Opportunistic Composition of Human-Computer Interactions in Ambient Spaces

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Opportunistic composition

 requirements

 Ergonomic criteria

 Control of the emergence of assembly

 Multi-agent System

 Service agent

 Context agent

 Conclusion

 Ambient Environnement

 • Fast changing software environment
   • Needs
   • Evolution of the context of use (platform, user, environment)
   • Opening and dynamics of the context

 • A growing number of available devices in a connected world
   • Smartphone, camera…
Component composition

• **Software bricks: a software component**

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  Provided service
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```
  Required service
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• **Application: assembly of components**
Our opportunistic approach

**Opportunistic composition**

- Ambient env.
- Our approach

**Plastic HCI**

- Requirements
- Ergonomic criteria

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**Conclusion**

- **Opportunistic component (re)composition**
  - Use components available in the environment, that can be assembled, in order to suggest to users appropriate applications

- **Take advantage of the circumstances to produce applications:**
  - Useful
  - According to the context
  - Continuously (recomposition with new opportunities)

- **Bottom-up software development**
  - No pre-established plan
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When and how compose?

- **5 functional requirements**
  - User request of a component
  - Context evolution
  - Appearance of a component
  - Disappearance of a component
  - Update

- **7 extra-functional requirements**
  - Decentralization
  - Dynamic adaptation
  - Combinatorial optimization
  - Recomposition
  - Learning and context awareness
  - Utility of the result
  - Non dependent of user needs
Plastic HCI

• **Design time – help the developer**
  • Maximize the reuse for each new target
  • Reduce the development cost
  • Take into account the use

• **Execution – help the end-user**
  • Distribute an application or a task on multiple devices or another device
  • Keep ease of use and habit, ensuring also to adapt to the specificities of the devices

→ Common preoccupations Software Development - HCI:
  Mobility
  Adaptation to users

• **Specificity:** User role
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5 requirements of the field

• **Ergonomics of the resulting application**
  • Application that respects ergonomic criteria

• **Continuous adaptation**

• **Controllability of the composition**
  • Control by the user of his interactive ambient environment
  • Non-intrusivity of the composition

• **User assistance**
  • Non-expert users
  • Time saving

• **Response time**
Ergonomic criteria

• Taking into account the “Significance of the denominations and behaviours”
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Ergonomic criteria

• Second possible composition
Ergonomic criteria

• Third possible composition
Opportunistic composition

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• Fourth possible composition

• Four functionally equivalent solutions

• Two solutions that satisfy the ergonomic requirement
Control of the emergence of assembly

- **Two types of components available:**
  - Functional components
  - User Interface components

- **A same composition process:**
  - Try to compose what is
    - Available
    - Connectable
    - Might be useful
A three component model

- **Selection of services**: opportunism for the control of the consistency
  - Connector factory
  - Semantic binding

- **Assembly emergence**: opportunism for the exploration of the utility
  - Adaptive Multi-Agent System
  - Learning of previous connections

- **Controllability**
  - Meta-HCI for the control of the composition by the user
Meta-HCI

• Set of functions that are necessary and sufficient to control and evaluate the state of the interactive ambient space [Coutaz, 06] [Coutaz et al., 16]

• Used differently:
  • Catalogue of estimated relevant composition
  • Validation of the composition of HCI

Control of the emergence of assembly

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The multi-agent system

- **Agent**
  - Autonomous software entity
  - Evolves in a software environment
  - Has its own goal
  - Life Cycle: Perception, Decision, Action

- **SMA**

- **AMAS**

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**Oppportunistic composition**
*Ambient env.*
*Our approach*

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[Boes, 14]
Service agent

- An AMAS as composition engine
  - Composition based on the cooperation of agents
  - Agentification of component services

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Service agent

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• **Local goal: connect at best**

• **Life cycle**
  • Perception
    - Messages of other agent services that want to be connected
    - State of the neighbours
    - Its state
  • Decision
    - Announce, Response, Connection, Disconnection, Do nothing
  • Action

![Diagram of Multi-agent System]
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**Context agent**

- **Agentification of the knowledge**
  - Learn the good composition, in terms of context and ergonomics
  - Thanks to the validation of the user in the meta-HCI

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[Boes, 14]
Prototype

- An AMAS in Java
  - A class by agent

- That handle the connections of software components
  - WComp
  - UPnP

- Integrated in the execution environment Wcomp

- To be experimented and evaluated
Conclusion

• A novel approach for adaptive software engineering
  • Component-based
  • Bottom-up
  • Context-sensitive
  • Emergence and plasticity of applications and user interfaces