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DATA COLLECTION FOR PORT NOISE MONITORING

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The impact of noise generated by harbour actives gained a very important role in the last years. While the evaluation of the noise impact of industrial plants and transportation is fully integrated in the activities of noise mapping in urban areas, a lack of regulation exists regarding the activities carried out in ports. The complaints of citizens living close to the harbours pushed the authorities to face the problem. In this context several EU Interreg Maritime research projects have been launched in last few years. Each project is focused on a specific aspect of the problem, but all of them have in common the implementation of a network of sensors aimed to the monitoring of the noise for long periods of time. Such monitoring activity will generate a huge amount of data that must be collected, integrated and stored in a proper database in order to be accessed in a second time. The data can then be used for the management of the harbour (e.g.: by changing the docking position of ships) or to support the decision making in terms of mitigation strategies. In this paper possible ways of storing and managing the data will be described.
Keywords: noise monitoring; harbour noise; database; noise pollution; environmental noise.

1. Introduction

People living near port areas are often victims of noise pollution from port activities [1]. This noise can cause health problems, such as sleep disorders [2], discomfort [3, 4], learning difficulties [5, 6], cardiovascular and respiratory diseases [7, 8], and hypertension [9, 10]. Although several studies related to noise from ports have been addressed [11, 12], the rules and regulations are not as explicit as in other sectors (road, rail and industry). Some ports have already approved measures to manage noise pollution in different locations [13], but these types of studies are highly dependent on the specific environment.

Since a wide range of noise sources (e.g. cargo loading and unloading, container handling, people embarking and disembarking, shipyards, industrial machinery, etc.) operates here simultaneously, the port area is a more complex environment to study if compared with other ones [14]. Despite its complexity, some scholars [15, 16] have developed algorithms that allow the identification, classification and localization of ships based on the sound emitted; these algorithms are useful for monitoring maritime traffic and for identifying the source of noise in monitoring systems.

This work is part of the EU Interreg Maritime Programme [17, 18] and has as its purpose the design and construction of an interoperable database set up with a level of accessibility such as to guarantee participation even in ports not directly involved in the project, but qualified and interested in sharing the planning on acoustic monitoring. This database collects information regarding the actual operational activity that takes place inside the ports and the noise produced. The direct measurement of the noise produced in the port is closely related to the correct preparation of the acoustic monitoring systems that describe the overall noise pollution levels, for the benefit of the ports themselves, of the competent in-

stitutions for environmental protection and of citizens exposed to pollution. All this to allow joint planning of the interventions to reduce noise levels, and to allow port decision-makers, in choosing the location of port activities, to plan operations according to the principles of environmental sustainability.

2. Database structure

The application was created with Visual Studio 2019 Community edition, using the C# language and the .NET framework 4.8. The application was designed and structured to be able to respond to specific needs in case of need:

- data sharing: the information stored in a database must be accessible by more than one person, even at the same time;
- data integration: a database should be a collection of data which, at least ideally, does not have redundant data;
- data integrity: it must reflect the general sense of the aspect to be modeled;
- data security: to ensure the integrity of a database, it is necessary to limit access, diversify the functions according to the user and protect the data;
- data abstraction: the information stored in a database is usually a support to represent the properties of some objects;
- data independence: the organization of data must be transparent and safeguarded both for users and for the application programs that feed on data, even if a change is made to a part of the application system.

The proposed database design (illustrated in a simplified way in figure 1) has 5 classes within it:

- development of the actual website: thanks to the MVC (Model-View-Controller) pattern, the entire presentation part was developed, using the potential made available by the .NET 4.8 framework;
- entities: these classes have the purpose of communication between the the business layer (BL) and the data access layer (DAL);
- interfaces: allow to list all the interfaces necessary to implement if the DAL has to be changed;
- DAL.SqlServer: this section contains all the data access logic, including the database entities, written in Entity Framework Code First, the migrations to be able to create and update a SQL Server database and all the implementations interfaces previously described;
- Tool.AddUser: creates the first active user.

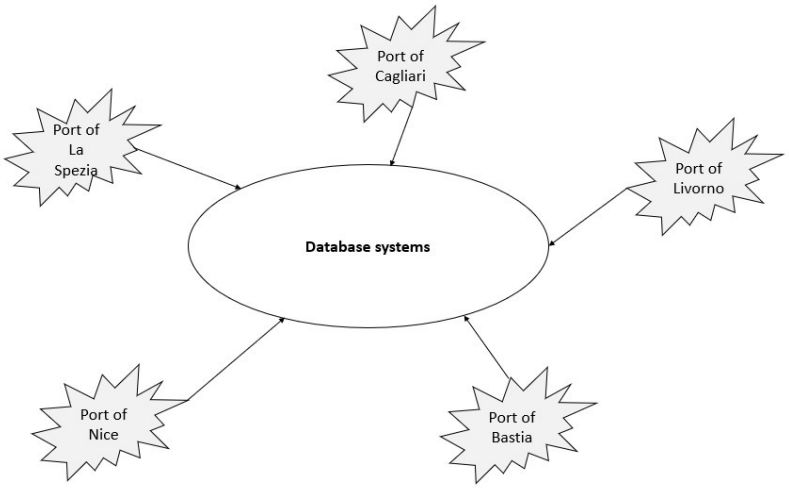

Figure 1: Database design.

From a practical point of view, all enabled users with a computer, a tablet or a smartphone can choose to view the data from the selected sector of the database by simply clicking on the desired icon.

3. Recording and Storing data

The system can essentially be divided into two parts (Figure 2): the data acquisition unit installed in the individual ports and the centralized data collection unit located in a server. In detail:

- the data acquisition unit installed in the individual ports is positioned at strategic points to give more information on the responsibility for the noise emission, its task is to acquire the acoustic parameters and send them to the collection server;
- the centralized data collection unit has the task of receiving data, storing and publishing them in real time on a public or protected web page.

The data acquisition unit is connected to the collection unit by means of a transmission channel based on the GPRS network, Ethernet / DSL network, wireless, etc ... The whole system thus configured allows data to be sent through the transmission medium chosen for an unlimited time, whereas the documents will be saved on the filesystem.

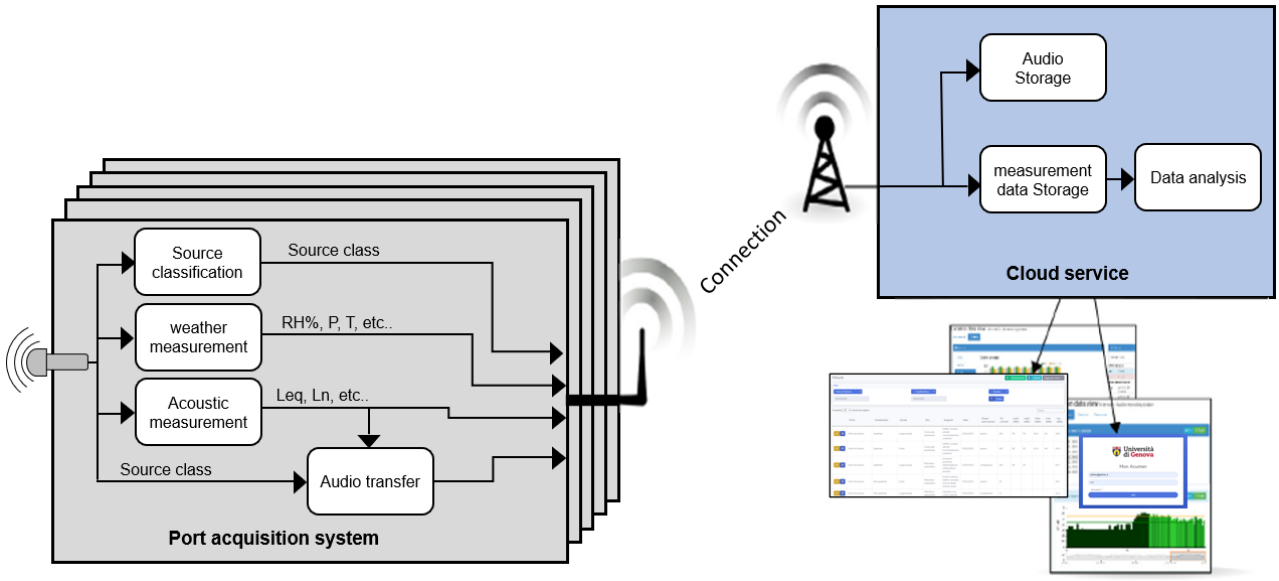

Figure 2: Functions of the Database system.

4. Database management

The database chosen is SQL Server (Express version). The database model was defined according to the *code first* paradigm: C# classes were then written to represent the objects needed to run the application. Subsequently, thanks to the migrations made available by the *Entity Framework*, the database scheme was created (Figure 3).

The main entities are:

- user: contains the personal data of each user; a user can have associated roles, and all the operations performed by him are recorded in the "Operations log" table; at the same time, his name is kept in all documents uploaded to the system;
- measurements: contains all the data recorded in the system; each measurement, in addition to its own data, is identified by a port and by two other kinds of informations, e.g. characteristic and duration (these are user-configurable fields).

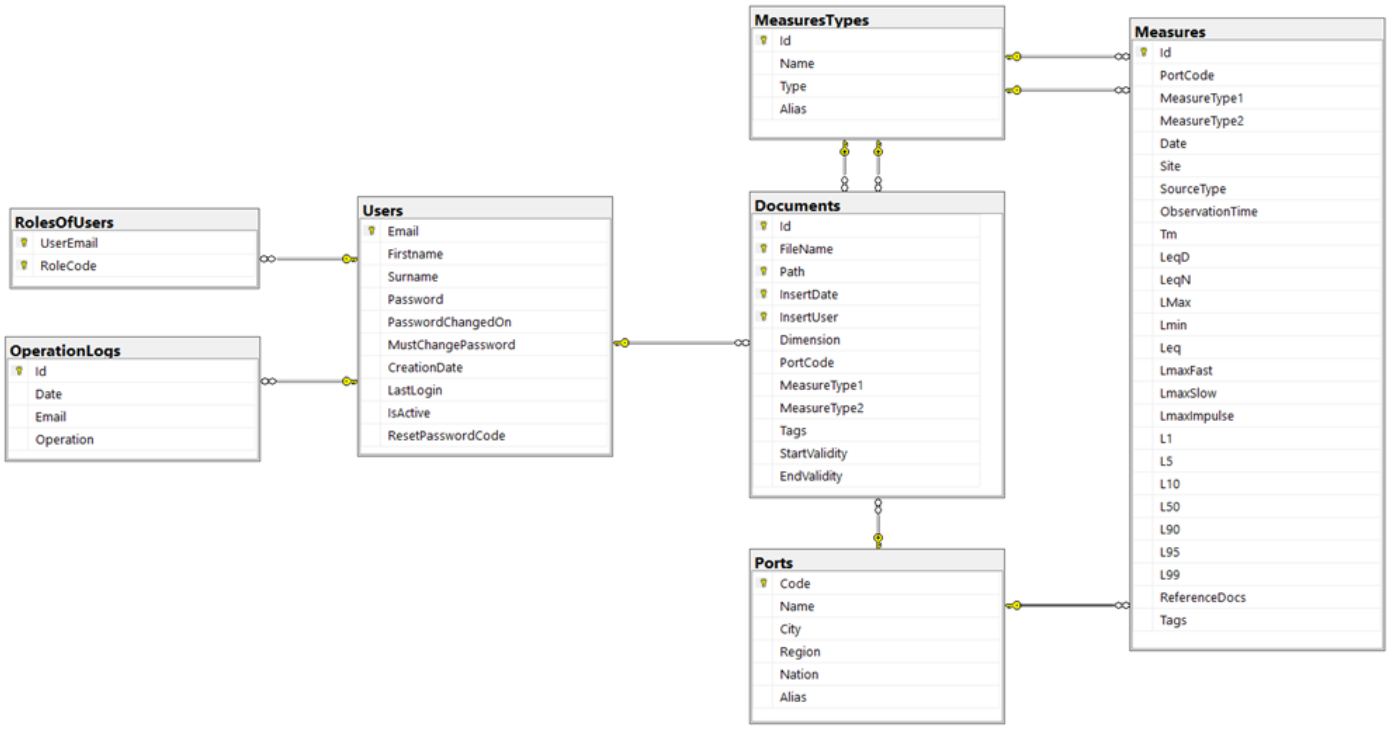

Figure 3: Database layout.

5. Application

All measurements acquired during the activities are available in the database in: excel or csv files, audio WAV files, audio-video MP4 files and photo documents. The database makes it possible to compare data obtained from acoustic and meteorological monitoring systems and an interchange interface facilitates cross-border sharing. In addition, it has in its archive files containing a data matrix that allows a port noise classification based on the description, identification and distribution in time and space of port activities that can potentially contribute to the global noise climate generated within the port areas. These port activities are carried out by the means that characterise the main noise sources, which can be divided into two groups: fixed sources and mobile sources (land traffic, sea traffic).

For each stationary source, the following are reported: the type of source, its location in the port, its operating time (start and end time), its distance from the measurement sites, the measured noise events, the number of measurements made, the number of records made and the type of power supply (diesel or electric). While for each mobile source, the following are indicated: the paths and geolocation in the port area, the speed of movement, the operating time (time spent in the port area), the type of operation performed, its distance from the measurement sites, the measured source events, the number of measurements performed, the number of cards made and the type of power supply (diesel or electric).

The description of each source provides the undoubted advantage of having an up-to-date noise mapping, making it possible to know the cause of the noise emission (sound level in frequency and time) in the event of criticality or complaints from the population. The descriptive framework of the port activities will then help all port enterprises in the co-operation area to make environmentally aware investments and to set up their own pollution prevention systems combined with more environmentally friendly investments, in order to encourage public decision-makers to choose less polluting equipment and facilities for port concessions.

6. Conclusions

This paper describes a methodology for the real-time capitalisation of large amounts of data collected from port acoustic monitoring systems within the EU research project Interreg Maritime. The advantages of this methodology are manifold: it completely eliminates problems due to storage space limitations, it allows the downloading of data without the need to move, and it enables easier and more effective internal data sharing between the ports involved in the project. Furthermore, it guarantees accessibility and participation also to ports that are not directly involved, but are qualified and interested in sharing the planning on noise monitoring, so as to form a cluster of information concerning the real operational activity taking place in the ports and the noise produced.

Finally, the inclusion of more recordings in the database is very useful for the detection, classification, identification and tracking of the main sources of acoustic noise in port areas.

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