

THE SURVEY ASSOCIATION

CLIENT GUIDE TO **PEDESTRIAN MOBILE MAPPING**

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The Survey Association's Client Guides are primarily aimed at other professionals such as engineers, architects, planners and clients in general. They are not intended to go 'in depth' into practical issues but to act as a basic guide on a given topic and in particular, on procedures which may govern how a certain aspect of the survey is carried out.

Introduction

During the last decade there have been significant advances in the technology used to capture data for mapping. Laser scanners, Global Navigation Satellite System (GNSS) receivers and Inertial Measurement Unit (IMU) devices are now smaller, portable and more accurate. This is changing the way reality is captured. Developments in the accompanying hardware and software bring advantages, such as cost-efficient workflows, increased productivity and improved onsite health and safety.

Figure 1
A backpack pedestrian mobile mapping system

1. What is a Pedestrian Mobile Mapping System (MMS)?

In its simplest form, a Pedestrian MMS is the process of collecting geospatial data while moving. This is achieved with a lightweight system that can be worn or carried by an individual whilst the geospatial data around them is captured.

2. How does a Pedestrian MMS Work?

The technology used for a Pedestrian MMS integrates different sensors and intelligent algorithms to provide precise positions, whilst capturing real-time geospatial data on the move.

Before capturing data with a Pedestrian MMS, designing the optimal trajectory path is crucial. All external conditions must be considered, including the range of active and passive sensors, GNSS conditions and SLAM (Simultaneous Localisation and Mapping) limitations, which are explained in more detail below.

Once the data is recorded through the pedestrian MMS sensors (active and passive), it is time-stamped and linked to the trajectory simultaneously.

Areas to consider when planning an optimal trajectory

The trajectory of a Pedestrian MMS can be computed using:

- The combination of GNSS and IMU
- The SLAM algorithm, fast becoming a common tool to capture data, especially in GNSS denied areas and confined spaces
- The combination of GNSS, IMU and SLAM configuration that offers a complete solution for the geospatial capture of the surrounding terrain and infrastructure.

3. Main Components within a Pedestrian MMS

A Pedestrian MMS may or may not have all the sensors listed below:

Active Sensors

Time of Flight Laser Scanners (Class 1) to provide LiDAR (Light Detection and Ranging) point clouds, which are a set of dense data points represented in the space. These sensors emit a laser electromagnetic pulse millions of times a second. The pulse of energy travels until it finds a surface and is reflected back to the sensor (as long as the surface is within the range of the laser). The result is a coordinated 3D representation of the area captured.

Many laser scanners have the capability to record the intensity values of the returning pulses of energy, which are directly linked to the reflectivity properties of the materials.

When visualising the LiDAR point cloud based on the intensity values, a new level of extremely useful information is added to the dataset. This information can be utilised by automatic and semi-automatic feature extraction tools in most of the software for LiDAR point clouds, and also provides crucial information in the scan to BIM process.

Passive Sensors

Passive sensors collect visual information to enrich the LiDAR point cloud by adding colour values such as RGB and thermal imaging.

In addition, when the internal and external orientation parameters for the cameras and images are accurately determined, the images can be used to digitise features, and to extract coordinates and measurements by applying photogrammetric techniques.

Positioning Sensors

GNSS Receivers are utilised to track satellite signals available from different constellations (GPS, GLONASS, GALILEO, BEIDOU, NAVIC, QZSS) to determine the position of the equipment. Differential GNSS techniques are applied for accurate positioning during the data acquisition.

IMUs are electronic devices compounded by accelerometers and gyroscopes that report changes in speed and direction at a high rate. The drift suffered from accumulated error is a disadvantage with these sensors.

SLAM is an intelligent algorithm with the ability to localise the system in an unknown environment, whilst simultaneously creating a coherent map of its surrounding area. More frequently, organisations are developing their own SLAM algorithms to merge and process the data provided by the IMUs and the sensors of an MMS to calculate the trajectory of the system. The time duration of the data acquisition is the main limitation.

LiDAR SLAM is based on the point cloud provided by the laser scanners of the MMS. The trajectory solution is dependent on the number of features available to engage the LiDAR data.

Visual SLAM is based on the images provided by the cameras of the MMS. The trajectory solution is dependent on the quality of the images, textures and light conditions.

Figure 2
Pedestrian mobile mapping systems vary in size, sensor type and accuracy





Figure 3
Pedestrian mobile mapping system being used in difficult terrain

4. The Benefits of Pedestrian MMS

Flexibility for the operator during data acquisition and the capability to capture large areas in short periods of time.

Productivity is increased as data is recorded in a continuous mode while the operator moves. The processing stage at the office is simplified as registrations between static scans are no longer required.

Pedestrian MMS are small, light and versatile. Therefore, the technology can also be utilised to capture data on moving platforms such as cars, UAVs, quadbikes, segways, boats and cherry pickers.

Large areas of data can be captured with only one surveyor therefore making it a cost effective way of creating 3D point clouds for visual representations of landscapes and infrastructure. Pedestrian mobile mapping has a relaxed accuracy compared to static survey techniques and is a less expensive alternative to more costly static survey techniques if accuracy is not the priority.

5. Deliverables from Pedestrian MMS

The deliverables generated through a Pedestrian MMS dataset can be used in a variety of applications and represent the foundation of many projects. The data is the beginning of workflows and processes, the raw material from which additional products are generated. Consequently, accuracy has a direct impact on the entire process.

– **LiDAR point clouds** with intensity, and different colour properties

– **Imagery**, georeferenced, in some cases providing metric capabilities

– **Panorama imagery** for visual information and point cloud colourisation.

6. Applications of Pedestrian MMS

– Topographical surveys

– As-built and Digital Documentation

– Smart Cities and City Modelling

– Volume calculations in large construction sites

– Mapping the unknown – SLAM algorithms

– BIM and Asset Management: Pedestrian MMS fits perfectly in the process of capturing, creating and managing all the information about an asset throughout its lifetime

– Public safety, event preparation, demonstrations and evacuation routes

– Disaster recovery for fast and flexible acquisition of critical damaged areas

– Environment applications for monitoring geological features such as rivers, coastline erosion or landslides

– Create realistic VR environments for gaming and filming industry

– Augmented Reality

– Digital Elevation Model generation.

7. Summary

The absolute accuracy of the deliverables is reliant on the position of the sensor, the precision of the trajectory (active or passive), the synchronisation of all sensors and the accuracy of the calculation.

The trajectory of a Pedestrian MMS is influenced by many factors, including the experience of the operator, GNSS conditions (where appropriate), the duration of the data acquisition when capturing data in GNSS denied areas, the SLAM solution and the sensors carried by the system.

These systems are designed to enhance the profession's current workflows and methodologies whilst providing increased benefits that help enhance performance, accuracy, health and safety and productivity.

The Survey Association

Formed in 1979 as The UK Land and Hydrographic Association, TSA is now established as the representative organisation for UK private surveying firms. The Association's aims are:

> To provide a vehicle for members to act effectively together on agreed courses of action

> To promote the interests of the profession to all those who determine the economic and social conditions in which the industry operates

> To identify and represent the views of the industry.

Using a TSA Member

By using a TSA member you can be assured that your project will get off to the best possible start. Whatever the size of project, you can be certain that TSA member companies are expert in the provision and management of spatially related data on which to base your concept, design and construction.

Professional attention from a TSA surveyor will reduce risk, repetition, possibly save you money and will ensure that your project receives the best possible attention.

Contact the UK Survey Association phone **01636 642840** or visit the TSA website **www.tsa-uk.org.uk** to locate an established survey firm.

TSA Contact Details

If you would like any more information about the TSA or its members or about other Information leaflets then please contact TSA at:

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