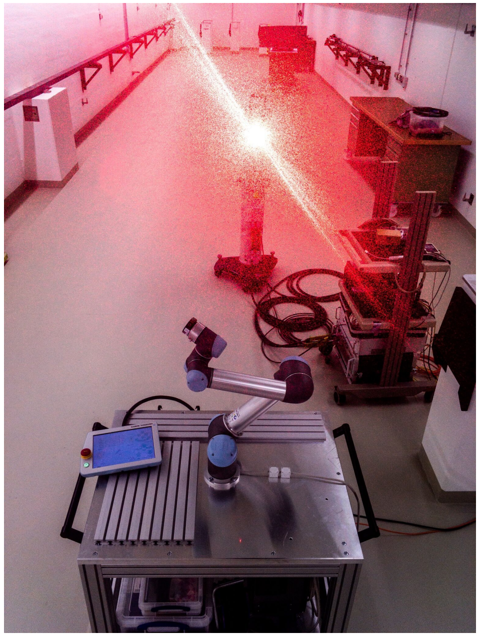
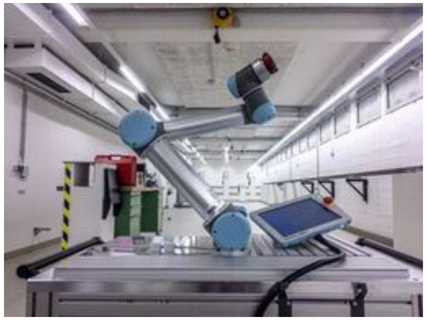
Laborsituation

Festpunktfeld

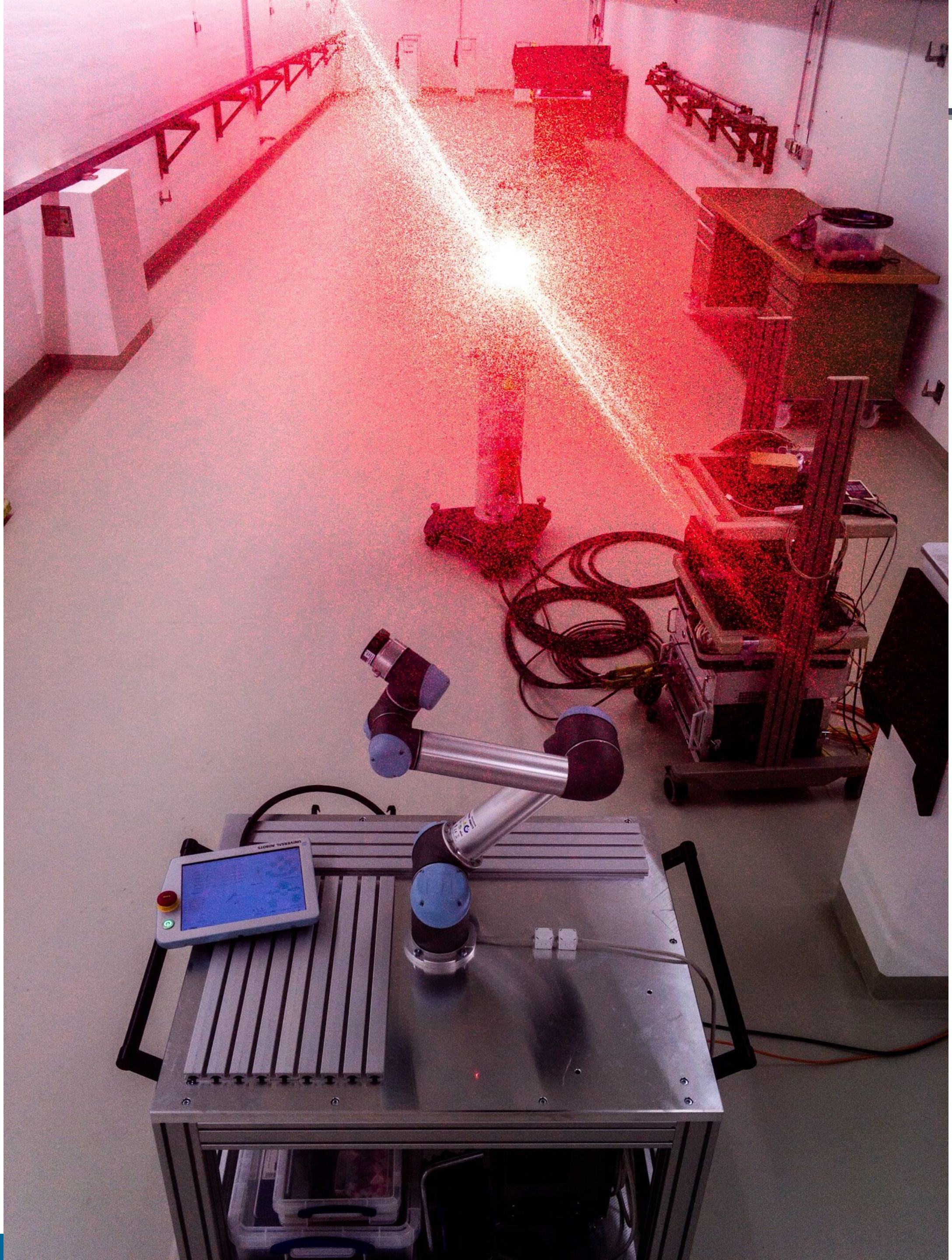
Infrastruktur (Strom/Internet)

Äußere Einflüsse (Temperatur/Belüftung)






UNIVERSAL ROBOTS

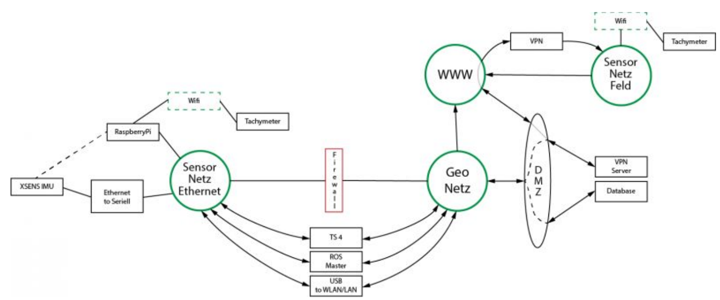


Geo-Sensor Netzwerk

Das Datennetz der Ingenieurgeodäsie

Zugriff/Zutritt Kontrolle

Bezug zum Monitoring

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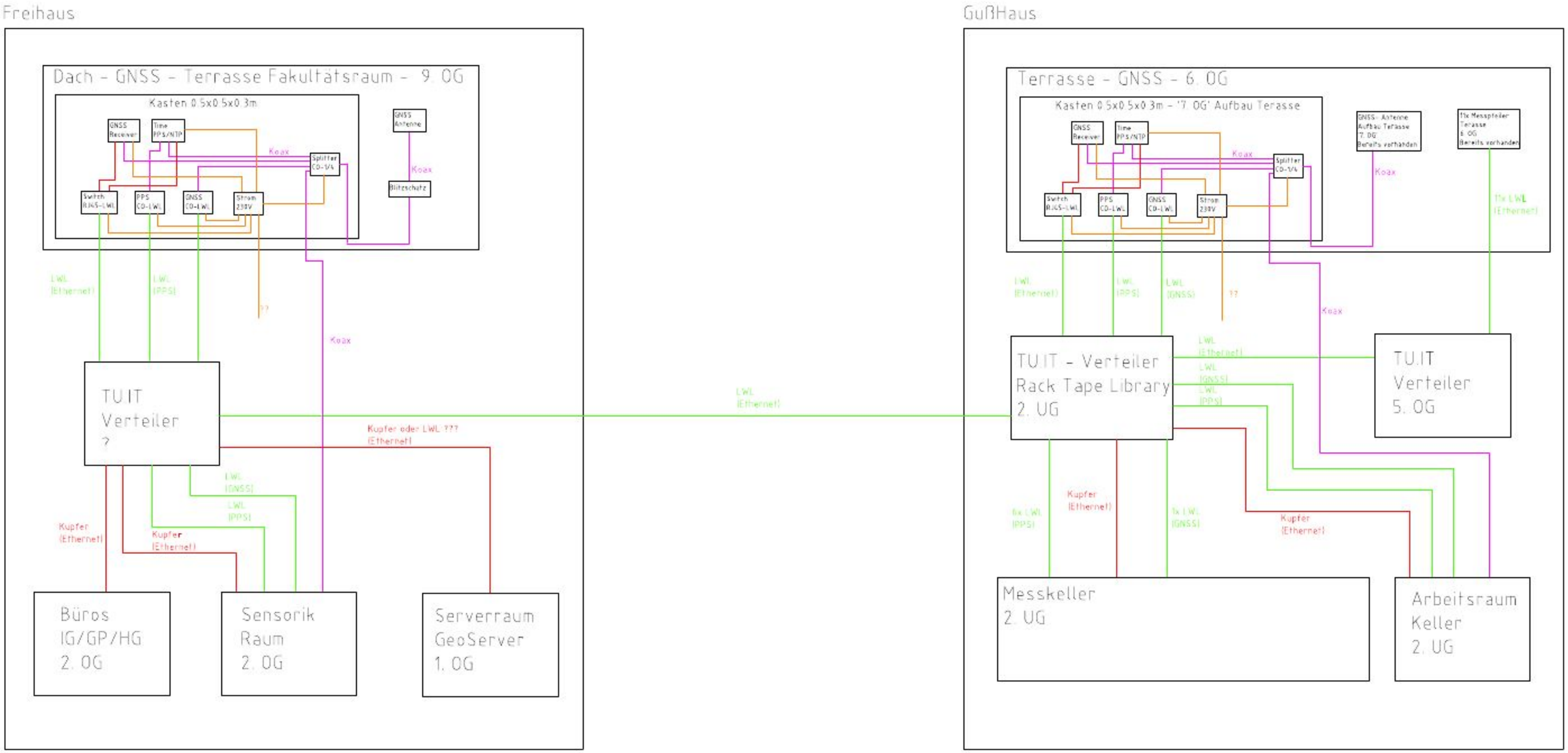
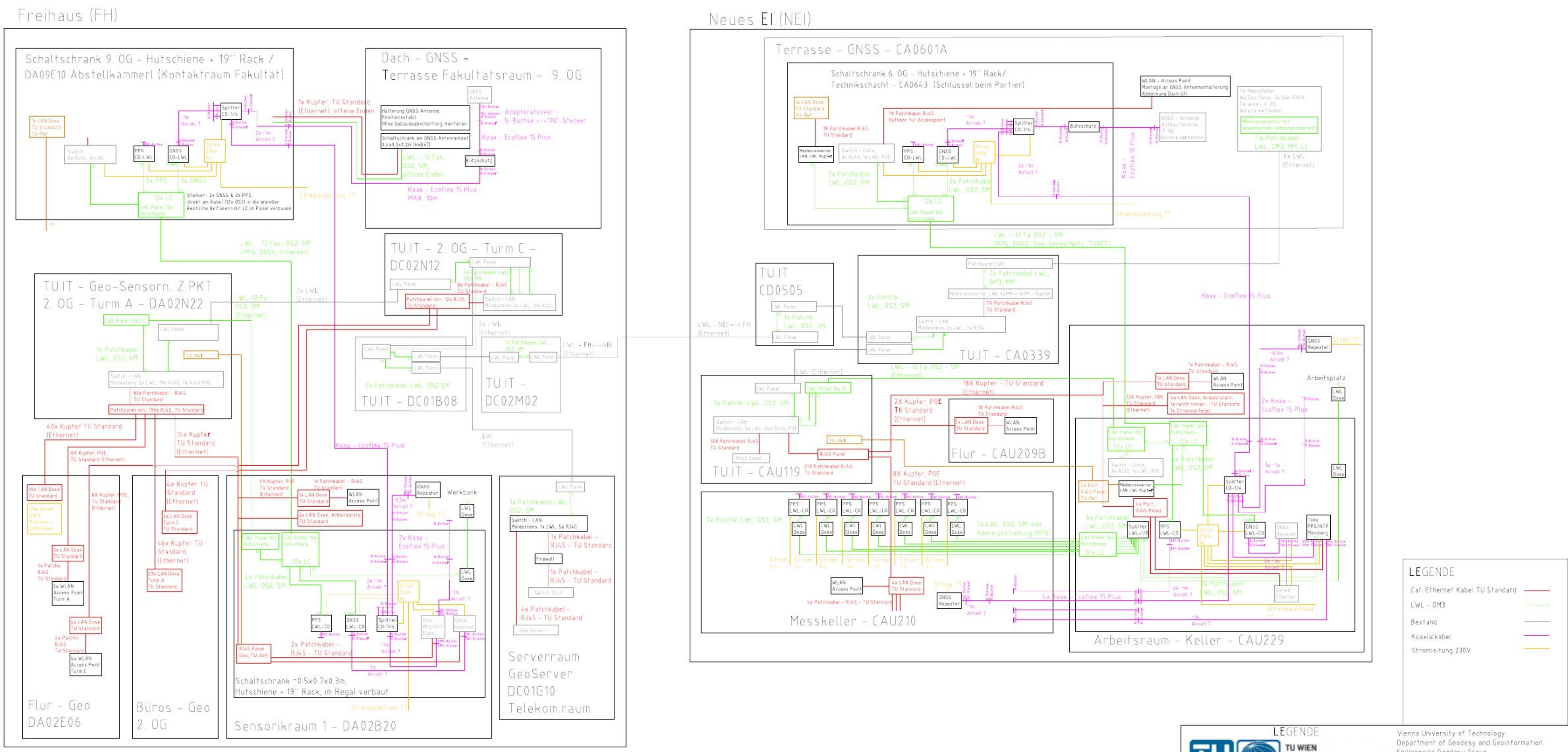
Geo-Sensornetz – Ein IP-Adressbereich

Sensornetzschema_v2
Stand: 30.05.2018
Gezeichnet: C.Schmitt



Geo-Sensornetz - Ein IP-Adressbereich - Neues EI & Freihaus



LEGENDE

TU WIEN
DEPARTMENT OF GEODESY AND GEOINFORMATION

Vienna University of Technology
Department of Geodesy and Geoinformation
Engineering Geodesy Group

Gusshausstraße 27-29
A-1040 Vienna
Phone: +43-1-58801-12804

Projekt: Geo-Sensornetz

Planverfasser: CSC

Datum: 07.06.2019

Ansprechpersonen: Claudius Schmitt, claudius.schmitt@geo.tuwien.ac.at

Plantitel: Geo-Sensornetzschema, Neues EI & Freihaus

Maßstab: Topologietreu

Beschreibung:

- Alle Bauteile Außer der Bestand sind im LV mit aufzunehmen
- Die Beschreibung der Bauteile inklusive Datenbalatt sind in der Materialliste aufgeführt
- MM = Multimode
- SM = Singlemode
- Steckverbidnungen der LWL Anschlüsse werden separat in der Materialliste spezifiziert
- Anschlüsse der Stromzuleitungen sind nicht mit geplant, sondern mit ?? gekennzeichnet

Programmieren

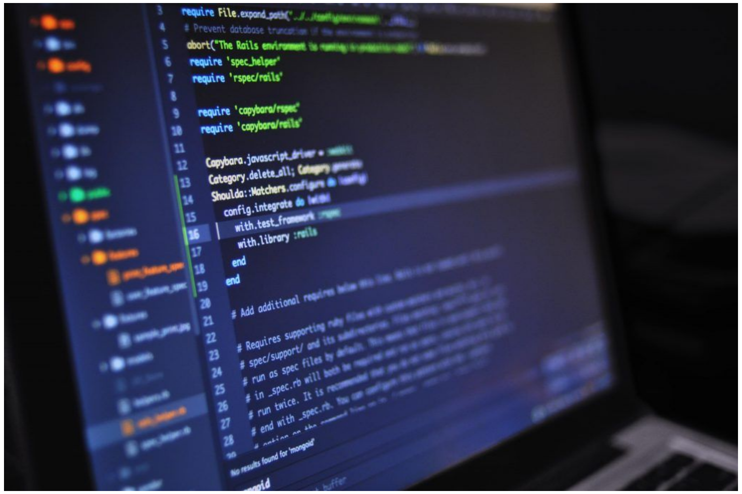
Möglichkeiten

Sprachen

C++/Python/Matlab

GIT

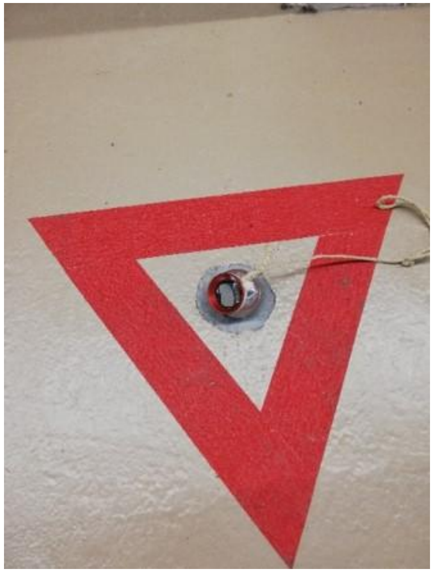
IDE

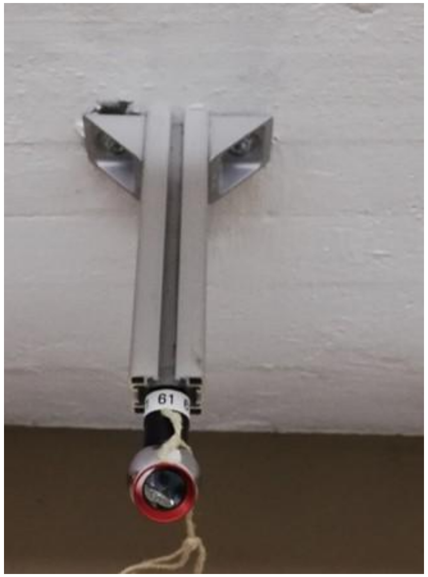


Equipment of the Research Division Engineering Geodesy

Space Continuous Tasks in Engineering Geodesy

Hybrid reference system for testing terrestrial laser scanners (TLS):

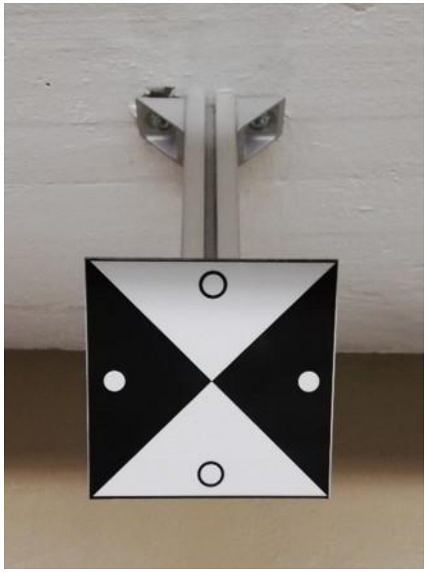




Equipment of the Research Division Engineering Geodesy

Space Continuous Tasks in Engineering Geodesy

Hybrid reference system for testing terrestrial laser scanners (TLS):



Equipment of the Research Division Engineering Geodesy

Large Volume Metrology - Industrial Measurement Tasks

Laser Tracker Leica LTD 800:

MPE:

All accuracies are specified as maximum permissible errors (MPE) and in accordance with ASME B89.4.19-2006 & ISO10360-10 using precision Leica 1.5” Red Ring Reflectors.

Reflector:

U_{xyz} = 15µm + 6 ppm (3D)

Uncertainty distance meas.:

U_D = 30 µm

(in a range of 9 m)

Equipment of the Research Division Engineering Geodesy

Large Volume Metrology - Industrial Measurement Tasks

Laser Tracker Leica LTD 800 + T-Probe:

MPE:

All accuracies are specified as maximum permissible errors (MPE) and in accordance with ASME B89.4.19-2006 & ISO10360-10 using precision Leica 1.5” Red Ring Reflectors.

Reflector: U_{xyz} = 15µm + 6 ppm (3D)

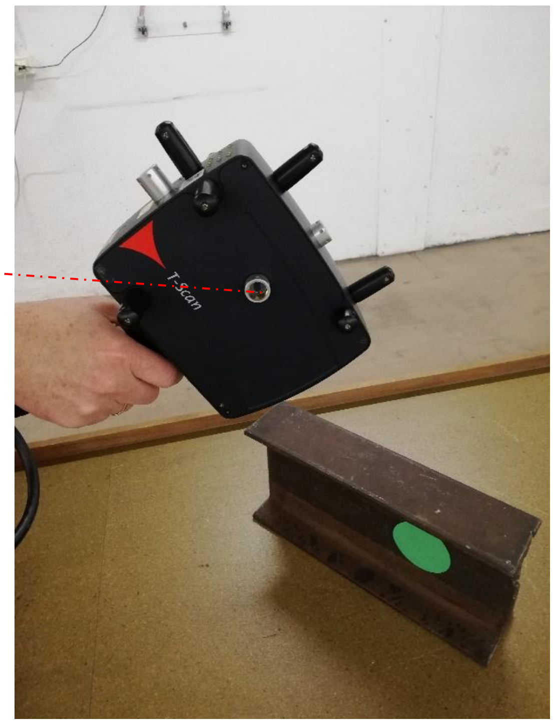
T-Probe: 35 µm (6DoF) additionally to U_{xyz}

Orientation: σ_{Ori} = 0.01°

Equipment of the Research Division Engineering Geodesy

Large Volume Metrology - Industrial Measurement Tasks

Laser Tracker Leica LTD 800 + T-Scan:



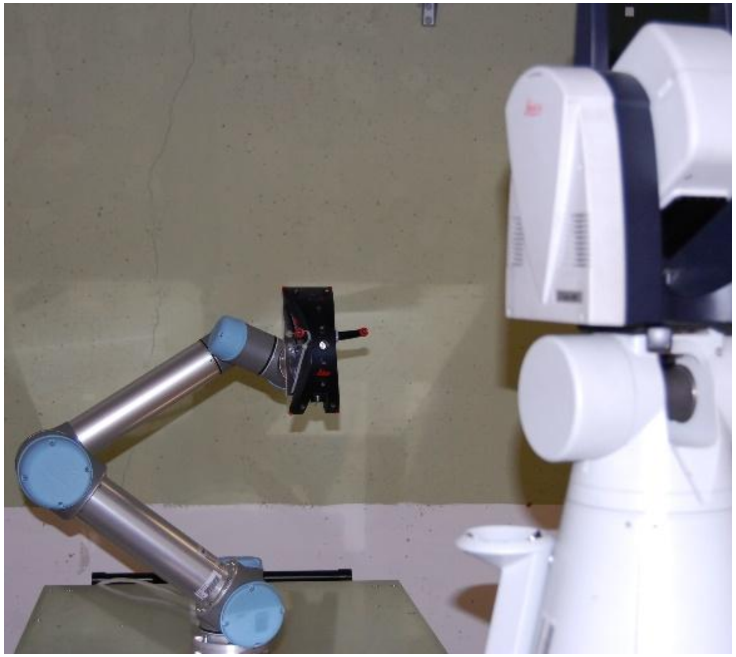
<u>MPE</u>: 60 µm

All accuracies are specified as maximum permissible errors (MPE) and in accordance with ASME B89.4.19-2006 & ISO10360-10 using precision Leica 1.5” Red Ring Reflectors.

Equipment of the Research Division Engineering Geodesy

Large Volume Metrology - Industrial Measurement Tasks

Collaborative Robot Arm UR5:



Max. load: 5 kg

Range: 850 mm

Rotation of joints: +/- 360°

Velocity:
- Joint: max. 180°/sec.
- Tool: ca. 1 m / sec.

Repeatability: +/- 0,1 mm

Leica LTD 800 Lasertracker

Benutzen (in der Wirtschaft)

Spatial Analyzer

ROS

Datenexport

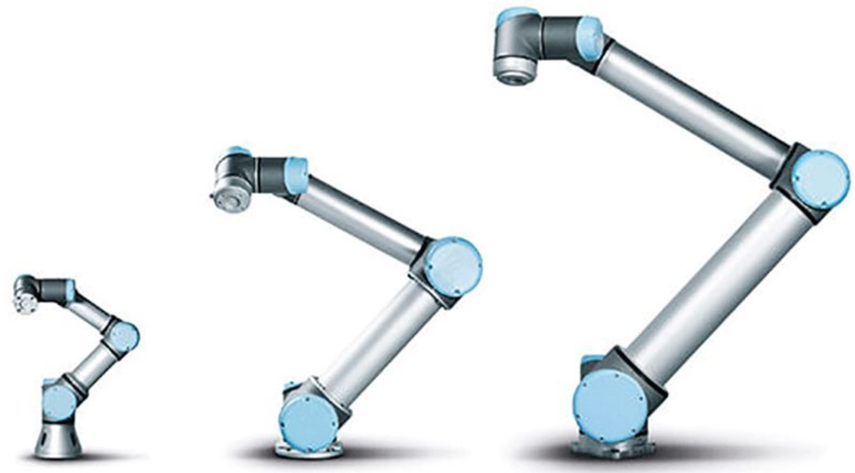
Universal Robot UR5

Sicherheitsbestimmungen

Ansteuerung/Potenzial

ROS-Bedienung

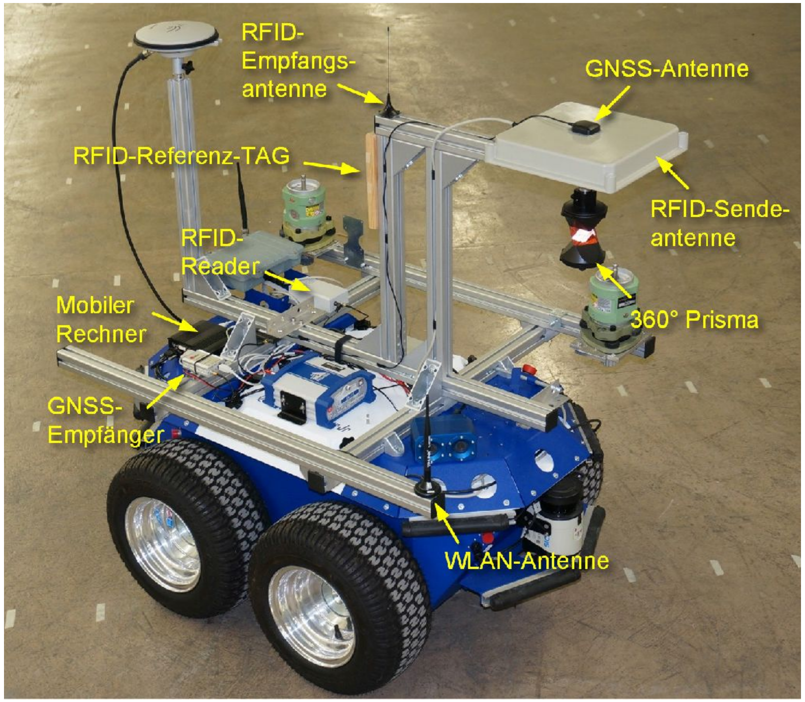
Bestimmen des TCP



Equipment of the Research Division Engineering Geodesy

Multi-Sensor-Platforms

Ground-based mobile robots:



Equipment of the Research Division Engineering Geodesy

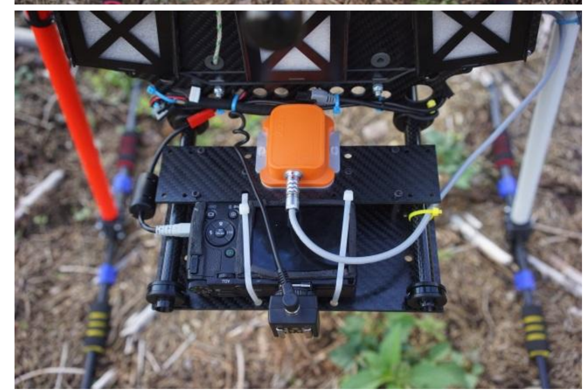
Multi-Sensor-Platforms

Low-cost multi-sensor-system (for UAVs)

- Sensors:
  GPS antenna and receiver (Rover) – µblox 6
  IMU – xsens MTi-28 / xsens Mit-710-G
  Camera – Ricoh GR digital IV
  Small 360 degree prism (TPS)

Synchronized by PPS-signal

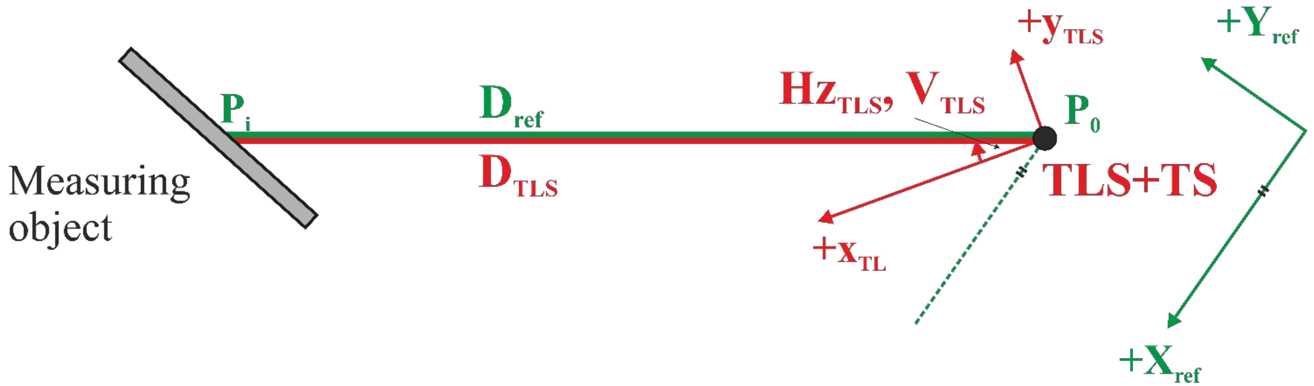
Control of all sensors in ROS-environment



Space-continuous measurement and processing techniques in engineering geodesy

- Combined Influence of Incidence Angle and Roughness on Reflectorless Distance Measurements of Terrestrial Laser Scanners

3. Key feature of the principle:
   Direct analysis of single measured distances



$$\Delta D = D_{ref} - D_{TLS}$$

Kinematic measurement tasks in engineering geodesy

Indoor Navigation…

2. … using Wi-Fi reference stations

Wi-Fi Access Points: distinguished by their MAC address

Low-cost implementation:

Reference Stations: Single-board Computer (Raspberry Pi units)

© www. raspberrypi.org

Integrated Wi-Fi chip
and USB Wi-Fi dongle

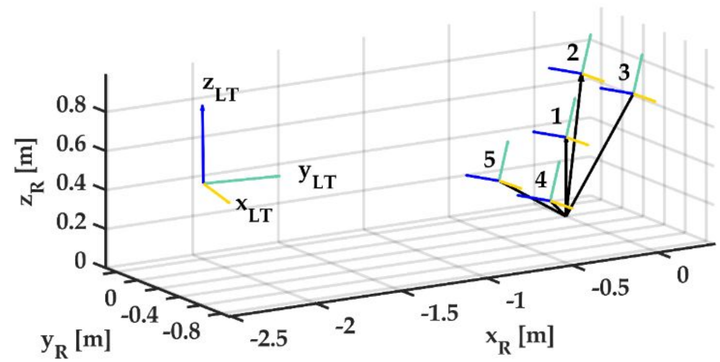
Python Script

Large Volume Metrology - Industrial Measurement Tasks

Testing procedure of the Collaborative Robot Arm UR5

2. Implementation

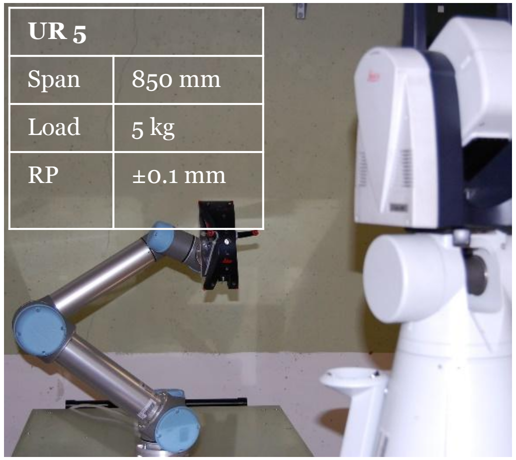
- Laser tracker + T-Probe
- Load 0,5 kg
- Test cube



Robot test poses (diagonal plane P1-P5 of the testing cube) and LT transformed in robot CS

UR Communication

UR 5	PC	LT
TCP/IP client	*TCP/IP server*	
- UR Programm	- Simulation - Transmit Joints - Receive Pose	- Stable Points



UR 5	
Span	850 mm
Load	5 kg
RP	±0.1 mm

Large Volume Metrology - Industrial Measurement Tasks

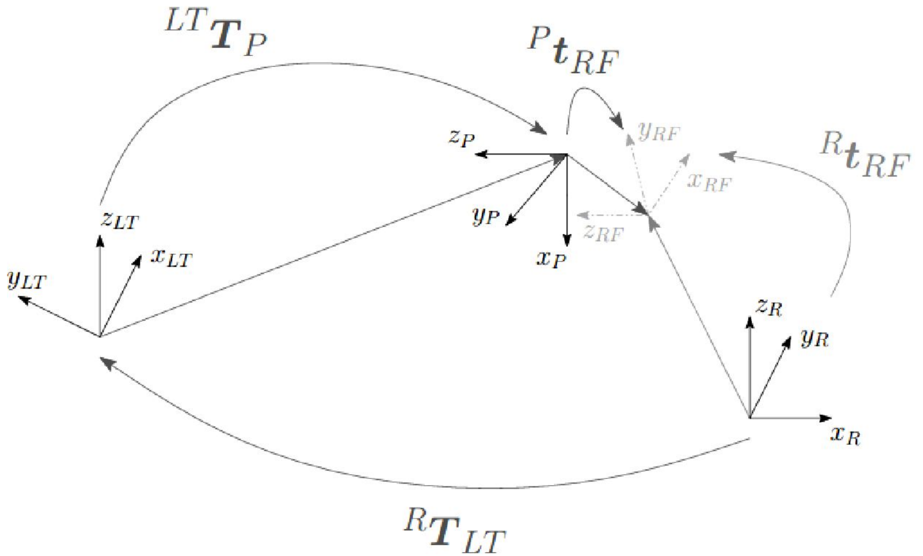
Calibration of Robot Arms

1. Transformation of the measured pose in the robot arm's coordinate system

- Robot's nominal position ${}^{R}\boldsymbol{t}_{RF}$

  Nominal position:

  ${}^{LT}\boldsymbol{T}_{P}$ Laser Tracker pose
  ${}^{R}\boldsymbol{T}_{LT}$ Transformation
  ${}^{P}\boldsymbol{t}_{RF}$ lever arm



- Joint estimation of ${}^{R}\boldsymbol{T}_{LT}$ and ${}^{P}\boldsymbol{t}_{RF}$

- Estimation model:

$${}^{R}\boldsymbol{t}_{RF} = {}^{R}\boldsymbol{R}_{LT}\left({}^{LT}\boldsymbol{R}_{P}()\, {}^{P}\boldsymbol{t}_{RF} + {}^{LT}\boldsymbol{t}_{P}\right) + {}^{R}\boldsymbol{t}_{LT}$$

Vorläufiger Zeitplan

- 02.10 Vorbesprechung, Laborsituation, Aufgabenvergabe (Seminarraum)
- 09.10 Proprietäre Software und Messaufbau (Labor GH)
- 16.10 ROS-Tutorial 1/2 (Seminarraum)
- 23.10 ROS-Tutorial 2/2 (Labor GH)
- 30.10 Vorlesung zu Vorwärtskinematik/Zeitsynchronisation/Transformation/…
- 06.11 Vorlesung/Übung Geo-Sensor-Netzwerk und Monitoring (Seminarraum)

- 13.11 Aufgabenstellung Programmierung (evtl. mit Tutorial)
- 20.11 Tutorial Programmierung in C++/Matlab/Python in ROS (jeweils Aufgabenbezogen)
- bis 08.01 wöchentliches Treffen und Update zur Aufgabenstellung
- 15.01 und 22.01 Präsentation und Diskussion
- 29.01 Nachbesprechung

Anwesenheitspflicht
Die Prüfungsleistung ist immanent, sowie eine Präsentation am Ende

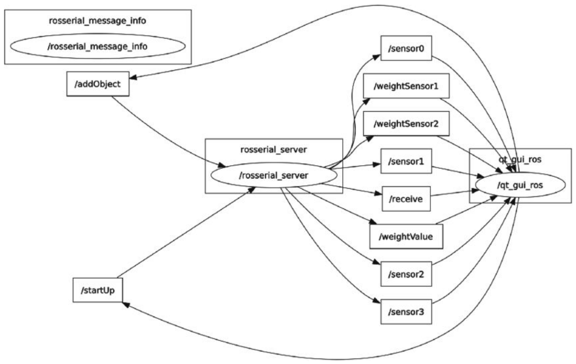
Robot Operating System ROS

Was bringt ein Framework?

Was geht?

Wie geht es?

C++/Python/Matlab



Wissenschaftliches Arbeiten

Paper lesen

Zitierrichtlinien

Ergebnisse präsentieren

An Introduction to the Classic Paper by M. I. Pupin

ROBERT E. COLLIN, LIFE FELLOW, IEEE

This paper provides an introduction to the paper presented by Prof. Pupin, which deals with a method of measuring the radiation resistance of an antenna. In order to provide a perspective for the significance of Pupin's paper, a brief review of the state of antenna knowledge in 1913 is given first. The highlights of Pupin's paper are then discussed, followed by a summary of significant milestones in the development of our current state of knowledge about the impedance properties of wire type antennas and how it is evaluated.

I. Introduction

Michael Idvorsky Pupin was a Hungarian-born American physicist (October 4, 1858–March 12, 1935). He was a Professor of Electro-Mechanics at Columbia University and had an ongoing interest in radio telegraphy and broadcasting. In the late 1890's he successfully extended the range of long distance telephony by placing inductance coils along the transmitting wires. He also made inventions related to multiplex telegraphy. In 1896 he discovered secondary X-ray radiation and invented a method for rapid X-ray photography by using a fluorescent screen. He carried out various investigations into electrical wave propagation and electrical resonance. His 1913 paper focused attention on a method of determining the radiation law of antennas by measuring the radiation resistance of the antenna using a Wheatstone bridge, with which he had prior experience from other research works. In order to appreciate the substance of Pupin's paper it is appropriate to first review the existing state of knowledge of antenna theory in 1913.

II. Nineteenth Century Developments

Maxwell had presented his theory of electromagnetic waves in 1864 [1]. But it was not until 1887 that Hertz provided convincing experimental confirmation of Maxwell's theory [2]. In his basic experiment, Hertz used an antenna consisting of two thin rods 30 cm in length and terminated in two small spheres spaced a small distance apart at the center. The extremities of the rods were attached to metal plates 40 cm wide along each side so as to form a parallel plate capacitor. The antenna was excited at its natural resonant frequency by means of a spark discharge from a Leydan jar, using a Ruhmkorff coil, across the two centered spherical electrodes. Hertz used a circular loop of wire with a small air gap to detect the presence of radiation in the receiving antenna. He found that a coil 35 cm in diameter resonated at the frequency of the radiated waves and gave the strongest signal. In later experiments Hertz carried out investigations of the wavelength of radiation and means of focusing the radiation, using a cylindrical reflector, in order to strengthen the received signal. Hertz recognized that in order to create a large current in the rods it was necessary to deliver substantial electric charge to the antenna and this would require some charge storage capability in the antenna. This concept of charging the capacitance of the antenna was utilized in many of the antennas built in later years for low frequency radio telegraphy and telephony. Various arrangements of horizontal wires were connected at the top end of a vertical radiator to increase its capacitance. On the theoretical side Hertz introduced a vector potential function, now known as the Hertz vector, to calculate the radiation to be expected from a short current element [3]. This calculation is the standard beginning point in the analysis of antennas in current textbooks.

In 1898 Abraham succeeded in calculating the radiated field from a half wave dipole [4]. Another important theoretical contribution around this time period was the formulation of an integral equation for the current on a wire antenna by Pocklington in 1897 [5]. This integral equation has figured prominently in both theoretical developments and numerical work related to antenna impedance from its inception to the present. Pocklington was able to show that in the limit of a very thin wire the current wave travels with the speed of light and standing wave current distributions are sinusoidal with a node spacing of one half wavelength. However, it was not until 1908, ten years later, that Rüdenberg calculated the radiation resistance of the dipole antenna [6]. His formula could be adapted to a vertical radiator above ground using the image concept presented earlier by Blondel [7].

A. The Early 20th Century

Following the work of Hertz, Marconi experimented with short wavelength radiation but found experimentally that

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The author is with the Department of Electrical Engineering, Case Western Reserve University, Cleveland, OH 44106 USA.
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