Politecnico di Milano - Courses on Photogrammetry
Laboratory report

First Name:	Gaia	Person code:	10505043
Last Name:	Vallarino	Matriculation:	996164
CFU group:	10	Date:	03/01/2023
Lab Topic:	04 - Laser Scanner Facade Survey		

Description of the performed activity *(max 50 lines)*

The aim of this laboratory is to orient a point cloud acquired via TLS during a survey of Politecnico's building 3 façade. The point clouds acquired, since the instrumentation doesn't have RGB sensors, show the intensity in a greyscale scalar field, with values ranging from [0 to 255], which is a number discretized with 8 bits. From a first analysis of the PC on CloudCompare, it is possible to detect areas where the intensity is lower, such as grass and windows. Furthermore, since the ray is not punctual but rather conical, there are some points along edges and corners where parts are completely missed and thus, overlooked with lower intensity. Moreover, it is possible to note that the resolution of these scans is also not regular, being higher in areas near the instrument, and higher elsewhere.

After having loaded the data, we need to perform a first rototranslation of a certain number of double points. These transformation parameters and the related accuracy will be further modified in a second step, with higher redundancy, which will involve an iterative procedure known as ICP (iterative closest points). For the purposes of the lab, it would be better to choose more than the minimum necessary 3 double points needed to estimate the parameters of the transformation, to have more redundancy and better statistics to check the proper functioning of the transformation. Aftewards, we computed the octree for all PC, which is a way to organize the points to make the access to the PC quicker.

Finally, we registered the scans, which is nothing other than bringing two scans together in a unique reference system. We collimated double points in the two PC. Since the scans are made up by points, we can't really collimate the center of the markers. In the point tables, it's possible to observe the error column, which represent the distance between the couple of points after the translation. To validate these values, we take into consideration the resolution of the scans of few centimeters. We can also choose which transformation to apply the rotation section of the point-collecting, and the translation too, for example, between the XYZ rotation or a rotation only around Z (if we consider that the scans were already all leveled around the gravity vertical); in this latter way, the residuals increase because we are removing degrees of freedom. This could be solved by adding more double points, reason for which we hypothesize that 4/5 points per transformation are probably enough to get a few centimeters of accuracy. After the alignment, we get the 4x4 rototranslation matrix, where the first 3x3 matrix is the rotation (planar, because the last row/column is 0,0,1) and the last column is the translation vector. The RMS is another very important value because it must be comparable to the resolution, which in this case, is of a few centimeters. We finally perform the Fine Registration (ICP), fixing a coherent final overlap of about 60-70%. The RMS, in this case, should be of ca. few centimeters. We finally make the absolute orientation in a known reference system by importing the GCP coordinate. We get an error in the façade alignment of few mm, but we can accept it, because we have severely increased the number of points and thus the resolution of the PC. This also means a heavier file, with lots of points; however, it's not reasonable to maintain all the points, which is why we halve the number of points by inputting a minimum space value in between points.

Now, we compare the PC with the result of the drone survey. The drone survey has more information than the LS, because not only it has color, but it can look at the façade from different heights, so we have more information regarding certain parts (e.g., windowsills) that are not available in the LS. Instead, with photogrammetry, you have less clear corner and edges, because it has more noise on borders, reason why you have to take two sets of oblique images and the nadiral one. It’s also easier to set up the LS instrumentation than to go through the rules of a drone survey, like allowed flight areas. In LS, though, the resolution is not constant in the horizontal/vertical direction, because the instrument rotates vertically, and we need to set horizontal intervals; thus, more intervals equal more time spent for each survey.

We can compare the two set of scans with cloud-to-cloud distance. We can assume that points in the parts where there is no image overlap (right side of façade, roof) will have very high distance values. The distances on the X, Y, and Z planes can be seen as different scalar fields where X is parallel to the façade, Y is the out of plane component and Z is the gravity vertical. The color scale must be resampled to view relevant information. For absolute distances, higher values can be found in corners, near windows and alongside the gutter. There’s nothing of note in X, but we can see that in Y we can see more distant values along the gutter and following the façade bas-relief lines (+/- a couple of centimeters). The two technologies produce quite similar results, but we know that the cost of the photogrammetric instrumentation is lower than the LS one.

Final Line Count: 49

Attachments

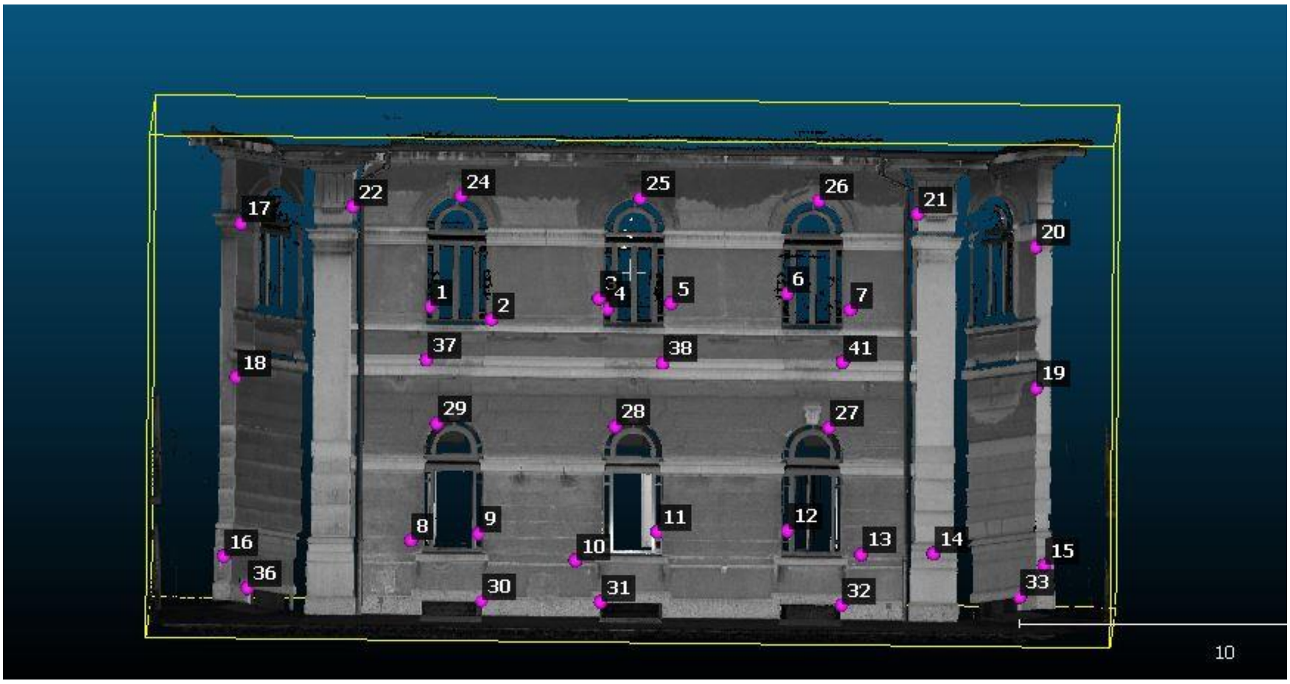

Fig. 1 – Final result and alignment

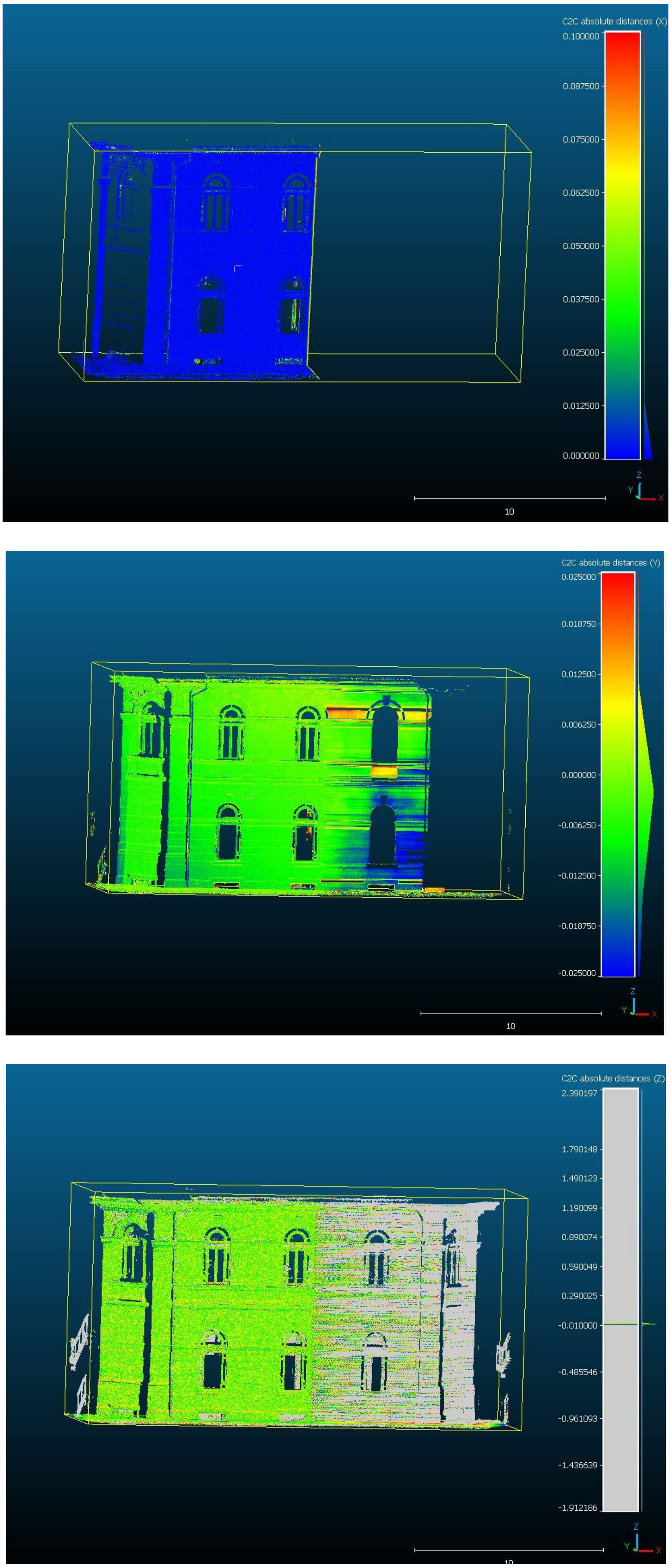

Fig. 2-3-4, differences on X, Y, and Z