Connected Archaeological Sites

- Mosaic Climate Survey and the IoT[1] -

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Introduction

Climate and condition surveys are crucial tools to understand deterioration phenomena and trends of architectural surfaces (such as mosaics) and have therefore been widely employed in conservation practices. At the mosaic site of Orbe-Boscéaz, we consider these tools very important as we encounter significant salt crystallization and frost cycles.

A weak point of climate survey in the past has been the follow-up on installed sensors. Those who have ever been involved in climate surveys have likely encountered inconsistent, faulty, or simply forgotten sensors, some of which were out of order for weeks or months, leaving gaping holes in the climate data. Furthermore, locally-stored climate recordings cannot trigger reaction from the remote conservator.

The Internet of Things, describes the interconnection of all objects via the Internet, and does not stop at archaeological sites. In this poster we present our open-hardware, open-source approach to remotely monitoring climate in a reliable and inexpensive way.

Figure 1: Mosaics are conserved in protective buildings designed like one-room houses.

Context

The archeological site of the *Villa romaine of Orbe-Boscéaz* contains several mosaics. These mosaics are conserved in protective buildings designed like one-room houses (Figure 1).

Our offices are approximately forty-five minutes away from the mosaics and we usually pass by for check-ups (and eventually interventions) four times per year.

This is not enough if we want to discern the extent to which salt crystallization cycles are happening, or if during a long period of cold frost reaches the mosaics. Additionally, when a climate control system has been installed in two buildings in the past, we do not know when malfunctioning occurs or if it actually does what it was designed to do.

For those tasks, we required a remote climate monitoring system which we based on the Internet of Things.

To fit the requirements of being:

- GSM-compatible;
- inexpensive;
- easily modulable;
- sustainable at data storing;

we opted for an open-hardware, open-source approach.

Method

Logger

For the climate survey we use an open-hardware system from *Yoctopuce*, a Swiss startup. Their relatively inexpensive environmental climate modules contain high-quality temperature and relative humidity sensors from *Sensirion*. These modules can communicate through a corresponding hub with data networks (Figure 2).

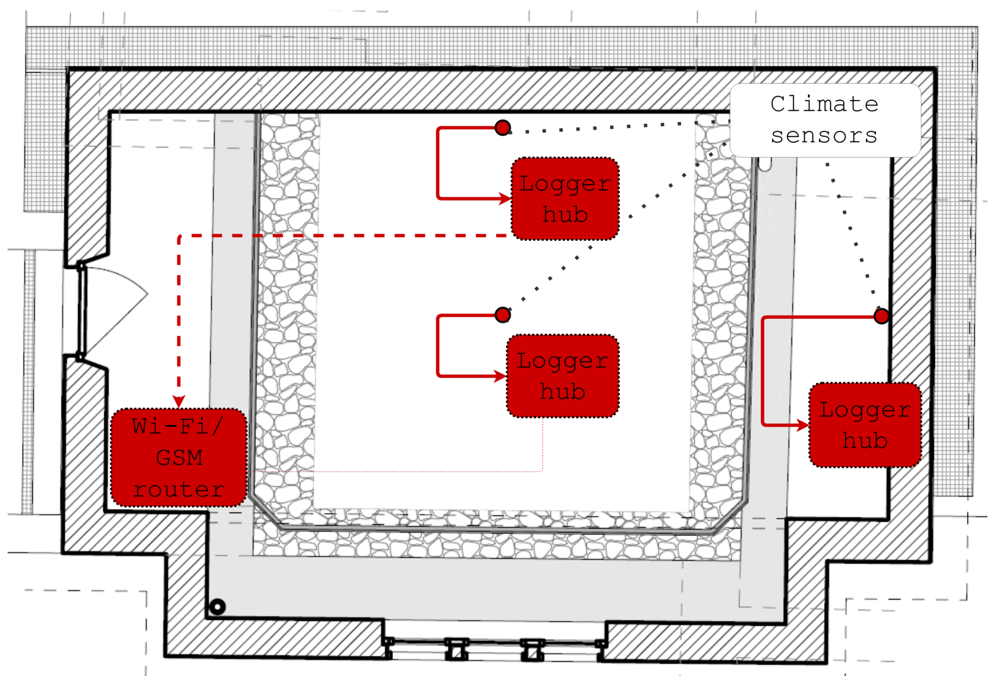

Figure 2: Climate sensors communicating with logger-hub and Wi-Fi/GSM router at Pavilion 4.

The devices are configured to send the values of temperature and relative humidity every five minutes.

Posting data

The data is sent via the HTTP request method POST. This looks like:

http://api.thingspeak.com/update?key=XXXXXXXXX&field1=70.1&field2=7.4&created_at=2017-10-17T01:02:03Z

which means:

api.thingspeak.com -> address

update -> update request

key=XXXXXXXXX -> key to the data storage

field1=70.1, field2=7.4 -> contains the logged values of relative humidity and temperature.

created_at=2017-10-17T01:02:03Z -> contains the time at which the values were logged.

Our POST request looks slightly more packed because we squeeze the climate data of three loggers in one POST request.

Once the climate measurement is taken the destination of the data is the platform *Thing Speak* (Figure 3-a). *Thing Speak* is an established open-source "Internet of Things" application and API; it stores and retrieves data using HTTP over the internet. *Thing Speak* will also send notifications via Twitter (Figure 3-b).

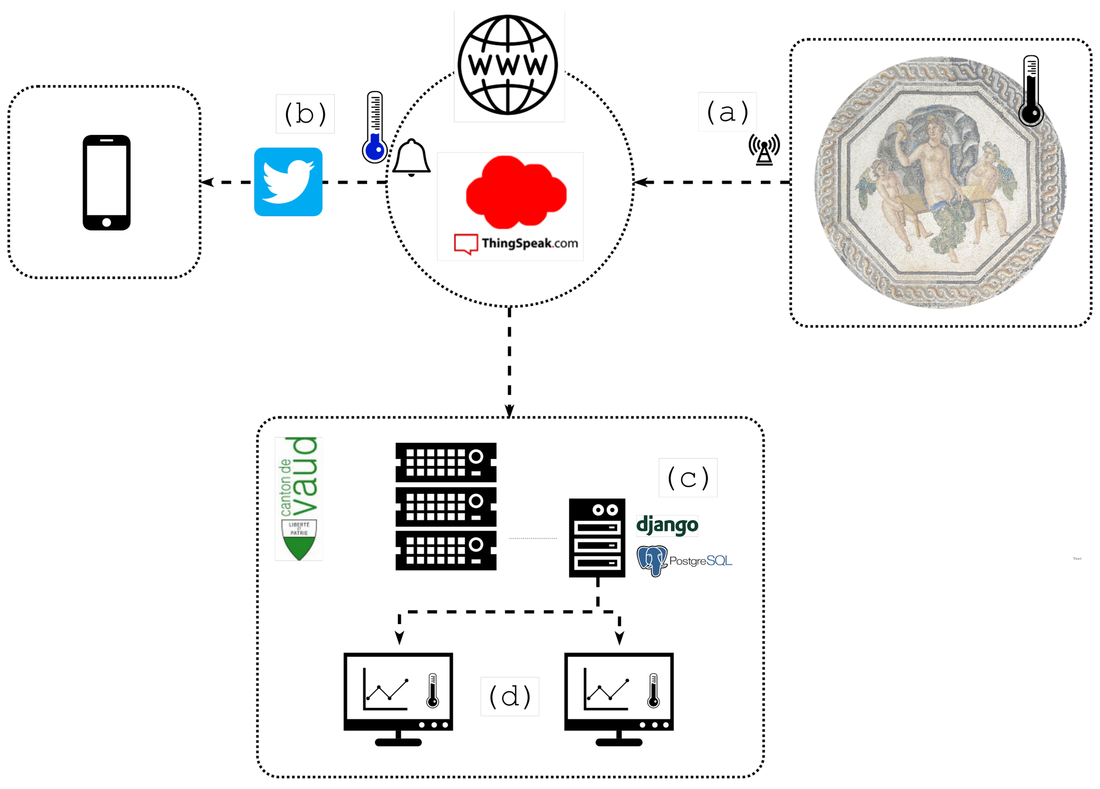

Figure 3: (a) The climate data is sent to the *Thingspeak* cloud; (b) alerts and reports are transmitted via *Twitter*; (c); the data is downloaded to a local server and is (d) explored on a browser.

These notifications can be weekly reports, alarms when a sensor fails, or critical values of temperature or relative humidity are reached.

The data is sent through the GSM network. For the data of three loggers, we estimated a total amount of 1.3MB/month.

Local server and user interface

The second part of the remote climate survey system is mounted on a local server containing the *Django*-based *ClimateSurveyApp* (Figure 3-c). In a browser interface, the user queries the data of a specific sensor (Figure 3-d). The *ClimateSurveyApp* checks whether new data is available on *Thing Speak* and downloads new entries.

The climate graph is generated through the app using the *Plotly* library. The visualized data can now be explored interactively or downloaded for report usage (Figure 4).

Within the administration interface of the *ClimateSurveyApp*, projects and loggers can be defined and channels to the *Thing Speak* platform are configured here as well.

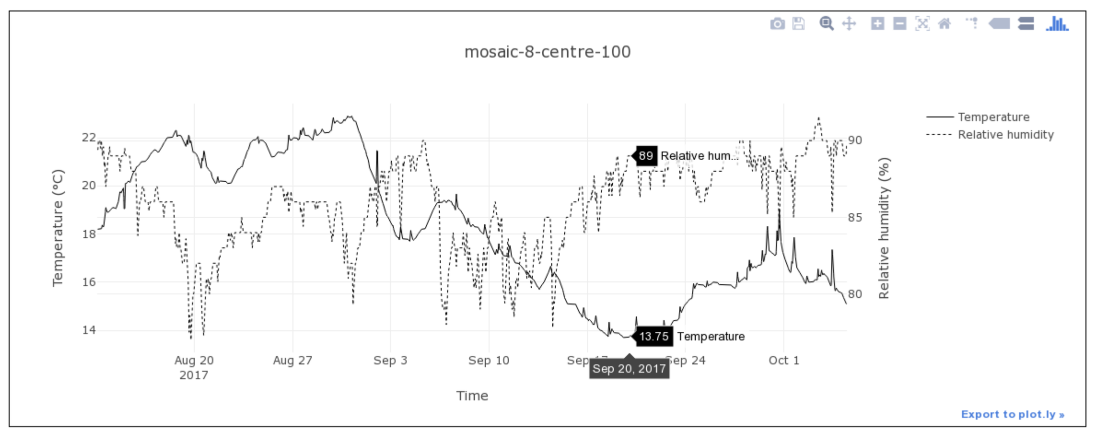

Figure 4: Example of a explorable graph output through the *Plotly* library.

Employment

The *ClimateSurveyApp* application will be available for usage or improvement at *GitHub*. It ideally runs on a Linux server but it can be equally hosted on any desktop PC.

Conclusions

By combining open-hardware and open-source applications we are able to follow up on environmental climate changes at the Orbe-Boscéaz mosaics. The method proposed uses inexpensive but precise open-hardware modules. By using the open-source "Internet of Things" application *Thing Speak*, we have a reliable and free method for initial data storing in the cloud. Through the employment of the Django framework and the representation through the *Plotly* library, climate plots can be easily generated and explored. The modular construction of the system is a great strength as each module, hardware or software, can be exchanged at a given time by another product if necessary.

We have just gotten closer to our mosaics.

Acknowledgements

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[1] Internet of Things