Map Reduce for Optimizing the Large-Scale Industrial IOT towards Digital Manufacturing

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Industrial relevance

The proposed project enables efficient information processing in large-scale Industrial IOT, which will help real-time decision making in manufacturing process.

Facts:

- *Impact of manufacturing sector* - In 2015, $5,940.6 billion (i.e. 18.92%) of total U.S. GDP is from the manufacturing sector.
- *Opportunities of IIOT* – IIOT allows manufacturing facilities to be digitalized and monitored in real-time.
- *Computation complexity* – numerous machines and proliferation of big data lead to significant challenges in analytical computing.

Urgent need: an algorithm that allows ***real-time*** information processing and decision making in large-scale IIOT.

Thrust area: Intelligence

Current TRL: TRL - 2

Final TRL: TRL - 6

Project type: Proposed project

Percent complete: 20%

Problem statement

Motivation

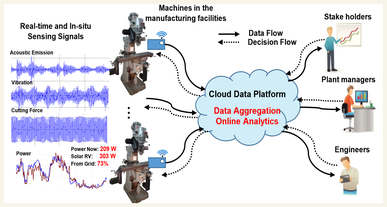
- Rapid advancement IIOT provides an unprecedented opportunity for digital manufacturing and mass customization.

Gap

- Large amount of machines and big data → traditional serial computing algorithm → analytical computing challenges.
- Existing information processing → lacks the ability to characterize machine signatures and quantify salient features that are sensitive to operational states of manufacturing system.

Need

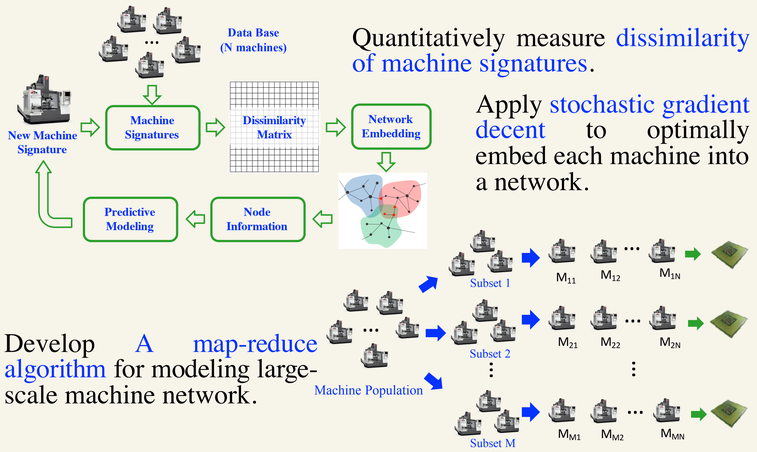
- Handle big data.
- Extract pertinent information about operational dynamics.
- Data-driven modeling and optimization.



Objective

Develop parallel and distributed algorithms to leverage real-time big data in large-scale IIOT for data-driven modeling and optimization of the network of manufacturing systems.

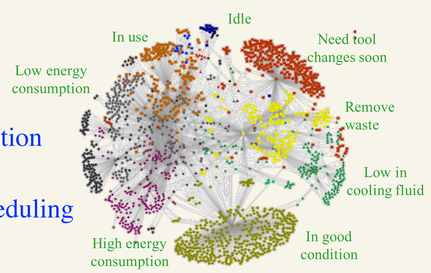
Approach and method



Deliverables and benefits

A *software package* that contains parallel and distributed computing algorithms for data-driven modeling and optimization of large-scale IIOT of manufacturing systems.

- ➢ Forecasting machine health
- ➢ Optimizing energy consumption
- ➢ Providing optimal work scheduling



Potential application areas

- **Healthcare** – real-time monitoring of patients' health conditions for telemedicine.
- **Supply chain** – control ambient temperature and optimize delivery efficiency.
- **Smart City** – provide information-communication solutions to improve the quality-of-life.

Project plan and progress

- Review current literature
- Multi-channel condition monitoring, signal modeling and forecasting
- Develop parallel-computing algorithms for data-driven prediction of machine conditions and service decision making
- Real-world case studies for implementation, evaluation and validation

Month	1	2	3	4	5	6	7	8	9	10	11	12
Literature review												
Machine signature extraction												
data collection												
modeling and analysis												
Development of large-scale machine network												
Characterization of machine similarity												
network embedding algorithm												
map reduce algorithm												
Evaluation and validation												
Document and presentation												

Current state of practice and research

Traditional network embedding → ***serial computing***:

- ➢ Classical multidimensional scaling (MDS)
- ➢ Scaling by majorizing of a complicated function (SMACOF)

⇨ Computational complexity increases exponentially with increasing number of machines in the system.

Gap: *Very little work has focused on fully utilizing the potential of the big data and addressing challenges in information processing in IIOT digital manufacturing*

How ours is different

Our proposed approach		Existing practices
• multi-channel signals	*vs.*	single-channel signals
• dynamic network	*vs.*	static network
• parallel computing	*vs.*	serial computing
• stochastic gradient descent	*vs.*	deterministic algorithms

References

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