Enrolling towards Industry 4.0

Panel Session Intelli 2017

Moderator: Leo van Moergestel

Panelists

- Gil Gonçalves, Faculdade de Engenharia da Universidade do Porto (FEUP), Portugal
- Sungshin Kim, Pusan National University, Republic of Korea
- Heinz Woern, Karlsruhe Institute of Technology (KIT), Germany

Presentations

- Gil Gonçalves: “Will robotics and artificial systems completely replaced the human operator in production?”
- Sungshin Kim: “Multivariate statistical techniques for fault detection and diagnosis of large-scale industrial processes."
- Heinz Woern: "Intelligent robots for Intelligent Manufacturing-Industrie 4.0"

Panel session

- Three presentations
- Discussion, questions ...

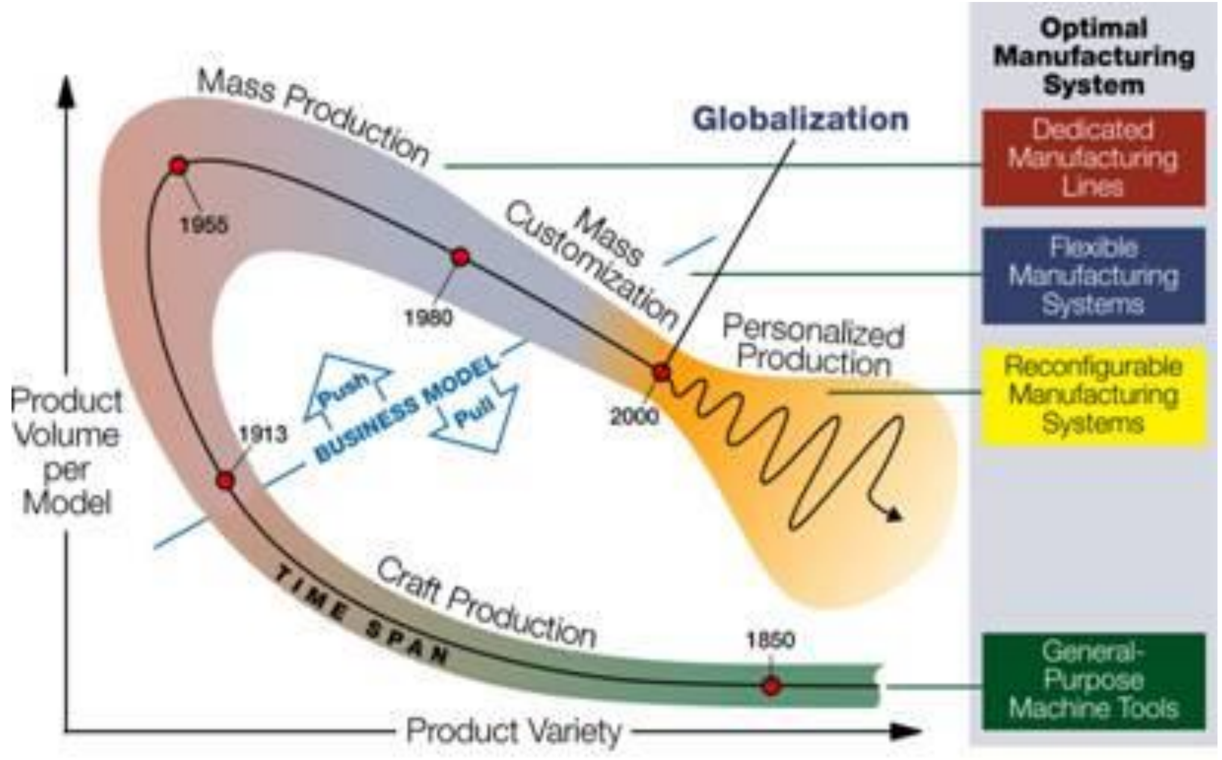
Will Robotics and Artificial Systems Completely Replace the Human in the Production Environment?

Gil Gonçalves, University of Porto, Portugal

INTELLI 2017
July 23 - 27, 2017 - Nice, France

From craft production to personalised production

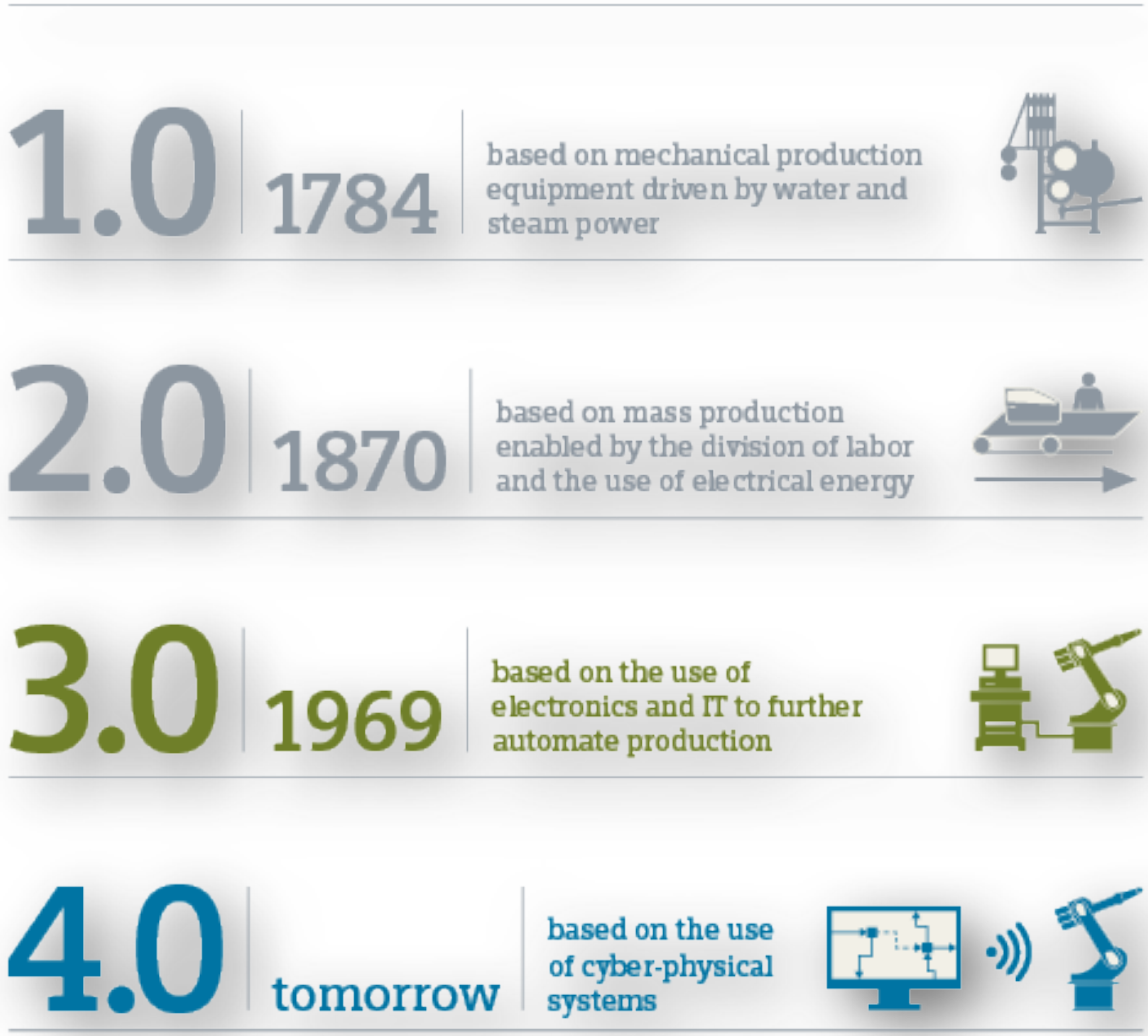
Companies are subject to constant changes in their operational environment (new regulations, economic up/downturns, environmental issues, technological innovation, competition and customer trends)



CHALLENGES FOR INDUSTRY

- More demanding specifications
- Small lots and one-of-a-kind
- Material re-use and zero-waste
- Quality/performance after ramp-up
- Huge amounts of data

Industry 4.0



Technology:

- Digital networking production facilities
- Fast pace of technological change and innovative technologies

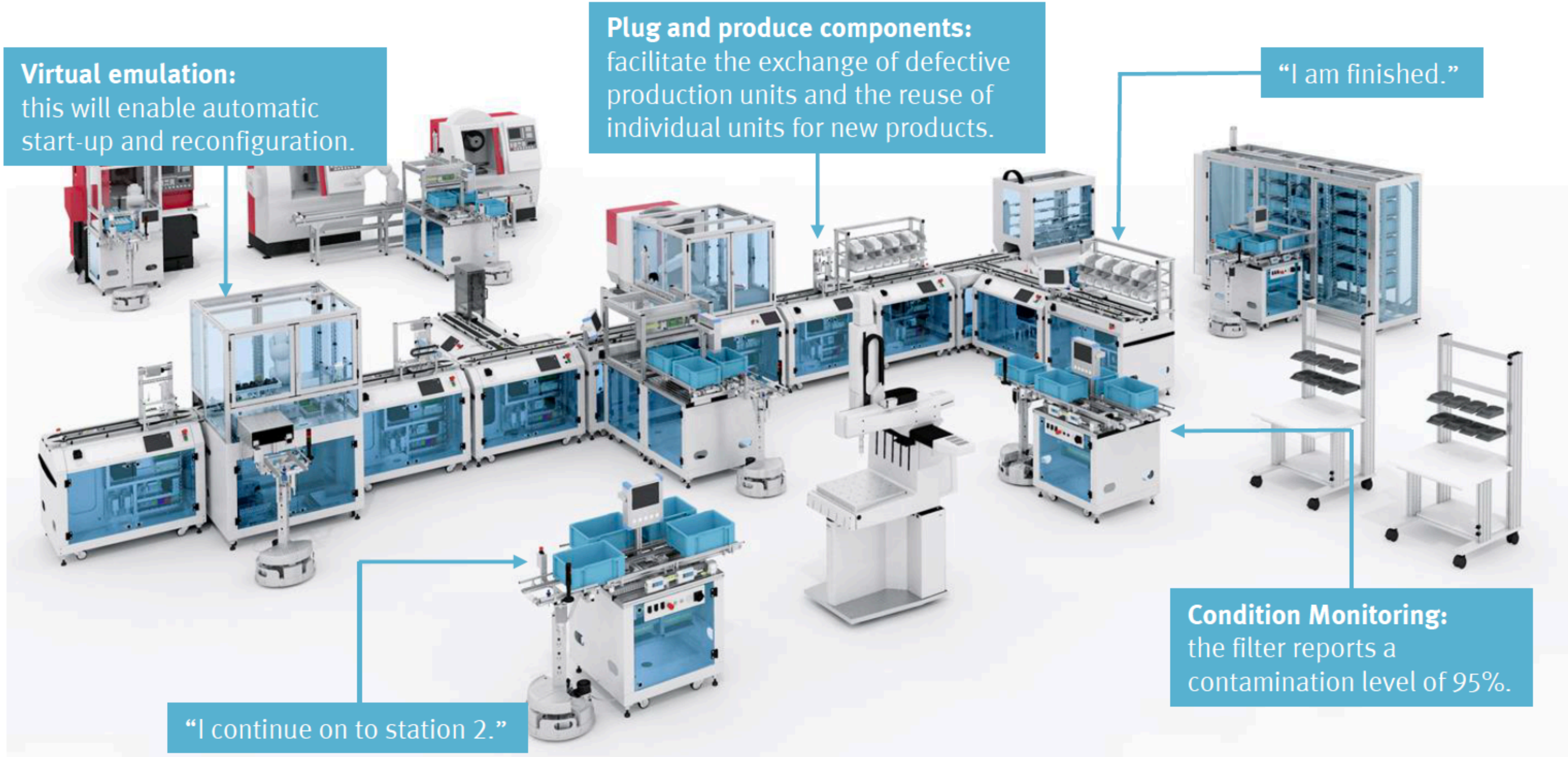
Customers:

- Customised solutions
- Wide diversity of customers and markets
- New services

People:

- Demographic development
- Training and qualifications
- Interaction between human beings and technology

Intelligent Manufacturing Environments



What role for the human in these new intelligent manufacturing environments?

Mechanisation: steam and water machines mechanised some of the work

Assembly line: along with electricity brought mass production

Automation: robots and machines started to replace human workers on the assembly lines

CPPS: brings robotics and automation connected in an entirely new way and artificial systems that can learn, control and cooperate with each other.

Will Robotics and Artificial Systems Completely Replace the Human in the Production Environment?

Gil Gonçalves, University of Porto, Portugal

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http://systec-fof.fe.up.pt/systec/web_pt.html

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Panel INTELLI 2017

Multivariate Statistical Techniques for Fault Detection and Diagnosis of Large-Scale Industrial Processes

JULY 24, 2017

Department of Electrical Engineering
Pusan National University
South Korea

Sungshin Kim

Contents

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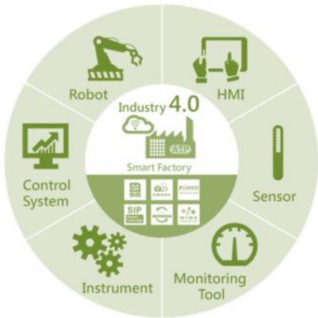

IARIA

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◆ Enrolling Towards Industry 4.0: Large-scale industrial processes

Solutions

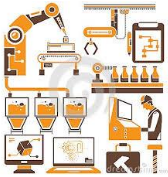
Process knowledge

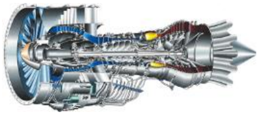
+

Data-driven approaches

Large-scale industrial processes


[Power plant]


[Manufacturing]


[Aircraft engine]

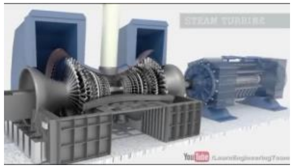

[Railroad]


[Solar & Wind]


[Chemical]

Objectives

[Steam boiler]



[Steam turbines]

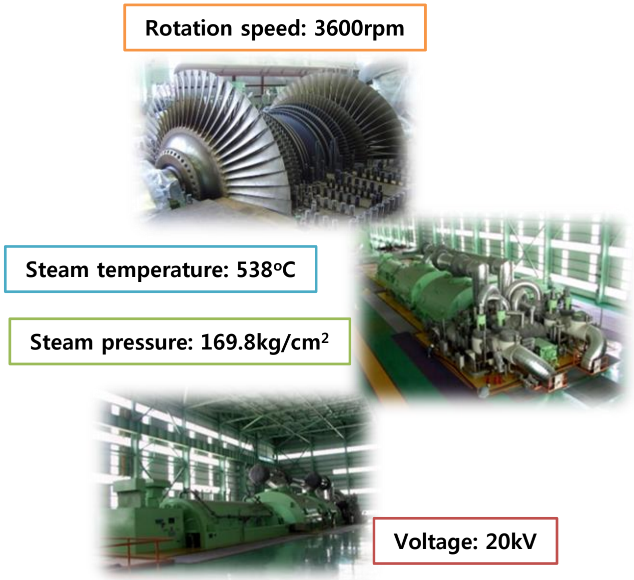
[Generators]

Source of video: https://www.youtube.com/watch?v=IdPTuwKEfmA

Research background: Thermal power plants

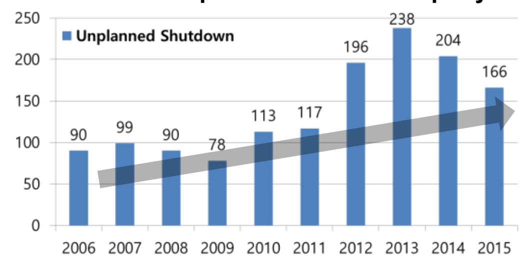
- Main equipment in thermal power plants (TPPs) (Right)
- Statistics related with reliability of power plants (in South Korea) (Middle)
- Implementation of distributed control systems (DCSs) in TPPs (Left)

Very dangerous conditions



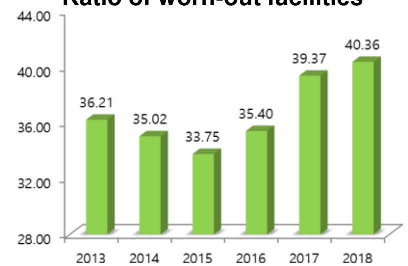
Gradually increasing

“The number of unplanned shutdowns per year”



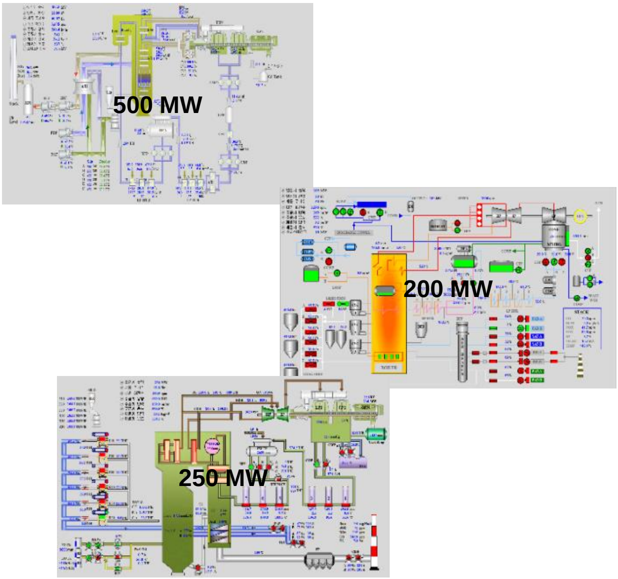
Source: Korea Power Exchange (KPX) (2016)

“Ratio of worn-out facilities”



Source: Korea Electric Engineers Association (2013)

Massive historical operation data



		Actual state	
		H_0 is true (H_1 is false)	H_0 is false (H_1 is true)
Decision	Reject H_0 (Accept H_1)	Type I error (false alarm)	Correct
	Accept H_0 (Reject H_1)	Correct	Type II error (miss detection)

H_0 (**normal**) : $SPE(k) < SPE_\alpha$
H_1 (**abnormal**) : $SPE(k) \geq SPE_\alpha$

AAKR: auto-associative kernel regression

Multivariate statistical techniques: AAKR

- Non-parametric multivariate technique to estimate new query vectors by online local modeling
- Involves storing training data in memory and finding the relevant data in the database to answer a current query

The bandwidth parameter can be determined by k-fold cross validation.

$$\mathbf{x}(k) = \begin{bmatrix} x_{\text{temp.}}(k) \\ x_{\text{press.}}(k) \\ \vdots \\ x_{\text{flow}}(k) \end{bmatrix} \in \Re^m$$

$D = \{\mathbf{x}^1, \mathbf{x}^2, \ldots, \mathbf{x}^n\}$

Similarity measure (Distance function) → $d^i(\mathbf{x}^i, \mathbf{x}(k))$, $i = 1, \ldots, n$ → **Weight assignment** (Weighting function)

$$K_h(d^i) = \frac{1}{\sqrt{2\pi}h} \exp\left[-\frac{(d^i)^2}{2h^2}\right], \; i = 1, \ldots, n$$

h: bandwidth

Weighted average → **Residual generation** → **Calculating test statistic** → **Hypothesis testing** → **Normal** or **Abnormal**

$$\hat{\mathbf{x}}(k) = \frac{\sum_{i=1}^{n} K_h(d^i) \cdot \mathbf{x}^i}{\sum_{i=1}^{n} K_h(d^i)}$$

<Estimated vector>

$$\mathbf{e}(k) = \mathbf{x}(k) - \hat{\mathbf{x}}(k)$$

<Residual vector>

$$SPE(k) = \mathbf{e}(k)^T \mathbf{e}(k)$$

<Test statistic>

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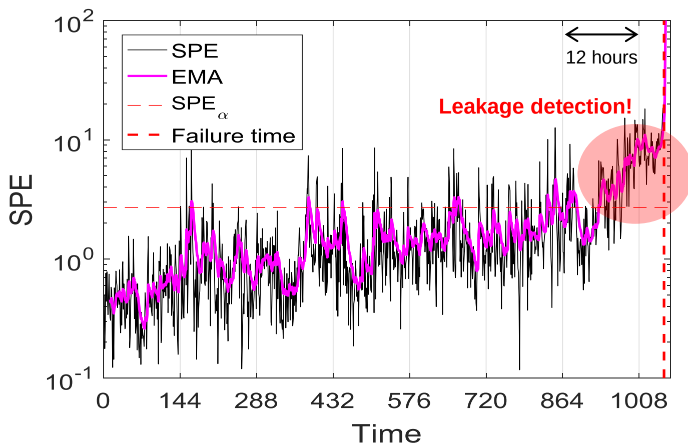
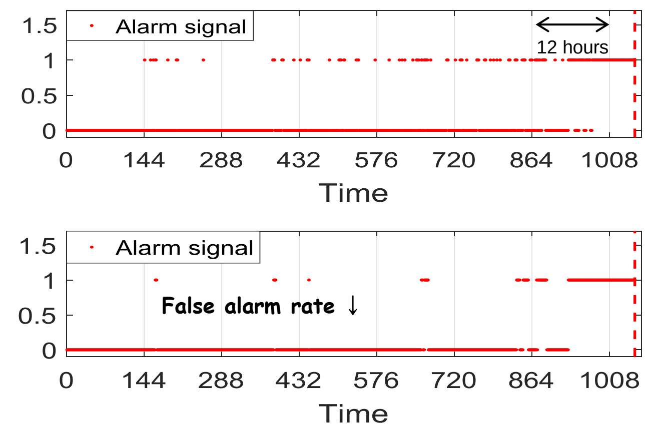
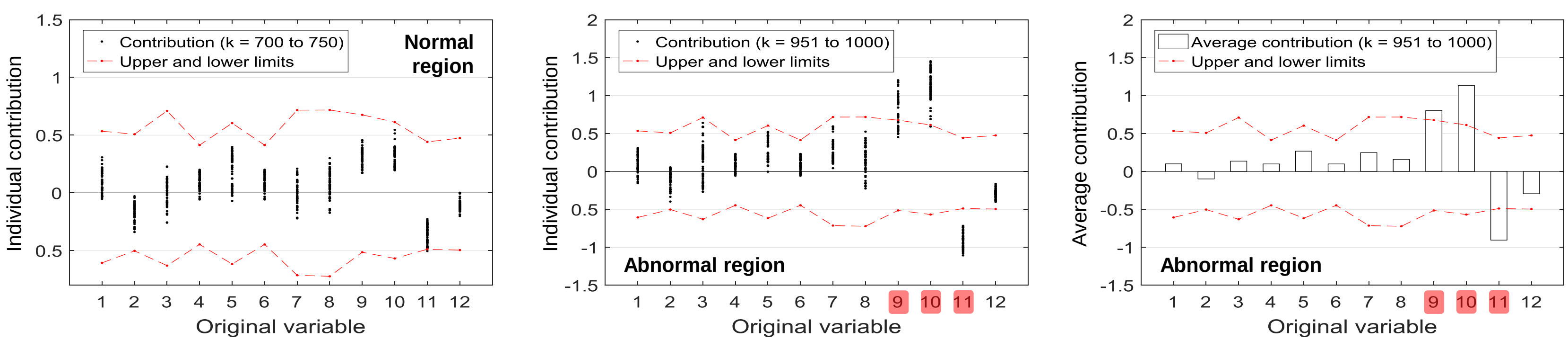
$$\overline{SPE}(k) = \lambda SPE(k) + (1-\lambda)\overline{SPE}(k-1),\ \text{for } k > 1$$
$$\overline{SPE}(1) = SPE(1),\ \lambda = 2/(w+1)$$

◆ Results of tube leakage detection (250 MW drum-type boiler)

- Leakage detection before unscheduled shutdown
- Contribution analysis for faulty variable identification







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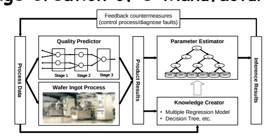
Previous research topics in KINCO using data-driven techniques

Knowledge Creation of e-Manufacturing



KITECH DB.TECH

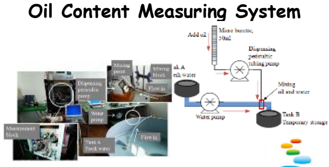
Ozone Forecasting

Hi Seoul

Diagnosis of Motor

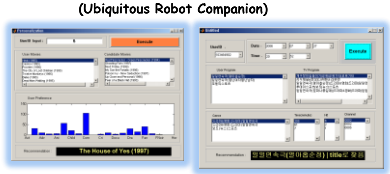
MINISTRY OF EDUCATION
MOTIE
HYOSUNG

Oil Content Measuring System



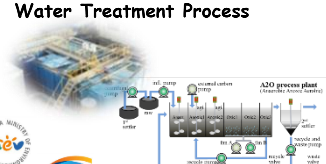
MARSEN SMBA

Contents Recommendation
(Ubiquitous Robot Companion)



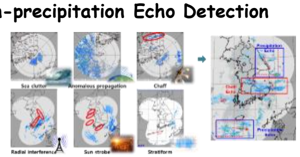
ETRI Electronics and Telecommunications Research Institute

Water Treatment Process



K water

Non-precipitation Echo Detection



KMA

Sensor-Fusion Autonomous Guided Vehicle

ATIS KIRIA

THANK YOU

Q & A

The 21st Century
Toward The Intelligent Planet

Intelligent Systems
Information
Automation

KnowledgeINformation & COntrol Laboratory

PUSAN NATIONAL UNIVERSITY

Report panel session Intelli 2017 “Enrolling towards Industry 4.0”

Panelists: Gil Gonçalves, FEUP Portugal, Sungshin Kim, Pusan National University, Republic of Korea, Heinz Woern, KIT, Germany
Moderator: Leo van Moergestel, HU Utrecht University of Applied Sciences, the Netherlands
Date: 24-07-2017

Today, the industry has its fourth revolution, Industry 4.0 or Cyber-Physical systems. The first revolution was the use of steam and water power, next came the concept of a production line and division of labor that was supported with the usage of electric power in manufacturing. This revolution resulted in mass manufacturing. The third revolution was driven by information technology and automation. PLCs (Programmable Logic Controllers, special programmable devices for industrial automation), computers and robots entered the production floor of factories. In Industry 4.0 everything will will be connected and will be digitized. Personalization driven by the end-user, waste prevention and sustainability are important goals.

Topics presented by the panelists:

Gil Gonçalves: “Will robotics and artificial systems completely replaced the human operator in production?”

Sungshin Kim: “Multivariate statistical techniques for fault detection and diagnosis of large-scale industrial processes."

Heinz Woern: "Intelligent robots for Intelligent Manufacturing-Industry 4.0"

Several question were raised by the panelists: the role of the human in future manufacturing, the cooperation of robots and humans, combination of possibilities and technologies, how to manage data and to build knowledge?

After the introduction of the panelists several topics were discussed.

The human worker will not disappear but a different type of worker will be needed. The new worker in the industry will be highly educated and having a broad view over the manufacturing process. Robots will become more intelligent, will be more human like, will learn and build a knowledge-base. So robots are more apt to do the dirty, dull and dangerous work. Cooperation with humans is an important aspect, because now most industrial robots are separated from places were humans operate, mostly because of security. Same situation will arise in the situation where autonomous cars will enter the domain of traffic.

The business model for manufacturing could also change by new techniques and network based solutions that can be on demand. This might result in zero waste, reuse and sustainability.

The last topic of discussion was security. The common idea among the panelists and people in the audience was that this is still underestimated. Most systems are built and security is added afterwards. Security is missing in the design. 100% security is not possible, but today, the vulnerability if IT systems is high. A solution could be a design that includes graceful degradation. This means that a plant will still work when it is infected by malware. Perhaps some work has to done manually, but the system as a whole should not stop functioning as is now sometimes the case.