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IMPLEMENTATION OF TABLETS FOR PERIODICAL CALIBRATION OF MONITORING SENSORS AND DATA READING

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ABSTRACT

Dam monitoring comprehends several tasks that have to be carried out periodically on the dam. These are not just limited to reading of manual data but also include the calibration of sensors and other maintenance works. In order to optimize these tasks, handhelds can be used.

In this article an innovative solution is described that manages periodical calibration works for monitoring sensors, combining a software for handhelds with a web based management and control system for monitoring data. A bidirectional synchronization allows the transmission of forms and tasks to the mobile devices and return collected information to web platform. In this way, different maintenance tasks for the monitoring team on site are scheduled, assigned and reviewed. Therefore, custom-built forms for the calibration of different monitoring sensors and forms for the reading of manual data were elaborated.

The main functions of the adapted solution and the experience gained during the development and implementation are described.

1. INTRODUCTION TO DAM MONITORING

Dam Monitoring plays a key role within the framework of Dam Safety. It aims at managing risks and reducing the probability of occurrence by providing a means of early identification of undesirable events that can possibly cause failure. In order to avoid misinterpretation of monitoring data and guarantee the reliability of monitoring systems, it is essential to provide representative and precise data. This is achieved through periodical maintenance works of all elements of the monitoring system.

One important task of periodical maintenance for guaranteeing a long life time of sensors and other elements is keeping them clean and protect them from humidity and dirt. But not less important is a periodical calibration of sensors and automatic data acquisition systems. Often an apparently correct working monitoring system can provide data that might lead to misinterpretation just because of not being calibrated. Due to the long lifetime of sensors and external conditions on the dam site, it is essential to review the accuracy of data and, if necessary, recalibrate sensors. Malfunction sources can be found in the proper sensor, but also in its physical installation, the data acquisition system or the communication system. On the left photo of Figure 1, an automated data acquisition system is reviewed and calibrated and on the right photo, the value of a measurement weir is controlled.

The calibration of monitoring systems has to be done periodically and should be documented. This is especially important for dam owners that are in charge of several dams. A good organization of the monitoring team helps to optimize site visits and the execution of works for example by combining maintenance tasks with manual data reading.

Figure 1 : Review and calibration of automated measurements

In this article, an innovative solution for the planning and execution of calibration tasks and data reading is presented. It combines the application of tablets and digital forms with the monitoring platform DAMDATA. The described solution is currently being implemented for a dam owner in charge of more than 50 large dams.

2. GENERAL DESCRIPTION OF THE SOLUTION

The solution is integrated in the dam monitoring management tool DAMDATA. It comprehends an additional function tab for the organization of field work, both manual readings and system calibration, and an application for the installation on handhelds.

2.1 Introduction to DAMDATA

DAMDATA is a web based application that runs in a conventional internet browser and does not require any installation of additional software. It is freely configurable and gathers and processes automated data in real time. Hand readings can be input directly via web or imported in files or through handhelds.

DAMDATA transforms raw data into engineering values either by means of a free configurable formula editor or by providing algorithms for more complex calculations as needed for inclinometers. It gives detailed information about monitoring data, independently of the manufacturer of the sensors and the automated system.

It includes SCADA views, flexible and multiple threshold value configurations for each sensor and numerous options for multivariable graphical visualization of monitoring data. A statistical model allows a more detailed analysis of data and forecasting for different scenarios in the future. A warnings, events and alerts manager incorporates the management of Emergency Action Plans.

In Figure 3, an example of the graphical visualization of monitoring data and SCADA views prepared with DAMDATA is shown.

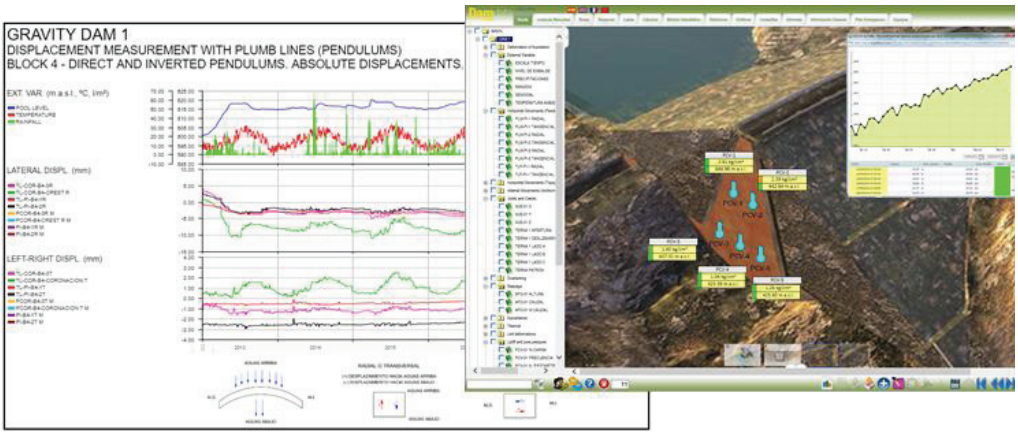

Figure 2 : Example of graphical layout and SCADA in DAMDATA

2.2 Management of field works

Main monitoring tasks that require field works are manual data reading and maintenance works of the physical installations of the monitoring system, especially reliability control of data and calibration of sensors.

Therefore, a planning tool was incorporated within DAMDATA in order to plan field works and manage the obtained information.

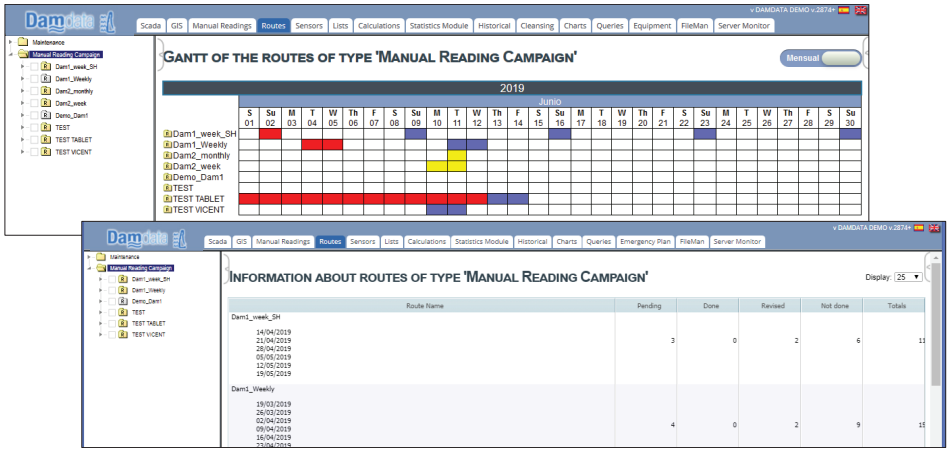

Figure 3 : Example of planning tool in DAMDATA

The concept is that only the people in charge for the organization of the maintenance personnel can assign the works or routes that have to be done on site. For each route he defines personnel, periodicity of works, dates, dams and the corresponding sensors. The maintenance personnel is automatically informed about the works to be done and receives all necessary forms on their mobile devices. After completing the works and filling out the forms, DAMDATA is updated with the progress of works.

The engineer can review and approve the information received. He always provides updated information about the progress of works, for example if they are pending, finished, not done or reviewed. This can be shown in tabular view or with bar charts.

As soon as the received information is approved, the data is made available for other users and can be used with all other functions incorporated within DAMDATA.

3. DIGITAL FORMS FOR MOBILE DEVICES

In order to guarantee high flexibility and compatibility with mobile devices, an application for Android systems was developed.

The access to the app is managed with username and password. In that way, the planned tasks and corresponding forms are not related to a certain mobile phone or tablet but to the user or the technician who has to carry out the tasks and fill in the forms.

The app synchronizes with DAMDATA and the user receives the planning with the related forms. In order to guarantee a correct preparation of site visits, the planning for several days is made available.

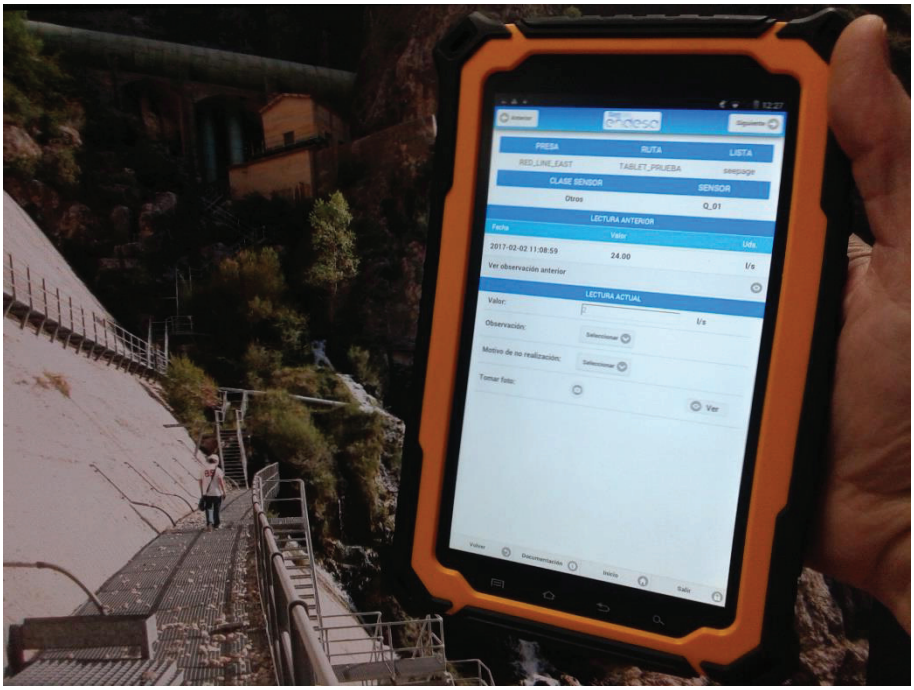

Figure 4 : Application of tablets with digital form for manual readings

3.1 Sensor calibration works

As mentioned before, sensor calibration works are a fundamental aspect of maintenance works for any monitoring system, in order to guarantee precise and representative data.

The works to be done during the calibration depend mainly on the sensor and the type of signal that is generated, but also on the automation and communication system. Therefore, customized digital forms were prepared for different sensor types, such as PT-100 thermometers and vibrating wire piezometers. These forms are not static and can be customized by the user as well. They are opened with the Android application of DAMDATA.

After measuring the raw value of the sensor with a multimeter or other reading device, the monitoring technician fills in the measured data in the corresponding field of the calibration form. Since these fields are programmed as active fields, the application automatically calculates the engineering values and compares them with the values obtained through conventional measurements. It can synchronize with the system in order to compare values taken and calculated at the same time within DAMDATA and the automatic data acquisition system, offline or online in realtime. Also historic data is available for comparing with values taken during the last weeks. In this way, the location of a possible wrong calibration can be identified and easily be corrected during the same visit.

Different acceptance ranges can be defined in order to classify the obtained value as adequate, sufficient or unacceptable. Both raw values and calculated engineering values are compared.

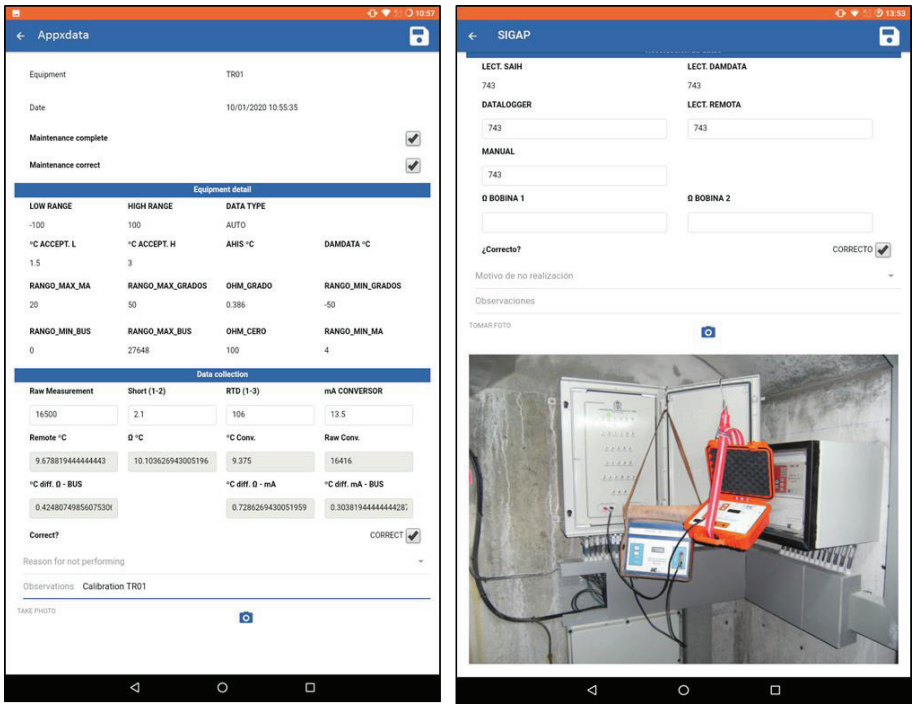

Figure 5 : Example of mobile form for sensor calibration works

After completing the forms, they are synchronized with the DAMDATA platform and can be reviewed by the user. In this way, a complete registry of all calibration works with results is made available.

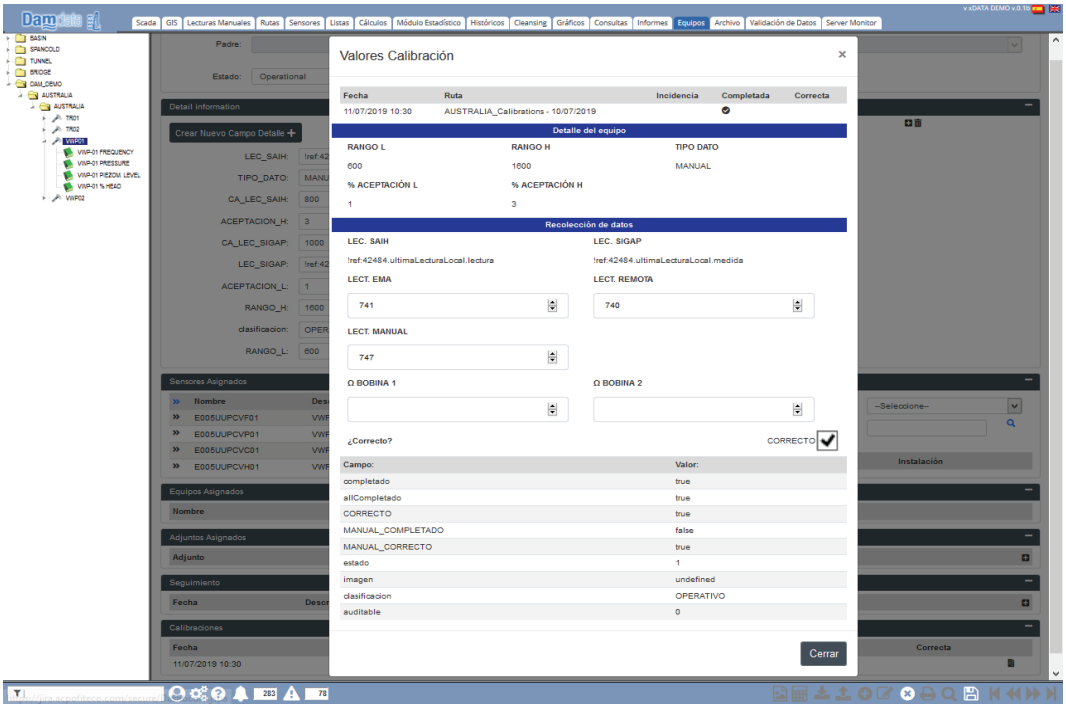

Figure 6 : Example DAMDATA interface for review of calibration sheets

3.2 Manual data acquisition

Sensors to be read are grouped in DAMDATA relating to sensor type, location or specific planning and according to the specifications of the surveillance plan. In this way, the user receives different forms for a group of sensors and can optimize the site visit.

As the digital forms are synchronized with the database of DAMDATA, time series of historic data can be queried which allows the user to compare directly on site the current reading with previous readings. In that way, erroneous

readings can easily be identified so that the user gets the opportunity to repeat the reading and provide more precise data. Especially for manual readings that are made less often, each reading is valuable and should be precise in order to get the maximum benefit of each site visit. In figure 7 an example of the interface for manual readings and review of previous data is shown.

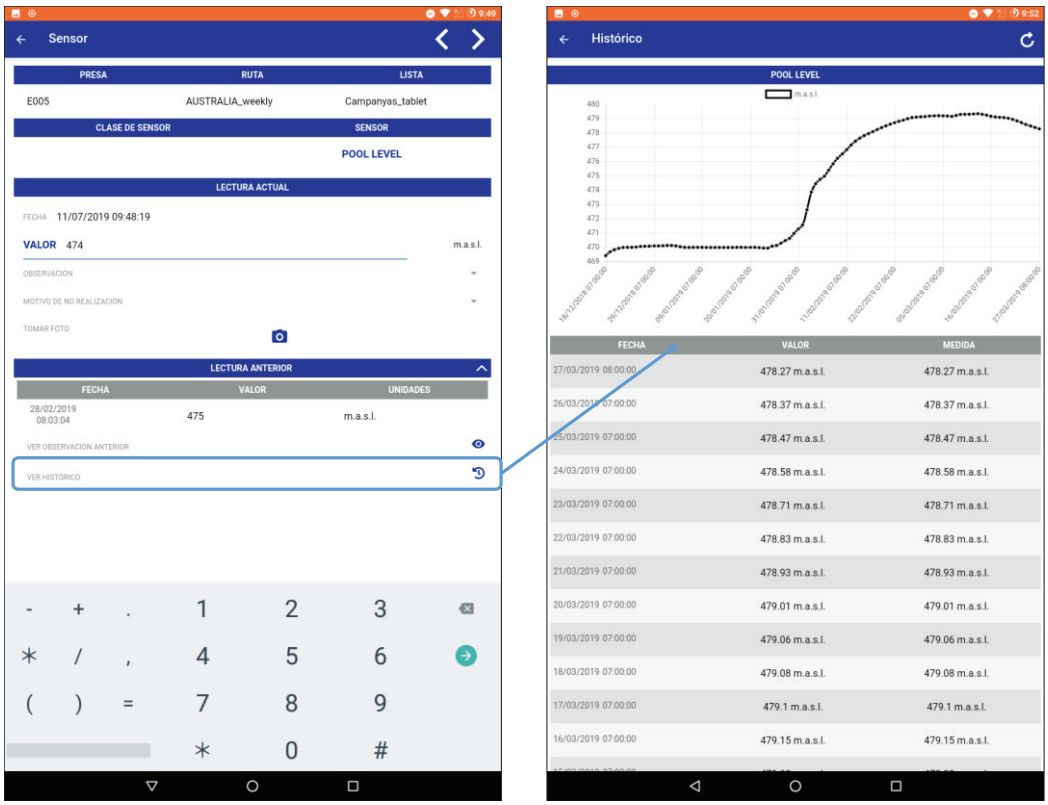

Figure 7 : Example of interface for manual readings and review of previous data in DAMDATA app.

The forms for including manual reading data allow the incorporation of additional information, such as special observations and the upload of photos. Site visits for hand readings are not just made for data acquisition but also for updating information about the current state of the monitoring system and carrying out basic maintenance works. Especially on dams without permanent qualified personal, the obtained information during each site visit is valuable and should be registered in order to avoid the loss of information. This input can be used for future dam behavior evaluations and the planning of necessary maintenance works.

In order to be aware of sensors that are not read or cannot be read, the user is obliged to fill in the reason for not doing so. This can be for example a sensor malfunction, access difficulties or dirt.

After completing a form, it is transmitted to the DAMDATA platform where it has to be ap-proved by the engineer in charge. Then, all data included in the form is automatically incorporated in the corresponding fields of the database and can be managed with the different visualization and evaluation tools.

4. CONCLUSION

Monitoring works include many different tasks that do not only comprehend data reading and interpretation but also maintenance works and calibration of sensors. An innovative software solution was shown that helps the dam owner to manage these activities and fulfill the requirements of the monitoring plan.

Through a centralized monitoring web platform, the dam engineer assigns specific tasks such as manual data reading or sensor calibration to the maintenance team. They receive detailed information of the corresponding sensors through digital forms on handhelds and can fill them in directly on site. Results are synchronized with the web platform and are approved and managed by the engineer in charge directly from the office.

In that way, resources and workflows are optimized, paperwork is reduced and the quality of data improved. This is of great importance for dam owners of several dams and limited human resources who need to optimize field works. Especially the calibration of the monitoring system, an important task that is often neglected, is carried out accurately.