Use of LiDAR Technology in Preparing Digital 3D Maps for Smart City Projects

Prashant ALATGI, India

Key words: Terrestrial / Mobile LiDAR, SLAM, digital 3D city maps.

SUMMARY

In today's era, there exists many advanced Geospatial technologies one can use for preparing a digital map of any city. Use of appropriate Geospatial Technology plays a vital role in the development of any smart city project. Preparation of accurate, up-to-date & dynamic digital map of the city is of utmost importance for effective planning & development. The selection of right combination of Geospatial technology has become a biggest challenge for the City development authorities. LiDAR is one of the most advanced and proven technology in the recent years.

In this paper, emphasis has been laid on the use of LiDAR technology (Terrestrial, Mobile or Aerial platforms) for preparation of high precise 3D digital maps which is one of the basic necessities of the smart city projects, in combination with other Geospatial Technologies. In case of relatively smaller size of cities, only Mobile LiDAR with Terrestrial / Backpack / Hand held LiDAR (with SLAM technology) can serve the purpose. Whereas for relatively larger cities, Aerial LiDAR mounted on manned or Unmanned Aerial Vehicles can be preferred. The output thus obtained can be fed to a suitable 3D modeling software to create a digital 3D city maps and model.

Use of LiDAR Technology in Preparing Digital 3D Maps for Smart City Projects

Prashant ALATGI, India

1. INTRODUCTION

We have witnessed a drastic changes and modernization in the field of Land Surveying and mapping since the last decade. The primitive methods of measurement using Electronic Total Station instrument has gradually slowed down and has been taken over by more sophisticated and advanced LiDAR (Light Detection And Ranging) technology. Some other platforms like the UAV (Unmanned Aerial Vehicle), GPR (Ground Penetrating Radar) have also seen good development in the recent years. However, considering the speed and density of data captured along with high accuracy, LiDAR technology has become an obvious choice for the city development authorities who are responsible for building an updated 3D base map for implementing the smart city projects.

2. EXISTING SENERIO

2.1 Size of the cities

Generally size of the cities are classified in terms of population or the geographical area covered. The development and urban growth along with the infrastructure like roads, buildings, transportation network, facilities to the citizens also play an important role in deciding the class of the city. However, it is observed that accurately mapping a large city with huge population (generally greater than 1 million) along with all its infrastructural development is a difficult task.

2.2 Challenge for the City Development authorities

The biggest challenge for the City development authorities is the selection of the right combination of Geospatial technology for Preparation of accurate, up-to-date & dynamic digital map of the city for its effective planning & future development. Though many technilogies are available for mapping a city, using the best combination suited for accurately mapping a large and complex city has become the need of the hour.

3. PREPARATION OF HIGH PRECISE 3D DIGITAL MAPS FOR SMART CITIES

LiDAR (Terrestrial, Mobile or Aerial platforms) is one of the best available technologies for preparation of high precise 3D digital maps in smart city projects. For cities with a larger geographical area and with heavy vegetation cover, Airborne LiDAR (Brian Nicholls 2019) is the best solution, provided cost and flying permission are not the concern for the city authorities. Many Airborne LiDAR sensors like the Leica ‘City Mapper-2’ Airborne hybrid

sensor (Welter 2019) uses both the LiDAR and the photogrammetry techniques for high quality data capture. The accuracy of data captured is upto the tune of 10 centimeters by such high precise airborne sensors, which is usually sufficient for the city development and planning authorities.

Light weight Airborne LiDAR sensors can also be mounted on UAV (Unmanned Aerial Vehicles) with the camera sensors, (Gottfried Mandlburger 2019); example like in RIEGL RiCOPTER UAV (using RIEGL VUX-1UAV or RIEGL miniVUX-2UAV LiDAR sensors).

However, for relatively smaller size of cities, only Mobile LiDAR with Terrestrial / Backpack / Hand held LiDAR (with SLAM technology) can serve the purpose. In this method, a LiDAR sensor along with high definition cameras, GPS / GNSS & IMU sensors are mounted on a moving vehicle for data capture. Usually some GPS base stations are observed in static mode during the Mobile LiDAR survey for getting more precision in positioning of the vehicle trajectory which is used for the accurate registration of the 3D point cloud data with the camera data. Mobile LiDAR survey can be carried out for mapping the assets and features in direct line of sight along the roads easily upto 150 m corridor (75 m on both sides of road centerline) in a single run, with the accuracy of upto + / - 5 centimeters, in presence of good GPS signals.

About 50 Km to 80 Km of city road network can be easily captured in a day using one unit of such mobile LiDAR system. Many solution providers are available in the industry viz, Trimble MX9, Leica Pegasus Two Ultimate, RIEGL VMX-2HA, Topcon IP-S3 HD1, Teledyne Optech's Maverick, HI-TARGET HiScan-C, with vide range of specification and price range to choose from.

For areas where the Mobile LiDAR cannot capture the data (shadow areas and areas not in direct line of sight) say areas not along the roads, wearable backpack or terrestrial LiDAR is the best solution, since these have the GPS coordinates integration facility.

However, now a days with the availability of light weight hand held LiDAR like the Leica BLK2GO which uses the SLAM (Simultaneous Localization And Mapping) technique for accurate mapping the features in absence of GPS signals, mapping the interiors of the premises has become simple. This is a more cost effective & feasible solution as compared to the backpack or the terrestrial LiDAR solutions.

The output thus obtained from any of the above data capture methods can be fed to a suitable 3D modeling software viz. OpenCities Planner from the Bentley Systems; to create a digital 3D city maps and model of the city for further planning by the city development authorities.

4. CONCLUSION

LiDAR technology (Terrestrial, Mobile or Aerial platform) is one of the most advanced technologies which can be used efficiently for creating the 3D Digital map and model of any city. The density, speed & accuracy of data captured even in variety of city conditions including vegetation and urban sprawl makes this technology the most feasible solution for data capture in preparing digital 3D city maps for smart city projects worldwide. Moreover this data can be readily analyzed in the 3D city modeling software's to prepare a high precise digital 3D city model framework useful for further planning and development of any smart city project.

REFERENCES

Brian Nicholls, Daniel Kruimel, 12-04-2019, The Relevance of Aerial Mapping in 2019 and Beyond, (Modern Mapping Systems and Techniques), GIM International, Magazine published by Geomares.

John Welter, 23-09-2019, Leica Geosystems Announces Major Efficiency Improvement to Airborne Urban Mapping Solution, GIM International, Magazine published by Geomares.

Gottfried Mandlburger, 19-04-2019, Recent Developments in Airborne Lidar, GIM International, Magazine published by Geomares.

BIOGRAPHICAL NOTES

With 20 years of industrial experience after graduation in Civil Engineering 1999, now a Ph.D. Research Scholar, in 'Advanced Surveying Techniques'; made application of advanced Land Surveying & Mapping the passion in his life. 'Head : Technical & Business Development' of his 28 years old Company "Prashant Surveys" founded by his father, headquartered at Pune, India. Completed more than 12,000 Km of highway Topographic and City Survey projects, using advanced Mobile LiDAR & DGPS Technology. Speaker in 12 international conferences on Advanced Surveying.

Secured Gold medal in Masters of Civil Engineering (Construction and Managment) 2014 from MIT, India and ranked 2nd in the University of Pune, India. Certified Subsurface Utility Engineer in 2018 from IndSTT & Engineering Council of India. Secured First Class with Distinction in 2010 on "Remote Sensing & GIS – Technology and applications" conducted by Government of India, Department of Space, Indian Space Research Organisation (ISRO), National Remote Sensing Center, Hyderabad, India. Life Member of Institute of Engineers, Indian Road Congress, Indian National Cartographic Association, Indian Society of Remote Sensing, Indian Society of Geomatics, Surveying and Mapping Association of India.

CONTACTS

Mr. Prashant Alatgi
Ph.D. Research Scholar at MIT-World Peace University, Kothrud, Pune India.
Prashant Advanced Survey LLP, 204 Mayfair Arcade, 563 Nana Peth,
Pune – 411002.
India.
Tel. +91 9890055670
Email: prashantalatgi@gmail.com
Web site: www.prashantsurveys.com