Bundesamt für Kartographie und Geodäsie

FRANKFURT UNIVERSITY OF APPLIED SCIENCES

A Modified Approach for Process-Integrated Reference Point Determination

Metrological Challenge

The GLOBAL GEODETIC OBSERVING SYSTEM (GGOS) calls for continues and automated determination of the geometric reference points of space geodetic techniques such as DORIS, GNSS, SLR and VLBI. Whereas the reference points of DORIS beacons and GNSS antennas can simply be measured by observing well-defined reference markers, the determination of SLR and VLBI reference points is a metrological challenge, because these reference points are inaccessible and non-materialized. Indirect methods are needed to fulfil the requirement of the GLOBAL GEODETIC OBSERVING SYSTEM.

Modified Approach for Reference Point Determination: *IRP-II*

Reference point determination is a challenging metrological task in the framework of reverse engineering. Here, the telescope is analyzed and virtually deconstructed into its geometrical basic elements to reveal its desired design parameters, e.g. the reference point or the axis-offset.

Such a model parametrizes a transformation of a telescope coordinate frame onto an Earth fixed global geodetic reference frame, cf. Fig. 1. Based on observed trajectories of mounted targets, telescope specific parameters are estimable by

$$\mathbf{P}_{\mathrm{TRF},j,k} = \mathbf{P}_{\mathrm{IRP}} + \mathbf{R}_{x,\beta}\mathbf{R}_{y,\alpha}\mathbf{R}^{\mathrm{T}}_{z,\kappa_k}\mathbf{R}_{y,\gamma}\left(\mathbf{E}_{\mathrm{AO}} + \mathbf{R}_{x,\omega_k}\mathbf{P}_{\mathrm{Tel},j}\right).$$

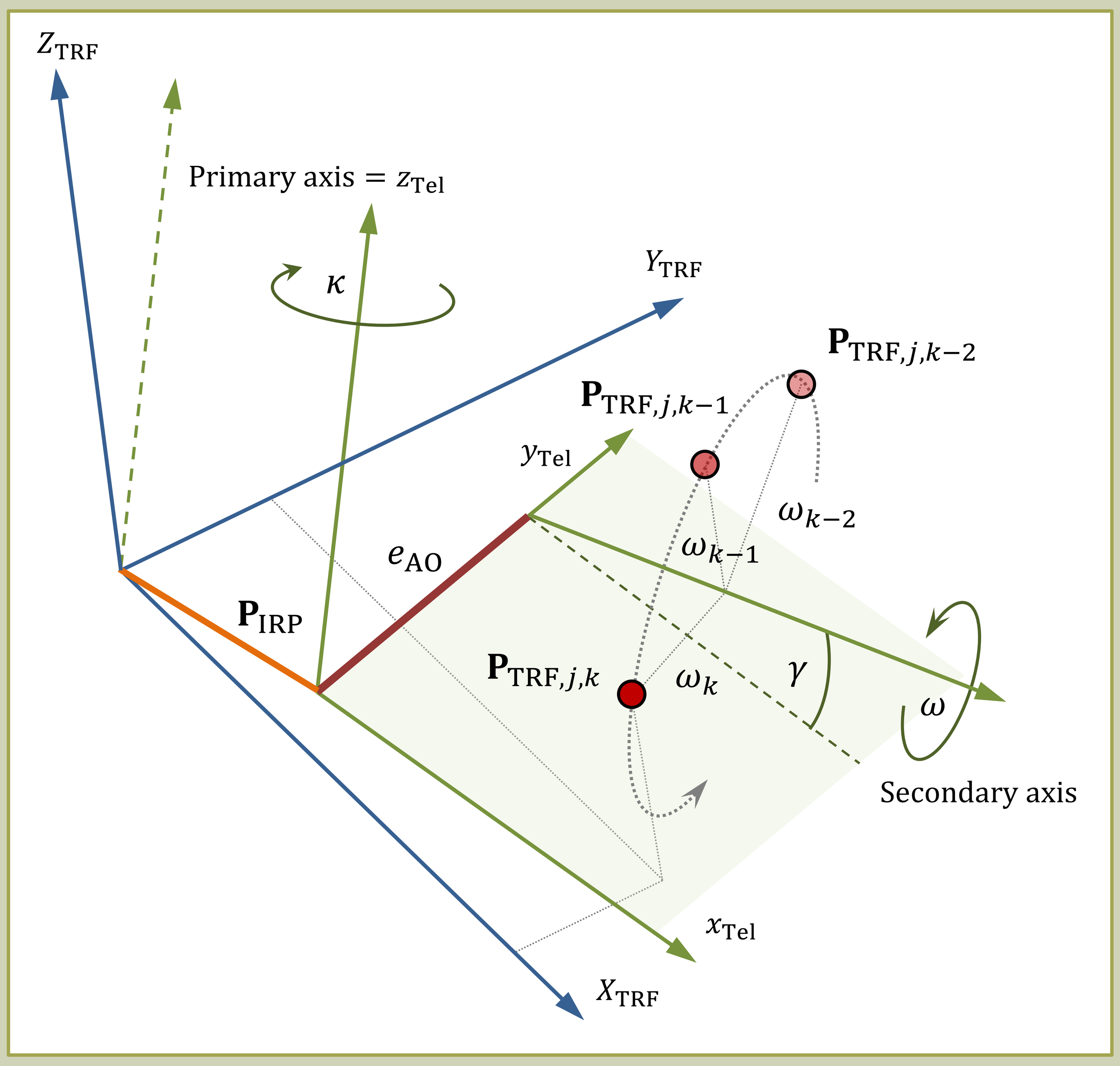

Fig. 1: Schematic representation of the model equation for reference point determination, using the new *IRP-II* approach.

Advantages of the new *IRP-II* approach

In contrast to the *IRP-I* approach derived by Lösler (2008) and refined by Kallio and Poutanen (2012), the telescope angles are not part of the input quantities in the new *IRP-II* approach. Therefore, the probability density functions of the telescope angles do not have to be specified. Moreover, a synchronization of the terrestrial instrument and the telescope is omitted and, thus, reduces the total uncertainties of the analysis process.

Fully Automated Measurement Process

The new *IRP-II* approach was evaluated at the SATELLITE OBSERVING SYSTEM WETTZELL. The SLR-telescope was equipped by four CatEye reflectors and trajectories were observed in a fully automated way by HEXAGON's high-precision mobile Laser Tracker AT401 using the software package HEIMDALL, cf. Fig. 2.

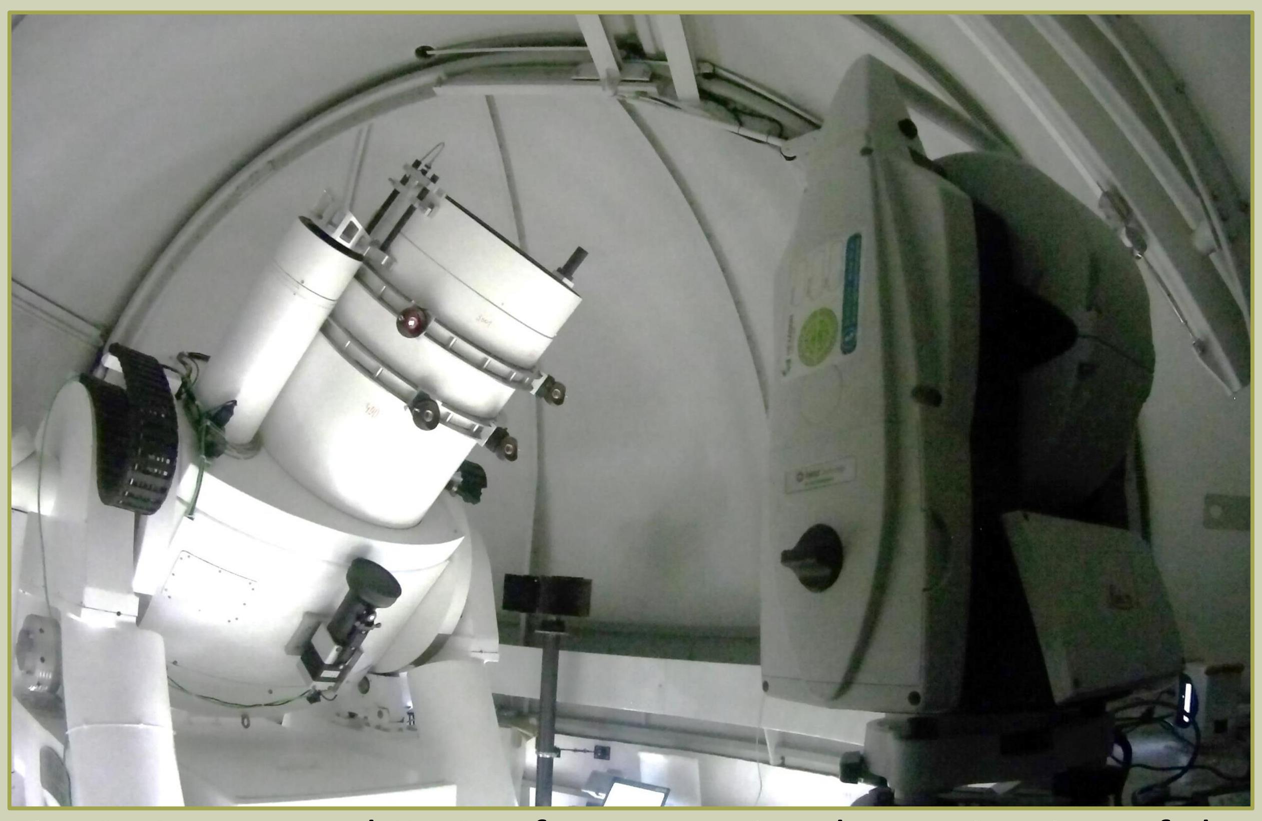

Fig. 2: Automated ILRS reference point determination of the SOS-W, using the high-precision mobile Laser Tracker AT401.

Results and Comparison

Table 1 summarizes the obtained results of the reference point and the axis-offset derived by different approaches. The model deviations are negligible w.r.t. the uncertainties of 50 µm. In particular, the estimated axis-offset is insignificant.

Table 1: Comparison of new *IRP-II* approach to two approved models.

	X in m	Y in m	Z in m	e_{AO} in mm
IRP-I	100.16246	197.69374	50.01237	-0.03
IRP-II	**100.16246**	**197.69376**	**50.01234**	**-0.02**
Sphere	100.16247	197.69375	50.01234	–

Contact:
Michael Lösler – michael.loesler@fb1.fra-uas.de
Cornelia Eschelbach, Stefan Riepl, Torben Schüler

Faculty 1:
Architecture • Civil Engineering • Geomatics