

Indoor Mapping by using Smartphone Device

Shuib Rambat, Ruzsyahriman Jenal, John Elgy

Abstract—This paper presented the potential of smart phone to provide support on mapping the indoor asset. The advantage of using the smart phone to generate the indoor map is that it has the ability to capture, store and reproduces still or video images; indeed most of us do have this powerful gadget. The captured images usually used by maintenance team to save a record for future reference. Here, these images are used to generate 3D models of an object precisely and accurately for efficient and effective solution in data gathering. Thus, it could be a resource for an informative database in asset management.

Keywords—3D modeling, Asset Management, Object Extraction, Smart Device

I. INTRODUCTION

SMARTPHONE is a necessary gadget in today life styles. The advantage of this electronic devices is the ability to enable the development of unwired intelligent sensors for a wide set of applications [1]. [2] has demonstrate the competency of smart phone in managing the location aware of books on the shelves as part of the inventory process. It shows that typical maintenance through manual updates or deployments of barcode or radio-frequency identification (RFID) technologies is labor-intensive, tedious, and costly operation even though [3] claim that the RFID system could lead to an automatic solution for the inventory process.

On the other hand, modern smartphones are equipped with auto-focus cameras, orientation sensors and high-speed network access that allows to capture and share good images in the virtual environment. In this paper, the images are used to create 3D models of the objects captured and will be stored in a database for future query. An exceptional technique called terrestrial photogrammetry was used to extract the 3D model from several of 2D images. The advantage of the terrestrial photogrammetry is the ability to generate three dimensional object precisely and accurately for efficient and effective solution in data gathering[4]. Infact, the terrestrial photogrammetry technique has been applied on various applications such as restoration of architecture building[5], painting[6], artifacts[7], archeology[8] and etc.

S.Rambat is with the Universiti Teknologi Malaysia, International Campus, Kuala Lumpur, 54100 Malaysia (phone: 603-2615-4537; fax: 603-2615-4315; e-mail: shuibrambat@utm.my).

R. Jenal is currently Master Student in the School of Tun Abdul Razak, Universiti Teknologi Malaysia, International Campus, Kuala Lumpur, 54100 Malaysia (phone: 603-2615-4537; fax: 603-2615-4315; e-mail: syariman@yahoo.com).

J. Elgy is with the Aston University, Birmingham, B4 7ET United Kingdom (phone: 44-2615-4537; fax: 44-2615-4315; e-mail: j.elgy@aston.ac.uk).

Later, the extraction data from this technique can be used for 2D and 3D mapping or as an input in Geographic Information System (GIS). A map is often the easiest way for humans to aggregate many sources of data together to visualise them all and understand their condition[9]. GIS has been known to be efficient for data management, analysis and displaying the referenced data[10]. The advantage of GIS is the capability of linking digital object to their attributes and vice-verses. The GIS competence has been proved in geology, urban planning, forestry, lanscape architecture, civil engineering and etc.

II. PROCEDURE FOR 3D OBJECTS EXTRACTION

Terrestrial photogrammetry is a technique of representing and measuring 3D objects using data stored on 2D photographs, which are the foundation for rectification [11]. Thus, it required at least two photographs in order to constructs the projections and obtaining the 3D model of the objects pictured in the photographs [12] and [13]. Fig. 1, shows the projections plane and the objects.

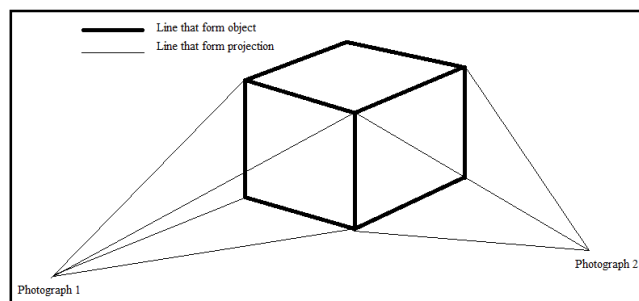


Fig. 1 The construction of projection line for an object from two photographs.

The reason of creating the projection line is to determine the exact location of objects in an arbitrary coordinate system. In early photogrammetry era, the projection line has been created through complex mathematical equations which can be found in manual photogrammetry hand-book. Fortunately, advance technologies in computer programming has revolutionised the way of creating the projection line with the possibility of achieving high accuracy in generating 3D models. Thus, it made the prospect of implementing this technique in the inventory process to reduce the man-hours, cost and time consuming is available. Principally, images of the subject will be taken from several different angles to provide complete veneer of the subject. Since, the inventory process usually takes place in a close-space area hence obtaining a complete

façade of the subject is difficult. Therefore, an appropriate technique is needed in data collecting and data processing to enable the generation of the 3D models.

III. TEST AREA, MATERIALS AND METHODS

A. Test Area

A pilot test has been conducted to show the potential of terrestrial photogrammetry in providing support on data inventory in assets management. For this pilot test, a pantry room with a size of 3 x 5 x 4 metre cubic has been used. The pantry room consists of one dining table, one refrigerator, one cabinet and one wall fan as illustrated in Fig 2.



Fig. 2 A pilot test area

B. Materials

The core material used in this project was a cell phone camera known as ZTE smart pad digital camera. The digital camera does not have detailed specification from the manufacturer. Thus, it requires camera calibration process in order to determine the intrinsic parameter of the imaging device. The calibration process has been carried out by using the facilities (camera calibration component) in photomodeler scanner software. The photomodeler scanner software provides the calibration grid contains recognisable reference marks that been purposely designed for Camera Calibrator in Photomodeler as shown in Fig. 3. Later, the parameters obtained from the calibration process were used as one of the input in 3D data extraction task.



Fig. 3 ZTE smartpad

C. Methods

The methodology used in this research project consists of two phases which are the extraction process and database development. The extractions process consists of two main components; 1) extracting the interior space and 2) extracting the asset. The idea of extracting the interior space is to create the landscape in order to make the model look likes existing [14]. While, extracting the asset is used to be as data recording. Extracting an asset is a simple task and it has been demonstrated by several researchers such as [8] and [9]. However, extracting the interior space by means of photography is still at the beginning state. For the extracting process, the photomodeler scanner software has been used to extract the shape and texture in the entire project. The extraction products are then exported into CAD environment to complete the 3D model. Once complete, it will be imported into GIS database systems which were developed in Phase 2 (not included in the paper). Fig. 4 shows the flow of process for inventory purposes by using digital photograph.

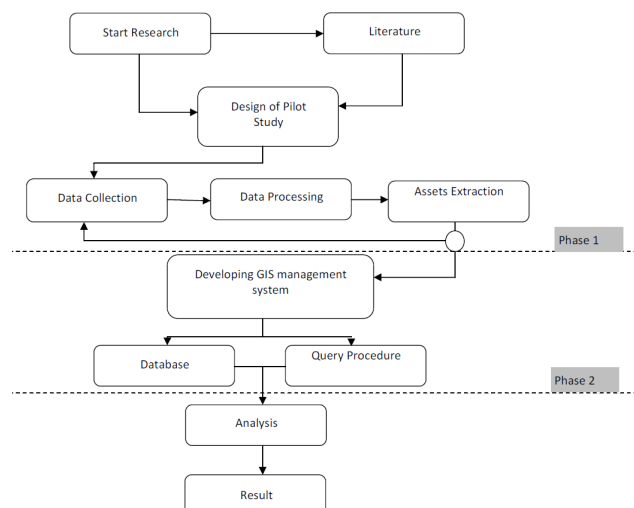


Fig. 4 Flow chart of extracting the 3D objects

IV. RESULT AND DISCUSSIONS

The extraction result has shown the potential of terrestrial photogrammetry to extract the 3D model of the surrounding area together with the assets. However, the generated 3D model only can be accepted in the camera direction whereas in other direction the 3D models created from the terrestrial photogrammetry were distorted. Hence, it's not able to present an accurate 3D presentation. Fig. 5 shows extraction result of the pilot study. The result shows that extracting the surrounding area was unsuccessful even though from the camera direction it shows almost perfect view. As an alternative, the surrounding area is mapped by using physical measurement data. The measurement data are used to create a 3D view of the surrounding area by using AutoCad software. Fig. 6 shows the surrounding area that going to be used as a landscape.

The result of extracting the particular assets such as the refrigerator was successfully done (Fig. 7b). Subsequently,

this asset was transfer into CAD environment in order to overlay the asset with the surrounding area which was mapped by using the CAD facilities. Fig. 7c shows the overlay images between the surrounding and the asset.

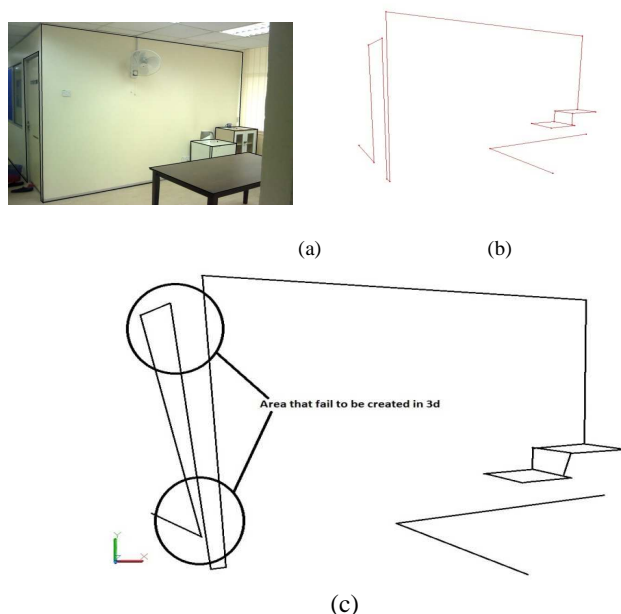


Fig. 5 (a) Image of pilot test area with delineate line to be extract; (b) the extraction of 3D model and (c) the distort area of the generated 3D model

V. CONCLUSIONS

As a conclusion, the terrestrial photogrammetry method has capabilities to be used for assisting the asset inventory process. However, the texture of the asset and surrounding area should be matched with the existing by installing the texture into the materials library in the AutoCad.

ACKNOWLEDGMENT

We thank the following for financial support or assistance enabling this research: Research Grant for Research University, Universiti Teknologi Malaysia with a Grant number Q.K130000.7111.01J50, Ministry of Higher Education and the Government of Malaysia.

REFERENCES

- [1] Morón, M., et al., A Smart Phone-based Personal Area Network for Remote Monitoring of Biosignals 4th International Workshop on Wearable and Implantable Body Sensor Networks (BSN 2007), S. Leonhardt, T. Falck, and P. Mähönen, Editors. 2007, Springer Berlin Heidelberg. p. 116-121.
- [2] Chen, D., et al. Low-cost asset tracking using location-aware camera phones. 2010: SPIE.
- [3] WiseTrack. The Wise Way too Track your Assets Anytime and Anywhere. 2010 [cited 2011 8 August]; Available from: <http://www.wisetrack.com/wireless.pdf>.
- [4] Samad, A.M., Mohd Isa, A.F., Nordin, T.E., and Abdullah, M.N., , Projek Pemetaan Fotogrammetri Jarak Dekat Berdigit (FJDB) [Digital Close-Range Photogrammetric (DCRP) Mapping] Masjid Lama Kg. Kuala Dal, Padang Rengas, Kuala Kangsar, Perak Darul Ridzuan. Buletin GIS. Jabatan Ukur dan Pemetaan Malaysia, 2008: p. 44-51.
- [5] Mohd Din, M.A.a.A., M.Y., Integration of GIS and Digital Photogrammetry in Building Space Analysis, in Innovations in 3D Geo

Information Systems Lecture Notes in Geoinformation and Cartography. 2006. p. 721-735.

- [6] Korumaz, M., and Korumaz, A.G., Reproduction of Turkish Traditional Wall-Painting using Close Range Photogrammetry, A Case Study in Gaziantep. International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences, 2010. XXXVIII(Part 5): p. 367-371.
- [7] Mussadiq, S.a.A., F., A realistic view of 3D models of artifacts using photogrammetric approach, in International Conference of Emerging Technologies. 2009: Islamabad. p. 44-43.
- [8] Jauregui, L.M., and Jauregui, M., Terrestrial Photogrammetry Applied to Architectural Restoration and Archaeological Surveys. International Archives of Photogrammetry and Remote Sensing, 2000. XXXIII(Part B5): p. 401-405.
- [9] Crothers, H. GIS and Enterprise Asset Management. 2010 [cited 2011 8 August]; Available from: <https://blog.esri.com/Dev/blogs/waterutiities/archieve/2010/03/04/GIS-and-Enterprise-Asset-Management.aspx>
- [10] Ismail, M.H., GIS Education and Potential Career in Malaysia. Buletin GIS. Jabatan Ukur dan Pemetaan Malaysia, 2008: p. 11-21.
- [11] Vesna, S., Terrestrial photogrammetry and application to modeling architectural objects, in Architecture and Civil Engineering F.U. Series, Editor. 2008, University of Novi Sad: Serbia. p. 113-125.
- [12] Debevec, P., Modeling and Rendering Architecture from Photographs. 1996, University of California at Berkeley: California.
- [13] Stanbridge, R. Photogrammetry a Practical Guide. 2010; Available from: <http://www.buildingconservation.com/articles/photogram/photogrammetry.htm>.
- [14] Canter, P., Stott, A., Rich, S., and Querry, J.L. Creating georeferenced indoor maps, images and 3D models: Indoor mapping for high accuracy and productivity. The journal of the Chartered Institution of Civil Engineering Surveyors 2010 [cited 2011 8 August]; Available from: <http://www.civilengineeringsurveyor.com>.