EXPLOITING OLD TECHNIQUES FOR UNDERWATER SURVEYING AND METROLOGY

Underwater Metrology

Photogrammetry has existed as a method for more than hundred years. Digital techniques and data power have made it possible to exploit another side of photogrammetry, Close Range Photogrammetry.

Close Range Photogrammetry is the name given to the ingenious technique of ascertaining from two dimensional images spatial data such as the size and position of objects. Blom Maritime AS began using this technique onshore in the early 90s for customers in the oil industry. While it certainly showed promise, technological restraints prevented success. However, with the advent of improved digital cameras, enhanced software and faster computers, Blom returned to this technique in the late 90s and carried out underwater measurements in the spring of 2000.
There are a number of advantages to using Close Range Photogrammetry. It is flexible and perfect for areas that are dangerous or difficult to access, i.e. under water. The fieldwork can be completed quickly and, if necessary, additional data can be computed from these existing images long after. The technique is very exact, delivering results correct to within 1/10,000 of object size, which is important for many engineering purposes.

How it All Began

A request from the offshore industry in 1999 to measure an anchor support where traditional survey methods did not meet the required accuracy, led to developing the concept of using Close Range Photogrammetry under water. Several attempts had been made in the past to use photogrammetry under water. Most had not been very successful, perhaps because the method used was based on stereo photogrammetry and film-based cameras. Blom needed to run tests and prove that Close Range Photogrammetry using digital techniques could now successfully address the tasks.
Together with Stolt Offshore/Statoil, the method was tested in a watertank onshore. Imenco supplied a suitable underwater camera for the test, which proved that photogrammetry was a suitable solution for the task in hand. The challenge was to survey ten bolt holes on an anchor support of approximately 2x2 metres. Due to the construction, the position accuracy of the centre holes had to be better than +/- 0,3mm. The task was carrried out to the client's full satisfaction.

Field Operation

Before image acquisition can begin, the ROV (Remotely Operated Vehicle) places marking equipment on and around the object according to a prepared photo plan. The ROV then takes the camera down to the survey site. It eases ROV operation that the position and orientation of the camera is approximate. The camera sends back video images, which are viewed by the team in the vessel control-room. They are then able to determine the best shooting position and settings. Depending on job size, several hundreds or thousands of high-resolution images can be acquired during one trip. These are saved on the in-built computer's hard drive. After all the images have been acquired the camera is brought onboard the vessel for downloading and quality control.

Method Acceptance

After the first job was completed with success, a number of requests came in from the oil industry or related companies. In the early days the photogrammetry concept was mainly used as a backup system to existing methods. As time has gone by, however, Close Range Photogrammetry has become more and more accepted as a stand-alone method. This is mainly thanks to the accuracy, short mobilisation and field time, ease of changing scope in the field and not being influenced by acoustic noise etc. An additional advantage is that photogrammetry gives the same accuracy in all three axes (XYZ). During the first two years after the success of the anchor support survey, we were mainly asked to carry out smaller-object surveys, like HUBs, flanges, nodes and tees. Mostly the requests for accuracy were between 1 and 3 millimetres.

The Valhall Project

At the beginning of 2002 we were challenged by Halliburton/BP to carry out for the first time a long-route underwater survey. A distance of 37 metres between two pile centres had to be determined. The total distance to be surveyed was approximately 70 metres along existing framework/piles. The task was to determine the exact distance between the centers of two piles to be used as bucket guides for a new platform. The clearance between the bucket guides and the mounting piles was only 70 millimetres. At that time we could promise an accuracy of only +/- 50mm. The client therefore required this accuracy to be within 97% confidence. Studies allowed us to confirm that this could be accomplished.
Marking equipment was planned for 5 metres visibility. After our arrival offshore bad weather reduced the visibility in water to 2 metres. The marking equipment setup was changed accordingly, on-the-fly. We proceded to split the survey area into two halves. Marking equipment was placed closer together than had been originally planned in order to cope with the shorter photo distance; and it was reused

on the next half after the first half had been surveyed.
The measured distance showed quite some deviation from the asbuilt drawings. The pile guides were installed on the new jack according to the measured distance. It fitted perfectly, and photogrammetry had again proven its exellence. If the asbuilt data had been used it could have caused problems.

The Way it Works
Before work starts offshore, a photo plan and field procedure are established. The plan is confirmed with the client and marking equipment is prepared. The photo plan is a 3D representation of the object, with marking equipment and approximate camera positions. Offshore, ROV operators place the marking equipment, and then acquire images according to the photo plan. The staff onboard the vessel guides the ROV operators in order to ensure that enough images are taken from the correct positions. After the images have been downloaded to the working computer and quality controlled, processing may start onboard the vessel. Normally processing is completed onshore. Several control routines have been established to ensure that the promised accuarcy is achieved. The result is usually presented as 2D drawings in a report; however, 3D models are also possible.