality) version of the Service Fusion

- AR Service Fusion with the cinema payment use case
Thank you!

Any comments & questions?

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Mobile stereoscopic 3D UI design

13.06.2013 The Chiru Result Seminar

Jonna Häkkilä
Background
Perception of 3D

Our 3D perception builds on

- Stereoscopic information
- Focusing system of eyes
- Our experiences from the surroundings and the 3D world
Different images to each eye without any special glasses → illusion of depth

Technologies (e.g.)
- Parallax barrier displays
- Lenticular displays

Disparity:
+ image appears behind the screen
- image floats on front of the screen

Figure: http://en.wikipedia.org/wiki/Autostereoscopy
Holistic User Experience design is currently missing

- Input design for 2D
- 2D GUI metaphors
- UX design focus on visual design only
In current S3D products,

- Stereoscopy focuses on hedonistic, not utilitarian side of UX
- UIs with conventional interaction metaphors dominate
- 2D – 3D compatible designs
  - Easy (and fast) way for R&D
- Demos vs. Products: design gap
Earlier S3D HCI Research

Most of the S3D HCI research on stereoscopic displays or GUIs focuses on visual comfort or display design, not UX.
Our work on S3D
Key Research Questions

• How to use S3D for utilitarian means?

• What are the user perceptions of S3D UI design?

• How to improve the usability and user experience (UX) of S3D UI design?
Study I
Initial User Perceptions on How to Use S3D
Study I – User Perceptions of S3D

• What kind of information could S3D effect convey?
  ▪ User research grounded information
  ▪ Wider, generalizable perspective

• Initial user perceptions related to four mobile applications
  ▪ Phonebook, Music player, Map, Photo gallery

• Two user studies
  A: No visual stimuli; n = 33
  B: Example UI layouts; n = 27
Study I – User Perceptions of S3D

• Results, Study A (No visual stimuli)
  • For highlighting relevant information.
  • For categorization or grouping
  • For the whole application UI layout
  • Map: for topographical information

• Both utilitarian as well as delight
Study I – User Perceptions of S3D

• Results, Study B:
  • Context information
    • Relevancy, age, origin
  • User’s preferences
  • Selections, grouping
  • As input feedback

• More detailed answers than in Study A
• Examples confine the imagination

Both studies emphasized the utilitarian aspects for S3D UI design
Study II
Mobile S3D Phonebook
Study II - S3D Phonebook

Objective:

- To developing a S3D which combines utilitarian and hedonistic aspects for holistic UX
  - Utility
  - Usability
  - Accessibility
  - Pleasant design
Study II - S3D Phonebook

Design process:

• Charting initial end-user perceptions
• Creating alternative concept designs
• Refining the final design
• Implementation of the application
• Evaluation with users in the wild
Study II - S3D phonebook

Final design

Screen surface
0.5 cm positive disparity level
1 cm positive disparity level
Background
Study II - S3D phonebook

Evaluation:

- 21 users
- appr. 3 days in the wild

<table>
<thead>
<tr>
<th>First impressions</th>
<th>Field study</th>
<th>First impressions</th>
<th>Field study</th>
<th>First impressions</th>
<th>Field study</th>
<th>First impressions</th>
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<th>First impressions</th>
<th>Field study</th>
<th>First impressions</th>
<th>Field study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy to use</td>
<td>Util</td>
<td>Intuitive</td>
<td>Clear</td>
<td>Pleasant</td>
<td>Positively surprising</td>
<td>Refreshing</td>
<td>Exciting</td>
<td></td>
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</tr>
</tbody>
</table>

S3D

2D
Study III
S3D UI for Photo Sharing
Study III - Content sharing with S3D mobile UI

- Photo sharing between two mobile devices
- Utilizing stereoscopy for distinguishing private and shared screen space
- Functional demo and a user study
Study III - Content sharing with S3D mobile UI

Preferences in UI design (n=26)
Study IV
Touch Screen Interaction with Mobile S3D UI
Study IV - S3D Interaction

- Accuracy test
- Depths and Size matching test
- Sitting / Walking
- Subjective / Measured
Study IV - S3D Interaction

- Minimum target size for 95% press success
- 10 degree difference in holding the device walking / sitting
- Press position does not differ in different parts of the screen
Conclusions
Conclusions

• Perceived meaning for S3D use
  • Highlighting relevant and contextual information
  • Indicating item selections and grouping

• It is possible to create S3D UI designs, where the utility, ease of use, and delightful design meet
  • Examples of concept designs

• Providing guidelines for S3D touch screen target press accuracy
References


Thank you!

Any comments & questions?

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Mobile 3D graphics and energy consumption

13.06.2013 The Chiru Result Seminar

Jarkko Vatjus-Anttila
Mobile devices go 3D

- Mobile devices have already enough power to run 3D application.
- However, they are BATTERY LIMITED and users hardly understand why they cannot run the services like a PC does.
- Mobile graphics need to be understood from the energy consumption point of view in order to:
  1) to be able to deliver optimized 3D content for mobile devices, and
  2) to allow a chance for mobile devices to utilize the same 3D services, as a PC
Automatic 3D asset optimization with a network proxy
Screenshots from the proxy setup

- Mobile client gets 90% lighter 3D assets
- PC client gets original 3D assets
5” mobile display vs. 17” PC display

The argument is: in most cases the user does not see the detail reduction!
Energy measurement setup

- In order to make correct optimizations we need to understand the mobile GPU behavior under different load.
- Test cases include, for example, VBO vs. Arrays test & half-floats and other partial datatypes.
- The energy consumption was recorded using mobile hardware and a digital multimeter.
Energy measurement results

- The test included several variants of the Oulu3D scene
  1) Compressed and scaled textures
  2) Optimized geometry

- The total effort was to render 1000 frames as fast as possible, and measure total consumed energy

- Combination of texture scaling, compression and geometry optimization took 40% less energy
**Power consumption model**

\[ P_{\text{tot}}(t, b, i) = P_{\text{min}} + (P_{\text{max}} - P_{\text{min}}) \left[ W_t \left( 1 - e^{-\frac{t}{X_t}} \right) + W_b \left( 1 - e^{-\frac{b}{X_b}} \right) + W_i \left( 1 - e^{-\frac{i}{X_i}} \right) \right] \]

- Using the measurement data, we crafted a mathematical model, which is using 3D primitives as input and is able to predict the mobile power consumption.

- The crafted model is able to predict the power consumption within 3.5% error margin.
Related publications

Published:


In review / progress:

- J. M. Vatjus-Anttila, T. Koskela. Energy Consumption Model of a Mobile GPU Based on Rendering Complexity
Thank you!

Any comments & questions?

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Visualization in 3D UIs

• Early research indicated the importance of the 3D visual design
• The background design of 3D UIs has meaning for
  • context, behavior, privacy
Research studies

- 2D UIs on the autostereoscopic 3D display
- Hybrid 2D/3D UIs
- 3D UI Concepts
- 3D icons
- 3D space design (depth, context)

Visual Design Guidelines
3D menu on touch phone?

3D visual appearance
2D interaction

http://www.lg.com/uk/mobile-phones/all-lg-phones/LG-android-mobile-phone-P920.jsp
Study: Auto stereoscopic 3D menu on touch phone

Positive experiences:

• Visually pleasant, fun, entertaining, innovative, empowering, exciting, different, cool

Negative experiences:

• Uncontrollable, unclear, useless, time-consuming
• Today it would be fun, tomorrow already annoying
• Too much visual noise -> Too much animation

83% of users perceived the UI as 3D (S3D effect)
Study: Depth in 3D UIs

- Organization of objects on the screen
- How deep should the objects’ hierarchy go?
- Studied with multiple depth levels from 0 to infinity
Design guidelines for Depth

Design 3D UI space with controllable depth

- Design 3D UI with depth levels 3-5
- Increase levels automatically based on the amount of 3D icons or objects
- Give a user a possibility to customize depth levels and increase when needed
Examples of the 3D UI with Depth

Service Fusion 3D UI

3D Portal UI
Study: Hybrid 2D/3D UI

- Hybrid UIs: A mix of 2D and 3D UI components
  - 2D Overlay + embedded 3D components
- 4 applications evaluated with users
  - Dungeon Defender game
  - Order and Chaos game
  - Pocket Legend game
  - YesCitiz Barcelona 3D map
- Finding: Overlaid 2D icons decreases touch-based interaction with 3D space and 3D objects in it
Study: 3D Icon Design

- Design 3D Icons from scratch
- Adding features (e.g. eyes)
- Animations
  - should have a clear purpose
Study: 3D Space vs. 3D objects

• A 3D object defined for one space, will not always be suitable for a different space
  • The background can change a meaning of UI to the user

• An object designed for one space can elicit a different meaning when the space is changed
  • The Pie UI design can look like a plate or flying saucer when appeared in an outdoor setting
Privacy in 3D GUI

- A 3D space which has a social context causes concerns over privacy
- Users understand that objects embedded in the 3D Space are public
- Dragging private objects to public space causes concern
- Design focus on visual indications to protect privacy
  - e.g. walls, curtains, dimming effects
Privacy in 3D GUI

Running prototype:
3D Portal UI with four virtual environments

Concept:
3D Room UI with one virtual environment
3D on a 2D UI screen

Occlusion
- important, establishes a depth-order

Design
- Rotatable objects
- depth of space
Study: Gaze and non-touch gesture based interaction (1/3)

Our demo setup

- Gaze tracking and non-touch gesture based interaction method for mobile 3D virtual spaces
- Touch screen device, led lights, camera, sensors

![Diagram showing camera and led lights connected to a device]

Led lights

Camera
Study: The task in the user tests (2/3)

- The task was:
  - to take 6 dices to a goal area (yellow circle) and
  - turn the dices so that the pips from 1 to 6 are facing the user in order
The users performed the task by using
A) only touch gestures and
B) gaze and non-touch gestures
Research contribution

• Publications of studies
  • Design guidelines for 3D UI design
  • UX research methods especially for early design phase
• Support for OS Community
  • 3D models
  • code

Research in 3D fields will continue!
Thank you!

Any comments & questions?

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Virtual environments for sensing human activity

13.06.2013 The Chiru Result Seminar
Matti Pouke
3D Internet is coming; what to do with it?

• The advent of 3D-internet brings 3D virtual environments more accessible and easy to use for everyone

• We studied using sensor networks to both simulate and visualize human activity through 3D VE:s
Simulation and visualization through virtual environments

Case 1: Using Wifi and Bluetooth connections to populate a virtual city...

Case 2: Using telepresence to visualize elderly patient’s activities
- How do people move in the city?
- Can we use sensor data to simulate pedestrian crowds in virtual cities?
- Can we use this information elsewhere?
Realistic pedestrian crowds are simulated by weighted random crowds. Weights are based on hotspots.
Using the acquired information in other city models.
Using telepresence to visualize elderly patient’s activities

- Information visualization tool for monitoring elderly activities at home or in a smart living environment

- A solution between conflicting needs for privacy and surveillance

- Patient data captured with wearable sensors from regular household activities
System overview

Wearable sensors → Pattern recognition → Visualisation
System overview

[Diagram showing a network setup with a server software, client software, user sensors, and proximity sensors connected through wireless signals.]
Evaluation

- A focus group interview with healthcare professionals was conducted

- Especially useful for nursing home care patients, somewhat useful for hospice patients

- Nurses hoped for a mobile version with automatic sound alerts in cases of emergency
Conclusion

- We studied using external sensors with virtual environments to simulate and visualize human activity
- The results can be applied to entertainment, city simulation and telehealthcare applications
- Detailed results can be seen in the publications to follow
Thank you!

Any comments & questions?

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Mixed reality city UX

13.06.2013 The Chiru Result Seminar

Jonna Häkkilä
Background
Mixed Reality

• Virtuality Continuum (Milgram and Kishino ’94)
• Only ~10% of the Mixed Reality (MR) research contain user studies (Dünser ’07)
• Mobile augmented reality has come a long way

Azuma ’97

Layar (www.layar.com)
http://booktwo.org/notebook/noticings-layar/
Our research
Motivation

Expanding the use cases for MR applications

Improving the UI and UX design for MMR

Exploring

• The role of virtuality and reality
• User perceptions of preferred use cases
• Find usable and appealing use cases for people living in a MR world
Study I

Balance between Virtuality and Reality in Mobile MR UI
Mixed Reality UI design

Comparing camera based Live UI and 3D model based UI

User study in city center

- N = 35
- Wizard-of-Oz
- In Oulu city center
Comparing Live vs. 3D model view

Camera based UI preferred by 68%

Live UI strenghts
• Feels vivid
• Real, easy to comprehend
• Feels personal

3D model UI strengths
• Clarity (omitting light conditions, shadows, people)
• Remote use
Annotations with stick-it notes, n=166

Annotations, how many people added such annotations

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private (Own)</td>
<td>9</td>
</tr>
<tr>
<td>Semi-public (SOME)</td>
<td>11</td>
</tr>
<tr>
<td>Public</td>
<td>32</td>
</tr>
</tbody>
</table>

The amount of annotations n=166

- Public - map related: 34
- Public - Institutional: 33
- Public - Commercial: 64
- SOME created (semi-public): 20
- Self created (private): 18
### Public notification categories

<table>
<thead>
<tr>
<th>Business related (64)</th>
<th>Map related (34)</th>
<th>Community or city related (33)</th>
</tr>
</thead>
<tbody>
<tr>
<td>List of services and their locations (19)</td>
<td>Route instructions to different places (24)</td>
<td>Historical and general facts (10)</td>
</tr>
<tr>
<td>Opening hours of services (18)</td>
<td>Own location, addresses and map (10)</td>
<td>Weather forecasts (9)</td>
</tr>
<tr>
<td>Offers and personalized advertisements (17)</td>
<td></td>
<td>Upcoming events (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Public transportation, e.g. bus timetables (5)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Community announcements (4)</td>
</tr>
</tbody>
</table>
Annotation types

Friend / community created content (20)
- Friend’s home or office (10)
- Recommendations or path (4)
- Friend’s location (3)
- Meeting places (3)

Own notes (18), e.g.
- To do -list (8)
- Memories, notes (3)
- Parking car or bike (3)
- Feedback or suggestions to the city (2)
Online Survey of MR City

- Online survey, n= 111
  - 23 different categories for MMR content for a city application evaluated

<table>
<thead>
<tr>
<th>Message Category</th>
<th>Would like to see</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Most popular categories</strong></td>
<td></td>
</tr>
<tr>
<td>Opening hours</td>
<td>77 %</td>
</tr>
<tr>
<td>Bus timetables</td>
<td>70 %</td>
</tr>
<tr>
<td>Upcoming events</td>
<td>65 %</td>
</tr>
<tr>
<td><strong>Least popular categories</strong></td>
<td></td>
</tr>
<tr>
<td>Messages by friends</td>
<td>21 %</td>
</tr>
<tr>
<td>Traffic information</td>
<td>21 %</td>
</tr>
<tr>
<td>Advertisements</td>
<td>2 %</td>
</tr>
</tbody>
</table>
Study II
Exploring MR Concepts at Home
User Study on Mixed Reality Views at Homes

- Participants from 12 households were asked to tell their perceptions of imaginary mixed reality views at their homes
- Cultural probes inspired study
User Research in the Field

- Diary, annotated map, brainstorming tasks, low-fi prototyping
- Imaginary annotations on top of photos
Resulted Material

- over 120 photos
- over 150 concept ideas
- Annotated photos and maps
Results - Locations

Different content types preferred in different locations

- Front door
  - Reminders
- Window
  - Temperature
  - Communication with authorities
- Lifestyle/Wellness
  - On fridge or scale
Results – User groups

Preferences of content vary between age groups

- Senior people
  - Reminders
  - Sharing family histories

- Families with kids
  - Decorative content from kids
Results - Context

• Contextual information increases the value of annotations
• Weather, temperature, recommended clothing
• Mixed opinions on
  • Communication
  • Reminders
• Decorations
  • Christmas, Easter
  • Bathroom
Results - Concerns

Privacy
- Visualizations on the front door
- Content created by other people
- Information access

The loss of private space
- Home as a retreat
- Relaxing without technology
Next Steps

• Developing mobile augmented reality application and service concepts based on the results
• Evaluating them with users at their homes
  • Augmenting views at participants’ home
  • Diary study
  • Wizard-of-Oz approach
• On-going: 8 participating households
• Personalized content
Evaluated Concepts (MMS)

- Location-based information
- Weather
- Communication with authorities
- Future views
- User Created Virtual Graffiti
- Post card
- Personal communication
Examples – Preliminary results

- Public content shown outside the window
- MR window inside the home
More studies – Designing 3D Digital Cities for People
3D Digital City for the Community

• A: Community content creation for the virtual city
  • case study with school kids

• B: Virtual Run demo & user study
  • exploring how to utilize 3D city model for motivating for physical activity

A: Virtual City content

B: Virtual Run demo

http://www.youtube.com/watch?v=RmLlaRZKlmk&feature=youtu.be
Visualising the Edge of the 3D City

Alternative designs created and evaluated

- Laboratory based user study
- n ~ 30
# Visualising the Edge of the 3D City

## Design recommendations

<table>
<thead>
<tr>
<th>Realistic</th>
<th>Match with 3D virtual world environment, real world</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>Themes from the nature: mountains, forests, water</td>
</tr>
<tr>
<td>Impression of an open space</td>
<td>Rather open space than narrow and closed</td>
</tr>
<tr>
<td>Pleasant to watch</td>
<td>Aesthetics is an integral part of UX</td>
</tr>
<tr>
<td>Add context information</td>
<td>Providing context information when possible</td>
</tr>
</tbody>
</table>
Conclusion - Contributions
Contributions

• Very little earlier research on MR application and services concepts, especially in the wild

• Preferred and expected content types for MAR city application charted

• Preferencies of MR applications at home environment charted

• Recommendations how to design the edges of the virtual world UIs
Thank you!

Any comments & questions?

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