Lab 3:
Kinematic Tachymeter Measurements

1. **Dead Time**: time required to transmit the data and to calculate the position

2. **Synchronisation Error**: time difference Δt between different sensors in the total station → the result is a falsified position

...EXTRACT FROM TASK SHEET

In this task you should compute the synchronization error for the tachymeter Trimble 5601. For doing so, you have to measure using the linear calibration unit in the measurement cellar. With this linear unit it is possible to simulate movements on a given trajectory. By means of the formulas which you had got in the lecture and the measurement data, the synchronization error for the used tachymeter Trimble 5601 has to be calculated.

The following steps have to be done:

- Every Student has to measure with the Trimble 5601. The output of base of the measurements will be the time stamp, measuring elements (angles, distances). Additionally the coordinates and the lateral deviation to the reference trajectory (rail of the linear unit) will be provided.
- You have to make two kinematic measurements (forward and backward) with the same velocity. Additionally, a forward and backward drive has to be realized with a different velocity (minimum factor is two).
- Before computation of the synchronization error, you have to calculate the moving average of the lateral deviations (choose a useful filter depth). You also need the velocity which can be computed using the distances between the measured coordinates and the time stamps. For each drive you have to calculate the mean velocity. For this, delete the first and last seconds of each drive.
- Visualize your measurement data in graphs and calculate the synchronization error of your tachymeter. Correct the measured elements using the formulas of the lecture (interpolate the distances between the time stamps) and compute the corrected coordinates.

File contents:

Measurements:

- Time stamp
- Measuring elements (V- angle, Hz- angle, Slope distance)

Additional data:

- Coordinates (X, Y)
- Lateral deviation of the reference trajectory
- Position of the tachymeter (X_S, Y_S)
- Orientation angle $(Orient)$

Calculation Steps:

1. Smoothing of lateral deviation data using „moving average“, e.g. filter depth 5 → average of 5 values

2. Calculation of difference between max and min of the lateral deviation:

$$delta\ lateral\ deviation = lateral\ deviation_{max} - lateral\ deviation_{min}$$

The difference between minimum and maximum deviation from correct values equals with the distance d travelled during synchronization time.

3. Calculation of mean velocity (can be derived from delta distance)

$$Delta\ distance: \quad d_{delta,i+1} = \sqrt{(X_{i+1} - X_i)^2 + (Y_{i+1} - Y_i)^2}$$

$$Time\ interval: \quad dt_{i+1} = t_{i+1} - t_i$$

$$Velocity: \quad v_{i+1} = \frac{d_{delta,i+1}}{dt_{i+1}}$$

$$Mean\ velocity: \quad v_{mean} = \frac{1}{n} \sum v$$

4. Synchronization error:

$$\Delta t = \frac{delta\ lateral\ deviation}{v_{mean}}$$

5. Real horizontal distance:

a) Conversion of slope distance to horizontal distance: $S_H = S_{slope} * \sin(V)$

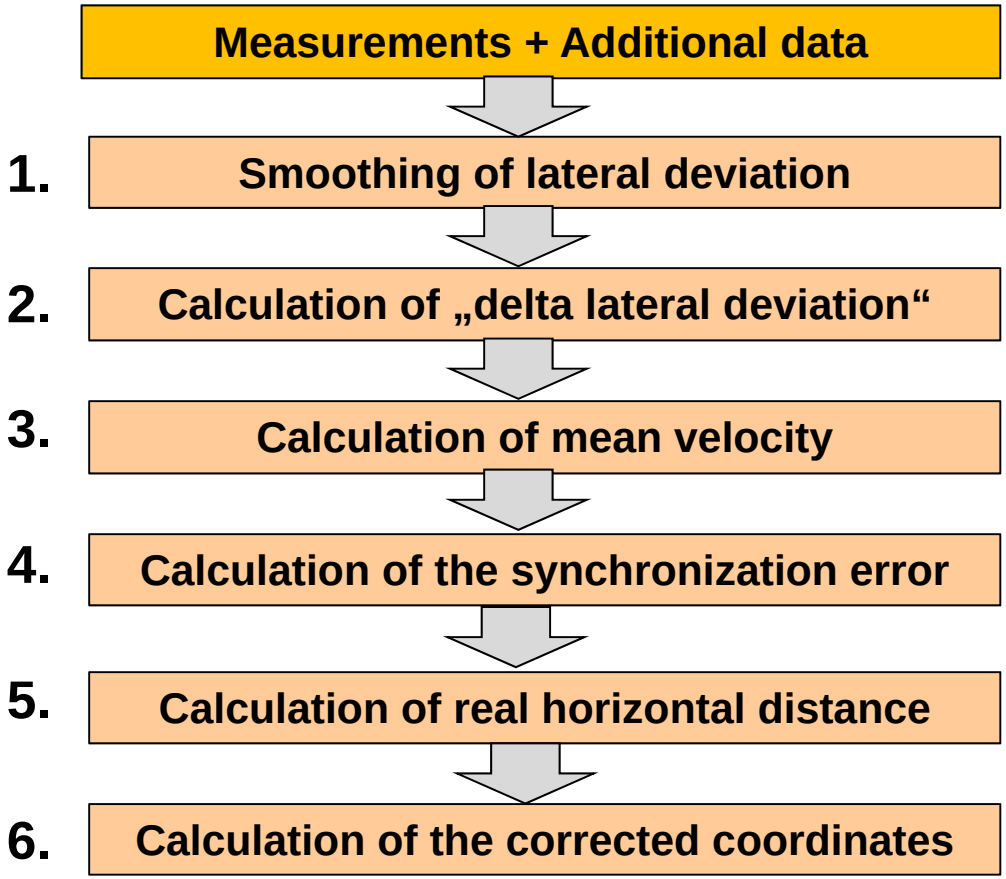
b) Computation of real distance: $S_{real,i+1} = S_{H,i+1} + \frac{\Delta t}{t_{i+1} - t_i} *(S_{H,i} - S_{H,i+1})$

6. Corrected Coordinates:

$$\boldsymbol{X_{Corr}} = X_S + S_{real} * \cos(Orient + Hz)$$

$$\boldsymbol{Y_{Corr}} = Y_S + S_{real} * \sin(Orient + Hz)$$

Summary:


Measurements + Additional data
1.
Smoothing of lateral deviation
2.
Calculation of „delta lateral deviation“
3.
Calculation of mean velocity
4.
Calculation of the synchronization error
5.
Calculation of real horizontal distance
6.
Calculation of the corrected coordinates

KINEMATIC MEASUREMENT SYSTEM - LAB 3

Group Number	Date and Time	Students	
		First Name	Last Name
Group 1	*Monday 04.06.2018 14:00 – 15:00*	Shkelqim Andrews Chih-Chieh Yujing Yongxu Hussein Shengping	Ahmeti Akosah Chen Chen Duan Elshoqirat He
Group 2	*Monday 04.06.2018 15:00 – 16:00*	Yi Shimeng Muyu Nian Zhouyan Mansoor Mohamad Hakam	Hong Li Liu Liu Qiu Sabzali Shams Eddin
Group 3	*Monday 04.06.2018 16:00 – 17:00*	Shu Yazheng Yining Wang Chanjuan Ziqiang	Suo Wei Yuan Yusheng Zhang Zhang

Meeting Point: Messkeller

Please be in time !!!