Pattern Extraction for the Design of Predictive Models in Industry 4.0

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Abstract. The accelerated proliferation of the Internet of Things (IoT) has laid the foundations for the new paradigm of Industry 4.0 and of digital transformations that now arise in organizations. However, these changes have also created challenges related to the management of the large amounts of data; how to process them, store them and convert them into valuable information enabling for effective and efficient decision making.

Currently, the research is in its initial stage; we have reviewed literature on multisensor data fusion, which will provide a complete overview of the methodologies, techniques and recent developments in this field. Then, we examine the data fusion model proposed by Bedworth and O'Brien (2000) called the Omnibus Model, since we will be able to use it in the recognition and extraction of unstructured data patterns, such as those coming from IoT sensors. After applying this technique of extracting patterns with less uncertainty and imprecision, we could establish a predictive model oriented at Industry 4.0 for a multi-sensor industrial environment.

Keywords: Industry 4.0 · Sensor · Data fusion · Internet of things · Omnibus model · Pattern extraction

1 Problem Statement

Networks generate massive amounts of digital data and thanks to their analysis, doors to new technological trends open, in the search for added value. The technological evolution caused the emergence of new inter-connectable sensors of diverse nature, which are quickly being integrated into our daily life. In this research we address the problem of modelling and integrating the data generated in Industry 4.0, originating fundamentally from sensor solutions, we apply techniques such as integration and data fusion.

2 Related Work

For Mourtzis et al. (2016), the accelerated evolution of information and communication technologies that interconnect objects around us to create intelligent ecosystems, help to adopt of cyber - physical and IoT systems in industries, with the aim of machines and communication facilities being connected by a network [8].

The concept of Industry 4.0 was first used by the German Government in order to stimulate the technological development of businesses, indeed, many countries took this approach by making use of terms such as the fourth industrial revolution; Smart Manufacturing, Smart Production, Industrial Internet, i4.0, Connected Industry etc. Industry 4.0 touches upon the greatest challenges regarding volume, diversity and speed of access to data, with various questions arising about its implications and linking this paradigm to the technological concept of Big Data [5].

Facing the challenge presented by Industry 4.0 this research will tackle the topic of modelling and integration of the data generated by IoT sensors in an industrial environment, having as its aim the extraction of patterns for the design of models which will be able to make precise predictions on the basis of the data obtained from the installed sensors, documented in this case. Thus, a predictive model is the result of the combination of data and mathematics, where the learning can be translated into the creation of a correlated function between the data input fields and the answer or the variable.

3   Hypothesis

The establishment of a hypothesis in a research, is something that can be done after the key problem of the work is addressed and elaborated. In this sense, "hypotheses are the guides of a research or study and indicate what we try to prove; they are defined as tentative explanations of the phenomenon investigated and are derived from existing theory" [7].

In this research the hypothesis that will guide our study argues that by using data fusion techniques for pattern extraction, a predictive model can be designed and applied in an Industry 4.0 environment.

4   Proposal

Bajo J. et al. (2015) stresses the importance of finding new solutions to deal with the problem of automatic fusion of the information generated by heterogeneously distributed sensors in an effective and efficient manner, outlining various information and data fusion techniques found in the literature [3]. In this context, the literature points out new trends in data fusion, which inspires further research [6]; in this sense, the research project that will be developed will analyze the problem of data generated by a network of sensors installed in an environment of Industry 4.0, extracting patterns through data fusion techniques.

Al Momani B. et al. (2011) states in [1] that data fusion has proved to be valuable for many uses, like the recognition of patterns and classification. In the initial stage of this research, we will examine the literature on multisensory data fusion with the aim of applying a technique which enables us to extract patterns with lesser uncertainty and
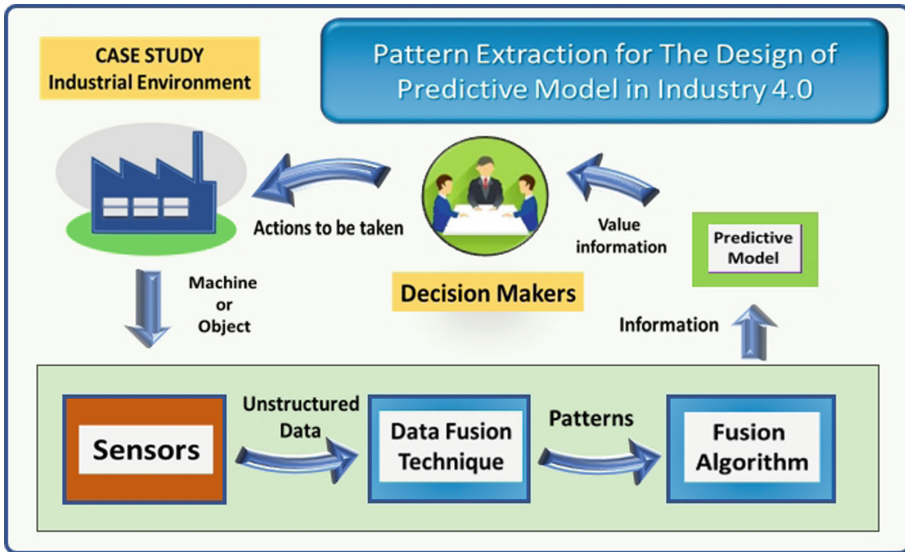
Fig. 1. Design proposal: predictive model in industry 4.0

imprecision. For the design of predictive models in Industry 4.0, we will draw from the multisensor data fusion techniques (Fig. 1).

5   Preliminary Results

This research is in its early stage. The preliminary design in this study consists of examining the multisensor data fusion literature in order to provide a comprehensive overview of the methodologies, techniques and recent developments in this field. We will analyze the data fusion model proposed by Bedworth and O'Brien (2000) called the Omnibus Model, that in opinion of Almasri M. et al., this model: "*has all components needed for an effective data fusion model as it still has the cyclic loop like other models but it considers the importance of having a feedback explicitly in the system*" [2].

The Omnibus Model is based on context activities and its stages follow a cyclic sequence in four steps [4]:

- **Detection and processing of the signal**: the information is collected and pre-processed.
- **Extraction of characteristics**: With the pre - processed information, patterns are extracted and merged to create the necessary contexts.
- **Decision**: the context is processed and the actions that follow are established
- **Act stage**: choosing which is the best plan to follow.

6 Reflections

Before the Industry 4.0 paradigm, data fusion models and architectures have been successfully used in military applications, navigation, robotics, security systems, image analysis and medicine, now with this research we want to apply the omnibus model to measure its effectiveness in the fusion of data in sensors installed in an industrial environment.

The fourth industrial revolution demands data integration and standardized interfaces, which is why more detailed research is required to address the topic of data processing in Industry 4.0 [6] New trends emerge in data fusion prompting extensive research. The main interest of this work is the extension of the application of data fusion algorithms to sensor networks, as well as the need for the evaluation of standard fusion protocols which are suitable for any domain.

References

1. Al Momani, B., Philip, M., McClean, S.: Fusion of elevation data into satellite image classification using refined production rules. In: Kamel, M., Campilho, A. (eds.) Image Analysis and Recognition, pp. 211–220. Springer, Heidelberg (2011)
2. Almasri M., Elleithy K.: Data fusion models in WSNs: comparison and analysis. In: Proceedings of 2014 Zone 1 Conference American Society of Engineering Education—Engineering Education Industry Involvement and Interdisciplinary Trends, ASEE Zone 1, vol. 203 (2014)
3. Bajo, J., De Paz, J.F., Villarrubia, G., Corchado, J.M.: Self-organizing architecture for information fusion in distributed sensor networks. Int. J. Distrib. Sens. Netw. **2015**, 1–13 (2015)
4. Borges, V.: Survey of context information fusion for ubiquitous Internet-of-Things (IoT) systems. Open Comput. Sci. **6**(1), 64–78 (2016)
5. Gilchrist, A.: Industry 4.0: The Industrial Internet of Things. Apress, Berkeley (2016). doi:10.1007/978-1-4842-2047-4
6. Gölzer, P., Cato, P., Amberg, M.: Data processing requirements of industry 4.0-use cases for big data applications. In: ECIS (2015)
7. Hernández Sampieri, R., Fernández Collado, C., Baptista Lucio, P.: Metodología de la investigación, Sexta Edición edn. Editorial Mc Graw Hill, México (2014)
8. Mourtzis, D., Vlachou, E., Milas, N.: Industrial big data as a result of IoT adoption in manufacturing. In: University of Patras, 5th CIRP Global Web Conference Research and Innovation for Future Production. Procedia CIRP 55, pp. 209–295 (2016)