

Multi-sensors Based 3D Mobile Navigation and Its Application on Telecommunication Services and Social Networking

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Abstract

GPS navigation has become an irresistible trend embedded into mobile phone while these powerful platforms would fulfill 3D display functionality in near future. The MEMS technology makes small profile sensor manufacturing possible, which could be integrated into the mobilephone quite easily. Such integration would enhance the availability and robustness of navigation solution greatly. The paper presents these multi-sensors based 3D navigation system on high-level, introduces some typical application scenarios on social networking.

Key word: Navigation, 3D (three dimensions), multi-sensor integration, social networking

1 Introduction

Satellite navigation technology is now becoming a navigation and positioning technology for various applications ranging from missile trajectory determination, scientific applications such as crustal deformation detections, GIS (Geographical Information System) surveying to car navigation, personal navigation and location-based service. The accuracy of the positioning ranges from a few millimeters in the case of a geodetic class receiver to a few meters using a low end receiver. With time going by, the mobile platform (Pocket PC or smartphone) is an inevitable tendency for daily life. More powerful mobile phone could be found in the market which supports 3D display than decade ago. While the development of microelectronics makes it possible to fabricate the small profile MEMS (Micro-ElectroMechanical Systems) sensors which could be embedded into mobile handset. Such integration will greatly improve the availability and robustness of the mobile navigation and position^{[3][4]}.

2 3D mobile navigation

To bring the 3D experience to the mobile users, the successfulness for generating a 3D-city model is first essential issue for achieving this objective.

The implementation of the sub-system of 3D-city modeling covers the following aspects or steps:

- Data acquisition with airborne lidar and MMS system based on terrestrial laser scanner^{[8][9][11]} and . Figure 1 illustrates such procedure.

- Data processing to extra object-wise information from the georeferencing data, laser data, photos, and

- 3D-modelling. This is the step to generate the 3D models based on the classified object data sets outputted from the second step.

Geo-spatial information technologies are now continuously developing as well to meet all these requirements for building a modern information society.

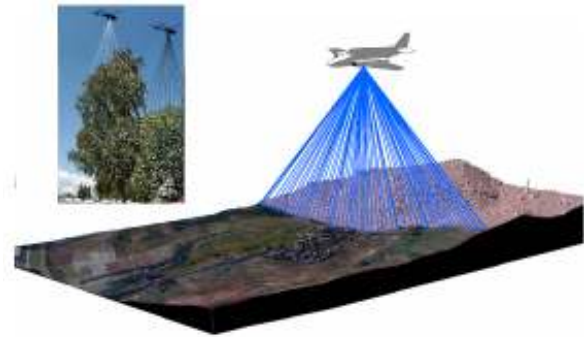


Figure 1 Data acquisition using airborne laser scanner

While after the 3D-city model is generated. There is another big issue to display 3D scenario into the mobile platform (e.g. Nokia Series 60). The application requires a greatly demanded requirement: real-time at least near real-time rendering of 3D scene using the 3D-city model. This requirement is mainly related to the following three factors

- detail level of the 3D-model,

- computing power of the handset, and
- efficiency of the visualization software component.

More precise model may cast better immersion for end-user but need more resource to support the rendering procedure while less detailed model may totally ruin the user’s experience. It should achieve a compromise after getting series feedback from final users.

Price does make performance. A better handset always gets better performance than cheaper one because normally the former has more powerful hardware which could accelerate the rendering procedure greatly.

A high efficient 3D-model visualization engine will be essential for successful solution. The engine based on the API (Application Program Interface) of OpenGL-ES will be possible and ideal solution for mobile platform. It is believed that all the phones by 2010 will support OpenGL-ES.

3 Multi-sensors supported navigation solution

However, most of the current successful applications of the satellite navigation technology are still limited to the condition of an open sky surrounding to the user. Using GNSS as a positioning technology in degraded environments, such as urban canyons and indoors is still a challenge research topic. There is an urgent need for providing a reliable determination of the user location under such environments because indoor and urban canyons are common places for emergency calls, personal navigation and location-based services.

To achieve a seamless indoor/outdoor, positioning solution is a “must” for the mobile users to experience the personal navigation and location-based services. The development of the microelectronics and sensor technologies makes in feasible to locate the mobile user anytime anywhere. One approach is to integrate different types of locating sensors including GNSS receiver, and MEMS sensors to form a multi-sensor solution. This subject is still needed to be studied to fulfill the requirements of low power consumption, small size and low cost for mobile applications. A multi-sensor solution will provide a better positioning availability and accuracy than that of the GNSS (Global Navigation Satellite System) receiver embedded inside the mobile phone. It is a luxury seamless indoor/outdoor positioning solution which will greatly extend the existing applications and business services

It will be achieved by developing a multi-sensor positioning device integrating the following sensors:

- GNSS receiver with support for pseudolite,
- 3D digital compass or 3D gyroscope
- 3D MEMS accelerometers,
- a short range RF sensor (WLAN, or BT or RFID).and
- Other sensors for special application.

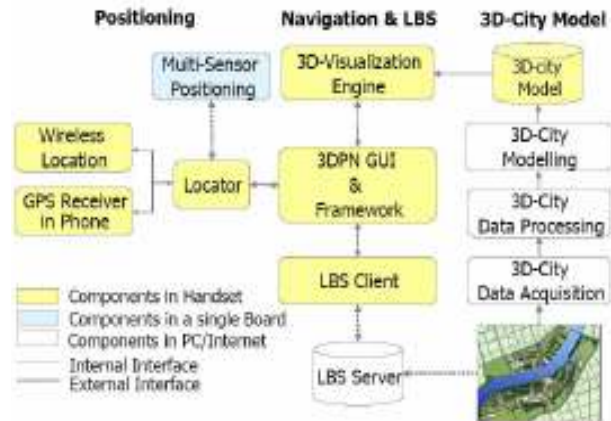


Figure 2. The high-level system architecture

It is obvious that the pseudolite (Ground-based GPS signal transmitters) should be installed in typical scenarios to transmit the navigation message (including user-define message), which will increase the GPS signal coverage greatly in degraded environment such as in-door position application or city canyon.

Figure 2 presents the high-level system architecture of the multi-sensor based 3D mobile navigation and corresponding location-based service.

4 Typical application scenarios

Multi-sensor based 3D mobile navigation offers great technical base for all kind of business cases, which enhances the potential and possibility for almost all LBS (Local Base Service) applications. Nowadays, a lot of softwares support pseudo-3D functionality such like “Tomtom” and “Router 66” as Figure 3 illustrated, and 3D driving view offers a clear picture of the road and maneuvers ahead, which will release the user’s payload by offering the ability to view more detail of drivers’ immediate surrounding. The multi-path error caused by the city canyon would result the big error in tens meter, most probably, the software will match the user’s location on other roads. While with 3D profile of the building, the pedestrian is easy to recognize the right destination. Of course, some prototyping systems have been developed or under developing based on VRML (Virtual Reality Modeling Language). [5][6][7][10] However,

all these 3D models are not generated by the real construction in real world. The 3D model mentioned in the paper is calculated by the achieved data by laser scanner, on the other word, it is real 3D model captured from real world and these models cast more realistic immersion for the mobile user comparing with the VRML model.



Figure 3. The 3D driver view of Tomtom navigator

Supported with multi-sensor integration, the system could tell us not only where the user are but also when time it is according to the decoding result from GPS signal, at both open sky environment and other degraded environments such like city canyon, even indoor. Combing location, time with social network, there would be a lot of profitable LBSes on telecommunication market in near future. A few typical applications are presented in the following paragraph.

1) "Exposition Guider": 3D model navigation casts a more realistic feeling (Immersion) upon the end-user while LBS server distributes real information during the exposition for better interaction. Last but not the least, the seamless indoor/outdoor navigation solution offers the best coverage than the other solution for large-scale exposition such as World Exposition or Olympic Games. Of course, location-based advertisement is also possible only if the solution offer the accuracy in a few meters, which may create a brand-new advertisement in near future. Figure 4 demonstrates such location aware advertisement for mobile users.



Figure 4 An example of "Exposition Guider"

2) "Mall rat". Such indoor/ outdoor seamless navigation solution may be greatly useful for a delivery person who wishes to find their recipient, equally helpful for end-users to find their friends in a crowd shopping mall and similarly available for "curious" parent to trace their underage children for sake of the security. The height information of the user coordinate is critical in some application, while the traditional solution (GPS only) never offers acceptable accuracy in these degraded environments. Sharing position information among close social network may be the next boost profit in telecommunication market in next decade. Anyway, the "friend-find" functionality may cause the conflict between public shared information and personal privacy. Further research should be carried out to resolve the corresponding ethical and juristical problems^[1].

3) "Intelligence Shoes": embedded the multi-sensor device into shoes, the shoe could tell users the following information

- a. Position related information such as: location, speed and direction.
- b. The energy consumption of you daily activity
- c. Pulse rate and blood pressure

With some appropriate algorithms and sensors, the shoe could detect faint or heart shock of the user and send an emergency call to his/her relative and hospital. With the help of 3D navigation, the rescue staff could easily find the patient no matter where the patient is.

4) "LAG (Location aware game)": you may be tired with the tedious games in cyberspace. While these new technology give you an opportunity to enjoy the "location aware game" based on the real world. The basic ideas of the LAG is similar like "geocaching"^[12] which is an entertaining adventure game for GPS users to find the catches which is set up by other participators

who share the locations (coordinates) of these caches on the internet. Combining the multisensory integration, 3D interface, social network with “geocaching”, a brand new LAG will cast totally different immersion for players. Just like most role play games, but this time you are the real player and play in a real world with your real mates. The 3D scenario demonstrates the real environment which is achieved by photogrammetric method; while the multi-sensor locating device offers ubiquitous position solution for indoor-outdoor seamless navigation. It sounds exciting just like fiction by far, while it would be real in near future only if the multi-sensor solution survives in degraded environment in hours.

5 Conclusions

The development of the information technology offers the researchers more availability to implement seamless indoor/outdoor navigation solutions in near future. While real 3D model mobile navigation provides a better immersion especially in pedestrian navigation.

The successful combination of both leading technologies would widen the LBS for our social network dramatically. However, the accuracy of the location overwhelms the final applications. Supported by multi-sensor integration, the traditional GPS position solution increases its availability and accuracy greatly. Meanwhile, a lot of researching works on multi-sensor integration algorithms should be carried out to fulfill the design.

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