FIG WORKING WEEK 2023
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Protecting Our World, Conquering New Frontiers

RiverCloud

A Multi-sensor UAV/USV Tandem System for High Resolution Data Acquisition of Water Bodies

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Organized By NSPS FIG INTERNATIONAL FEDERATION OF SURVEYORS RIVER CLOUD gia Geodätisches Institut und Lehrstuhl für Bauinformatik & Geoinformationssysteme RWTH AACHEN UNIVERSITY
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Introduction

- Waterways are of high relevance for exchange of goods
- Expansion and maintenance must be carried out in accordance with legal regulations
- Consistent as well as spatially and temporally highly resolved geometric and semantic data with spatial reference (geodata) are required
- e.g. for water quality, vegetation structure, underwater/ overwater structure geometry, water body topography

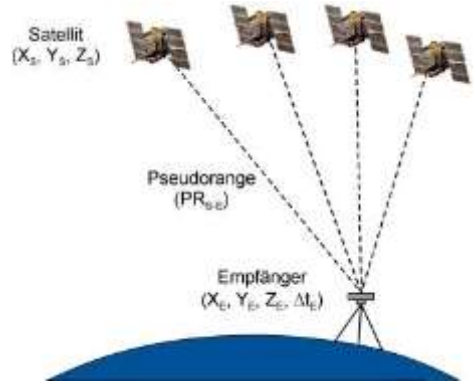
Data capturing

- Hard-to-reach areas
  - Shallow waters and surroundings of groyne areas, backwaters, oxbows, tributaries – especially their interstices
  - Locks and weirs, under bridges
- Idea
  - Small, maneuverable unmanned surface vehicles (USV) with low draught




Georeferencing

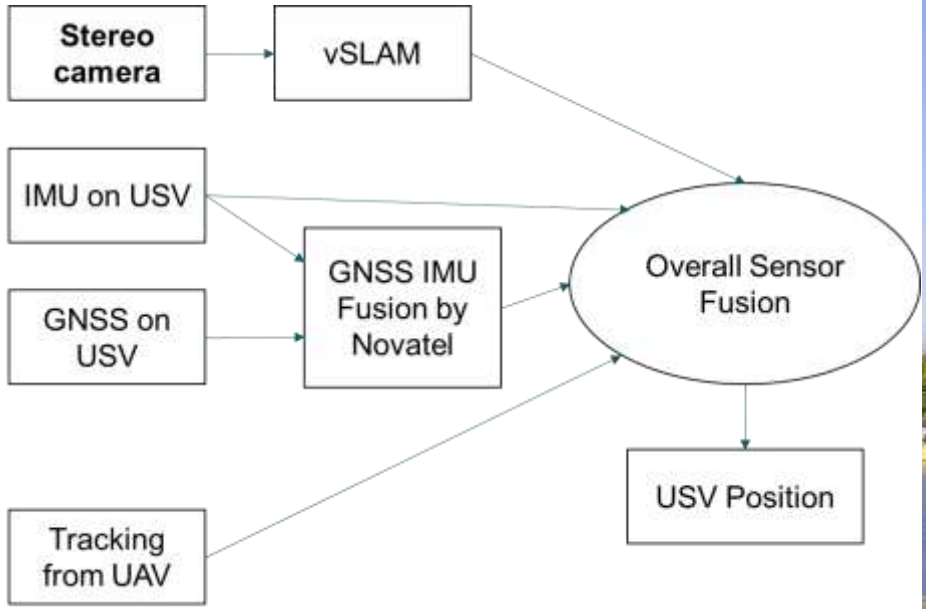
- Consistent as well as spatially and temporally highly resolved geometric and semantic data with spatial reference (geodata) are required
- Usually GNSS is used, but:
- Lack of sky clearance complicates or prevents (accurate) GNSS solution
  - Under bridges, inside of lock chambers, under riparian vegetation



Source: BKG

Idea: Multi sensor fusion

- Fusion of different sensors and positioning sources promises improvement, namely
  - GNSS / INS
  - Monocular/stereoscopic vSLAM of camera images
  - Tracking with camera image data from an accompanying UAV

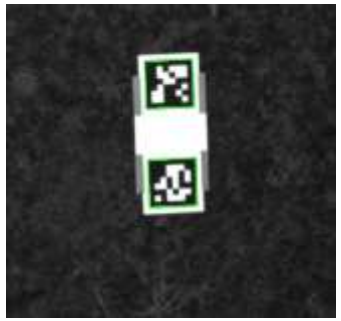


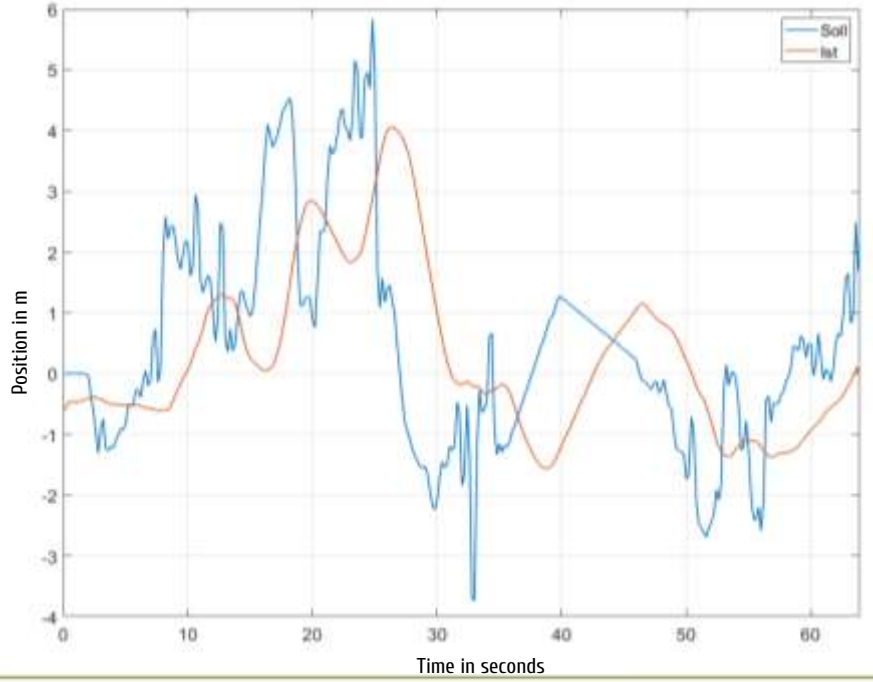
In full progress

- vSLAM

Distance	Real distance	vSLAM distance	Difference	Deviation
1-2	~ 100 m	~ 97 m	- 3 m	-3,0 %
1-3	~ 266 m	~ 255 m	-11 m	-4,1 %
1-4	~ 344 m	~ 327 m	-17 m	-4,9 %
1-1	~ 490 m	~474 m	-16 m	-3,2 %

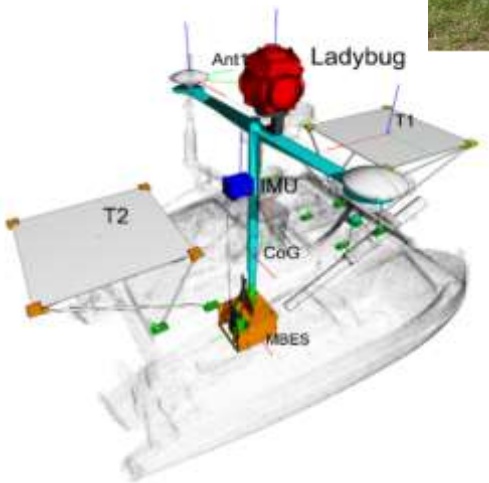
- UAV tracking – Follow-me mode





Survey boat (USV)

- Sensors
  - 360° camera Flir Ladybug 5
  - Multibeam Echolot R2Sonic 2020 – MBES
  - Multi parameter probe
  - Acoustic Doppler Current Profiler (ADCP) Teledyne StreamPro
  - GNSS / INS: NovAtel SPAN CPT 7
  - Marker on USV
- Essential: Adjustment and calibration



Origin Center of Gravity	X	Y	Z
CoG	0.0	0.0	0.0
IMU	6.8	-44.5	327.7
Ant 1	-522.6	21.4	547.5
Ant 2	523.6	15.4	585.4
MBES vertical	2.0	17.7	-488.1
MBES 30° right	101.8	16.9	-466.3
MBES 30° left	-95.3	17.9	-457.0
Ladybug	45.0	42.0	671.6
T1	6.7	631.5	376.1
T2	5.5	-540.8	271.0

Drone (UAV): Avartek Boxer Hybrid drone

- Sensors
  - Monochrome Ximea MX124MG-SY
  - PhaseOne iXM-MV100 with 35 mm lense
  - Bathymetric LiDAR-Sensor BDF-1

Source: Avartek 2022

Source: Ximea

Source: Edmund Optics

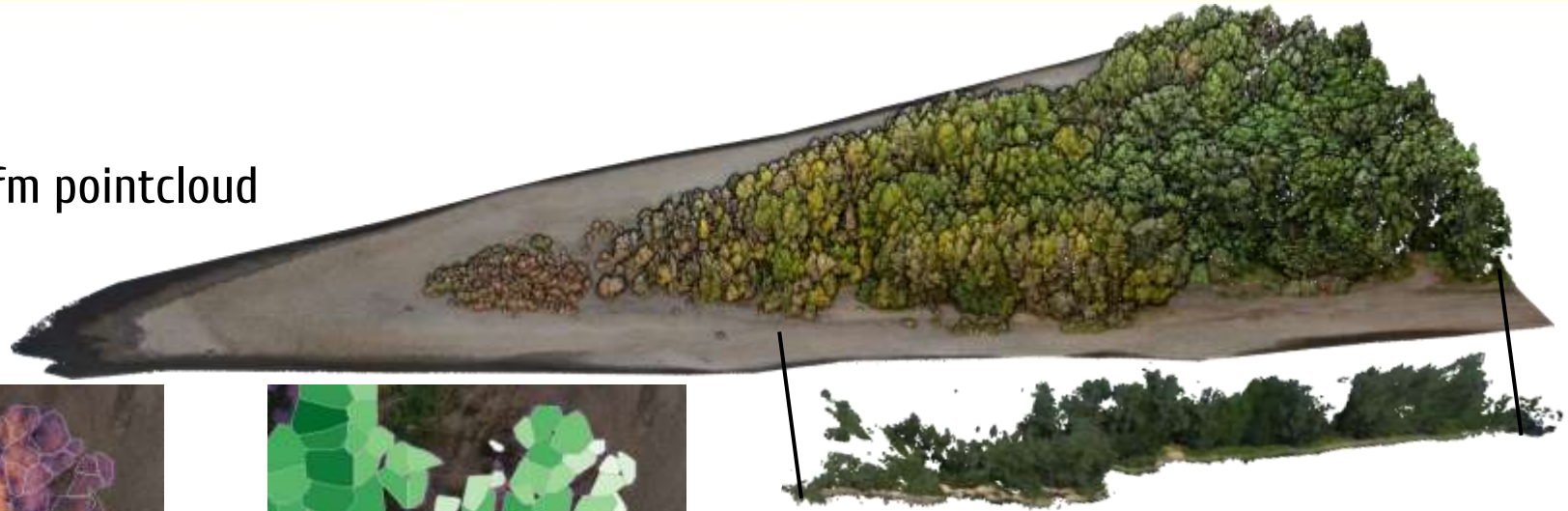
Kamerasystem
PhaseOne iXM
(Source: PhaseOne)

Bathymetric LiDAR (Source: RIEGL)

Test results

Flight height– 100 m AGL
GSD – 1.27 cm/pix
800 million points
Area – 250 m x 350 m

sfm pointcloud

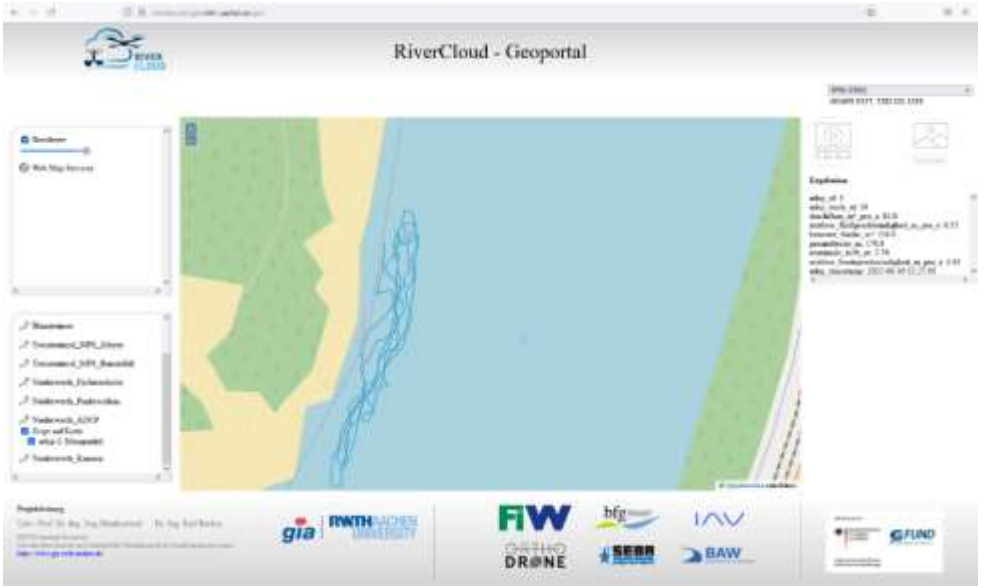


360° pointcloud

count	905
sum	115677 kg
min	0,2 kg
max	874 kg

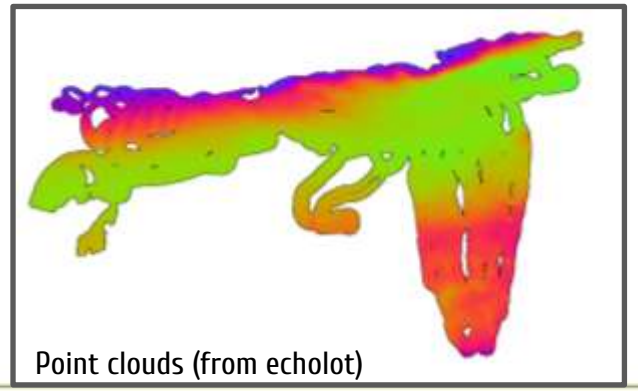
River cloud web portal

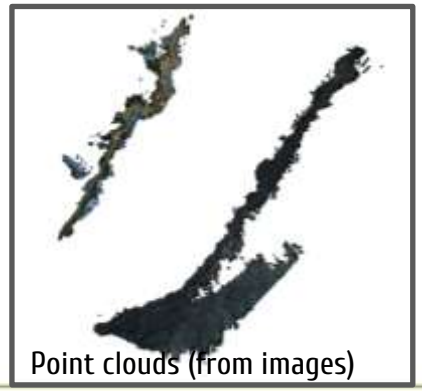
- Available data can be selected and viewed in a georeferenced way in specialized viewers
- Can be accessed via file download or data interfaces like web services (WMS / WFS)




Multi parameter prone (MPS)


360° viewer for panorama images


Point clouds (from echolot)


Point clouds (from images)

Thanks for your attention

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