

mmVu®

GNSS Deformation Monitoring System



GNT's mmVu® GNSS Monitoring System is a unique processor of GNSS single- and dual-frequency carrier phase observations that allows for mm level, relative position determination. It has been specifically designed for both short- and long-term deformation monitoring applications where monitored stations are moving several mm per day or less. The mmVu® system uses GNSS to continuously monitor the stability of stations of interest. The user has the ability to configure stations in mmVu® so that data is captured and processed using the mmVu® processor. The unique processing technology of mmVu® allows for high precision position updates so that the user is continuously informed of the status of the monitored stations.



mmVu® is one of the most advanced and sophisticated monitoring systems, designed and built to meet the requirements coming from a variety of deformation monitoring applications,

- where safety is critical and timely alert is essential,
- where your positioning needs are in challenging GNSS environments,
- where deformation monitoring faces limitations on technology and accuracy, and
- where robust quality control and performance assurance are required.

Software

mmVu® software system consists of real-time GNSS monitoring software (mmVu® Solver, mmVu® Server, mmVu® Synergizer and mmVu® Client) and post-processing software (mmVu® LabCue, mmVu® LabTime and mmVu® LabSync). mmVu® Integrity Monitoring System oversees the performance of mmVu® to maximize uptime of the mmVu® system. As each sub-system runs independently, it can be configured on either a single hardware platform or multiple server computers. According to users' requirements, system configuration can be optimized.

Hardware Components

mmVu® integrates the highest quality hardware components with GNT's mmVu® software to deliver continuous, high precision, position updates in real-time. At the project site, GNT's monitored stations (SGS100s or DGS100s) are located at critical areas that may illustrate abnormal physical behaviour. Data from each monitored station is streamed to GNT's Local Server computer (PS100) to calculate its position. GNT offers data communications solutions for projects where Internet infrastructure is not available.

Customized Solutions

mmVu® can be tailored for each project individually, customizing its solutions for each customer's unique situation by using optimized combinations of both single- and dual-frequency GNSS stations and its processing software. Our R&D team supports our customers to find the right solutions for their unique applications.

Integration

No single technology can be applied to all deformation monitoring applications. mmVu® can be easily integrated with other systems and sensors to offer complete monitoring solutions.

Reliable and Cost-Effective Monitoring

mmVu® offers reliable and cost-effective solutions for our customers who pursue a new industrial standard. Our ability to offer a spectrum of high precision GNSS solutions allows us to recommend sound, scientific and engineering solutions for the most challenging applications where other software packages may compromise their performance. Our practical approach provides our customers with the answers and solutions that they need.

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mmVu® is designed for a variety of applications where safety is critical. The system is specifically designed for deformation monitoring environments that poses limitations on technology and accuracy. mmVu® uses redundant processing modules to ensure the integrity of its results. Customized processing modules are available for unique applications.

Advanced GNSS Technology

mmVu® is a robust and sustainable – all weather and 24/7 – real time monitoring system, which is also an affordable system compared to traditional geotechnical or complex geodetic monitoring systems. mmVu® is a proven technology in environments where it is impossible to use other sensors.

Comprehensive and Flexible Applications

mmVu® offers comprehensive and flexible applications to the customers without restriction on the time period, distance or scale that monitoring needs might face with. mmVu® can be used for:

- Short/long-term stability monitoring applications
- Short/long-range baseline monitoring applications
- Scalable solutions from small to large projects
- Kinematic and dynamic monitoring applications
- Self-contained, stand-alone operation, or integration with existing systems

Standard Outputs

mmVu® accommodates very high measurement data rates up to 100 Hz and provides the user with its standard outputs, including:

- The original raw observations for post-processing or further analysis,
- Real-time solutions, residuals, outliers and observations information in ASCII format, and
- Real-time position solutions streaming to clients using GNT's data format, and
- Customized real-time output for users.

Sophisticated Software Design

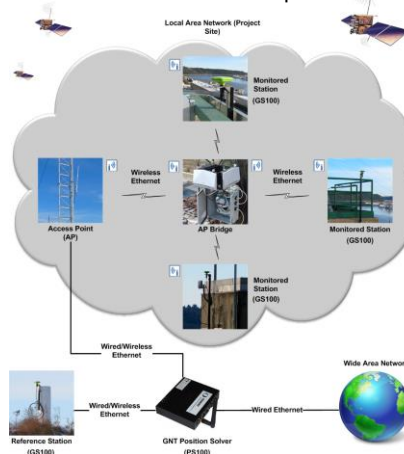
mmVu® is built on a sophisticated software design to achieve the highest accuracy and integrity of GNSS monitoring solutions. mmVu® offers:

- mm-level deformation and sub-mm trend detection
- Unique dual-processor engine (adopting TDD and DDC filters)
- Possibility to tune-up the filters for optimal performance for your application
- Multiple component system – mmVu® real-time processing software, mmVu® Client and mmVu® Engine
- Supports transformation to structure specific coordinate system for easier analysis and interpretation
- Advanced and flexible graphical output for easier analysis and interpretation of the results

Compatibility

mmVu® supports multiple input data formats from various receiver manufacturers and can handle various GNSS receivers and antenna types. It also supports receiver independent industry standard ASCII format (e.g., RINEX) and binary data format (e.g., RTCM version 3.1). mmVu® supports NTRIP (Networked Transport of RTCM via Internet Protocol) client streaming data as well.

mmVu® provides customized interface solutions for customer's hardware and software.



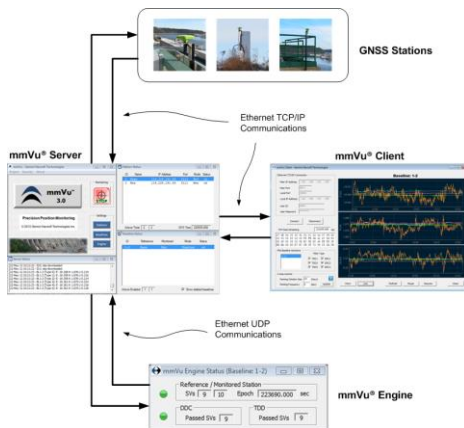
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Applied Technologies

mmVu® adopts GNT's parallel processing technology which utilizes proprietary GNSS carrier phase processing filters – Time-Delayed Doppler (TDD) filter and Double-Differenced Carrier (DDC) filter – to achieve mm-level deformation and sub-mm trend analysis. This unique technology delivers robust quality control and performance assurance to help the users achieve their positioning needs in the most challenging GNSS environments. Even under the most challenging GNSS environments such as long-range baselines, significant height differences between stations and strong multipath, mmVu® can provide positioning and monitoring solutions without compromising its accuracy by effectively mitigating the residual effects of biases and errors in the GNSS carrier phase observations.



mmVu® System Capabilities

mmVu® utilizes proprietary GNT's mmVu® software which implements advanced single- or dual-frequency GNSS data processing algorithms to achieve high precision, positioning results. mmVu® offers the following capabilities to users as:

Displacement Trend Analysis

mmVu® provides continuous 3D positioning solutions in real time so that users can analyze, long-term displacement trend of the monitored stations.

Short-Term Displacement Detection

Along with the long-term analysis, mmVu® is able to detect sudden, short-term displacements that occur naturally or be created intentionally by users.

Kinematic (Trajectory) Monitoring

mmVu® can process GNSS observations being received under a kinematic scenario, and enables users to monitor precisely the trajectory of a moving structure or object.

Dynamic Behaviour Analysis

In addition to providing positioning results under a kinematic scenario as well as a static mode, when using high sampling data rate (10 Hz or higher), mmVu® can also monitor the dynamics (e.g., velocity, acceleration, vibration and rotation) of target structures. This information is also valuable for detecting changes in state of the structure.

System Integrity Monitoring

mmVu® diagnoses the status of GNSS receivers, Ethernet communications and the mmVu® Engines autonomously. mmVu® monitors the data streaming status from all stations and examines the quality of all data packets, and also the status of positioning solutions from the mmVu® Engines.

Automatic Email and Short Message Service

Alerts associated with the failures of GNSS receivers, Ethernet communications and the mmVu® Engines are automatically e-mailed to the registered recipients and/or SMS (Short Message Service) is called to notify the failures to the users. Once alerts are issued, mmVu® Server is automatically rebooted to fix the failures.

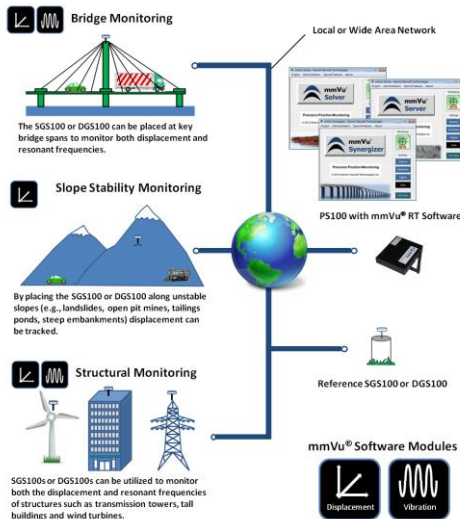
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mmVu® Monitoring Applications

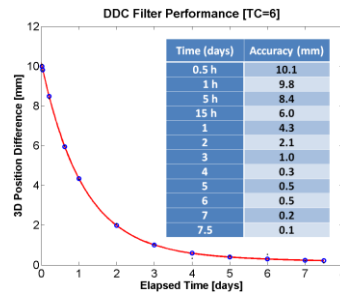
mmVu® delivers a leading edge solution for a variety of industrial monitoring applications which are faced with the most difficult GNSS challenges, including significant height differences between monitored stations and a reference station, long-range baselines, and multipath-rich conditions.



According to users' requirements, mmVu® can be tailored and packaged to accommodate customers' monitoring needs such as mmVu® Bridge, mmVu® Dam, mmVu® Offshore, mmVu® Landslide and so on.

Performance Analysis

Displacement detection capabilities of mmVu® software were tested on GNT testbed with translation stage which can generate controlled millimetre-level movement.



In one experiment 5 mm movement in 10 seconds was introduced. TDD/DDC filters have demonstrated capability to detect the full size displacement with different types of filter settings.

Optimal performance in this test in terms of detection time and maximum solution accuracy was obtained using 6 hour time constant DDC filter.

mmVu® Products Group

mmVu® software products consist of:

- mmVu® Solver, mmVu® Server and mmVu® Synergizer for real-time processing
- mmVu® LabCue, mmVu® LabTime and mmVu® LabSync for post-processing
- mmVu® Client for visualizing solutions
- mmVu® IMS (Integrity Monitoring System) for overseeing the mmVu® system

