Easy set-up system for monitoring the conservation conditions applied to historical violins

Markus Krüger,
MPA Universität Stuttgart (Hrsg.)

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EASY SET-UP SYSTEM FOR MONITORING THE CONSERVATION CONDITIONS APPLIED TO HISTORICAL VIOLINS

M. Fioravanti[1], G. Goli[2], L. Uzielli[3], S. Campinoti[4], P. Mazzanti[5]

ABSTRACT

In the framework of a research dealing with the conservation of the historic violin "Guarneri del Gesù'" 1743 known as the "Cannone" owned by Genova (IT) Municipality a monitoring campaign was performed in order to verify the hygro-thermal conservation conditions. Up to now the violin displaying/conservation case area was equipped with two *temperature* and *relative humidity* probes in order to monitor continuously the environmental conditions the violin was subjected to. The probes were acquired by means of an A/D converter and a notebook hidden in the lower part of the display/conservation case and configured to be remotely accessible. After few years of monitoring and after having modified the case in order to obtain a better *RH* control a new hygro-thermal measurement set-up was decided and designed. Together with the "Cannone", also the "Vuillaume" (another violin owned by Genova municipality and exhibited in the same room) as well as the room will be monitored. The new system, not yet implemented, is based on wireless modules, in order to allow for a simple set-up and to avoid expensive and more complex cable connections. The hardware is composed of 4 wireless devices, both battery and network powered, equipped with *RH*, *T* and *light intensity* sensors. Data collection will be performed by CEAM CWS32 acquisition and displaying software running on the Genova Municipality server facilities. The software provides a web-interface in order to allow remote access to Conservators and Curators as well. E-mail alarms will be set-up and triggered according to given rules. This paper presents in some detail (a) *T* and *RH* dynamics over time acquired in two different periods, as well as (b) the wireless system which will be implemented in a near future.

Keywords

Violin, Guarneri 'del Gesù'; Cannone; Niccolò Paganini, wireless sensors, relative humidity, temperature, conservation

1. Introduction

Historic musical instruments are objects of a great value because of several reasons: because the wood they are made is old and a lot of importance is given to this fact by the players, because of the manufacturer, because of the players that have owned and played the violin, because of their sound. Several instruments during their history were largely modified in order to adapt their sound to new trends. These changes (one common operation was the adaptation of the neck to modern geometries by replacing the original one with a new one) were performed because a special value was ascribed to old violins (in terms of old wood and distinctive sound). These instruments, considered by the players and violinmakers as musical instruments instead of a cultural heritage, in a large number were completely re-adapted. This is not the case of the "Cannone" violin, made in 1743 by Giuseppe Bartolomeo Guarneri "del Gesù" and owned by the great violin player Niccolò Paganini. After Paganini's death, the violin, according to his will, was left to the city of Genova, where he was born. This was an important fact for the violin conservation because after Paganini's death the instrument has maintained its own integrity. In the year 2004 an important restoration for the accessories and the set-up was undertaken by the violinmaker and restorer in charge of the violin conservation Bruce Carlson assisted by his colleagues Alberto Giordano and Pio Montanari (AA.VV., 2004). This operation would allow for recovery of the historical image of the "Cannone" as it was when it was bequeathed to the City of Genoa in 1851. Nowadays the "Cannone" is on display in the Paganiniana Collection in Palazzo Tursi, part of the Museums of Strada Nuova located in Genova (IT). As regards wood conservation and especially violins conservation one of the main

[1] DEISTAF / University of Florence, 50145 Italy, marco.fioravanti@unifi.it

[2] DEISTAF / University of Florence, 50145 Italy, giacomo.goli@poste.it

[3] CEAM Control Equipment, 50053 Italy, s.campinoti@ceamgroup.it

[4] DEISTAF / University of Florence, 50145 Italy, luca.uzielli@unifi.it

[5] DEISTAF / University of Florence, 50145 Italy, paola.mazzanti@unifi.it

problems can be considered the physical ageing (Hunt & Gril, 1996) of the material. Physical ageing could be determined by the effects of both moisture variation and mechanical stress, as well as the coupling effects determined by their interaction over time. In order to better understand the hygro-thermal stress the violin is subjected during its conservation a monitoring system for temperature (*T*) and relative humidity (*RH*) conditions was implemented. After the first monitoring period some modifications were performed in the display/ conservation case and in the room in order to stabilize as much as possible the environmental conservation conditions. Once good conservation conditions were reached, a new monitoring system for the violins and for the room was designed.

2. Material and Methods

2.1 T and RH Monitoring Inside the Displaying Case

In order to monitor *T* and *RH* inside the display case two Rotronic Hygroclip probes (accuracy ±1 % RH, ±0.3 °C) with analogue output were used. One was placed in the upper and one in the lower part of the violin display area in order to verify the differences inside the case. The probes output was digitized by the means of a Measurement Computing 12 bits USB board type PMD USB-1208LS set to work between ±1 V in differential mode connected to a PC driven with National Instruments LabVIEW. One sample was collected every 5 minutes. The data shown are the result of an average between the upper and lower probe.

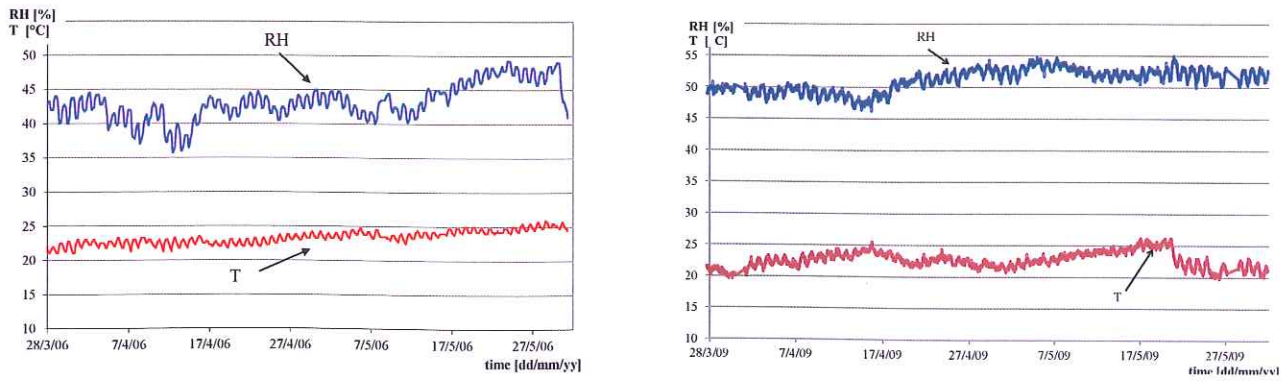
3. Results

3.1 T and RH trends inside the displaying case

On the *T* and *RH* trends inside the displaying case of the "Cannone" violin (see *Figure 1*) different superposed trends can be observed. A daily trend resulting from the day and night cycle, a medium frequency cycle depending on particular events (dry or humid weather due to different kind of wind, rainy periods etc.), and finally, a low frequency cycle depending on seasonal environmental parameters. In this paper these trends will not be analysed into the details, only the improvements resulting from modifying the cabinet after the monitoring campaign will be highlighted. In *Figure 1* the situation of the "Cannone" displaying/conservation case at the beginning and at the end of the project is shown. As shown in *Figure 1a*, for the period 28/03/2006 - 30/05/2006 the average *RH* value is computed to be 41.9%. This value in general is considered to be low for a proper conservation. At the same time a 2.5 value of standard deviation and an interval of 12.1 % between maximum (47.9 %) and minimum (35.8%) *RH* values are computed. The temperature is more regular because the trend inside the displaying/conservation case is the direct result of the external conditions. The average temperature is measured to be 22.8 °C.

After this first monitoring period the display/conservation case was modified. As a first step the ArtSorb moisture conditioner were placed closer to the violin instead then inside a drawer placed in the lower part of the case. This allowed the ArtSorb to work properly and improve the conservation conditions. As a second step a glass plane placed under the violin was removed in order to allow the ArtSorb to work properly even being hided in the drawer. This simple solution resulted in a relevant improvement of the conservation conditions.

As it can be observed in *Figure 1b*, for the period 28/03/2009 - 30/05/2009 the average *RH* value is computed to be 51.1 %. This value is higher than the one measured before the display/conservation case was modified and more in line with values for proper conservation. Moreover lower data variability was observed with a standard deviation computed to be 1.8 instead than 2.5 as measured in the previous period. The fluctuation cannot be avoided but in this case is reduced because the interval between the maximum *RH* (55.2 %) and the minimum *RH* (46.1 %) results in a maximal *RH* variation of 9.1 % (the one before modifying the display/conservation case was 12.1 %). These conservation conditions improvements are confirmed even by the measurements conducted up to now.



a b

Figure 1 Relative humidity and Temperature trends inside the display/conservation case before (a) and after (b) having modified the case

4. New displaying case monitoring set-up

Once that the conservation conditions were optimized, a final hygro-thermal measurement set-up for the room and the displaying/conservation case was decided and designed. The new system was designed because considered fundamental for the proper conservation of the violins. The main futures of the new system are:

- real time monitoring by web based technologies;
- e-mail and SMS alarms.

These two functions have to be considered as fundamental in order to react promptly in case of problems. Together with the "Cannone" violin, also the "Vuillaume" (another violin owned by Genova Municipality and exhibited in the same room) and the room will be monitored. The new monitoring system, not yet implemented, is based on wireless communication technologies. This technology was chosen in order to allow a simple set-up and to avoid expensive and more complex cable connections. The acquisition hardware is composed of 4 wireless devices model C310-DLA produced by CEAM Control Equipment and working at a wireless frequency of 869 MHz. This frequency is not very directional and in general these devices are able to cover areas with a radium from the gateway going from 150 to 300 m according to the attenuation resulting from local barriers. The sensors will be both battery (PoLi) and network powered, equipped with *RH*, *T* and light intensity sensors. The *RH* accuracy is ±3 % *RH*, the *T* accuracy is ± 0.4 °C, the light intensity sensor works on a range between 400 and 780 nm and can measure between 0.3 and 10000 lx. The battery will guarantee the continuity in the data acquisition in case of power black-out. The devices will be positioned as follows (see *Figure 2*):

- 2 devices in room that being very wide and with the heating system on one side could present different environmental conditions in different emplacements;
- 1 device in the "Cannone" displaying/conservation case;
- 1 device in the "Vuillaume" displaying/ conservation case.

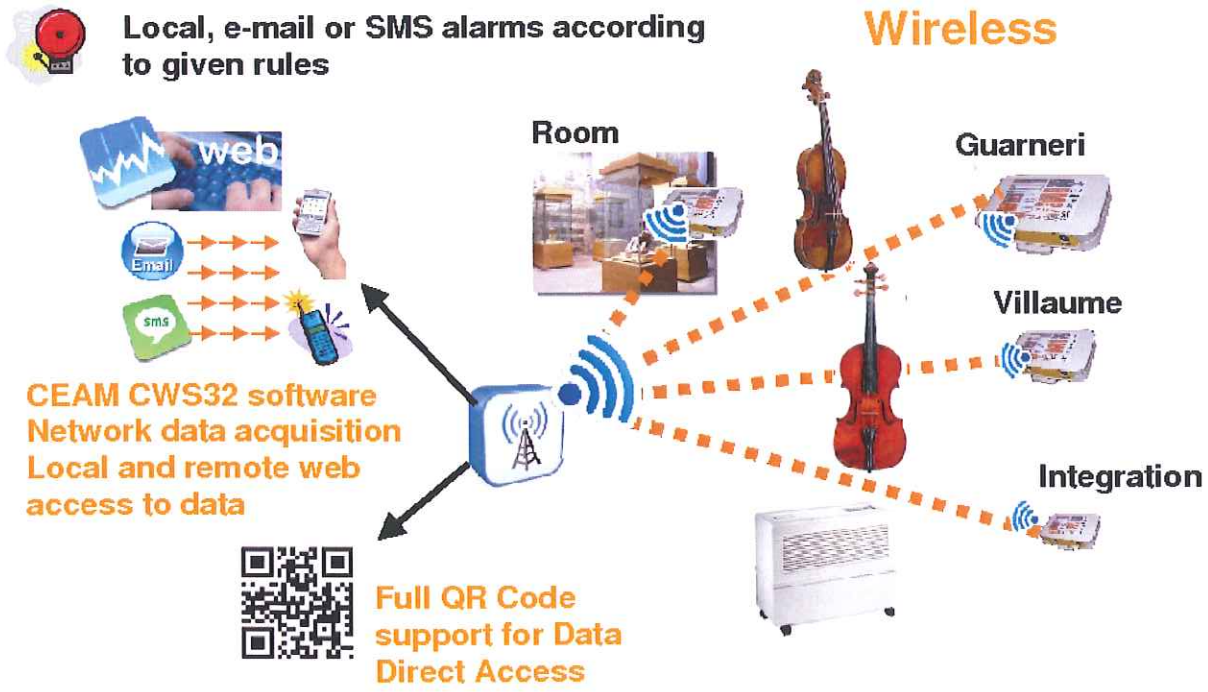


Figure 2 General scheme of the new monitoring system

The acquisition devices are equipped with on-board memory working circularly in order to avoid as much as possible data losses and overwriting. The four wireless monitoring devices will be connected to a wireless gateway model D9020 produced by CEAM Control Equipment and connected to the Local Area Network. Data will be collected by CEAM CWS32 acquisition, analysis and data displaying software running on the Genova municipality sever facilities. The software provides data logging functionalities over Ethernet, a control panel completely configurable in order to customize the data visualization (photographs, indicators, graphs), a web-interface in order to allow local and remote real time access and control to Conservators and Curators as well, SMS and e-mail alarms to be triggered according to given rules (a given time over a given threshold for one variable for example). The general scheme of the whole system is presented in *Figure 2*. The web interface in particular is very important (see *Figure 3*) because it can allow

people to access the system for monitoring reasons or to retrieve any kind of data. Different permissions can be set in order to allow Conservators and Curators to access every section of the data base while for the public internet navigator only a restricted part of these information could be made available. The system is an open system, new acquisition devices can be added without any particular action on the hardware, just configuring a new channel on the software. Several further considerations should be outlined on the system in order to add new points of view to those already presented:

- the system is fully supporting QR Code generation and Data Direct Access. This function could allow Conservators and Curators to store detailed information about the violin in the software data base and the visitor to access (by a tablet or a smart-phone with a normal camera and a free software) authorised areas of these information during the visit in the museum;
- the software have a maintenance module allowing the scheduling of given operations and the starting of a procedure whom advancement can be kept under control by a QR Code system if needed;
- the network of sensors can be expanded as needed, one gateway can manage 20-40 units without problems (the limit is the amount of data to be transmitted) and in the software there is not limit to the number of variables to be acquired;
- the system can be integrated in local control processes such as conditioning, light control as well as inside special applications (building management). One application already planned after the first basic installation is the integration of a wireless module inside the moisture generator placed in the instrument's room. This would lead the logger to be connected to a level sensor in order to manage water level alarms of the moisture generator device. This would result in an e-mail or SMS when the water level in the tank is low.

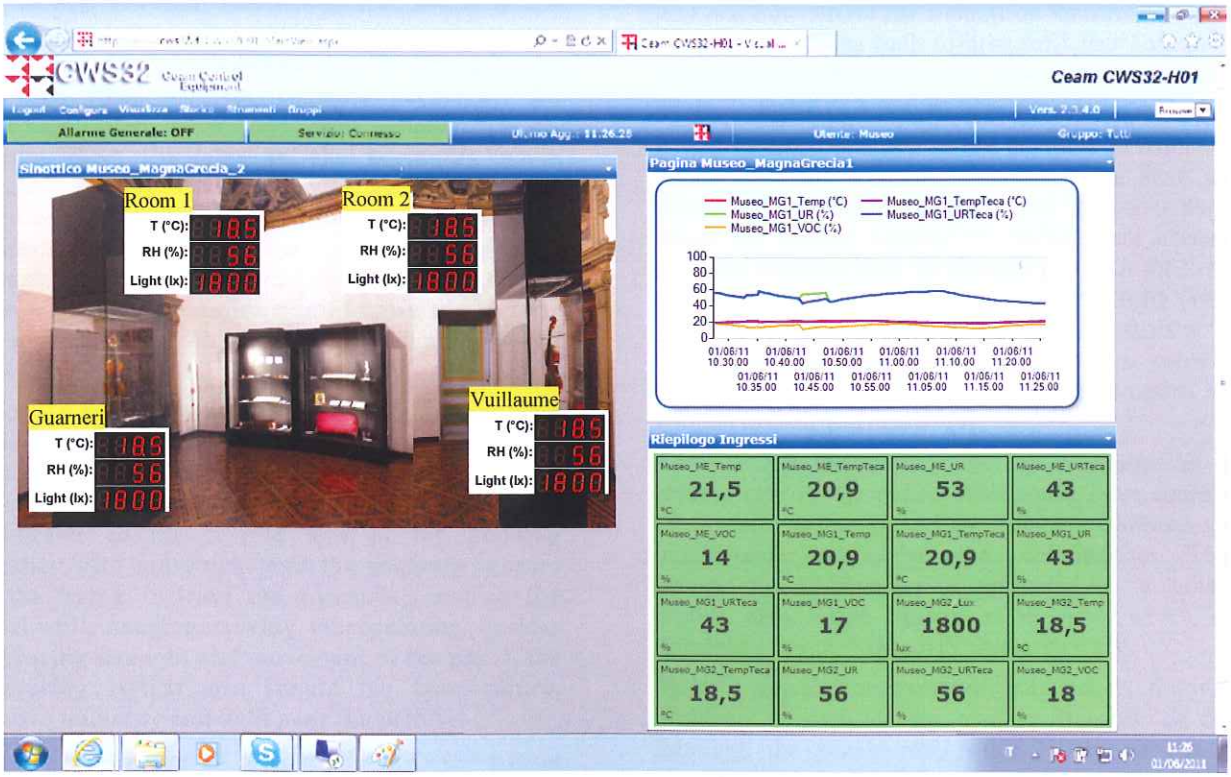


Figure 3 Monitoring web interface of the software

5. Conclusions

A monitoring campaign to determine the conservation conditions of the "Cannone" violin was undertaken. This allowed to understand some problem of the display/conservation case and helped us to enhance the conservation conditions by making some modifications. Once the conservation conditions were considered to be suitable for the violin a final monitoring set up was chosen. The system chosen was based on wireless technology in order to reduce the installation costs (no special wires are required and the power supply is already present). The data will be acquired by software installed on the Genova Municipality web-farm assuring service continuity and high standard of data safety.

6. Acknowledgements

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7. References

[1] AA.VV. (2004). Atti del Convegno Internazionale di Liuteria Recupero e conservazione del violino Guarneri "del Gesù" (1743) detto "Cannone." Comune di Genova.

[2] Hunt, D. G., & Gril, J. (1996). Evidence of a physical ageing phenomenon in wood. *Journal of Materials Science Letters*, *15*(1), 80-82. Springer Netherlands. Retrieved from http://dx.doi.org/10.1007/BF01855620.