Indoor Mapping

Creating georeferenced indoor maps, images and 3D models

Indoor mapping for high accuracy and productivity

Peter Canter and Andrew Stott, Applanix, with Stu Rich, Chief Technology Officer, PenBay Solutions, and James L Querry Jr, Director of Enterprise GIS, City of Philadelphia

Mobile mapping, or the creation of accurate geospatial information from a moving platform, is the most cost-effective and productive way of acquiring quality infrastructure data today. Conventional methods of data acquisition of this type, i.e. static surveys, are far more time consuming and expensive to execute than mobile mapping, particularly when considering the cost of labour and processing data.

Mobile mapping has, however, always been limited to outdoor environments, where satellites for positioning information are in view. New indoor mobile mapping systems have now overcome this hurdle and made this a reality.

Technology of mobile mapping

At the heart of many mobile mapping systems are position and orientation systems which integrate precision GNSS with advanced inertial technology (accelerometers and gyros) to provide uninterrupted measurements of the position, roll, pitch and true heading of moving vehicles.

Applications for these solutions have proven to be widespread and mobile mapping of this kind is being used extensively today around the world. These POS-based solutions rely on GNSS access and are therefore not suitable for mapping inside buildings and in underground locations.

Introducing changes

New technology changes all this and brings mobile mapping, and all its associated benefits, to just about any indoor environment. Systems like the Trimble indoor mobile mapping solution (TIMMS) are mobile, easily manoeuvred and can be operated by a single operator around offices, cubicles, in elevators, washrooms, around equipment and so on. They have variety of features for enabling the accurate georeferencing of sensor data without the use of satellite positioning and, in the case of TIMMS, the Applanix POS position and orientation system for inertial measurements (and GNSS measurements when operated at the exterior of the building).

The emphasis is on the concepts of mobile and productivity. Indoor mobile mapping systems can be moved at normal walking speed; meaning total data collection time is equal to the amount it takes for the average person to walk the area concerned. Using traditional survey methods, collecting the data for an office building could take weeks, with indoor mobile mapping it’s done in a day. This remarkable reduction in time is accompanied by a remarkable reduction in cost as well, with no loss in accuracy. Accuracy achieved with these systems is better than 10cm in accurate real world positions, with relative accuracies of 2cm or better.

Once the walk-through is completed, software can be used for the accurate production of interior maps, spherical maps, videos and 3D models. Users can translate their environments into visual 2D and 3D layouts and structured interiors. The interior maps can become an integrated part of more widely acquired regional GIS databases — meaning complete indoor situational awareness is achieved.

Interior maps

Indoor mobile mapping systems create excellent 2D floor plans which contain a level of detail previously unavailable. The 2D floor plans are accurate; precise measurements can be made, distances, angles, areas and volumes can be exactly computed. The 2D floor plans are a snapshot of interior space at a given time. In the case of TIMMS, because it has been specially designed to be manoeuvrable, all interior spaces can be captured, allowing floor plans to be as complete as possible. It is more than a 2D system, as all data is acquired for 3D representation and modelling as well. Data can be rendered in a 3D viewer and the user can be immersed in the interior space.

Spherical maps

Systems can be optionally equipped with spherical cameras which cycle once per

The spherical camera system cycles once per metre, immersing a building in photograhic images. All 360° image data is georeferenced.
Indoor Mapping

metre, immersing a building with photographic images. All 360° image data is georeferenced. Situational awareness for building security and event planning is greatly enhanced when the spherical camera data is made available to regional GIS databases. 360° views of any interior space can be controlled by the user, enabling any perspective desired. The user can be immersed in a room and take in the surrounding area much the same way as if they were really there.

Building owners, planners, designers, engineers, construction contractors, facility managers, plant operations, law enforcement, first responders, and the military are just some of the benefactors of these products and of this technology.

Philadelphia

In order to effectively analyse and manage its critical public infrastructure, the City of Philadelphia looked into the best method for obtaining a detailed and comprehensive spatial data set. Information was sought on several areas, including:

- Pedestrian concourses with platforms, corridors, stair locations and ramps.
- Ingress and egress points.
- Emergency access and air vent facilities.
- Connections between levels.
- Partial interiors of at least three buildings that connect to a defined pilot area.
- In-building floor maps.

GIS specialists PenBay Solutions provided the city with a programme that used the TIMMS system for collecting a host of information in one pass. Data collected was further developed, resulting in a standards-compliant geodatabase useful to multiple city agencies as an extension of their existing GIS. Deliverables from this pilot project included:

- A 3D LiDAR point cloud that is dimensionally accurate in real-world coordinates
  This deliverable is used as a beginning dimensional framework for the derivation of multiple data sets from architecture, engineering and construction planning to facilities asset inventories, emergency action planning and real property space plans.

- A 3D video data set for the entire captured area
  This deliverable is of particular interest to the public safety community for planning and preparedness workflows. This deliverable also provides assistance to facilities managers in condition assessment and asset inventory.

- A set of in-building floor maps of the captured area
  This is of interest to real property and space planners, as well as public safety. This provides the city with a unique view of its indoor space with reference to the surrounding landscape.

In creating data compliant with this building interior space data model (BISDM), Philadelphia and other stakeholders were able to begin to test the efficiency and cost-effectiveness of extending their existing enterprise GIS, giving them a holistic, 3D geospatial view of one of the city's busiest areas. The vision of this comprehensive 'common operational view' is to enable Philadelphia to increase its effectiveness in the areas of facility management, public safety and real property issues in and around its complex infrastructure of buildings, railways and surrounding areas.

The TIMMS data collection platform, combined with PenBay's ability to develop building information models, CAD and GIS representations of the underground areas near the city centre, also enabled the City of Philadelphia to fill in any gaps in existing plans available for this underground infrastructure, plans which were paper-based, dated and not widely shared across city departments. New plans of this critical infrastructure were created quickly and cost effectively; enabling managers across city departments from capital planning to emergency management personnel, as well as stakeholders such as the Southeastern Pennsylvania Transportation Authority, to leverage the existing enterprise GIS systems at Philadelphia's division of technology to make more effective decisions.

Officials within the City of Philadelphia are excited to be at the forefront of this advance in 3D in-building and subsurface spatial data collection. Combined with other initiatives, such as video surveillance and advanced enterprise GIS, it is hoped they will play a pivotal role in achieving their vision of making Philadelphia the safest large city in the US.

Peter Canter and Andrew Stott, Applanix, with Stu Rich, Chief Technology Officer, PenBay Solutions, and James L Querry Jr, Director of Enterprise GIS, City of Philadelphia

Indoor mobile mapping systems create 2D floor plans which contain a level of detail previously unavailable; precise measurements can be made, distances, angles, areas and volumes can be exactly computed.

360° views can be controlled by the user — you can be immersed in a room and take in the surrounding area in much the same way as if you were really there.