**KMS Lab 3 Report “Kinematic Tachymeter Measurement”**

**1 Aim of the lab**

Compute the synchronization error for the tachymeter Trimble 5601. Perform measurements using the linear calibration unit in the measurement cellar. With this linear unit it is possible to simulate movements of a target on a given trajectory. By means of the formulas and the measurement data, the synchronization error, for the used tachymeter Trimble 5601, has to be calculated.

**2 Detailed explanation**

**2.0 General Procedure**

In this experiment, two kinematic measurements (forward and backward as one measurement) with two different velocities are conducted. One tachymeter is fixed to measure the moving object and output a data file including time stamp, horizontal angles, vertical angles, distances, Y, X, ds (difference between reference line and actual coordinate). Due to a time delay of distance measuring, the synchronization error should be calculated and finally the corrected coordinates.

**2.1 Lateral Deviation**

The lateral deviation is shown as ‘ds’ in the given data file, and is averaged by a 5-depth filter. After that, the difference between maximum and minimum value is calculated:

The difference between minimum and maximum deviation from correct values equals with the distance d travelled during synchronization time, in which way the synchronization error can be calculated.

**2. 2 Mean Velocity**

In this step, the distance of neighboring points is first calculated:

And the time interval:

Then the velocity of time i+1 is evaluated:

And finally the mean velocity of the whole process:

**2.3 Synchronization error**

With 2.2 and 2.1 the synchronization error is calculated:

**2.4 Real Horizontal Distance**

To get the real horizontal distance, the slope distance should first be transformed to horizontal distance:

Then the real distance can be calculated:

**2.5 Corrected Coordinates**

Finally, the corrected coordinates can be calculated:

**3 Results**

**3.1 Required figures**

Fig.1 XY coordinates of the prism

Fig.2 Lateral deviation and smoothed lateral deviation

Fig.3 Velocities

Fig.4 Corrected coordinates and original measured coordinates

**3.2 Mean Lateral Deviation**

**3.3 Mean velocities**

**3.4 Calculated Synchronisation errors**

**3.5 Corrected Coordinates**

**4 Analysis and Discussion**

Fig.1 shows the change of Y coordinate w.r.t X coordinate, apparently indicating the synchronization error. In principle, the forward and backward trajectory should be exactly the same, while here there are two symmetric lines. The intersection point of the two lines is the orthogonal point of the tachymeter, where the synchronization error can be seen as zero. The further the object goes from the intersection point, the bigger the error becomes.

Fig.2 exactly proves the above paragraph, from which it can be seen that during one-way drive, the lateral deviation decreases from the start point to zero and then increases again. It shows also the effect of smoothing, which makes the lines more fluent.

Fig.3 shows the change of velocity during the drive, oscillating around one stable value, which is correspond to our feelings in the experiment. The zero part in the middle of the figure is just the stabilizing time when the object gets to the end point and is about to go backwards.

Fig.4 indicates the influence of the synchronization error, which makes the points away from their correct location. After correction, the intersection angle of the two lines of one velocity becomes smaller, proving that the error has been considered and reduced.

Comparing the figures of two different velocities, those with smaller velocity are denser, which is because more points are measured during the drive. Another effect of the more points is that the trajectory is smoother.