



Most Valuable Lessons Learned Over the Last 10 Years Part 3/3

Mobile mapping on steroids

Groningen, June 2023

Introduction

In the field of GIS, the acquisition, processing, and analysis of geospatial data are crucial for informed decision-making. As a GIS expert, you understand the significance of accurate and reliable data in delivering valuable insights.

In this whitepaper, we will explore the importance of utilizing your own data compared to relying solely on third-party sources. Additionally, we will delve into the unparalleled advantages of imagery data over LiDAR data, highlighting the unique insights it can provide. Furthermore, we will emphasize the necessity of employing tailored and robust mobile mapping hardware and software solutions, rather than settling for action cameras or camera-only mapping systems.

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1. Hardware & software requirements for large scale mobile mapping projects

1.1 Introduction

As large-scale HD mapping and surveying projects continue to push the boundaries of what is possible, robust mobile mapping systems equipped with efficient power management, seamless data storage and transfer capabilities, and user-friendly interfaces with powerful software become indispensable assets. Large-scale HD mapping and surveying projects require robust mobile mapping systems with several important features. Here are the 10 key features that are crucial for such projects.

1.2 Hardware requirements

- Imagery data is a must have

Mobile mappings system should be equipped with high-resolution imaging capabilities to capture detailed imagery of the environment. This typically involves high-definition, spherical or even thermal cameras capable of capturing clear and sharp images. No critical information goes unnoticed, ensuring a comprehensive representation of the surveyed area. So, imagery data plays a crucial role in asset management and mobile mapping projects due to its inherent advantages in providing high-resolution visuals, efficient data processing, wide coverage area, and user-friendly visualization. These advantages contribute to improved decision-making processes and effective utilization of data in various scientific and practical applications.

High-resolution visuals derived from imagery data offer a detailed and realistic representation of the environment. This level of detail enhances asset management tasks by enabling better visualization and identification of assets. By capturing fine-grained information about the physical characteristics of assets, imagery data supports accurate asset inventory, condition assessment, and maintenance planning.

Efficient data processing is another significant advantage of imagery data. Through the use of advanced computer vision techniques, such as object detection, classification, and change detection, relevant information can be extracted from imagery in a quick and efficient manner. These automated processes eliminate the need for manual inspection, saving time and resources. The extracted information aids in asset management and mapping tasks by providing valuable insights into asset conditions, changes over time, and potential risks or anomalies.

Imagery data also stands out in terms of its ability to cover large areas at once, allowing for extensive coverage and fast data acquisition. This attribute is particularly advantageous in mobile mapping projects where capturing a wide coverage area efficiently is essential. By employing mobile mapping platforms, imagery data enables efficient data collection over large territories, facilitating comprehensive mapping and monitoring of assets and landscapes at highway speed.

Furthermore, the user-friendly visualization of imagery data enhances its accessibility to a wider audience, including non-experts. Unlike complex point cloud data from LiDAR, imagery data can be easily understood and interpreted by stakeholders with varying levels of expertise. This accessibility fosters effective communication and collaboration among different parties involved in asset management and mapping projects. Stakeholders can readily visualize and comprehend the information conveyed by imagery data, leading to informed decision-making processes and successful project outcomes.

In conclusion, imagery data offers valuable advantages in asset management and mobile mapping projects. Its high-resolution visuals, efficient data processing, wide coverage area, and user-friendly visualization capabilities empower researchers, practitioners, and decision-makers with comprehensive and accessible information. Leveraging these advantages leads to improved asset management practices, informed decision-making, and efficient utilization of resources in various scientific, environmental, and practical applications.

- Accurate positioning is the cornerstone

The combination of Global Navigation Satellite Systems (GNSS) and Inertial Measurement Units (IMU) has sparked a revolution in mobile mapping, revolutionizing the field by enabling remarkably accurate and efficient data collection. In mobile mapping, GNSS receivers integrated into mobile mapping systems determine the vehicle's exact location and trajectory. This information is pivotal for ensuring accurate georeferencing of collected data and generating precise spatial coordinates for mapped features. However, relying solely on GNSS may not deliver the level of accuracy required for high-precision mapping in urban environments or areas with limited satellite visibility. This is where the IMU enters the picture. Consisting of accelerometers and gyroscopes, the IMU measures the vehicle's acceleration and rotation rates. By combining this data with GNSS measurements, the IMU offers continuous and accurate positioning information, even during temporary disruptions or degradation of GNSS signals.

The integration of GNSS and IMU in mobile mapping systems enables two significant techniques: loose coupling and tight coupling. In loose coupling, the GNSS and IMU data are fused during processing, with the IMU measurements complementing and enhancing the GNSS positioning solution. This integration compensates for short-term signal interruptions, reduces position errors, and delivers a smoother and more precise trajectory estimation. Conversely, tight coupling involves the real-time fusion of GNSS and IMU measurements at the sensor level. This approach allows for continuous and highly accurate positioning, even in challenging environments. By combining GNSS satellite measurements with the motion sensors of the IMU, the system can estimate the vehicle's position and orientation with exceptional accuracy, providing dependable and precise mapping data.

The integration of GNSS and IMU in mobile mapping systems has opened up a realm of possibilities. It enables the collection of data with unparalleled accuracy, efficiency, and reliability, revolutionizing the field of mobile mapping. This powerful combination enhances the precision of spatial data, empowers decision-making processes, and drives advancements across various industries, including infrastructure planning, environmental monitoring, and resource management. With GNSS and IMU, mobile mapping has reached new heights, transforming the way we perceive and interact with our spatial world.

1.3 Software requirements

- Data Synchronization and Integration

Sensor integration and data fusion are vital features of large-scale mapping projects. They allow for comprehensive data collection, improve accuracy and precision, enhance data quality and completeness, increase mapping efficiency, and enable advanced data interpretation and analysis. By leveraging the strengths of different sensors and fusing their measurements, mapping projects can achieve superior results, leading to more informed decision-making and better understanding of the mapped environment.

The mobile mapping system should have the capability to synchronize and integrate data from various sources, such as cameras, LiDAR, GNSS, and IMU. This orchestration will create a comprehensive dataset, maximizing accuracy and enhancing the overall quality of the final results. Unlike camera-only solutions like Insta and Mosaic, our technology allows you to effortlessly integrate and synchronize with other components, maximizing your mapping capabilities.

Sensor fusion in mobile mapping hardware poses significant challenges that must be addressed to ensure accurate and reliable data fusion. One crucial challenge is synchronization and timing, as mobile mapping hardware integrates multiple sensors operating at different frequencies and data rates. Precise alignment of sensor measurements is essential, requiring techniques like time synchronization using common reference clocks or timestamping.

Calibration and alignment are also vital considerations. Each sensor in the mobile mapping hardware has its own calibration parameters, including intrinsic and extrinsic calibration. Intrinsic calibration deals with internal characteristics like lens distortion, while extrinsic calibration focuses on relative positions and orientations of sensors. Accurate calibration and alignment are necessary to ensure correct and precise fusion of data.

The heterogeneity of sensors used in mobile mapping hardware further complicates the fusion process. Different sensors, such as LiDAR, cameras, GPS, IMU, and radar, possess varying characteristics, accuracies, and limitations. Integrating data from these diverse sources requires sophisticated algorithms and techniques to handle the different outputs and fuse them into a coherent representation.

Seamless data synchronization and integration are critical aspects of sensor fusion. Sensor data obtained by different sensors may have varying sampling rates, resolutions, and coordinate systems. Techniques such as data interpolation, resampling, and transformation are employed to align the sensor data accurately, enabling effective fusion and analysis.

Determining how to associate and fuse measurements from different sensors presents a complex task. Real-time sensor fusion demands robust algorithms that consider sensor accuracy, noise characteristics, and changing environmental conditions. Techniques like Kalman filtering or Bayesian estimation are employed to combine sensor measurements, enhancing the accuracy and reliability of the fused data.

Sensor fusion algorithms can be computationally intensive, requiring significant processing power and memory resources. Mobile mapping hardware must possess sufficient computational capabilities to handle real-time processing and fusion. Efficient algorithms and hardware optimization techniques are crucial for timely and efficient sensor fusion.

Mobile mapping encounters various environmental factors and limitations, such as urban areas with high-density buildings, foliage, or adverse weather conditions. These conditions can impact the performance and accuracy of individual sensors, posing challenges for sensor fusion. Robust algorithms capable of handling environmental uncertainties and adapting to varying conditions are essential for accurate and reliable sensor fusion in mobile mapping.

Addressing these challenges requires a multidisciplinary approach, combining expertise in sensor technology, calibration, data synchronization, algorithm development, and system integration. Overcoming these difficulties ensures that sensor fusion in mobile mapping hardware optimally leverages the strengths of different sensors, providing accurate and reliable mapping data for a wide range of applications.

- The power of near real-time data processing

The integration of efficient data processing capabilities in mobile mapping systems brings significant advantages. Real-time processing enables immediate quality control checks and feedback during data acquisition, ensuring data integrity and reducing the need for post-processing. By optimizing efficiency, mobile mapping systems deliver results with exceptional speed and accuracy, providing stakeholders with timely and actionable insights.

Near real-time data processing goes beyond speed and convenience. It enhances the overall reliability and accuracy of collected data by promptly addressing quality issues during acquisition. This ensures subsequent analysis and decision-making are based on trustworthy and up-to-date information. Additionally, immediate feedback loops enable on-the-fly adjustments during data acquisition, leading to continuous improvement and enhanced mapping outputs.

The integration of near real-time data processing empowers users to harness the power of now, revolutionizing the way spatial data is collected, processed, and utilized. It facilitates efficient data analysis, immediate quality control checks, and prompt feedback, resulting in the delivery of accurate and actionable insights. By optimizing efficiency and minimizing reliance on post-processing, mobile mapping systems unlock their full potential and significantly impact spatial data workflows.

1.4 Daily operation requirements

- Ruggedness & durability of the mobile mapping solutions

Mobile mapping systems are deployed in diverse and demanding environments, including rugged terrains, dense forests, urban areas, and extreme weather conditions. These conditions can subject the equipment to vibrations, shocks, extreme temperatures, humidity, dust, and water exposure. The system's ruggedness and durability are vital to ensure continuous operation and the collection of accurate data in such challenging situations.

Unlike consumer action cameras (GoPro & LabPano) and camera-only solutions, (Mosaic & Insta360) mobile mapping systems must adhere to higher performance standards. They need to withstand continuous operation over extended periods, often involving long-distance travels and intense data acquisition. The systems must maintain their integrity and functionality even in the face of external stressors and demanding operating conditions.

To meet the requirements of ruggedness and durability, mobile mapping systems feature robust construction. The hardware components, including the housing, connectors, mounting systems, and internal mechanisms, are engineered to withstand physical impacts, vibrations, and environmental exposure. The materials used are chosen for their strength, resistance to corrosion, and protection against dust and water ingress.

Mobile mapping systems employ effective sealing techniques to protect the sensitive internal components from dust, moisture, and water. Sealed enclosures, protective gaskets, and waterproof connectors ensure that the system remains operational even when subjected to rain, splashes, or temporary submersion. These measures safeguard the integrity of the equipment and prevent damage that could compromise data acquisition.

Given the dynamic nature of mobile mapping operations, systems must be designed to withstand vibrations and shocks. Robust mounting systems, shock absorbers, and anti-vibration measures are employed to minimize the impact of vibrations on the sensors and internal components. This ensures that the acquired data remains accurate and unaffected by external disturbances.

Mobile mapping systems encounter a wide range of temperature and humidity conditions, from scorching heat to freezing cold and high humidity levels. The equipment is engineered to operate reliably within specified temperature ranges, with effective thermal management systems in place to dissipate heat. Additionally, moisture-resistant coatings and humidity control mechanisms are implemented to protect the internal electronics.

In large-scale mapping endeavors, where equipment uptime is critical, the longevity and reliability of mobile mapping systems are of utmost importance. The robust construction and durability of the equipment contribute to extended operational life, minimizing downtime and maintenance requirements. This allows mapping projects to proceed smoothly and efficiently, ensuring the timely acquisition of accurate geospatial data.

In summary, mobile mapping systems are purpose-built to endure challenging environments and demanding operating conditions. Their ruggedness and durability enable seamless performance in large-scale mapping endeavors, distinguishing them from consumer-grade action cameras and camera-only solutions. By employing robust construction, sealing techniques, vibration and shock resistance, and tolerance to temperature and humidity, these systems ensure reliable and accurate data acquisition, even in the harshest environments. The longevity and reliability of mobile mapping systems further enhance their value, facilitating uninterrupted mapping operations and contributing to the success of geospatial projects.

- Smart Power Management for uninterrupted exploration

Efficient power management is crucial for mobile mapping systems as it directly impacts the system's ability to operate continuously and collect accurate geospatial data. Without reliable power sources and management mechanisms, interruptions in data acquisition can occur, compromising the quality and integrity of the collected information. A robust power management system is essential to ensure uninterrupted exploration and maximize the productivity of mobile mapping operations.

Mobile mapping systems should incorporate intelligent power management features that optimize power usage and prolong operation time. This includes advanced power management algorithms that prioritize power distribution to critical components and optimize energy consumption based on the system's requirements. Intelligent power management ensures efficient utilization of available power resources and extends the system's operating time.

To mitigate the risk of power failures and extend the autonomy of mobile mapping systems, backup power supplies should be implemented. These can include additional batteries, external power banks, or generators that serve as secondary power sources in case the primary power supply is depleted or encounters a problem. Backup power supplies ensure continuous operation, allowing for uninterrupted data acquisition and eliminating the need for frequent battery swaps.

Integrating mobile mapping systems with the vehicle's electrical system can provide a reliable and continuous power source. By utilizing the vehicle's power supply, the system can be powered directly from the vehicle's electrical system or recharge its batteries while the vehicle is in operation. This integration reduces dependency on standalone batteries, enhances power efficiency, and eliminates the need for manual battery replacement or recharging. However using the car power supply is not recommended as it is not designed for this specific purpose. Depending on it can lead to various issues, with overheating being a significant concern, especially during long production days. To ensure uninterrupted and reliable operation, it is crucial to explore alternative power management solutions that are specifically designed for mobile mapping systems.

Mobile mapping systems are often deployed in challenging environments where power disruptions can occur due to factors such as vibrations, extreme temperatures, or uneven terrains. An efficient power management system should be designed to withstand these conditions, ensuring seamless operation and reliable power supply. This resilience guarantees continuous data acquisition and minimizes the risk of data loss or incomplete mapping coverage.

By selecting a mobile mapping solution with efficient power management capabilities, users can maintain uninterrupted productivity throughout their mapping operations. The elimination of constant battery swaps or downtime for recharging allows for a continuous workflow, maximizing the efficiency of data acquisition and reducing operational disruptions. A reliable power management system keeps the user powered and productive without interruptions, leading to improved project timelines and outcomes.

In conclusion, mobile mapping systems require efficient power management solutions to ensure uninterrupted data acquisition and maximize productivity. Intelligent power management, backup power supplies, and integration with the vehicle's electrical system are key components of a reliable power management system. By selecting a solution that provides seamless power supply in demanding conditions, mobile mapping operations can proceed without interruptions, enhancing the quality and efficiency of data collection.

- Efficient Data Storage & Transfer

Large-scale mapping projects produce massive volumes of data that require adequate storage capacity within the mobile mapping system. It is essential for the system to have sufficient onboard storage to accommodate the acquired data. Additionally, efficient data transfer mechanisms should be in place to facilitate the seamless offloading of data to external storage or cloud-based platforms for further processing and analysis.

Constantly swapping SD cards during operations is an impractical practice that can introduce errors and disrupt the workflow. Relying on manual card changes not only increases the risk of data loss or misplacement but also hampers operational efficiency. Therefore, it is crucial to explore alternative solutions that eliminate the need for frequent SD card swaps.

Furthermore, data security is a paramount concern in large-scale mapping projects. Without robust encryption capabilities, the confidentiality and integrity of the collected data may be compromised. Ensuring the protection of sensitive information and maintaining data privacy should be a priority. It is vital to seek mobile mapping systems that offer robust encryption measures to safeguard your data against unauthorized access or breaches.

In conclusion, mobile mapping systems for large-scale projects should possess ample onboard storage capacity and efficient data transfer mechanisms. This eliminates the need for frequent SD card changes and facilitates seamless data transfer to external storage or cloud-based platforms. Additionally, robust encryption measures should be implemented to ensure the security and confidentiality of the collected data. By adopting these alternative solutions, mapping professionals can enhance data management, improve operational efficiency, and mitigate potential risks associated with data security.

- User-Friendly Interface & tailored GIS Software

A mobile mapping system should have an intuitive and user-friendly interface to facilitate easy operation and data visualization. Additionally, the accompanying software should provide efficient data management, processing, and analysis capabilities. This combination empowers users to harness the full potential of the system, enabling them to extract valuable information and make informed decisions.

The significance of having a full end-to-end GIS software suite cannot be overstated. Utilizing separate software packages from different manufacturers, such as the Mosaic mapping solutions, introduces complexities and inefficiencies in the workflow. Having a comprehensive software suite enables a seamless flow from data capturing to processing, feature extraction, and data sharing. This integrated approach streamlines the entire GIS workflow, enhances productivity, and minimizes errors. By investing in a unified software suite, organizations can achieve greater efficiency, accuracy, and collaboration, ultimately leading to more effective decision-making and successful GIS projects.

1.5 Conclusion

Mobile mapping systems play a crucial role in large-scale HD mapping and surveying projects by providing efficient data collection, storage, and transfer capabilities. These systems require specific hardware and software features to meet the demands of such projects. This summary outlines the key features and requirements for mobile mapping systems.

In terms of hardware requirements, high-resolution imagery data is essential for capturing detailed visuals of the environment. This data enables accurate asset inventory, condition assessment, and maintenance planning. Efficient data processing is another advantage of imagery data, as it allows for quick and automated extraction of relevant information. Imagery data also covers large areas efficiently, facilitating comprehensive mapping and monitoring of assets and landscapes. Its user-friendly visualization capabilities enable effective communication and collaboration among stakeholders.

Accurate positioning is crucial for mobile mapping systems, which is achieved through the integration of GNSS and IMU. GNSS receivers determine the vehicle's location, while IMU measurements provide continuous and precise positioning information, even in challenging environments. This integration revolutionizes mobile mapping, enhancing the precision of spatial data and empowering decision-making processes.

Regarding software requirements, data synchronization and integration are vital for comprehensive data collection and accurate mapping. Mobile mapping systems should be capable of synchronizing and integrating data from various sensors, such as cameras, LiDAR, GNSS, and IMU. This fusion of data maximizes accuracy and enhances the quality of mapping results.

Near real-time data processing capabilities are crucial for mobile mapping systems. Real-time processing allows for immediate quality control checks and feedback during data acquisition, reducing the need for post-processing and delivering timely insights. This integration revolutionizes the collection, processing, and utilization of spatial data.

In terms of daily operation requirements, mobile mapping systems must exhibit ruggedness and durability to withstand challenging environments. They should be able to operate in rugged terrains, extreme weather conditions, and other demanding situations. Robust construction, effective sealing techniques, and vibration-resistant features ensure continuous and accurate data acquisition, even in harsh environments.

Efficient power management is essential for uninterrupted exploration. Mobile mapping systems should optimize power usage, prioritize critical components, and utilize backup power supplies to ensure continuous operation. Integration with the vehicle's electrical system can provide a reliable power source and eliminate the need for frequent battery swaps.

Mobile mapping systems also require efficient data storage and transfer mechanisms. Adequate onboard storage is necessary to accommodate the massive volumes of data generated during mapping projects. Seamless data transfer to external storage or cloud-based platforms enables further processing and analysis.

Overall, robust mobile mapping systems equipped with high-resolution imaging capabilities, accurate positioning through GNSS and IMU integration, efficient data synchronization and integration, near real-time data processing, ruggedness and durability, efficient power management, and efficient data storage and transfer capabilities are crucial for large-scale HD mapping and surveying projects. These features ensure comprehensive data collection, accurate mapping results, and uninterrupted operation, leading to improved decision-making processes and successful project outcomes.

2. Contact details

If you have any further questions don't hesitate to contact:

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