Investigation of a Cyber - Physical framework for Micro Devices Assembly (MDA)

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Presentation Outline

• Background - MDA
• Problem Statement
• Research Objectives
• Research Activities: Initial and WIP
• Conclusion
Background - MDA

• Micro Devices Assembly

  Micro Devices Assembly (MDA) refers to the assembly of tiny, micron-sized parts (in the order of $10^{-6}$ m) [1].

• When do you need MDA [2]?

  - Shape is complex
  - Use of materials of varying properties

Reference [11]
Background - MDA

• Potential of MDA

  Extremely large industrial applications (micro monitors, surveillance devices, bio medical sensors, chem lab-on-a-chip, etc)

• Need for automation

  – Manual Micro Assembly involves using tweezers, high powered cameras and other mechanisms.
  – Manual micro assembly is tiresome, time-consuming, unreliable, and costly [3].
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Problem Statement

• In MDA, the resources and tools to accomplish the product life cycle activities are distributed
  ➢ Resources are expensive and cannot be found in a single organization involved in MDA
  ➢ Multiple organizations will have to form a virtual enterprise partnerships and collaborate to produce a target micro product in an agile manner

• Lack of research to develop an integrated approach involving collaborative cyber physical activities

• There is a need to develop an ‘agile’ framework
  ➢ changing customer requirements / designs
  ➢ Integration of cyber and physical tools (CPT) need to collaborate to accomplish the life cycle assembly

• No Support of access to CPT by ‘thin clients’

• No Collaborative analysis of assembly alternatives through VR based simulation
Research Objectives

• Overall goal is to develop a cyber physical framework that will support the agile assembly of micro devices involving distributed tools and resources.
  - Cyber: Design analysis, Assembly Planning, Path Planning, Simulation / Analysis of Assembly Alternatives
  - Physical: Manipulation, Assembly, Assembly Monitoring
Research Objectives

• To achieve this goal, the following objectives are identified:
  
  ➢ Investigate an integrated cyber physical approach to support collaborative MDA
  
  ➢ Explore the adoption of ‘cloud’ based principles
    ▪ to facilitate information exchange across heterogeneous platforms
    ▪ access through thin clients
  
  ➢ Design an advanced virtual prototyping approach for simulation and analysis of assembly alternatives
    ▪ Non immersive
    ▪ Semi immersive
  
  ➢ Investigate the feasibility of the Next Generation Internet (GENI) to support exchange of graphical data
    ▪ high definition graphics and visualization data used in the virtual prototyping and assembly monitoring activities
  
  ➢ Validate the feasibility of research outcomes
    ▪ creation of a Cyber Physical Manufacturing Test Bed (involving the US and EU)
Research Activities: Initial

1. Design of advanced virtual prototyping techniques to facilitate planning and simulation of assembly alternatives
   - Unity platform
     - Semi-Immersive
     - Non-Immersive
   - Initial exploration of this environment
   - Assembly Planning approaches

Micro parts design

WIP: Assembly Analysis using Distributed Virtual Environments (DC and Stillwater, OK)
Research Activities: WIP

- Explore the adoption of ‘cloud’ based principles to facilitate information exchange (WIP) [11].
Summary

• Proposed research involves the design of a cyber physical approach to help in the rapid assembly of micro devices
  – Explore cloud technologies
  – Agile response
  – Integration of cyber physical resources
  – Next generation Internet

• Conference paper
  Accepted: J.Cecil, Yajun Lu, A Virtual Reality based framework to support advanced manufacturing (ID: I313), ISERC2015
Background on Virtual Prototyping

Virtual Prototype: 3D software model with behavior properties
• Looks the same (accurate geometry & appearance)
• Mimics the real ‘system’ or target
• In real time
• Virtual Reality based 3D motion behavior
• The Immersive advantage

Work cell 1
What is GENI

GENI (Global Environment for Network Innovations) provides a virtual laboratory for networking and distributed systems research and education.

• Faster
• High gigabit data exchange
• Control flow data

Reference: http://www.geni.net/?page_id=2