Dynamic Self-Adaptive Software Technology
Using Collective Intelligence

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Introduction — IT Ecosystem

Collaboration, Participation, Sharing, ...

iriver VS [iWatch]

AppStore

iCloud

iPod VS [Apple TV]

ECO System
Introduction — Mega Ecosystem

- Monitor fire regime/Extinguish fire
- Context report/First aid
- Check patient's condition/Inquiry of medical records
- Assigning hospital/Prepare emergency
- Emergency patient

Robot (Eco-System)

Medical Eco-System

Car Eco-System

Smart Home (Eco-System)

Disaster Relief (Eco-System)

Emergency patient

Firewatching

Ambulance

Embulance moving using GPS, UTIS

Context report/First aid

Check patient's condition/Inquiry of medical records

Assigning hospital/Prepare emergency

Emergency patient

Firewatching

Embulance moving using GPS, UTIS

Global KU Frontier Spirit

Engineering Adaptive Software Systems (EASSY)
Challenges

- Increasing complex and diverse systems (SoS)
- Limits of human intervention
- Vulnerability due to dynamic changes

Solution Approach

SE support for Adaptization

Software Engineering methodology and tools
To transform from existing non-adaptable software
to adaptable software systematically
## Research Trends/Focus

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**SW-Driven**

**System-Driven**
Our Focus: Heterogeneous

- Self-Adaptive Mechanism for Multiple Robots (Systems)
  - Interaction among systems
- Knowledge interoperability between heterogeneous systems/robots
  - Data interoperability

One Robot / Homogeneous
- Single Processing
- Self-Adaptive system for single system (homogeneous)

Extension

Multiple Robots / Heterogeneous
- Collaboration & Cooperation Model
- Negotiation Model
- Self-Adaptive system for heterogeneous systems/robots

Interaction / Collaboration
Our Focus: Distributed

- **Distributed Decision**

  - Centralized Info.
  - Multi-Modal Model

  ![Diagram](image)

  - Distributed Info.
  - Multi-Modal Model
  - Interaction / Collaboration
  - Acting
  - movement sensing
  - sound sensing
Our Focus: Semantic KB

- **Ontological KB**
  - Expression power ➔ sophisticated reasoning
  - Reuse of knowledge ➔ means of communication in SoS
  - Interoperability support ➔ overcome heterogeneity

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Simple Knowledge Based (Syntactic)

- Centralized KB/Info.
- Full KB

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Ontological Knowledge Based (Semantic)

- Distributed KB/Info. (Decentralized Approaches for Self-Adaptation in Agent Organizations, TAAS, 2012)
- Partial KB
Our Focus: System of Systems

- Adaptive System of Systems (SoS)
  - Using Collective Intelligence
  - Model for Interoperability, Communication, Cooperation, Collaboration

1. Approach to dynamic adaptive product line
2. Approach to Single robot / one adaptive system

Extension

Adaptive System

Adaptive System of Systems
Our Focus: Adaptization

- **Adaptization**
  - Transform existing non-adaptable software to adaptable software by providing methodology and tools

- Ad-hoc Design
  - Ad-hoc model and design for system / robot

- Adaptization
  - Changing and evolution that non-adaptive robot, not-adaptive SW (ad-hoc model) to supporting adaptive SW

**Adaptization Mechanism**
Dynamic self-adaptive software technology using collective intelligence

- Proposed Work

- Adaptation Variation Detection
  - Variation Candidate: Weather, Time, Location, etc.
  - Adaptation Variation Point: Adaptation Degree = 1
    - Variation: GPS

- Adaptation Degree Evaluation
  - Adaptation Variation Point: Adaptation Degree = 4
    - Variation: GPS, Weather, Time, Location

- Adaptation Strategy / Plan
  - Variation Extraction
  - Variation KB (ontology)
  - Strategy: Each Adaptive pattern

- Adaptation Variation Detection
  - Variation: GPS, Weather, Time, Location

- Reverse Engineering
  - Design model / Model scheme / Req. Doc. (O)
  - Design model(X)

- Pattern-based Adapted Model Generator
  - Model of Non-Adaptable SW
  - Adapted Model (skeleton) with Added Adaptable Variations

- Implementation
  - Executable Model
  - Validated Model

- Run
  - Adaptive Middleware / Platform

- Validation

- Validation Model

- M A P E
Proposed Work — Issues 1

- A research on situation-aware based self-adaptive software system modeling and monitoring

- Reverse Engineering
  - Integrated automation tool for detecting Self-Adaptive Monitoring Factor

- Adaptation Degree Evaluation
  - Extended situation-aware and system modeling language.
  - Developing a quantitative and reasonable evaluation method of non-adaptable software or converted self-adaptive software as adaptation level

- Adaptation Variation Detection
  - To define self-adaptive services and match it with self-adaptive monitoring factor in current self-adaptation level of the non-adaptable software
Proposed Work — Issues 2

- Collective intelligence-based self-diagnosis for problem analysis

- **Variation KB**
  - Supporting Collective Intelligence by using Variation KB
  - Building and registration process for variation KB based on ontologies
  - Develops methodology of ontology sharing and administration based on an ontology registry

- **Adaptation Strategy/Plan**
  - Strategy and plan for identity self-adaptive factor required for converting form existing non adaptable software to adaptable software supporting
Proposed Work — Issues 3

- Development of a technique for self-growing adaptation strategy based on collective intelligence

- **Adaptization Strategy / Plan**
  - expand and patterned the technology for policy-based self-adaptation
  - To support high efficiency strategy construction based on variation KB (Ontology)

- **Validation …**
  - how do we guarantee for self-reconfiguration and self-diagnosis
**Proposed Work — Issues 4**

- Development weaving adaptive pattern into non-adaptable software and middleware
  - **Reverse Engineering**
    - To convert from non-adaptable software to self-adaptable software by reverse engineering techniques.
  - **Weaving Pattern model**
    - Researching reverse engineering for weaving adaptive pattern into non-adaptable software for adaptive software.
  - **Middleware for Self-Adaptive Software**
    - IDE for right middleware
    - Variation KB based self-adaptive to the assurance reconfiguration and managing

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**Flowchart Overview**

1. **Adaptation Degree Evaluation**
2. **Variation Detection**
3. **Pattern-based Adaptized Model Generator**
4. **Reverse Engineering**
5. **Model of Non-Adaptable SW**
6. **Validation**
7. **Implementation**
8. **Run**

**Process Steps**

1. Adaptation Degree Evaluation
2. Variation Detection
3. Pattern-based Adaptized Model Generator
4. Reverse Engineering
5. Model of Non-Adaptable SW
6. Validation
7. Implementation
8. Run
Thank You

For Your Attention!

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