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The mobile Tracker

Hydrolink

Figure 1.
Mobile Tracker
measuring a water level

THE MOBILE TRACKER

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Every year water districts can save a fortune by making measurements from the field more cost-efficient. Field measurements are often still jotted down in a notebook, only to be manually processed at the end of the week. These measurements are then sent to the boss, who archives them. This whole procedure can be reduced to one click using the Mobile Tracker.

Introduction

Water boards are responsible for managing the water in their area. To do this, they must know the behavior of their catchment very well. The most direct way of doing this is through measurements. Measurements are also necessary to calibrate physically based, numerical models, to better understand the water systems and forecast extreme scenarios. A third reason why water boards take measurements is to satisfy agreements with neighboring water districts. Finally, these field measurements are used for the operational managements of pumps and gates. It can thus be said that measurements are the heartbeat of water management.

Measuring Automatically

Many water quantity variables are currently automatically measured and sent to a central database. The costs for such automatic measuring apparatus have declined in recent years, which is why the number of measurement spots is still increasing. Rising management and maintenance costs will, however, lead to a saturation point in the number of automatic measurement apparatus: Wear and tear from outside weather, dirt from organisms in the water, animals and vandalism are only a few of the reasons for which the apparatus frequently needs to be replaced and maintained. Measurements that are done by hand are much less susceptible to such wear, and will thus in many instances remain an attractive measurement method in several locations in the area. An additional benefit is that water district employees continue to operate in the field, and thus can identify problems which are not noticed by automatic apparatus.

Manual Measurements

The problem with manual measurements is that these are less accurate than automatic measurements and often cannot be completely reproduced. The first problem primarily has to do with entering data manually, while the second problem is caused by different colleagues in the field taking measurements in different ways such as rounding up differently, incorrect use of measurement apparatus or an inability to see the readings. The recent, "Gage Repeatability & Reproducibility" [Tennant 2001] field experiment conducted at a water district in The Netherlands revealed how substantial these mistakes can be.

Table 1. Results from measurement experiments using different measurement tools or methods by experienced field operators.

	Standard deviation (mm)			
	R&R experiment 1	Uploading experiment 2	Total	95% significance
tape measure	4.7	9	10	20
measuring stick	8.1	9	12	24
staff gauge	2.0	9	9	18

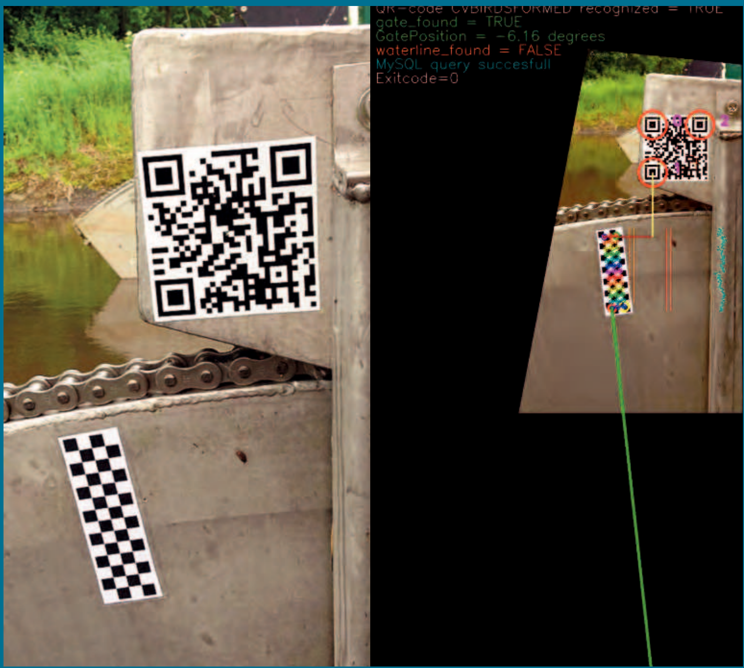

Figure 2. Mobile Tracker measuring a gate position (on the left is the original photo, on the right the manipulated photo with the perspective correction and how the angle resulting in the gate position is determined)

Figure 3. Mobile Tracker measuring a ground water level

Inaccuracies caused by manual data entry were also researched. The first experiment revealed how inaccurate measurement data was when read from measurement tools in the field. The second experiment revealed the inaccuracies in jotting down and analyzing the measurements taken. The results from these two experiments together revealed the total inaccuracies from the field data.

The data used in the gage R&R experiment was taken from three experienced operators on three different locations that used three different measurement tools: tape measure, measuring stick, and local staff gauge fixed to the embankment.
This gage R&R experiment determined the standard deviation of the different measurement tools. The tape measure has a standard deviation of 4.7 mm. This means that the measurement value taken from the tape measure is (with 95% significance) within 9 mm (double the standard deviation) of the true measure. For the other measurement tools (measuring staff and staff gauge this is respectively 16 mm and 4 mm.
The second experiment, whereby the measurement values are manually entered in a laptop and later in a central system led to a further 9 millimeters of standard deviation (thus a 95% significance of the true reading being almost 18 millimeters different from the one uploaded). This second experiment was done using 1000 measurement readings. The total inaccuracies can be determined by, per experiment, adding up the squared values and taking the square root of this summation. These results are shown in Table 1. It can thus be said with 95% significance that the uploaded reading is within 20 millimeters of the true measurement.

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Real-time Measurements

Another difficulty with manual measurements is that these are noted down and are only later added to a database for further use. As a result, these data are not a reflection of the actual state of the water system, and are thus not suitable as a basis upon which to take operational decisions. The measurements are often only available weeks after they were taken for

further use and analysis. While there are currently several systems in use which make it possible to make the data directly available to a central unit, these all require manual uploading of the measurements.
A recent innovation called The Mobile Tracker (MT) can be seen as the next generation of semi-automatic measurement devices. MT is made for the smart phone and uses the telephone's camera and special pattern-recognition software [Shih 2010]. This technology makes manual data entry of water variables unnecessary.

Mobile Tracker

The Mobile Tracker works as follows: When a field operator arrives at a location, they take the smart-phone and start an application that makes contact with the central database. The application uses the GPS coordinates and angles of the smart phone to identify the location and store all the relevant data. For water level measurements these would usually be the reference level, subsidence of the staff gauge and known impairments of the staff gauge. For flow measurements these are, for example, width of the gate and calibration coefficient. For ground water measurements it is the level of the top of the groundwater pipe. With one click on the app, a photo is taken and from the photo water variables such as water level, flow and groundwater level can be measured. These values are then sent to a database and saved including information pertaining to location with a time check, the field operator on duty, GPS coordinates and camera angles. The photo is also sent and saved with the other information. The advantage of this procedure is that is faster than manual data and no data errors can be made. Because the photo is saved, it can be referred to afterwards using the correct photo at the right place and at the right time to verify concerns about inaccurate readings or disputes about a presumed situation. The central system can be managed from FEWS [FEWS 2013]. The Mobile Tracker is also connected to WISKI [WISKI 2013]. Figure 1 to 3 indicate the measurement methods for water level, gate position/flow and ground water level.

Conclusion

The Mobile Tracker is an innovation that makes manual measurement of water variables significantly faster and reproducible. The procedure for taking measurements is as simple as taking a photo with a smart-phone. It can thus also be used by less experienced personnel. In exceptional circumstances it could even be used by farmers in remote areas or students passing a stream on their way to school. The only requirement is a smart-phone.
The Mobile Tracker is currently being tested at different water districts in The Netherlands. The initial results have shown an accuracy of less than 10mm.

References

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