IT Tralee Masters by Research Programme Details

Title of Project: The measure of Overall Equipment Effectiveness using Internet of Things

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Brief Biography of Principle Supervisor:

Krishna Panduru is the Strand Leader – Intelligent Mechatronics at the IMaR Technology Gateway based in the Institute of Technology Tralee. He has been a full time researcher and delivered lectures in numerous subjects for B.Eng students and undertaking supervision for B.Eng projects.

He is also involved in the H2020-SPIRE project, ProPAT, which aims to integrate affordable and smart sensors which deliver real-time information and robust control. Krishna is actively engaging with international, regional industries and start-up companies providing research expertise in the area of industrial internet of things, mechatronics, robotics and automation. His research interests include Fuzzy Logic Systems, Intelligent Autonomous Systems, Automation Technologies, Embedded Systems & Robotics.

One such project of interest is developing an intelligent power management system for renewable energy sources. Which involved in the Investigation and development of power management, control and distribution system from a renewable energy source using fuzzy logic and wireless sensor networks.

Recent Research Publications:

- Niall O' Mahony, Trevor Murphy, **Krishna Panduru**, Daniel Riordan, Joseph Walsh, *"Machine Learning Algorithms for Process Analytical Technology".* 2016 World Congress on Industrial Control Systems Security, London U.K.
- Trevor Murphy, Niall O' Mahony, **Krishna Panduru**, Daniel Riordan, Joseph Walsh, *"Inertia Sensing for Bulk Solid Measurement in Process Analytical Technology Systems"*. 2016 10th International Conference on Sensing Technology, Nanjing, China,
- Niall O' Mahony, Trevor Murphy, **Krishna Panduru**, Daniel Riordan, Joseph Walsh, "*Fibre-optic sensors for Process Analytical Technology*". 2016 33rd International Manufacturing Conference, 2016.
- Niall O' Mahony, Trevor Murphy, **Krishna Panduru**, Daniel Riordan, Joseph Walsh, "*Adaptive Process Control and Sensor Fusion for Process Analytical Technology*". 2016 27th Irish Signals and Systems Conference (ISSC), DOI: 10.1109/ISSC.2016.7528449.
- Niall O' Mahony, Trevor Murphy, **Krishna Panduru**, Daniel Riordan, Joseph Walsh, "*Smart Sensors for Process Analytical Technology*". 2016 IEEE International Conference on Advanced Intelligent Mechatronics (AIM), DOI: 10.1109/AIM.2016.7576901
- Revathi Nukala, **Krishna Panduru**, Andrew Shields, Daniel Riordan, Pat Doody, Joseph Walsh, "*Internet of things: A review from 'Farm to Fork'*". 2016 27th Irish Signals and Systems Conference (ISSC), DOI: 10.1109/ISSC.2016.7528456.
- **Krishna K Panduru**, "*FLCPlus: A light-weight open-source library in C++ for Fuzzy Logic Controller"*. International Journal of Computer Science and Communication, pp. 202 – 204, 2014, ISSN 0973-7391.
- **Krishna K Panduru**, Daniel Riordan, Joseph Walsh, "*Fuzzy Logic Based Intelligent Energy Monitoring and Control for Renewable Energy*". 25th IET Irish Signals & Systems Conference 2014 and 2014 China-Ireland International Conference on Information and Communications Technologies (ISSC 2014/CIICT 2014), pp. 96-101, 2014, DOI: 10.1049/cp.2014.0666.

Research Project Abstract

In this project, we aim to address the challenges of manufacturing efficiency through lean manufacturing and Industrial Internet of Things. Overall equipment effectiveness (OEE) evaluates the efficiency of a manufacturing process and consequently increase factory's throughput. The project aims to develop a connected OEE system which will compromise 'things' and 'central node'. The 'things'-devices contain various sensors & instrumentation, communication interface and an intelligent processor. A 'central node' with a communication interface, custom designed database and display module to enable floor managers take appropriate decisions.

O'Carroll Engineering Ltd is involved in the design & manufacture of architectural metalwork in the industrial, commercial and high-end domestic sectors. O'Carroll Engineering is continually implementing Lean Manufacturing throughout their processes. In the recent years, they are currently focused to enhance their lean manufacturing method, one such key-performance indicator (KPI) is the overall equipment effectiveness (OEE). O'Carroll Engineering Ltd have requirements for an advanced connected overall equipment effectiveness system which will enable real time and precise monitoring of manufacturing processes. To facilitate this, diverse manufacturing equipment are required which would be producing parts in real-time.

Research Context (Technical Merit & Impact)

The project will focus on the concepts of Lean manufacturing and Industrial Internet of Things applied to measure overall equipment effectiveness (OEE). OEE evaluates the efficiency of a manufacturing process and consequently increase factory's throughput. Lean manufacturing aims to remove wastage in production by reducing loading time, decreasing downtime and performance[1]. Machinery used in process plants are not always connected to a central system. Though SCADA and DCS systems are available in modern machinery, these systems lack inter-operability between various devices. Through the advent of modern technology, cost & resource efficiency and higher production requirements a communication standard was created. The OLE for Process Control (Object Linking and Embedding for process control)[2] provides reliable, secure and convenient method of communication among devices from various vendors.

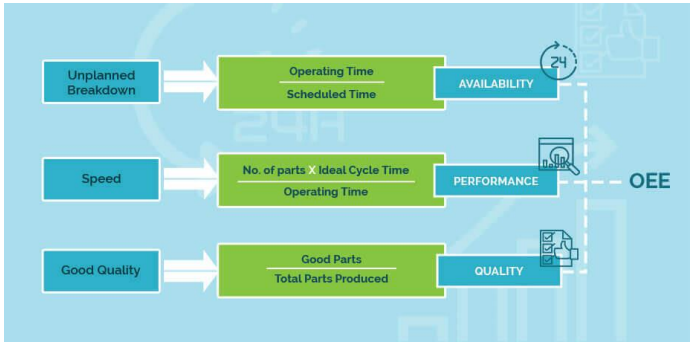

Figure 1: Calculating Overall Equipment Effectiveness (OEE) using Availability, Performance and Quality, http://altizon.com

The project aims to develop a connected OEE system using Internet of Things which will compromise of 'things'-devices and 'central node'. The 'things' contain various sensors & instrumentation section will gather real-time accurate process information from plant machinery. Sensing technologies such as

[1] The genealogy of lean production, Holweg Matthias, Journal of Operations Management, http://dx.doi.org/10.1016/j.jom.2006.04.001

[2] https://opcfoundation.org/about/what-is-opc/

CT, MEMs sensors will be investigated. Communication interface such as Wi-Fi, ZigBee, LoRa will be investigated based on the plant environment and an intelligent processor such as high performance cortex-M processors will be used. A 'central node' consists of a communication section, custom designed database and display module to enable floor managers take appropriate decisions. Figure 2 shows a block diagram of the proposed system. Other parameters which will enable better measure of OEE will be monitored as identified in the literature review stage of this project.

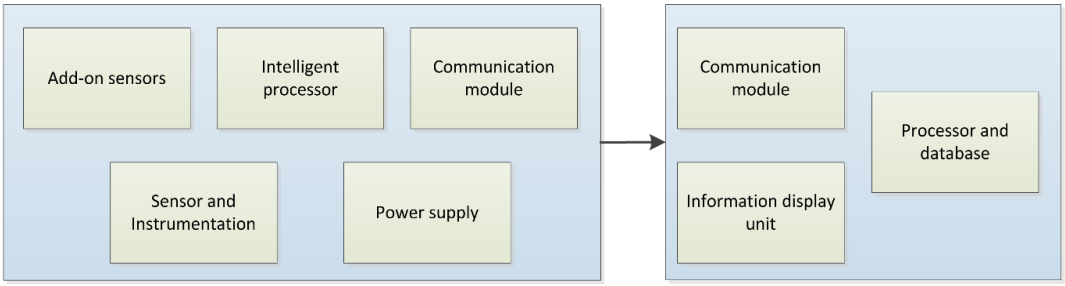

Figure 2: Proposed block diagram of connected OEE system

Research Methodology

Lean manufacturing along with Internet of Things applied create large amounts of data for a manufacturing plant. In this research, we are interested in the overall equipment effectiveness (OEE) which evaluates the efficiency of a manufacturing process and consequently increase factory's throughput. Lean manufacturing aims to remove wastage in production by reducing loading time, decreasing downtime and performance. Requirements analysis will be carried out after the literature review. Stakeholders' requirements, strengths and weakness of implementation and measurable goals will be analysed to developed concept prototype ideas for a connect OEE measurement system. Various use cases will be developed to fine tune various OEE parameters. Once a profound understanding of a complete system is established. Prototype hardware will be developed to perform technical feasibility of proposed system. Issues caused by EM interference caused in the environment will be tackled by monitoring stray currents or providing proper ground path to the connected devices.

The database design input will be fed from the requirements analysis task of the project. Additional records and fields will also be populated to add additional comments during the research phase of the project. Later to verify and validate this project established methods will be used to demonstrate the results based on availability, quality and performance of the manufacturing process.

PROJECT SCHEDULE – GANTT CHART

Task details		2017			2018														
		oct	nov	dec	jan	feb	mar	apr	may	jun	jul	aug	sep	oct	nov	dec	jan	feb	mar
Task No	Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Directed study																			
task 1.1	Educational development																		
task 1.2	Discipline specific training																		
Literature review																			
task 2.1	literature review in lean manufacturing methods																		
task 2.2	literature review and state of the art analysis in OEE systems																		
task 2.3	literature review and state of the art analysis in IoT																		
task 2.4	integration strategy of connected devices to machinery																		
Develop intelligent OEE prototype modules																			
task 3.1	specification and requirements gathering																		
task 3.2	development of embedded IoT module for OEE																		
task 3.3	software development for IoT module																		
task 3.4	lab based testing and performance evaluation																		
Design and develop connected OEE framework																			
task 4.1	design database and central node system																		
task 4.2	central node software development and testing																		
task 4.3	establish communication between IoT devices																		
System testing and evaluation of test results																			
task 5.1	perform system testing in lab level																		
task 5.2	perform system testing in industrial setting																		
task 5.3	evaluate and organize results on plant production																		
Dissemination																			
Task 6.1	submit literature review & research progress to conference																		
Task 6.2	present at ITT seminar																		
Task 6.3	present Demo at conference																		
Task 6.4	Write thesis																		
Task 6.5	write journal article																		
Task 6.6	thesis submission																		