Software Defined Control for Smart Manufacturing Systems

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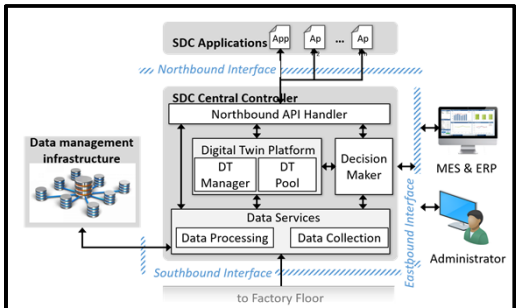
Technical Challenges

- ***Create a centralized framework*** for system analysis and control
- Augment existing systems with ***value-add capabilities***
- Derive requirements for ***Greenfield implementation***
- Derive a generalized ***Digital Twin (DT) platform***
- Determine algorithms for ***adaptive decision making***
- Derive methods in cybersecurity at the ***cyber/physical interface***

Scientific Contributions

- Improve ***robustness and resiliency*** of manufacturing control systems
- Framework for ***anomaly detection, isolation, classification and eradication***
- Framework for ***predictive analytics*** with ***secure data infrastructure***
- Framework for ***agile control reconfiguration***

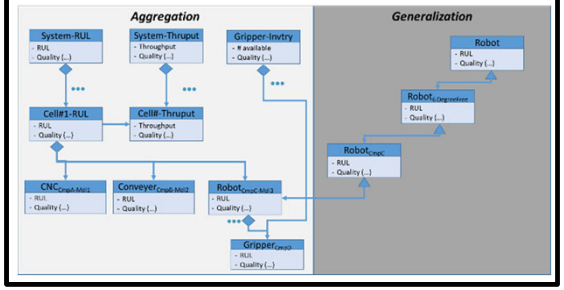


Software Defined Control Architecture

Flexible control reconfiguration to ***enhance throughput*** and ***increase overall system efficiency***

Technical Approach

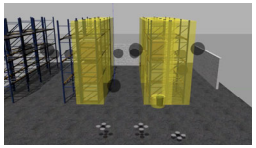
Digital Twin Baseline Framework



- Define a common DT structure to facilitate development, deployment & maintenance
- Define DT class inheritance capabilities to facilitate re-use and extensibility
- Develop solutions for a DT framework to facilitate scalability and reusability

- Develop security protocols and software engines to evaluate robustness in cybermanufact. systems
- Derive a new language and simulation platform for distributed agents

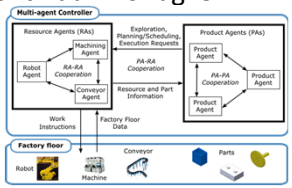
Security Architecture



Koord language and simulation

- Define a new description and formulation of the centralized/distributed continuum for agile control in manufacturing

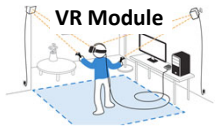
Multi-agent control architecture



Broader Impacts

Outreach Activities

DAPCEP



Student Project Teams

Impact to the field of CPS

- ***Simulation tools*** to verify control decisions
- ***Data infrastructure*** to store/secure data for CPS
- ***Generalized Digital Twin modeling framework***

Industry Collaborators

Ford, DOW, GM, MxD, Rockwell Automation, SIEMENS, HITACHI, ADI Applied Dynamics International

Dissemination (2020-2021)

1. Qamsane, Y. et al., in *IEEE Access*.
2. Moyne, J., et al., *IEEE Access.*
3. Balta, E., et al. *IEEE Trans. on Control Systems Technology* (x2)
4. Kovalenko, I,. et al., *Smart and Sustainable Manufacturing Systems*
5. Balta, E., et al. *IFAC World Congress* (x2)
6. Aksoy, D., et al., *American Control Conference (ACC)*
7. Mingjie B., et al., *Modeling, Estimation, Control Conference*
8. Wang, H., et al., *Manufacturing Science and Engineering Conference*
9. Mitra, S., et al., *Object-oriented Prog., Systems, Languages & Apps*
10. Jansch-Porto, J.., et al., *Int Conference Robotics & Automation*
11. Kao, B.C., et al., *Int. Conference on Embedded Software*
12. Nakano, et. al., *Conference on Automation Science and Engineering*

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