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MOMIS Dashboard: A Powerful Data Analytics Tool for Industry 4.0

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Abstract. In this paper we present the MOMIS Dashboard, an interactive data analytics tool built to explore and visualize contents from varied data sources through several dynamic views (e.g. maps, charts, pies, etc.). The software tool is very versatile, and supports connections to the major relational DBMS and Big Data sources. Moreover, it can be connected to MOMIS, a powerful Open Source Data Integration system, capable of integrating heterogeneous data sources such as enterprise information systems as well as sensors data. MOMIS Dashboard provides a secure permission management to limit data access on the basis of user roles, and a *Designer* to create and share personalized insights of the company KPIs, thereby facilitating enterprise collaboration. We will illustrate the MOMIS Dashboard efficacy in a real enterprise scenario: a production monitoring platform that analyzes real-time and historical data collected through sensors, located on machines, detects early marks of malfunctions or failures and sends alarm notifications to the supervisors, therefore optimizing both production and energy consumption, while ensuring preventive maintenance.

Keywords. Data Integration, Data Analytics, Big Data

Introduction

The advent of Industry 4.0, supported by the increase of automation and the inclusion of monitoring sensors in industrial chains, has led to a significant growth of data, and the present trend is one of constant growth [1-9]. For example, a Consumer-Packaged Goods company that produces a personal care product, generates 5,000 data samples every 33 milliseconds, that result in 4 trillion samples per year [2]. Analyzing this large amount of data (i.e., Big Data) and extracting valuable information is strategic for the Industry (e.g., to predict machine faults). Integrating and analyzing all the data could be challenging [8, 10, 11, 15, 16], especially for a non-expert user who needs statistics derived from data without worrying about their low-level management. Thus, we propose the MOMIS Dashboard: an interactive visualization tool (available also as a mobile application) through which any user can perform data analytics operations, without any programming skill.

MOMIS Dashboard has been conceived to be used in combination with MOMIS [3], yet it also can be used with several commercial DBMSs. MOMIS (Mediator EnvirOnment for Multiple Information Sources) is an Open Source Data Integration

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system designed by DBGroup[2] and reengineered by DataRiver[3], which integrates structured and semi-structured data coming from heterogeneous data sources.

Furthermore, in Industry 4.0 through the *industrial Internet of Things* (IoT) [7] a vast amount of data is collected from sensors placed on production machineries. These data can be efficiently collected using distributed systems such as *Flink* [5, 6] or Kafka [13]. One of the most straightforward application of data analytics on these data is related to the machine health maintenance (i.e. *preventive maintenance*) [12, 14]. Any physical machine needs periodic maintenance during its life cycle to keep working properly. However, due to workload or external factors, the same type of machine can need maintenance at different times. So, periodically inspections on the machines are needed, in order to avoid failures; but this involves bringing the machines to a halt to inspect them (i.e. stopping the production), and human labor, so it can result in a cost-effective problem. When a machine starts to malfunction, it can show different kinds of abnormal events, e.g. higher temperatures, vibrations, different power consumption, etc. These abnormal events can be detected analyzing the data collected by the sensors placed on the machines. So, through data analytics on the sensors data it is possible to improve the preventive maintenance, limiting the physical inspections to the machines, thereby reducing the maintenance cost.

In this work we show how MOMIS Dashboard can be used in combination with MOMIS to perform preventive maintenance in a real use-case scenario, by extracting useful information from sensors placed on above mentioned machines.

The rest of the paper is structured as follows. In Section 1 the architecture of the implemented monitoring platform is described. In Section 2 an overview of MOMIS is provided. Section 3 is dedicated to MOMIS Dashboard. A real use-case scenario is then presented in Section 4. Finally, we draw our conclusions in Section 5.

1. Architecture

The MOMIS Dashboard Monitoring Platform is designed with a modular architecture that guarantees great advantages in terms of flexibility and extensibility. It is composed of two main components (Figure 1).

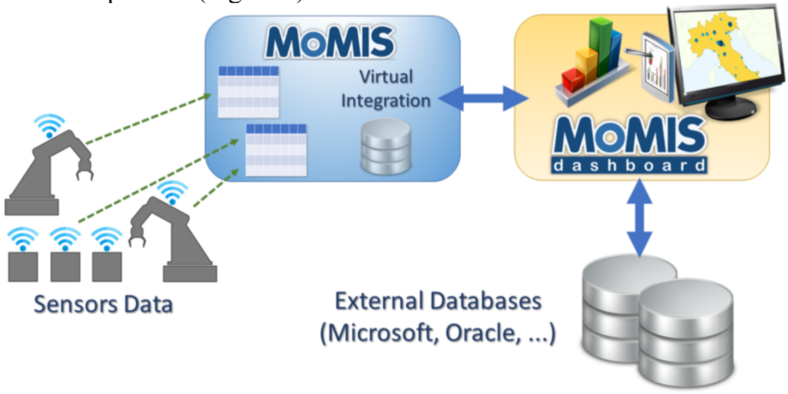

Figure 1. Platform architecture.

[2] dbgroup.unimore.it
[3] www.datariver.it/data-integration/momis

1.1. MOMIS

MOMIS is dedicated to the acquisition of real-time data coming from different sensors. It exploits the MOMIS IoT wrapper to get remote sensors data through a web service. This service waits for the sensor data to be sent, and saves them into a centralized Big Data repository. Data acquisition is scalable and topology-independent. Furthermore, MOMIS integrates sensors data with other production data coming from ERP and CRM software, by using appropriate wrappers to load them.

1.2. MOMIS Dashboard

MOMIS Dashboard is dedicated to the generation and display of platform charts. It can be used to generate the Key Performance Indicators (KPIs), and visualize them through different visualization means (e.g., bar charts, line charts, maps, tables, etc.). Moreover, in order to provide a complete predictive monitoring and maintenance solution, it implements an *Alarm Manager*. The *Alarm Manager* extension administers custom alarms through the definition of a set of rules, that allow the monitoring of devices which in turn enables preventive maintenance. The alarm notifications can be shown directly on the MOMIS Dashboard, but they can also be delivered via email or text message (i.e. Telegram[4], SMS, etc.).

2. The MOMIS Integration Framework

MOMIS Dashboard is specifically designed to work with the MOMIS framework. MOMIS it is a data-integration tool that implements Entity Resolution techniques [17, 19], and can be used for search applications [18, 20]. A detailed description of MOMIS can be found in [3], while in the current chapter we will briefly describe the main phases concerning the data integration process. From a given set of Local Sources (LS), MOMIS builds a unified view called Global Schema (GS) and allows users to formulate queries on it. MOMIS performs data integration following a virtual approach, preserving the independence and security of local sources.

The MOMIS data integration process is presented in Figure 2. First, through different wrappers MOMIS ingests data from different data sources (e.g. databases, spreadsheets, sensors, etc.). The data collected from the wrappers with their schemata represent the LS. For sensor data acquisition MOMIS uses an IoT wrapper, that allows to get data from any type of device connected to Internet. It is easily configurable and designed to handle both the delivery of single information and massive data stream. The data loaded as LS are merged together through a user guided process, creating a unique GS.

Once the desired GS is obtained, it can be queried through the Query Manager Tool (QMT) [4]. However, to use the QMT some familiarity with SQL is essential. Additionally, the results of the querying process are provided in a tabular view, that is not always easy and immediate to read. To overcome these issues, especially for non-advanced users, we developed the MOMIS Dashboard.

[4] www.telegram.org

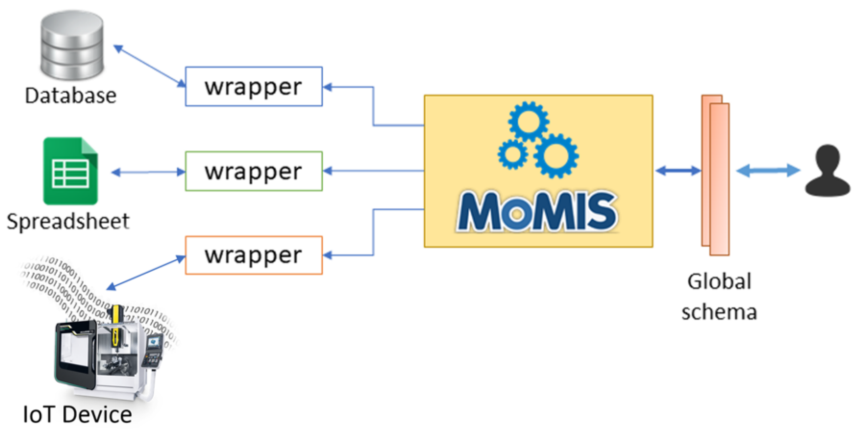

Figure 2. MOMIS Data Integration Process.

3. MOMIS Dashboard

MOMIS Dashboard is an interactive visualization tool for data analysis and monitoring developed by DataRiver[5] (available as a Web and Mobile application). It can be used to analyze integrated data obtained with MOMIS, or data coming from several structured and semi-structured data sources (Figure 1). It gives a unified view of data and preserves data security. It simplifies comparing data and captured information. It filters data and visualizes the results through several types of charts (e.g. lines, bars, pies, bubbles on maps or tabular views), as showed in Figure 3.

MOMIS Dashboard implements a comprehensive permission management to define advanced access rules on data. In this way, different users can access the same charts while visualizing only their proprietary data set. For example, if we have a chart that shows data of sensors coming from different divisions, we are able to show to each division only their data. Another interesting feature is the multilingual support, i.e., it can manage different languages for the same Dashboard.

Figure 3. MOMIS Dashboard: desktop UI (left) and mobile UI (right).

[5] http://datariver.it

MOMIS Dashboard is provided with the *Designer*: a tool to help users in creating their own charts through a simple interface. The Designer works as a wizard that guides the user to define a dashboard through different steps. Through the Designer a user can connect to a data source, import the data, create charts and share them with other users. The process is really simple: no low-level knowledge is needed, so anyone can make data analysis.

3.1. Alarm manager

The *Alarm Manager* is a MOMIS Dashboard extension developed to design alarms. With the alarm designer for each monitored measure a set of rules can be defined, in order to trigger an alarm to support the predictive maintenance. This extension handles the notification delivery, performed optionally via email or other media such as SMS or other instant messaging services.

4. A real use case scenario

MOMIS Dashboard has been used to create a specific monitoring solution for the ceramic sector.

In such context, the customer's need was to have a platform that allowed the remote monitoring of devices installed at the customer's site, and the scheduling of preventive maintenance activities. In this way the need to intervene only to resolve emergencies (malfunctions or failures) is avoided.

In the development of the MOMIS Dashboard Monitoring Platform we had also to consider that the operating data collected must be integrated with other information, in order to obtain the KPIs necessary for: production optimization, energy consumption, and preventive maintenance. Finally, we aimed to the maximum simplicity of use, a non-trivial problem since each device produces about 600,000 measurements every day, that have to be translated into easily understandable information for the customer. To fulfill these requirements the MOMIS Dashboard was organized in four main sections.

4.1. Overview and maintenance

The *Overview* section shows the main indicators with the most significant real-time operating data for the user. As shown in Figure 4 the user can view and interact with the four charts (from left to right, top to bottom): geolocation of active devices, the devices status in the last 5 days (i.e. the number of installed devices, online and offline and related alarms), produced square meters of products, and alarm trends in the last days divided by threshold.

The Maintenance section allows the visualization of all the KPI related to the real time operating data of the devices, such as operating hours, consumption trends, pressures, temperatures, etc.

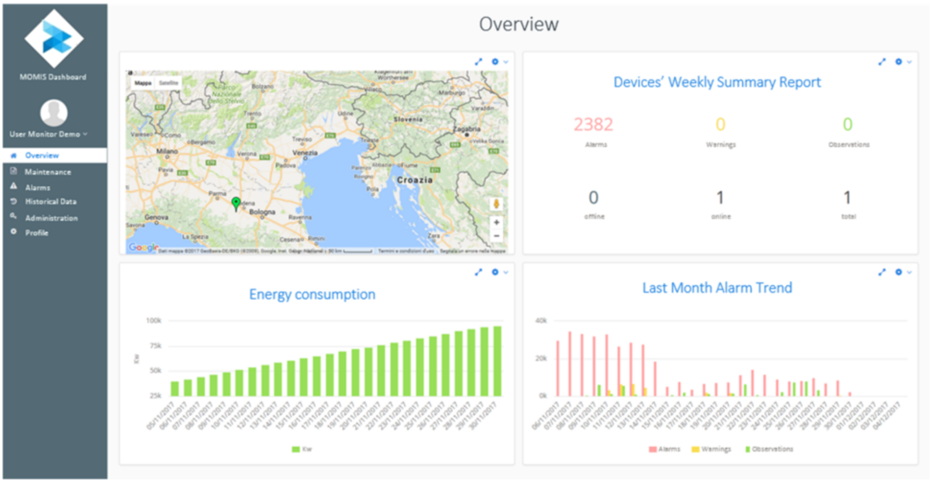

Figure 4. System overview. This section shows the operating data through four charts in real-time.

4.2. Historical data

This section shows the KPIs obtained from the analysis of the historical operating data of the devices. For example, Figure 5 shows the consequences of an action, that is the comparison of the energy consumption trend due to an action that determines the pre-action (on the left) and post-action temporal interval (on the right), such as the change of electrical supply in the plants; in this case the two-monitored device has a sensible drop of consumption after the action took place.

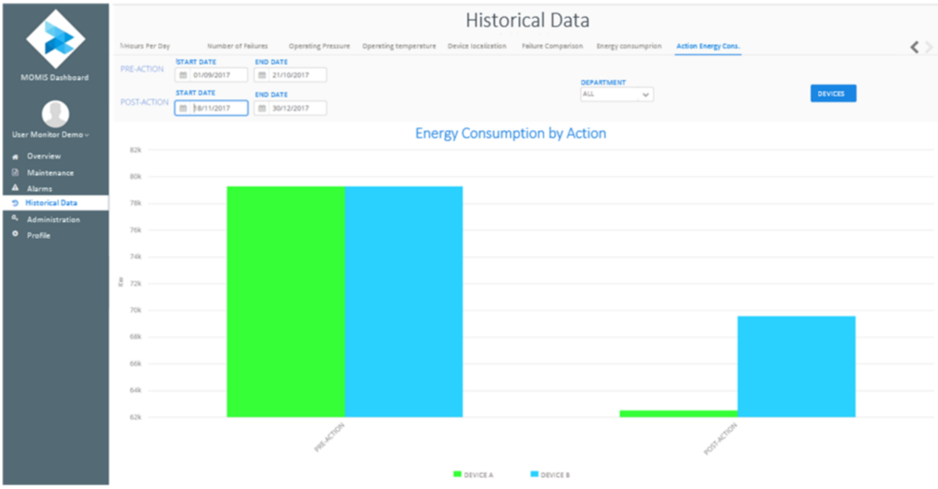

Figure 5. History User Interface: action chart.

4.3. Alarms

This section allows to view the alarms generated by the analysis of the operating data collected by the sensors (Figure 6). The information that can be viewed is both related to the detection of anomalies on the devices and to predictive maintenance. In fact, the alarms define tree thresholds: Critical, Intervention, Observation. The first (red rows) is relative to anomalous values that have therefore determined the device failures, the second and the latter (green rows) are relative to measurements that have not generated any operating anomaly, according to the preventive maintenance policies set, yet they still require verification by the operators. Each alarm also generates notifications that are automatically sent to the appointed figures, who are then notified in real-time of any critical issues even before a request for intervention from the customer arrives.

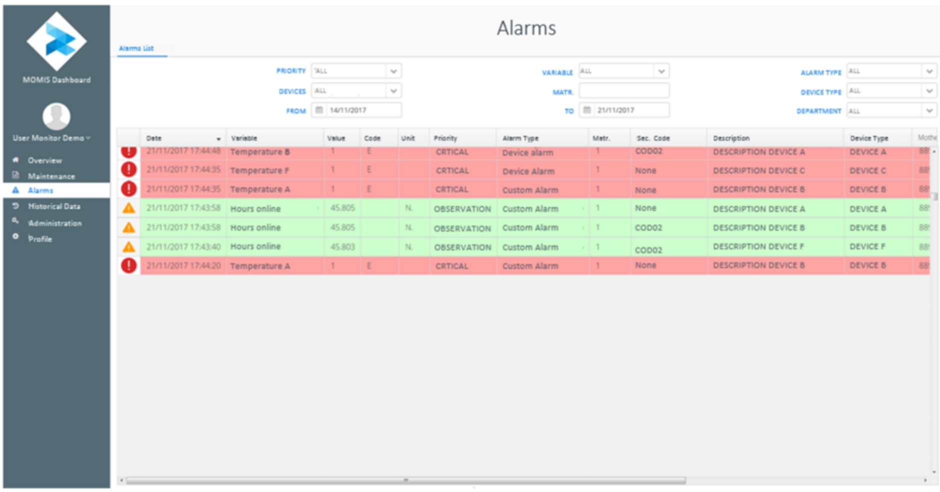

Figure 6. Alarm User Interface: alarms list.

5. Conclusion

By presenting the MOMIS Dashboard within the MOMIS data integration framework as applied to a real use-case scenario, the effectiveness of MOMIS in monitoring production and providing preventive maintenance was proved. In fact, the platform implemented for Industry 4.0 based on MOMIS system allowed access to the information available in different sources, through virtual data integration techniques, without requiring the migration of all data to a single system. The integration of data available in different locations will introduce more complexity to the analysis. Moreover the platform guaranteed considerable improvements: first of all, the increase of competitiveness and excellence of commercial offer; secondly, the acquisition of information on the life cycle of devices and spare parts to improve them; thirdly, the reduction of management costs for planning maintenance and supply processes; fourthly, the reduction of the costs of client companies due to malfunctions and machinery breakdowns; and, finally, the empowering of the support for client companies in the management of supply and maintenance processes.

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