ADOPTICUM

REVOPOINT – Range 3D Scanner

This document gives a brief overview of the Range 3D Scanner from Revopoint. It is based on evaluation of the sensor performed by Stiftelsen Adopticum in a project financed by Kempestiftelserna. For more information about the sensor, please feel free to contact Adopticum.

Quick facts

- Strucured light
- 300-800mm work distance
- Up to 0,1 mm accuracy in one single frame
- 360 mm x 650 mm @ 600 mm
- RGB-camera

The **Range 3D Scanner** from Revopoint is an infrared structured light scanner, using an IR projector with dual IR cameras to capture depth images in a sequence to scan entire objects, with possible color information included through the scanner's RGB camera. The scanner offers a working distance of about 300 – 800 mm and can capture an area of 360 mm x 650 mm in one frame. It is possible to scan relatively small objects, like a shoe, as well as objects as big as a car, under the right conditions. However, there are many things to consider when scanning an object for the results to turn out well, and it is important to remember that there is a learning curve before the user learns how to properly use the scanner, if the user lacks previous experience.

The scanner works together with the software program Revo Scan (version 5 at the time of writing), available for Windows, Mac, Android and iOS. This software communicates with the scanner and gives the user visual feedback during the scanning process to help the user get good results, like showing the scanned point cloud as it grows while the user is moving the scanner around the object, together with the active scan measurement area. The user can see what areas remain to be measured and the program also gives feedback if the scanner is losing track of its position, prompting the user to return the scanner to a position where the tracking algorithm can find points at the object that it recognizes.

The scanner can communicate with a computer or a smartphone through either USB or Wi-Fi. When buying the sensor package, it includes a power bank handle that the scanner can be attached to without needing to be connected through a cable to the user device (computer or smartphone), which makes moving the sensor around easier. A phone holder is also included, making it easy to use

a phone with Revo Scan to comfortably keep track of the scanning progress while moving the scanner around simultaneously. Keep in mind how much memory your device has available when scanning large objects or multiple scans.

After the scanning is completed, there are different post-processing tools available in Revo Scan. The user can fill in holes in the point cloud, remove specified parts and otherwise clean up the 3D data (smoothing, overlap-detection and more). By performing Fusion, which merges point cloud data into a unified model, a complete solid mesh can be created from the measured point cloud. If the RGB data from the RGB camera is chosen to be included in the Revo Scan settings, a textured mesh is also created. The user can also merge point clouds together if the overlap between the clouds is big enough (at least >10 % as a guideline), if the full object is deemed too hard or time-consuming to capture in one single scan. Examples of 3D models created form several merged point clouds can be seen in Figure 1 and Figure 2 below. In marker mode, where the software is looking for markers on the objects and uses them to track the camera's position relative to the object to scan, the user might have to manually select several (at least 3) points in the clouds that correspond to the same point on the real-world object for the merge to work.

The precision of a single frame is specified to be able to reach 0.1 mm. The error in precision for a complete point cloud is harder to estimate, since the error can grow larger as more and more of the object is scanned, particularly for large objects. With practice the result can get better and better. But the accuracy of the resulting 3D data can be kept to a couple of mm, but also easily increase up to even cm level for the full length of an object. In Figure 3 below a scanning of a flat table can be seen. Several attempts were made, with the best result reaching about ± 2.0-3.0 mm from the actual length and width of the scanned object. The table was 798.0 mm wide and 1599.0 mm long.

When creating a mesh from a point cloud in Revo Scan, the Fusing process uses a chosen point distance between 0.3 – 2.0 mm, which lets you choose to a degree how dense the resulting fused point cloud will be.

The scanner's limitations include difficulties when scanning flat/uniform surfaces where it is hard to distinguish details in the depth data, since the scanning tracking algorithm needs to be able to locate itself between frames to build a complete accurate point cloud. Using the marker mode (in Revo Scan) and placing markers on the surface to be measured, the problem can be solved. With the purchase of the sensor, make sure that reflective sticker markers are included since they can prove to be very useful.

The scanner similarly can have difficulties when scanning reflective, transparent and black surfaces, without first treating the surface to be scanned in some way (like using scanning spray). Also, the IR light from the scanner's projector can be drowned out by ambient light like sunlight, making its usefulness limited for outdoor applications in broad daylight.

The cost for a Range 3D Scanner is about 7 000 – 13 000 sek, depending on the package you choose. Premium package includes a turntable, which makes scanning objects easier where the object is rotating around its own axis while the scanner can be stationary during scanning.

Revopoints Range 3D Scanner is thus a relatively affordable 3D scanner, and paired with powerful software, Revo Scan 5, it offers a lot of functionality from scanning objects to processing point clouds in different ways. The result of the scanning depends on the properties of the object surface as well as the handling of the scanner, which does take some learning and practice to get right (as with most scanners). It is easy to make the scanner lose track of its location, but with the right tools (scanning spray, markers) even harder to measure surfaces are possible to scan. Under the right conditions and in experienced hands, mm precision for the scanned object is reasonable to achieve. The bigger the objects are the harder it is to scan the full object and there are more expensive 3D scanners that might be needed for sub-mm precision on such objects. But for the price and functionality that comes with the Revo Scan 5 software, the Range 3D Scanner can be very useful for scanning many different objects, particularly with sizes below 1 m which are often easier to scan in full.

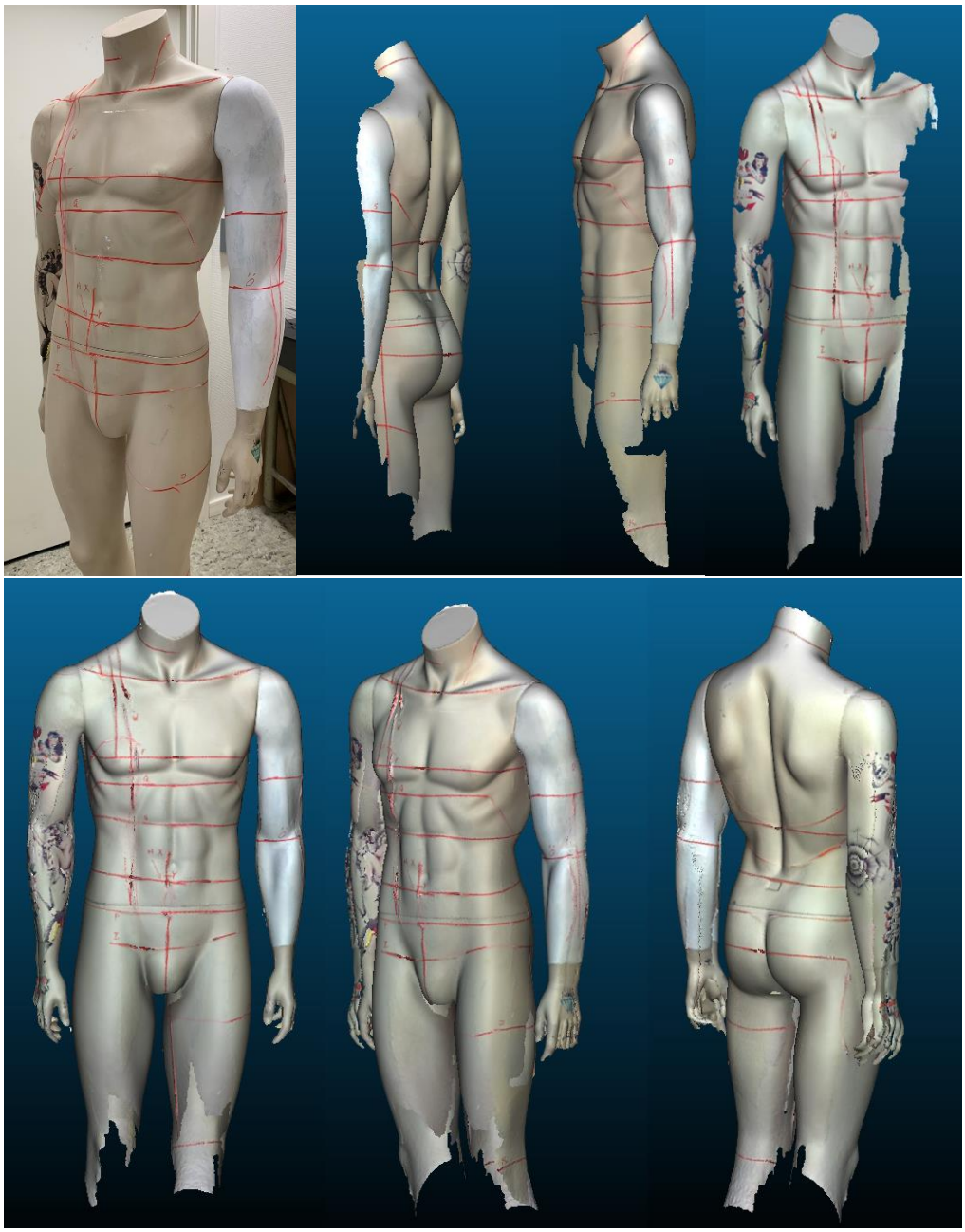

Figure 1: Top left: Image of a mannequin. Top right: The meshes from 3 scans of the mannequin captured with a Revopoint Range 3D Scanner. Bottom: The merged mesh from six scans captured with a Revopoint Range 3D Scanner. The parts below the knees were not scanned and there are some artifacts here and there, like at the edge at the top of the neck, which should be completely flat. The right arm of the mannequin appears to be doubled, due to the arm accidentally being moved a bit in between the later scans. Even despite this, the rest of the data was merged successfully. The merging was done using Revo Scan 5.

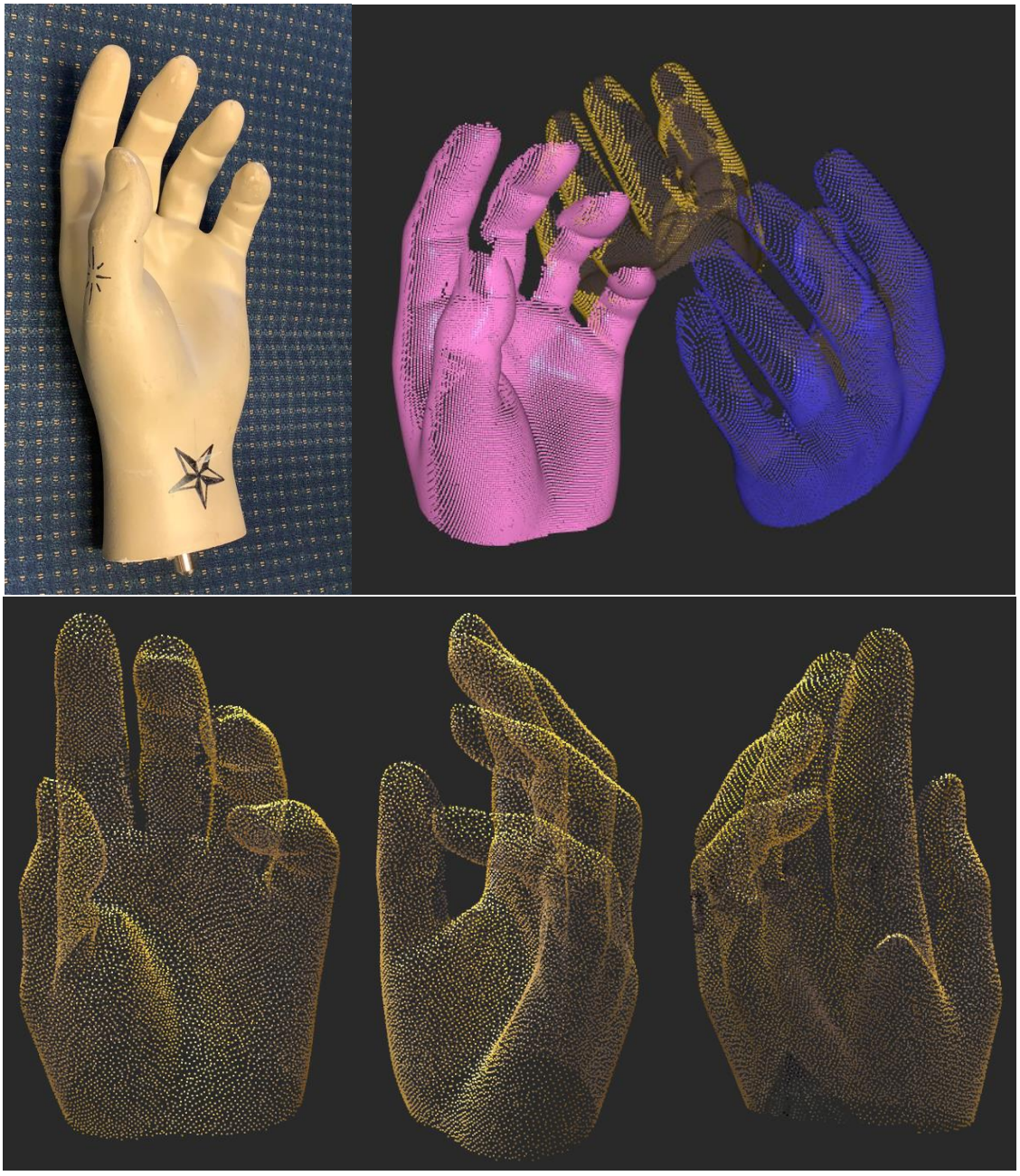

Figure 2: Top left: Image of a mannequin hand. Top right: The meshes from 3 scans of the mannequin hand captured with a Revopoint Range 3D Scanner. Bottom: The merged mesh from three scans captured with a Revopoint Range 3D Scanner. The merging was done using Revo Scan 5. To get a complete point cloud, the object must be scanned from all angles to avoid missing data, which takes patience and practice. This hand was scanned using a chair, rotating the hand, changing the hand position between scans and, in Revo Scan 5, manually removing all data except for the hand in every scan before merging them together to get a scan with 3D data from all sides.

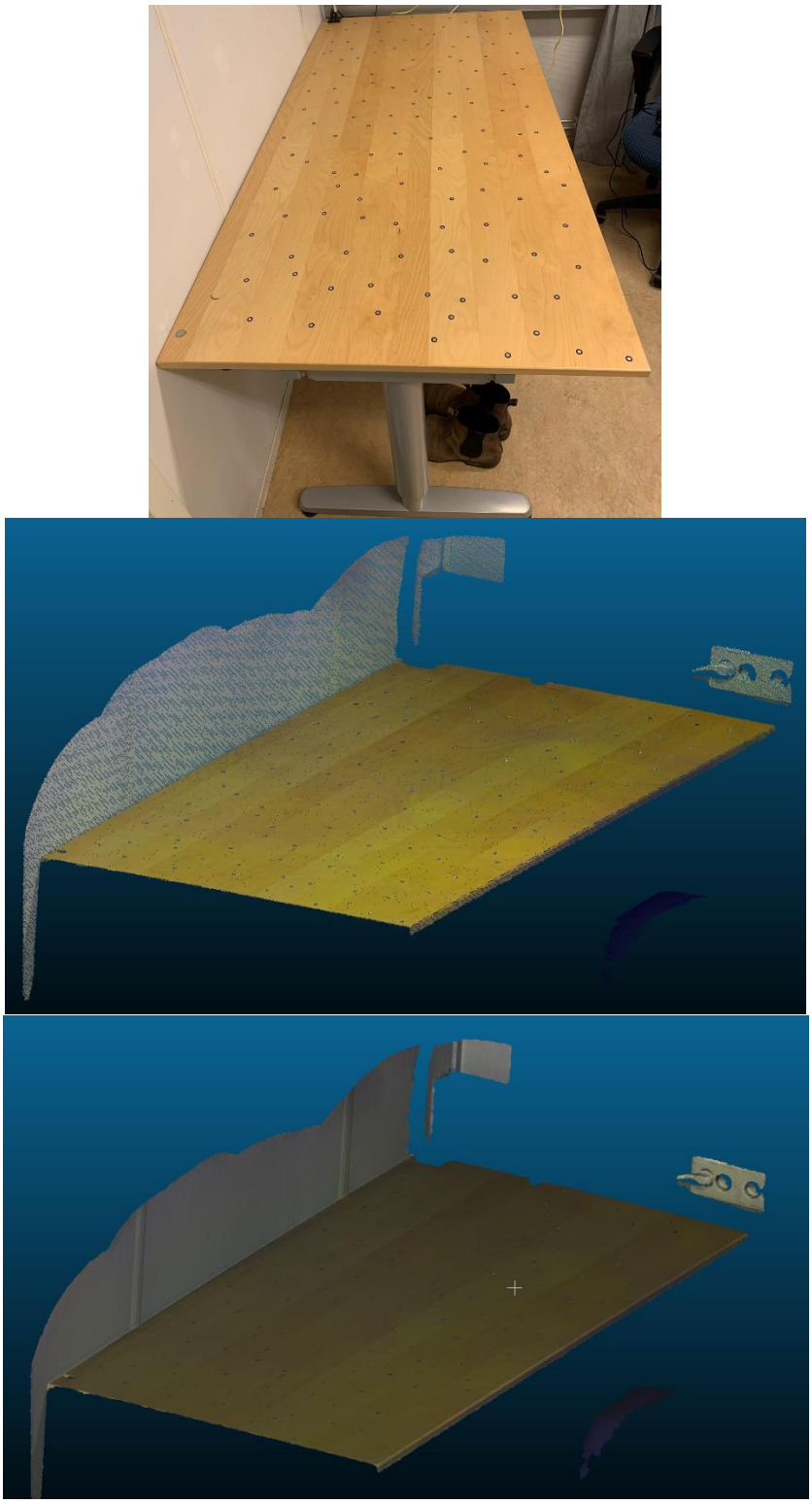

Figure 3: Top: Image of a table with reflective markers positioned randomly on its surface. Middle: The unified point cloud captured with a Revopoint Range 3D Scanner. Bottom: The mesh from a scan captured with Revopoint Range 3D Scanner. The processing was done using Revo Scan 5. A flat and uniform surface like the table in the top image is hard to scan properly since the tracking algorithm gets lost when not enough details/structure in the 3D data can be used to orient the camera. All attempts at measuring the table without markers failed during testing with the table and other objects. When using enough markers, the scanner (with Revo Scan) was able to scan the complete top of the table, except for some parts covered by a table lamp and cables in the upper left corner, in one single scanning session with no merging needed. Several scans were created. The length and width were compared to the real-life object sizes: Width 798 mm and length 1599 mm. Sometimes the resulting scan differed up to a cm from the real dimensions. At best the results achieved differed 2-3 mm from the known measurements. Better results can possibly be achieved with more practice with handling the scanner.