A new, effective way of Storing, Reporting and Visualizing Geotechnical data on a Web Page

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Abstract: It is generally well known that data handling in Geotechnical measurement systems can be time consuming and therefore a hindrance on the road towards making effective decisions when problems arise. Throughout years of work taking all kinds of field measurements, an automatic data handling system has been developed that addresses most of the problems associated with data collection, data storage, visualization, reporting and alarming. The result has greatly lowered the cost of data handling and has improved access to data for browsing and reporting for all involved.

1 – Introduction

Immediately after the instruments and dataloggers have been installed, data collection, data storage and data handling begins. To most engineers and scientists, the amount of data can quickly become overwhelming and it requires quite some effort to keep the data collection system up and running, not to mention the tedious work of keeping all the data in an organized manner. When data is kept in ASCII files, a spreadsheet is the most common tool for viewing data and plotting, but such a method is slow and cumbersome at best.

What is needed is an automatic process that will store data in a database, allow for setup of individual pre-defined trend lines for each site, and an access controlled web site for engineers and scientists to work with the data and make reports. This method can result in great savings with respect to data handling cost not to mention the time savings for the professionals that work with the data and who need to make effective decisions. It has been shown that a well organized data handling system can lower data handling and reporting costs by as much as 80%.

The following text describes the main features of Vista Data Vision, which is such a geotechnical data handling system.

2 – Data Base storage

The benefit of a data base is that all your data is stored at a single location and is organized to be used any way you desire. Data base storage is a huge step forward compared to keeping ASCII files as data storage. When data is kept in a data base, an automatic data browser can be used to plot data and compare in a speedy and flexible way. If the associated data browser does not offer all the options needed, the user has the ability to write their own SQL queries to the data base for specific reports.
Data is not added to the data base automatically, a “robot” is needed to monitor when new data has arrived and to store that new data in the data base. The data can be organized to be linked to a set of other dataloggers, as well as to specific customers, in order to prepare reports for that site and/or for that customer.

An important feature of the data base is the ability for the re-naming of variables where field sensors get real names instead of general engineering nomenclature. This new name, also called The Alias Name, can then be used throughout the system in all graphs and reports.

<table>
<thead>
<tr>
<th>#</th>
<th>FSL Name</th>
<th>Alias Name</th>
<th>Unit</th>
<th>Unit Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tran_Peak_inv</td>
<td>Tran_Peak</td>
<td>Select</td>
<td>in/s</td>
</tr>
</tbody>
</table>

Figure 1: An example of Alias Name, where the engineering nomenclature of a variable has been adjusted slightly to better suit use in graphs and reports.

3 – Visualization

Probably the most important of all features is the ability to display trend lines of measured data. Such graphs should be pre-defined and organized such that the engineer or scientist can understand what the data is indicating by simply glancing at it. Consequently, it becomes an easy process to check all data daily or even at more frequent intervals.

Figure 2: Trend lines showing 4 days of tilt data. The Scale and Scroll controls and the directional arrows allow users to view any time period.
By viewing longer periods of time, data can often show interesting trends. In the graphs below, 2 months of data are displayed, indicating a long term decrease in strain in Pile A and a sudden drop in temperature in Pile B. Interestingly, the strains in Pile B show an increasing trend.

Figure 3: 4 graphs with total of 16 variables are on display. The trends are easily recognized.

By clicking on any graph, it opens up in an enlarged format with new options, including check-boxes to hide one or more trend lines, and mini-report boxes showing maximum, average and minimum values of the data on display.

Figure 4: Seismic data from 3 sensors, clearly indicating some noise on the signals.
4 – Rolling Average

Noise, spikes and disturbance on signals can easily hide the actual value being measured. One classical method to “clean” a signal is to use the Rolling Average method. Several Rolling Averages may be configured using different rules. A common rule is to use 10 readings before and 10 readings after the actual value being processed, then by summing the 21 values and dividing by 21 to get the average value. In reality, the engineer has to use a trial and error method to determine the optimum rolling average parameters to use.

![Graph showing the original trend line and its corresponding Rolling Average version, using a +/-8 method.](image)

5 – Web Maps

Web Maps are ideal for showing an overview of numerous sensors at any location, using any photograph or drawing as a background. The sensors may be displayed as small boxes initially showing in green color but turning into yellow or red if an alarm condition is initiated. By moving the mouse above the sensor box, the most recent sensor value will show.

Web Maps can also be configured to display groups of sensors each associated with the value, complete with unit, alarm status and the latest update time stamp.
Figure 6: Cross section of a dam, showing sensor position along with their alarm status as shown by green, yellow or red colors. Values from sensor P1 are visible as the mouse (not visible in this figure) scrolls over its sensor box.

Figure 7: This is from the same cross section as figure 6, this time showing sensor group boxes, each with all sensors on display together with their green, yellow and red alarm status.

6 – Virtual Variables

Virtual Variables allow the creation of calculated variables that may be a function of one or several other variables often processed by a simple or complex calculus. A recently added feature is the ability to copy a (complex) equation and use it as the foundation to create a new virtual variable, a feature that greatly reduces creation time and lowers the risk of mistakes.

Figure 8: Typical template for Virtual Variables
7 – Alarms

The purpose of alarms is to lower the burden of monitoring all data at regular intervals. There are certain values that are easy to monitor and alarm, and there are others that require the keen eye of an experienced engineer to understand and forewarn of an alarm condition.

Alarms can be sent as emails and/or sms to cellular phones, as well as being visible on the Alarm Overview panel of the web site and web maps. Alarms may be acknowledged by authorized users via controls on the web site.

Alarms are used to monitor if values exceed or drop below a pre-set limit. Most common limits are labeled LowLow, Low, High and HighHigh. These limits can be individually set for each variable, along with the option of excluding certain variables from the alarm process. Most often only a handful of variables are considered for alarming. One of the most obvious alarm conditions is the battery voltage of the datalogger. A common operating voltage is 13-13.6Vdc. In the event that the mains supply fails, the battery voltage can drop to 12.5V or even lower if battery is weak, thereafter the battery voltage will slowly drop. When the battery voltage is at 12.0V, the battery only has 10% of its capacity remaining and the datalogger system is liable to collapse. In this case, the LowLow alarm threshold can be set at 12.0V and the Low alarm threshold at 12.4V. The Low alarm sent will indicate power outage and the LowLow alarm will inform that it is time to take remedial action.

One of the new features in VDV is the “Delayed Alarm”. Here, an alarm will not be sent unless the value has been constantly in alarm state for a specific period of time. This delay will filter out noise and short-duration peaks that might otherwise trigger false alarms.

Another new feature is the Update Monitor. Here, updating of data is monitored for arrival at preset intervals. As an example, say data is collected from a datalogger every 1 hour. If new data has not arrived for 2 hours, it indicates that something is wrong and an update alarm will be sent.

By monitoring the battery voltage and perhaps certain other variables in addition to the update monitor, the operation of a data collection system can become much more reliable with very little intervention by its staff.
8 – Web Access and Access Control

If the data is posted to a web page, engineers and scientists can access it from any location to check sensor values and so make decisions. Additionally, once the data is available, it is also possible to give other users access, for example, the owner of the site, or the principal engineer or others that might have a vested interest in the project. As there may be data for several projects in the same database, an access control becomes necessary such that each user can only access the data to which he is authorized. Further restrictions may also be required, such as to disable the feature to download from the web site, or a limit to the number of graphs or time period that is available to the user.

Figure 11: Some of the options that can be assigned to a username/password on the data web server.

9 – Automatic Reporting

Automatic Reports may be created at regular intervals, storing the report as a text file or Word document, and/or sending the report via email to the engineer for final verification and approval.

Figure 12: A selection from an automatically created report, showing daily average values for several sensors over a month, along with summary values for each sensor.
10 - Conclusions

The benefit of a well designed and fully equipped database handling system lies in the short time it takes to implement, the reduced installation and operation costs and the great savings in time and money that can be realized for all parties involved.

Other than an organized storage of logged data in a database, easy access is of greatest value. From there, web access to data, access control, alarm service and automatic reporting clearly becomes the backbone of a streamlined data handling system to ensure the highest quality data service at the lowest operational cost.

11 - References


12 - Authors


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