FILLING IN THE GAPS OF RTK WITH REGIONAL PPP

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SESSION F3: PRECISE POSITIONING AND RTK FOR CIVIL APPLICATION

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OUTLINE

- RTK: Real Time Kinematic
- PPP: Precise Point Positioning
- Products for PPP
- Regional PPP
- Global VS Regional PPP, static mode
- RTK VS PPP, kinematic mode
- Conclusions and future work
RTK: REAL TIME KINEMATIC

- Differential positioning technique based on the use of dual-frequency carrier phase measurements of GNSS signals where a base station receiver at a well known, calibrated location transmits signal corrections in real time to one or several rover receivers.

- RTK corrections compensate atmospheric delay, orbital and clock errors, etc, increasing positioning accuracy up to the centimeter level.

- Almost instantaneous convergence due to integer ambiguity determination.

- Limited corrections applicability due to decorrelation between base station and rover conditions (ionosphere, troposphere...).

- Enhancing methods such as VRS allows performing RTK positioning in reference station networks with distances of up to 40 km.
PPP: PRECISE POINT POSITIONING

- Absolute positioning technique based on undifferenced, dual-frequency observations coming from a single GNSS receiver, together with detailed physical models and corrections, and precise GNSS orbit and clock products calculated beforehand.

- Additional corrections used to mitigate systematic effects which lead to centimeter variations in the undifferenced code and phase observations; phase wind-up corrections, satellite antenna offsets, station displacements due to tides (earth and oceanic), etc.

- PPP has the advantage versus RTK in that no base station or network of base stations is necessary -> a PPP client is completely independent.

- Ambiguities need to be estimated (without further enhancements) -> Convergence time needed, longer than in RTK.
PRODUCTS FOR PPP

- GMV: Infrastructure for generation of precise GNSS orbits and clocks.

- Product comparison VS IGS:
  - **Real Time**: 0.3 ns and 6 cm for orbit vs IGS.
  - **Post-processing**: 0.2 ns and 3 cm for orbit vs IGS.

- Quality monitored via PPP.
REGIONAL PPP

- PPP normally conceived as global positioning technique. Regional positioning providers do not necessarily need global coverage.

- PPP products from global network:
  - Good performances everywhere
  - Data collection complex and expensive

- **Alternative** -> Products from regional network:
  - Range error good in coverage error only
  - More feasible solution for service provider
GLOBAL VS REGIONAL PPP (1)

- Only local accuracy of reference products needed for high PPP quality.

- 24 hour PPP comparison with IGS final products and regional products.

- Regional products generated with 5 IGS stations in Australia and Brazil via *magicGNSS* tool.

- Limited coverage, but enough for regional positioning.
GLOBAL VS REGIONAL PPP (2)

- Comparable position accuracy within the target country with respect to global PPP. **Few millimetres error.**

- Position accuracy degradation as distance from target area increases.
RTK VS PPP, POST-PROCESSING (1)

- Open field terrestrial trajectory, June 23rd 2010, around 2.5 km, without obstacles that may reduce the visibility, of around 30 minute of duration.

- PPP: Regional network composed of 8 IGS stations in Europe.

- RTK: GAP1 (1 km from trajectory) used as base station.
The rover estimated both by regional PPP and RTK using GAP1 as base station.

Performances of the two positioning techniques comparable throughout all the trajectory (RMS position error in all 3 components is below 3cm).
RTK VS PPP, POST-PROCESSING (3)

- RTK based on single base station require few kilometres distance to ensure position accuracy.

- Analysis of the RTK performance degradation with respect to the distance between the rover and the base station.

- RTK process performed using as base station 5 different base stations.

- No base station available within less that 25 km from the rover/receiver -> regional PPP may me a better choice.
RTK VS PPP, REAL TIME (1)

- PPP is not a differential technique, it cannot resolve (without enhancements) integer carrier phase ambiguities -> **Longer convergence period than RTK.**

- Real time scenario for PPP and RTK comparison. 46 minutes data from GAP1 receiver via NTRIP.

- RTK: rtklib tool retrieves observation data from GAP1 and IGNE stations via NTRIP protocol. IGNE used as base station.

- PPP: GMV’s core infrastructure used to generate real time products based on NTRIP European station network.
RTK VS PPP, REAL TIME (2)

- Comparison between the estimated coordinates for GAP1 station both with RTK and PPP in real time for the 46 minute observation period.

- PPP real time technique require longer convergence time than RTK due to the ambiguity estimation problem.

- After 35 minutes, real time PPP and RTK converge with comparable accuracy to the post-processing case.
CONCLUSIONS, FUTURE WORK

- Regional PPP has shown comparable positioning accuracy to PPP with global products and RTK, both with static and kinematic data.

- Regional PPP has shown to be a plausible solution for obtaining high position precision for local environments with minimal investment and avoiding external dependency.

- Regional PPP can be used as a valid complement for areas with RTK coverage but sparse base station density.

- Convergence time needed by PPP in real time applications needs to be improved so that it can be a plausible alternative to RTK.

- PPP and RTK performances in real time with a moving rover still remains to be tested.
Thank you

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