University of Applied Sciences and Arts Northwestern Switzerland
School of Architecture, Civil Engineering and Geomatics

MASTER OF SCIENCE IN ENGINEERING

Work on the Kinematic Test Track to Evaluate the Accuracy of Kinematic Measurements

A Vicon motion capture system was recently installed in the measurement laboratory of the Institute Geomatics (IGEO) to serve as a reference trajectory for the investigation of other measurement systems. In this thesis, a permanent coordinate system was installed in the measurement laboratory and the accuracy of the Vicon system was analysed. Further, tests were carried out with a total station to assess the suitability of the Vicon system as a reference in kinematic accuracy studies.

Kinematic Test Track

The kinematic test track consists of eight Vicon Vantage v5 cameras mounted on a truss on the ceiling of the measurement lab (Figure 1) and the measurements are published in the Robotic Operating System (ROS).

Fig. 1: Kinematic test track in the measuring laboratory.

Fixed Points

A permanent fixed point network for the Vicon system and total stations was installed in the measurement laboratory, which can be extended in the future for other measurement systems. For the Vicon system, eight specially developed sockets were embedded in the floor and for the total station, 5 SBB bolts were mounted with angles on the walls (Figure 2). The fixed points were measured nine times with the AT401 laser tracker. The points on the floor have a maximum standard deviation of 50 µm, those on the walls of less than 300 µm. In addition, a procedure was developed to transfer this coordinate system to the Vicon software.

Fig. 2: The metal socket, the installed socket, a marker placed on the socket and the SBB bolt mounted to the wall with an angle.

Accuracy Analysis of the Vicon System

The accuracy of the Vicon system was determined in the static state absolute to the fixed point network and in the kinematic state relative over inter-marker distances. From this, an absolute kinematic accuracy of 730 µm was estimated for the entire measurement volume and of 280 µm for the area in the center with optimal recording geometry. A direct determination of the kinematic absolute accuracy could not be carried out due to a lack of suitable measuring equipment available.

Author: Marius Hürzeler
Examiners: Prof. Dr. David Grimm, Ursula Kälin
Expert: Prof. Dr. Dante Salvini

Experiments with a Total Station

Four experimental set-ups were used to investigate the kinematic behavior of a Leica MS60 total station. The movement was generated with a Lego train. One test setup is shown in Figure 3.

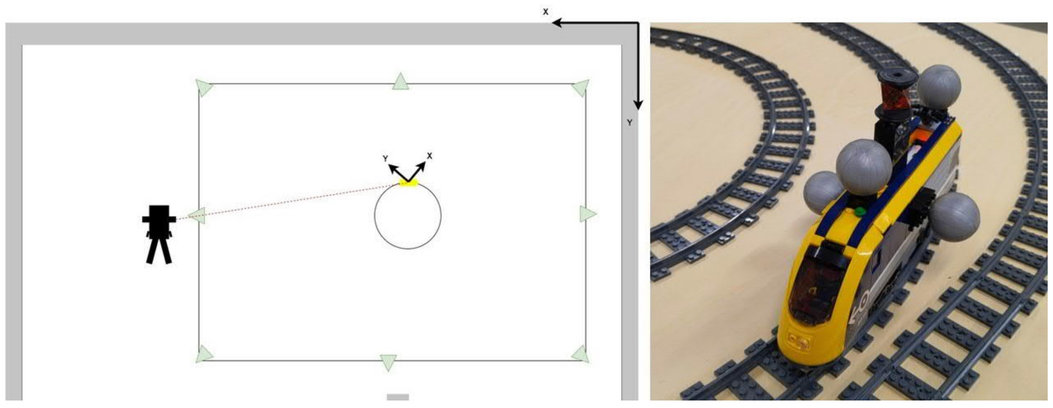

Fig. 3: Set-up of the experiment in the measurement lab and the Lego express trains with the mounted markers and prisms.

Since the two measuring systems do not measure at the same frequency, the data has to be resampled. Two different methods were used for this, which complement each other well. Nevertheless, in the areas with large value changes is the difference in accuracy after resampling not sufficient, to be able to see effects in the millimeter range (see top of figure 4). Only in the Z axis, where the values were relatively constant, the influence of the rotation of the mini 360-degree prism could be detected in the data, as shown in figure 4.

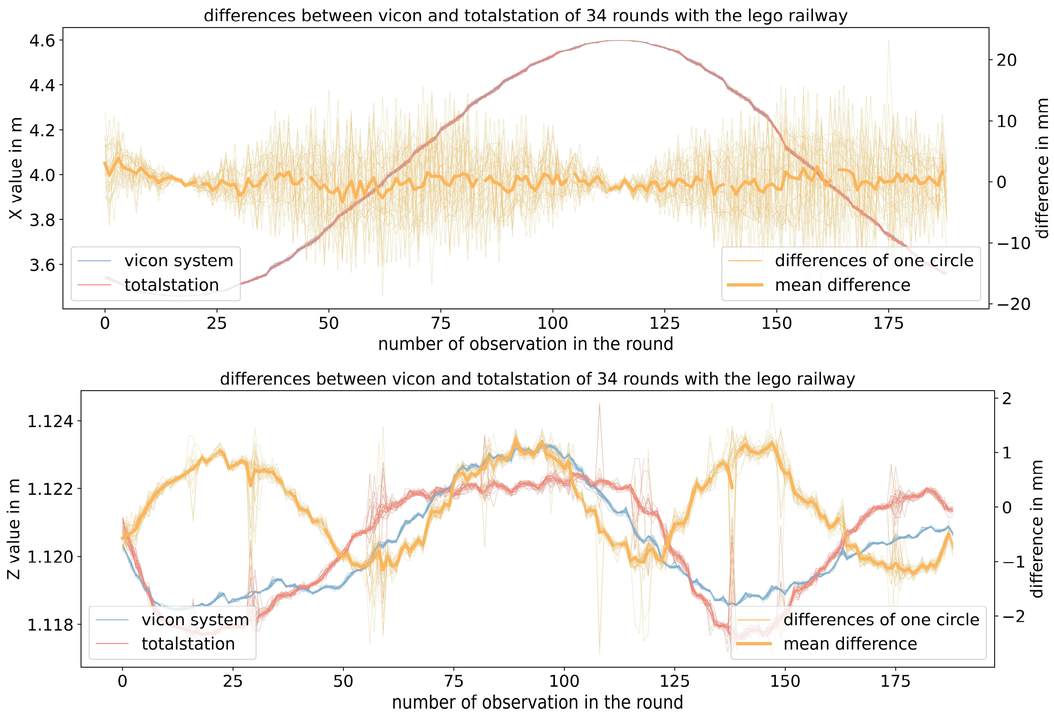

Fig. 4: The X and Z values of 34 rounds with the Lego train from the Vicon system and the total station, the difference between them as well as mean difference.

Conclusion

The Vicon system is basically suitable as a reference system for kinematic investigations. However, the difference in accuracy compared to a total station is, with the current evaluation methods, too small to make reliable statements about the kinematic behavior. For the evaluation of other measuring systems with higher measuring frequency and lower accuracy, such as IMUs, the Vicon system should be better suited.