INSTITUTIONAL PROJECT FOR INTERNATIONALIZATION

UNISINOS

Using Internet of Things and Machine Learning in Modeling a Smart Factory in the Context of Industry 4.0

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1. INTRODUCTION

The Institutional Internationalization Project (PII) of Unisinos, submitted to CAPES, within the scope of the International Institutional Program, Public Call 41-2017, was approved in August 2018. The PII seeks to consolidate the university's internationalization policy for the period between 2018-2021, which aims to concentrate efforts in three priority thematic areas, foreseen in its PDI: (a) Innovation and Entrepreneurship; (b) Microelectronics and; (c) Health and Technology.

These three areas were mobilized through the development of research, work missions and various interaction in the global scenario, for four themes:1) IoT and Health, 2) Industry 4.0, 3) Ecosystems of innovation, and 4) Digital Transformation and Humanities. The integration between the three priority areas that will be mobilized by the themes gave rise to four research projects in international cooperation capable of promoting a wide and systemic synergy among the University's PPGs, connecting in an interdisciplinary and unprecedented way 70 teachers and more than 400 students of 5 graduate programs. As only Graduate Programs with a grade higher than 4 (by CAPES scale) could take advantage of the resources of this call, those that fit the proposal were the Graduate Programs in Business Administration, Applied Computing, Communication, Design, and Education.

Unisinos internationalization project foresees that in the next four years the institution will become a national reference in the study of hospitals, intelligent factories, innovation ecosystems and impacts of digital transformation on social processes, as long as it does not neglect its vocation related to humanities and technology. This means that the Capes Print Notice presents an opportunity for Unisinos to strengthen its physical presence internationally in an interdisciplinary way by expanding the contact networks in partner universities on the strategic themes, also placing Unisinos among the global clusters of research and innovation so that it can consolidate its vision of becoming a world-class university.

The project also aims to provide society with qualified study results and technologies that are closely related to the interests of international policies, especially connecting the PRINT Unisinos actions with the UN sustainable development actions. Nationally, it intends to subsidize the decisions of public policies and governmental actions, such as industrial development policies, the national policy on Health Technology Management, the Brazilian Strategy for Digital -E-Digital Transformation, the Work Group for a National Strategy for Industry 4.0, among other strategic issues relating to the Ministries of Health, Education, Science, Technology, Innovation and Communication.

The approved grant includes resources for work assignments, scholarships and consumable materials in the total amount of up to R $ 6,167,610.08 for the 4 (four) years of project. The activities of the

first phase start in 2019 and end on 04/11/2020, when there will be a partial evaluation for the renewal of the project. If it is renewed, the project will continue until 04/11/2022.

2. MANAGEMENT GROUP

In order to manage the Institutional Project of Internationalization granted by Capes, Unisinos invited a group of researchers that met the demands of the edict. All should be active teachers and mentors in stricto sensu postgraduate programs, with permanent employment relationship in the institution, academic leadership and international experience in the areas defined as priority, including at least one (1) foreign member linked to an institution abroad. The group is led by the Provost for Academic and International Affairs:

Prof. Dr. Alsones Balestrin, Provost of Academic and International Affair
Profa. Dra. Dorotea Kersch, Director of Graduate Studies Office
Profa. Dra. Claudia Bitencourt, Business Administration Graduate Program
Prof. Dra. Maura Lopes, Education Graduate Program
Prof. Dra. Carlo Franzato, Design Graduate Program
Prof. Dr. Sandro Rigo, Applied Computing Graduate Program
Profa. Dra. Adriana Amaral, Communication Graduate Program
Prof. Dr. Leonel Rocha, Law Graduate Program
Profa. Dra. Gelsa Knijinik, Education Graduate Program
Prof. Dr. Emmanuel Raufflet, HEC Montreal
Prof. Dr. Flaviano Celaschi, University of Bologna

3. THEME: INDUSTRY 4.0

The context identified as the fourth industrial revolution, or Industry 4.0, is a natural evolution involving production aspects, relating new communication resources, data processing and approaches to manufacturing, expanding the possibilities of increasing industrial productivity with positive impacts on several areas. This process allows new software and artificial intelligence resources to be continuously associated with production platforms and systems, using advances in the area of microelectronics and communication to generate the conditions for automation of prediction, monitoring and planning activities, thus optimizing production. Unisinos has been consolidating its status as a university dedicated to academic excellence and wholesome education,

having chosen technological inflection as one of its priorities, observing a number of investments and actions in order to make consistent and continuous advances in this area. Unisinos now has undergraduate and graduate courses in strategic areas for industry 4.0, as well as a research park with intensive interaction with the productive sector, acting on key aspects in this scenario. We have agreements with institutions that have wide experience in related subjects, such as KAIST and SKKU in South Korea, EPFL (Ecole Polytechnique Fédérale) in Lausanne, Switzerland and also agreements with German universities, such as FAU (Friedrich Alexander University) in Erlangen, or the UAS7 consortium, which integrates nine applied science universities in Germany. Several challenges in this area have already been dealt with in an integrated manner with regional productive insertion, through a strong relationship with industries in different areas and interaction between the research and these entities, in a consistent knowledge transfer scenario. In addition, the theme is extremely relevant for the national scenario, highlighting actions such as the Work Group, created by the Ministry of Science, Technology, Innovation and Communication (MCTI) to develop and propose a National Strategy for Industry 4.0 (GTI4.0); the theme is also in line with UN's strategic goals, particularly goal 9 – Industry, Innovation and Infrastructure as its purpose is to improve the technological capabilities of industrial sectors and to significantly increase access to information and communication technologies, especially in developing countries.

3.1. POSTGRADUATE PROGRAMS LINKED TO THIS THEME

Applied Computing

The theme known as Industry 4.0, also referred to as fourth industrial revolution, is defined by the wide use of innovative features in operations automation activities and also, perhaps mainly, in the automatic monitoring of these operations, with large-scale data collection and their use for monitoring and prediction activities. Cyber-physical systems play a prominent role, as well as the Internet of Things, Cloud Computing and Artificial Intelligence approaches. Combining these heterogeneous sets of resources enables activities to be monitored and their results to be treated so as to generate predictive models, monitoring or simulation models, thus enabling a level of control and prediction of results never before available to the industrial sector. The Graduate Program in Applied Computing has active research lines with consistent experiences in these areas, which take into account agreements and collaboration with Korean institutions (such as KAIST, or SKKU), conducting notable studies on Internet of Things and development of microelectronic resources. The

experience in productive environments, based on simulation, prediction, decision support and control systems, proves the Graduate Program's vocation.

Business Administration

The Graduate Program in Business Administration, through the Ubi_Business research group, has been researching innovations for more than 10 years with the use of ubiquitous computing, whose technological platform is currently the IoT (Internet of Things). In addition, there is plenty of room for other Business Administration Graduate Program research groups to work on various types of IoT-related innovations and processes related to Industry 4.0.

3.2. PARTNER COUNTRIES

Activities funded under this theme should be restricted to the following countries:

1. Germany
2. South Korea
3. Switzerland
4. USA

3.3. GOALS

OBJECTIVES	ACTIONS	INDICATORS	GOAL
Generate academic immersion of Unisinos researchers in partner institutions	Postdoctoral internships abroad	Number of faculty members that did their postdoctoral internship on the theme	Current: 0 2nd year: 2 Final: 4
Consolidate interdisciplinary research networks and promote the Unisinos S&T&I System	PhD internships abroad	Number of students that did their PhD exchange internship on the theme	Current: 0 2nd year: 2 Final: 4
	Develop joint articles of international relevance	Impact Factor of Publications	Current: good 2nd year: excellent Final: excellent
		Joint publications	Current: 0 2nd year: 2 Final: 4
	Increase the number of joint research projects	Joint Research Projects	Current: 0 2nd year: 1 Final: 2
	Double degree / joint supervision abroad	Number of joint supervisions/double degrees on the theme	
Generate knowledge that can support decisions on public policies, governmental and managerial actions, making Unisinos a benchmark in studies related to industry 4.0	International Seminar	Number of participants	Current: 0 2nd year: 40 Final: 80
		Number of Scientific and Technological papers submitted	Current: 0 2nd year: 20 Final: 40

		Evaluation of participants	Current: - 2nd year: good Final: great
	Summer School	Number of participants	Current: 0 2nd year: 0 Final: 40
		Evaluation of participants	Current: - 2nd year: - Final: great
Qualify internationally the Unisinos researchers related to the theme	Conduct technical visits to Centers of Excellence	Number of technical visits conducted	Current: 0 2nd year: 4 Final: 8

4. FUNDABLE ITENS

4.1. Work Missions

Work missions include travel aid for flight tickets, 7 days accomodation and health and travel insurance. They may be carried out in the case of:

- Activities related to the execution of cooperation projects;
- Presentation of research results in congresses and international events of greater expression in the area of knowledge, with the possibility of technical visits in institutions to prospect for possible partnerships;
- Activities carried out by members of the Management Group or representatives indicated, aimed at enabling the internationalization actions of the Institutional Internationalization Project.

Average amount budgeted for mission is R$ 17,100.00.

The Management Group will be responsible for selecting the beneficiaries of non-project assignments, while the Project Coordinator will be able to select beneficiaries among the members of the project team. The same faculty member or researcher, with the exception of his or her coordinator, may not undertake more than one work assignment per year or consecutive years of project validity.

4.2. Resources for project maintenance

The resources for project maintenance will be managed by the project coordinator and may be used for: a) consumables, intended for the purchase of material necessary for the operation of the project; b) third party service (legal entity): regarding payment of suppliers of material or service, by means of a detailed invoice; c) third party service (individual): refers to payments by receipt to the person with no connection with the main or associated institution, the Public Administration or the Program, to perform a specific task that contributes to the achievement of the objectives of the project , provided that it is approved by Capes.

4.3. Scholarships abroad

4.3.1. Ph.D. Internship

In the form of a sandwich doctorate abroad, students regularly enrolled in doctoral courses in Brazil undertake part of the course in an institution abroad, returning and remaining in Brazil for finishing mandatory credits and thesis defense. In order to apply for the scholarship, the candidate must be in line with one of the Unisinos priority themes (it is suggested reading Unisinos internationalization plan, themes and research projects), be regularly enrolled in one of the participating Graduate Programs and wish to pursue his or her PhD internship in one of the countries that are part of the project.

The selection calls will be published on this page and will meet the CAPES criteria and also the internal regulations of each Graduate Program. It is important to pay attention to the foreign language proficiency requirements established by CAPES.

The scholarship payment will be made directly by CAPES to the scholarship holder and will not include full payment of tuition and fees or bench fees to foreign partner institutions.

It is necessary for Unisinos to have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of destination.

If Unisinos does not have an agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership.

4.3.2. Junior Visiting Professor

Professors or researchers employed by UNISINOS, who have a doctorate degree of up to 10 (ten) years, are eligible, with reference to the last day for enrollment in the selection process.

Candidates must submit a document from the host university stating that the candidate has sufficient language proficiency for the proposed activities or some of the proficiency certificates required by the host university.

It is necessary that Unisinos have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of destination.

If there is no agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership. It is the responsibility of the beneficiary to prepare the accountability and technical mission report.

4.3.3. Senior Visiting Professor

Professors or researchers employed by UNISINOS, who have a doctorate degree for more than 10 (ten) years, are eligible, with reference to the last day for enrollment in the selection process.

Candidates must submit a document from the host university stating that the candidate has sufficient language proficiency for the proposed activities or some of the proficiency certificates required by the host university.

It is necessary that Unisinos have a cooperation agreement, memorandum of understanding, agreement or legal instrument with the university of destination.

If there is no agreement with the foreign institution, it is possible to ask the Program Coordination to evaluate the possibility of a new partnership. It is the responsibility of the beneficiary to prepare the accountability and technical mission report.

4.3.4. Short courses or "summer / winter schools"

Scholarship for training in short courses or "summer / winter schools" abroad, valid for up to 1 month, or aid for participation in distance courses (MOOCs etc), aimed at postgraduate students linked to a research project in international cooperation or technical staff of the institution.

4.4. Scholarships in Brazil

4.4.1. Young talent with experience abroad

Scholarship for young talented researchers, Brazilian or foreign, residing abroad with proven international academic-scientific experience (as a master or full doctorate, or master's or doctorate sandwich for at least twelve months) to carry out research or teaching activities, effective for 6 months.

In the teaching activities carried out, a recording must be made for online transmission and subsequent availability, whenever possible.

Foreign candidates who are not native speakers of Portuguese or English must meet one of the following three requirements:

- Present a document issued by Unisinos stating that the interested party has sufficient linguistic proficiency for the proposed activities;
- Present, for Portuguese language, Celpe-Bras certificate; or
- Present, for the English language, TOELF, IELSTS or Cambrigde Exams certificate.

5. PROJECT: USING INTERNET OF THINGS AND MACHINE LEARNING IN MODELING A SMART FACTORY IN THE CONTEXT OF INDUSTRY 4.0

For each theme, Unisinos created a research project in international cooperation to encourage transdisciplinarity and contemplate the Graduate Programs involved with resources and scholarships.

Name of the project: Using Internet of Things and Machine Learning in Modeling a Smart Factory in the Context of Industry 4.0

Programs: PhD in Business Administration

PhD in Applied Computing

Coordinators: Dr. Rodrigo Righi, Unisinos

Dr. Dhananjay Singh, Hankuk University of Foreign Studies

Start date: 01/12/2018

End date: 31/07/2022

5.1. Description

The project aims to work in the context of the fourth industrial revolution, or Industry 4.0, which consists of a natural evolution involving aspects of production, relating new communication resources, data processing and approaches to manufacturing, expanding the possibilities of increasing industrial productivity, management of resources and performance of the firm, with broad positive impacts in several areas. This process is allowing new software and artificial intelligence resources to be continuously associated with platforms and production systems, using advances in the area of microelectronics, computing and data communication, generating the conditions for automation of prediction, monitoring and planning, thus optimizing production. Thus, the project's theme is defined by the wide use of innovative resources in operations automation activities and also by the automatic monitoring of these operations with the large-scale data collection and the use of these for monitoring, improvement of processes and prediction. In this way, cyber-physical systems play a prominent role as well as the Internet of Things approaches, Cloud Computing, Fog Computing, Machine Learning, Big Data, Event Prediction and Pattern Recognition. The combination of these heterogeneous sets of resources enables activities to be monitored and their results treated in order to generate predictive models, monitoring or simulation models, thus enabling a level of control and prediction of results, as well as improvement of processes and increase of productivity

that was never available to the industrial sector. In this sense, the project would explore efficient production systems with a greater degree of autonomy, and operate with greater efficiency and better consumption of resources (eg, human, equipment and raw materials), based on the technologies of industry 4.0. Finally, in order to achieve this objective, summarizing the previously mentioned themes, the project counts on researchers and professionals from several countries, including Brazil, Germany, South Korea, the United States and Switzerland.

5.2. Context

Nowadays, it is perceived that industries and companies have a high cost to keep their production lines functioning properly, and when a problem occurs, both at the level of human resources and equipment, many financial resources are demanded to remedy the problem. Or, a reality of industries in general refers to the monitoring of all items of production in real time, so that proactive tactics are created, with anticipation of potential problems, instead of traditional reactivity strategies, where a given problem only is perceived and resolved after its actual occurrence. In particular, in tropical or subtropical regions, as in the case of Brazil, operating costs tend to be higher due to high temperatures and high humidity during most of the year. In this sense, for Brazilian and international industry to become increasingly competitive, it is essential to reduce or optimize operating costs. One way to do this is to make the most of technology and good engineering and computing practices from the design, maintenance and construction of production lines, working on the equipment and human resources aspects.

In this project the greater focus will be the connection of the equipment to the internet in a reliable way and the use of predictive techniques to eliminate non-scheduled stops and reduce the costs of operation and maintenance. It is worth noting that the Industry 4.0 project is aligned with the technological and historical inflection of approach with South Korea, where we are in the seventh edition of the International Forum Korea Korea in Science, Technology and Innovation, which meets every year in Unisinos researchers from these two countries , along with other exponents in the area in the area of semiconductors and Industry 4.0 from the US and Germany. Finally, Unisinos now has undergraduate and postgraduate programs in strategic areas for industry 4.0 and has a research institutes complex with broad interaction with the productive sector, acting in key aspects in this scenario.

5.3. Problem

Nowadays, we have in industries and companies, both in Brazil and abroad, critical production line equipment that operates almost all the time at high load and the wear is higher at high temperature and humidity. To avoid problems with production equipment, it is essential that all parameters relating to software and electromechanical facilities be kept within narrow, well-controlled limits. They must be controlled, for example: temperature, pressure and resistivity of ultrapure water and cooling water, pressure and humidity of compressed air and nitrogen, pressure and temperature of liquid nitrogen, quality of electric energy. Critical parameters of the manufacturing equipment need to be monitored, among the main ones we can mention vibration, temperature, and consumption of electrical energy (current), besides other parameters specific to each equipment. One way to accomplish this is to connect the equipment to the internet. This extension of the Internet to the equipments fits in the field of Internet of Things (IoT). A segment that has gained prominence within the concept of internet of things and that is also linked to the concept of Industry 4.0, is the segment of Industrial Internet of Things (IIoT). These applications are a natural evolution of IoT, covering equipment control, machine-to-machine interactions, predictive maintenance, intelligent power management, large data analysis, ie applications that require system robustness and reliability. In this context, the present project works with the following problem sentence:

"How would it be a computational model that brings together Internet of Things and Machine Learning, including formalisms about architecture and algorithms, that can be employed in an industry production system, so that we can operate with prediction of critical events to generate reduction costs, increased productivity and reduced energy consumption? "

In order for the problem sentence to be transformed into a research process, the most relevant and defined industrial processes will be mapped out, the variables involved, the process redesign needs and the critical equipment to be monitored according to the impact of a possible shutdown, inadequate operation and maintenance cost. The variables will be monitored through sensors and actuators installed (Internet of Things) in sensitive points of the equipment and the information will be sent via wireless network to a processing center. From trend analysis, algorithms can indicate potential problems or failures before they occur, allowing for prior correction, avoiding greater costs of corrective or stopping maintenance.

There is also cost reduction and greater efficiency provided by the optimal exchange of worn items, such as bearings, bearings and belts, only when necessary, avoiding premature or unnecessary changes.

5.4. Relevance

The project aims to reduce maintenance / operation costs and increase factory uptime through continuous and remote monitoring, eliminating or reducing the need for maintenance technicians to perform on-site checks on equipment. However, the biggest gain is in the predictive ability of the system, offering a proactive system that can anticipate problems even before they actually occur. The project also has its importance in the creation of skilled labor in equipment maintenance, Internet of Things involving sensors and actuators and algorithms of Artificial Intelligence. It is worth reiterating that for each production equipment, the critical variables to be monitored must be identified, for example, pressure and temperature of the cooling water, compressed air pressure and humidity, vibration, temperature, electrical energy consumption, etc.

The relevance of the project in terms of social benefits can be seen in the optimization of production lines and reduction of financial costs in the medium and long term by the industry. Such a cost reduction can be passed on to the tertiary sector and the end consumer. In addition, since factories will now have sensors and actuators to analyze the entire production flow, involving both human resources and equipment, we are expected to have more reliable and higher quality end products on the market.

The relevance of the project to technical-scientific merit can be seen in the exploration of artificial intelligence techniques for process improvement and event prediction and pattern recognition for different features and types of sensors in an industry. Resources are both equipment (motors, mechanical arms, mats, computers, computer network systems, among others) as people who work and operate on the production line of a factory. In particular, it is very important to optimize the flow of people walking and operating so that the tasks are optimized and returned to the end product of the production line.

5.5. Input

The project contemplates the redesign and improvement of processes with the use of sensors and actuators in Industry 4.0, as well as the real-time analysis of all data that is being monitored. In this sense, we can cite as materials that will be used in the project:

- sensors and actuators of different types and functionalities, including those to obtain temperature, pressure and resistivity ratings of ultrapure water and cooling water, pressure and humidity of compressed air and nitrogen, pressure and temperature of liquid nitrogen, quality of electric energy, vibration and consumption of electrical energy (current), besides other parameters specific to each equipment.

- processing and connectivity boards, including, for example, chips from Texas Instruments and ST Electronics. The boards should be able to handle various types of sensors and mainly manage different types of communication including ZigBee, Bluetooth, BLE, 6LowPan, Wifi, among others.

- computational resources including complete computing nodes with high main memory power and processing. Such resources will be responsible for executing Artificial Intelligence algorithms and agglutination and data processing.

- network resources including configurable switches and beacons and radio frequency technologies that can be used on production lines in Industry 4.0.

- high volume data storage resources, involving disk bank equipment and fast technologies for reading and writing information.

At the outset, existing components will be used that will be integrated into modules and boards for concept validation and software development. The hardware will basically consist of sensors, signal processing module and RF transmission module (radio frequency). Subsequently, the possibility of further hardware integration through the creation of dedicated boards, multichip, SiP modules or dedicated chips using existing blocks (IPs) will be evaluated.

In terms of human resources, the project will have senior teachers from different countries, including Brazil itself and others such as South Korea, Germany, the United States and Switzerland. The project's proponent and professors from Unisinos, which is the proposing institution, have research partnerships with several professors and researchers from these countries within the scope of Industry 4.0. Moreover, the contacts abroad are seeking other partners in their institutions for the project to gain even more strength and technical staff. In addition, the project also counts on the participation of doctoral students, who will build their doctoral theses on the themes discussed in the project, in partnership with co-orientations of foreign partners.

5.6. Theoretical-methodological discussion

Nowadays, it is noticed that there are no well-established computational models to operate with industry 4.0, mainly with outputs for event prediction and pattern recognition. Today's hioje industries operate primarily with reactive systems, where problems are treated after they actually occur. Allied to this, the scientific part of the project also aims to exploit gains regarding the monitoring of the industry, logically exposing the issue of yield and optimization of time and quality, but not leaving aside the issue of energy consumption. That is to say, it is worth nothing to have a fully connected factory, with sensors and actuators and coputational systems of last generation, but spending absurdly more electric energy for this. In this sense, the project investigates architectures and Internet algorithms of Things and Artificial Intelligence with the focus on energy sustainability. Finally, it is expected that the system offers a good cost-benefit relationship, offering real benefits in terms of monitoring and predicting events, but not using high energy value to reach these premises.

Specific algorithms will be developed to analyze information in time to detect anomalies, trends or changes in behavior. Regarding Artificial Intelligence, supervised, unsupervised and semi-supervised algorithms will be studied. Unsupervised ones are those that operate without any information about the type of data being captured. The supervisors assume that we have a notion about the classification of data, distinguishing, for example, different types of data and what is called each type. On supervised methods, we have KNN (K-Nearest Neighbor), Baysian Networks, Supervised Neural Networks, Decision Trees and Support Vector Machine (SVM). As for non-supervised methods, we have Self-Organizing MaP (SOM), K-Means, Expectation-Maximization (EM) and genetic algorithms. Also in the area of Artificial Intelligence, in the part of prediction algorithms, we will investigate the use of ARIMA (Autoregressive integrated moving average), ARMA and moving average.

For the implementation of wireless communication (RF) between sensors and server nodes, a multi-protocol solution can be used. The suggested platform for investigation in the project allows the implementation of IEEE 802.15.4 and Bluetooth Low Energy (BLE) standards in the physical layer. Both standards use the ISM frequency range from 2.4 GHz to 2.4835 GHz. The choice of a multi-protocol solution was due to the main factors: (i) - IEEE 802.15.4 and BLE are the two solutions most adopted in the market when considering distances less than 100 m;

- Both protocols implement low-power connectivity solutions, and enable a possible future implementation using energy harvesting;

- The adoption of a multiprotocol chip allows implementing and evaluating the performance of IEEE 802.15.4, which supports the 6lowpan protocol in "mesh" applications. The standard is well-established for applications in the industrial environment and enables greater access to documentation as it is an older standard;

- The BLE standard in version 5.0 has recently implemented the mesh topology option and can also be evaluated through this platform in case an increase in the baud rate is required. Initially, hardware modifications will not be necessary, only in software to implement this protocol change;

The choice of a multi-protocol board is also due to the fact that we are in a research project, where a certain RF technology is still being chosen and validated. For example, if at any time if you opted for a certain RF technology in a fixed way and were bought several equipment that implement it, to realize in the field (that is, in this case in the company plan) that the technology was poorly chosen would be very bad , as well as financial loss. Therefore, a multi-protocol board allows us to test various RF options on different parameters and real situations, therefore choosing the most suitable one for tests that will come in the course of the project.

For the project to be executed, one of the steps is to find a partner industry so we can test the proposed Internet architecture of the Things, as well as artificial intelligence algorithms for event prediction and pattern recognition. In this sense, to date, we are working with the semiconductor industry HTMicron, which resides in São Leopoldo, RS, Brazil. In testing with industry, we will take the following steps:

1 - Identification of the critical variables and points to be monitored (temp., Vibration, current, pressure, etc.).
2 - Definition / acquisition of sensors.
3 - Choice / definition of network technology (6LowPan, Lora, Wi-fi, Zigbee).
4 - Design, manufacture, acquisition and integration of hardware.
5 - Hardware installation (acquisition points + network).
6 - Network tests.
7 - Development of the database.
8 - Development of data analysis algorithms.
9 - Acquisition of monitoring data.
10 - Adjustments, generation and analysis of results.

In particular, the project is linked to a certain industry (to be chosen during project execution), where we will have 2 main activities: (i) Proof of Concept: development and validation of hardware and software; (ii) validation in the field. For (i), it will be performed on a smaller amount of equipment. A representative equipment of each test type shall be chosen where the sensors shall be installed

and tested. For the initial tests in facilities and clean room it may be used the itt Chip infrastructure where there is more flexibility for evaluations. In this phase the equipment and variables to be monitored will be identified, the hardware and software will be developed and the tests and adjustments for the data acquisition will be performed. The system should be functional for all variables to be monitored and at least about 100 monitoring points. The algorithms of analysis and prediction should already use this data for the first assessments. For step (ii), the system shall be deployed and tested under actual factory use conditions with continuous operation and high number of points. The system will be installed at the HT Micron plant in São Leopoldo. The system must be installed and adjusted until fully operational generating the expected results. The data collected, graphs and resulting analysis should be available for remote access to whoever is defined. Adjustments in the parameters and algorithms should be performed to optimize the prediction and alertability of the system.

5.7. References

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Purushottam Gansar and Rajiv Tiwari. Comparative Investigation of Vibration and Current Monitoring for Prediction of Mechanical and Electrical Faults in Induction Motor Based on Multiclass Support Vector Machine Algorithms - Mechanical Systems and Signal Processing (94)2017 464-481.

Luke Strauss, Jeffrey Larkin, K. Max Zhang. The use of Occupancy as a Surrogate for Particle Concentrations in Recirculating Zoned Cleanrooms. Energy and Buildings (43) 2012 3258-3262.

Shaid Mumtaz et al, Massive Internet of Things for Industrial Application. IEEE Industrial Electronics Magazine. March, 2017.

5.8. Results

General Goal

Investigate and develop a system including algorithm architecture to remotely monitor critical variables in production equipment applying the Internet of Things (IioT) and artificial intelligence algorithms.

Specif Goals

- Propose strategies to detect variations or changes in behavior that may indicate operating or maintenance problems, allowing preventive action to be taken to correct them, avoiding downtime and reducing operation and maintenance costs;

- Train skilled labor in maintenance of equipment and infrastructure of clean rooms for microelectronics and IoT;
- Development of Business Model and Management Canvas especially focused on Industry 4.0.

5.9. Impacts Expected

1. Development of an integrative Internet board of Things that is capable of lifar with several digital and analog sensors, representing a novelty for the computing and engineering market;
2. Development of multidisciplinary research with the massive involvement of doctoral professors and doctoral students involving institutions from the 4 countries contemplated in the project. In this sense, the project has 8 sandwich doctorate scholarships in the partner universities, contemplating impact relative to the qualified training of students of Applied Computing and Business Administration;
3. Development of new algorithms focused on the problems of Industry 4.0, gathering topics such as event prediction, pattern recognition, sensors for industry, energy consumption and cost-effectiveness of the solution. Still, as for science, it is planned to submit at least 2 articles per year within the scope of the project, during the 4 year duration of the project. Post-doctoral training for Unisinos faculty at FAU.

5.10. Proposed Products

Integrated board of IoT	1
Book Chapters	1
Scientific publications in qualified international journals	12
Development of joint research projects	4

5.11. Partner Universities

1. Technische Universität Hamburg (TUHH)
2. Universidad Rámon Lull – La Salle
3. Sungkyunkwan University SKKU
4. Korea Advanced Institute of Science and TechnologyKAIST
5. Hankuk University of Foreign Studies(HUFS)
6. Hongik University
7. Electronics and Telecommunications Research Institute ETRI
8. Woosong University WSU
9. Seoul National University SNU
10. Friedrich-Alexander-Universität Erlangen- Nürnberg FAU

11. Technische Universität Berlin
12. Fraunhofer Institute for Production Systems and Design Technology IPK Berlin
13. University of California Irvine
14. Université de Neuchâtel
15. HES-SO University of Applied Sciences and Arts Western Switzerland

6. OTHER INFORMATION

Information regarding the operation of the project can be clarified through the documents available at http://www.capes.gov.br/cooperacaointernacional/multinacional/programa-institucional-de-internacionalizacao-capes-print