Frequency Scanning Surface Velocity Radar for River Monitoring

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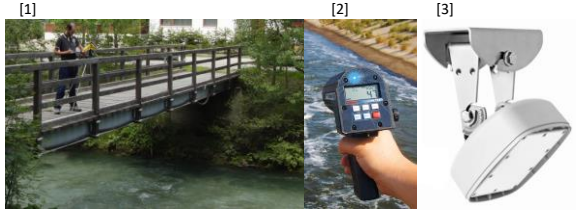
STATUS QUO

River discharge monitoring

[1] [2] [3]

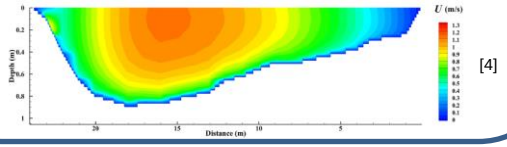


- ✓ River discharge can be estimated starting from measurements of **surface velocity distribution throughout the cross-section**
- ✓ Traditional monitoring requires **multiple sensors** with fixed-direction, or human operators with **hand-held** guns

NEW INSIGHTS

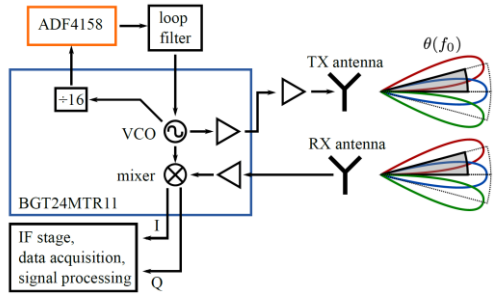
Frequency Scanning SVR

- ✓ Measure surface velocity throughout the cross-section of the river, **exploiting frequency squint** (passive beamforming) instead of moving the sensor
  - ➢ Antenna beam direction is chosen setting the SVR operating frequency
- ✓ This data can be used to obtain 2D velocity distribution and discharge of the river



[4]

DESCRIPTION

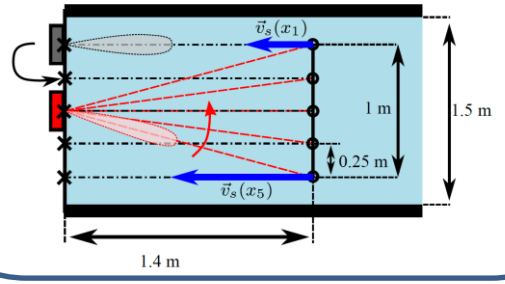


The proposed frequency scanning SVR is mainly composed of two parts:

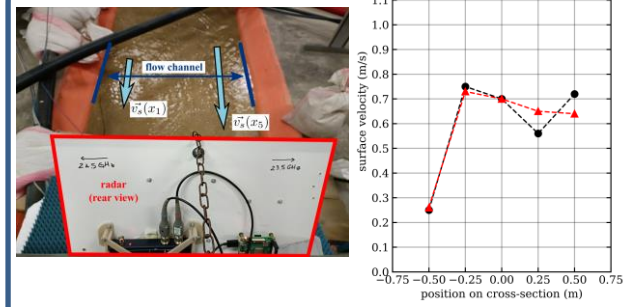
- ✓ 24-GHz Zero-IF transceiver (COTS PLL)
- ✓ Frequency scanning antenna
  - ➢ FOV: 30°
  - ➢ Beamwidth: 6° azimuth, 9° elevation

Surface velocities of a **flow channel** (5 points throughout the cross-section) measured in two different ways:

- ✓ Shift of radar position (**grey**)
- ✓ Frequency scanning (**red**)



QUANTITATIVE IMPACT



The two ways of measuring the surface velocity are compatible. Differences on measured velocities can be observed in flow channel area with turbulences (right side).

PROPOSED CONCEPT GOALS

Frequency scanning CW Doppler SVR

- ✓ DoA separability by means of a **single passive antenna**
- ✓ High-directivity
  - ➢ Long-range SVR
- ✓ SISO architecture
  - ➢ Minimal-effort signal processing

Next steps

- ✓ Further investigation on the relation between backscattering phenomena and the Doppler radar results
- ✓ Measurements on river sites

[1] Welber et al., «Field assessment of noncontact stream gauging using portable surface velocity radars (SVR)", DOI: 10.1002/2015WR017906
[2] Stalker Pro II SVR, https://www.stalkerradar.com/oem/SVR.html
[3] OTT SVR 100, https://nvm.ie/product/ott-svr-100-surface-velocity-radar-for-measuring-open-channel-flow/
[4] Bahmanpouri et al., «Estimating the Average River Cross-Section Velocity by Observing Only One Surface Velocity Value and Calibrating the Entropic Parameter", DOI: 10.1029/2021WR031821