Authors: Chunyang Gao, Dominik Mühlematter, Nick Teutschmann
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User Manual for Automated Data Acquisition with a Robotic Total Station (Part I)

Introduction

This assignment centered on the manual operation of a Leica TS60 total station, the execution of repeated point measurements, and the development of a Python script for data conversion and processing. In particular, we conducted the simplified test procedure for horizontal directions as outlined in ISO 17123-3 [1]. The software's design enables an automated and adaptable calculation of this procedure for sets of measured points.

Instrument Settings

The first four points were measured manually, before the measuring in two phases was completed automatically in the “ABBA” format. The remaining three sets were then measured completely automatically. Special settings like height did not have to be set as only the horizontal angle measurements were of importance.

Software for Conducting Simplified Test Procedure (ISO 17123-3)

This chapter presents a specialized software tool created for executing the simplified test procedure, as specified in ISO 17123-3 [1]. For the software application, the project's relative file path to the measurements needs to be written within the "read_process_file()" function found in the Jupyter Notebook named "lab1". Then, after the execution of the Notebooks code cells, the software will autonomously process the data, generate an output log and save it without requiring additional inputs or information. The remaining sections of this chapter will provide a brief overview of the software's core components, as programmed in the "measurement_processing.py" file.

Measurement Data

The measurements are required to be in the GSI-16 data format. Please consider that each data point should be measured in two phases within a single set. Additionally, it is essential to ensure that each measurement set contains the same points. Moreover, any measurements that are not part of the simplified test procedure should be excluded.

Data Processing

First, the dataset is decoded from the GSI-16 format into a numpy array. Important variables, such as the number of points and sets, are extracted from the file. Subsequently, the measurements of the horizontal angles are converted into numerical values in gon units. In the next step, a wide range of measurement values and statistics are computed, including mean measurements, residuals, and reductions as specified in the norm.

Arithmetic Checks

Tolerance thresholds are needed as floating-point or rounding errors can cause deviations. Therefore, it is not possible to simply check if the result is equal to zero. We used both 0.001 and 0.0000001 as thresholds depending on whether the results were supposed to be approximately or completely equal to zero according to the simplified test procedure.

Next, using the preprocessed measurements and statistics, six arithmetic checks were implemented that follow ISO 17123-3 guidelines to evaluate the measurements [1]. A measurement is considered to pass an arithmetic check if the deviation falls within an acceptable tolerance threshold.

Measurement Standard Deviation

Afterwards, the sum of squares of the measurement residuals is computed, considering the degrees of freedom, which depend on the number of sets and points. Subsequently, the experimental standard deviation of the measurements is calculated in milligon units.

Output Log

The output log documents the entire test procedure by recording input data, results of arithmetic checks, degrees of freedom, sums of squares of residuals, and the measurement standard deviation. This log is displayed in the Jupyter environment and saved as a .log file within the "Output_log" folder of the project, carrying the name derived from the original file.

Results

Our project's measurements have successfully passed the simplified test procedure outlined in ISO 17123-3 [1], with a measurement standard deviation of 8.78e-05 milligon.

References

[1] International Organization for Standardization. (2001). ISO 17123-3: Optics and optical instruments – Field procedures for testing geodetic and surveying instruments – Part 3: Theodolites. Geneva, Switzerland: ISO.