

FIG WW 2012

Evaluation of Mobile Mapping System (MMS) Survey for Public Housing Estates in Hong Kong

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Housing Department

1953 Big Fire in Squatter Area



Constructed 7-Storey Buildings by Resettlement Department



Redeveloped by Housing Department in early 20s'



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Sudden Tree Falling Accidents



Actions from the Government

- Set Up a Task Force on Tree Management headed by the Chief Secretary for Administration
- Urge the Need for Setting Up a Tree Management Database
- In HD, 200 Public Rental Housing Estates, about 100,000 Trees



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Launched a Pilot Study of the Applications of Mobile Mapping System (MMS) Survey in 2010

- Testing on Estate Environment for Tree Survey
- Testing on Potential Sites Environment for Creation of 3D Geo-Referenced Image



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MMS Technology



- A **survey and information mapping technology** integrating the functions of **GPS** and **remote sensing** devices to acquire a wide variety of spatially related information (e.g. **3D Geo-Referenced Video**) on a **mobile platform** (e.g. vehicle based) dynamically.



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MMS Technologies



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MMS Tree Survey Lei Muk Shue Estate



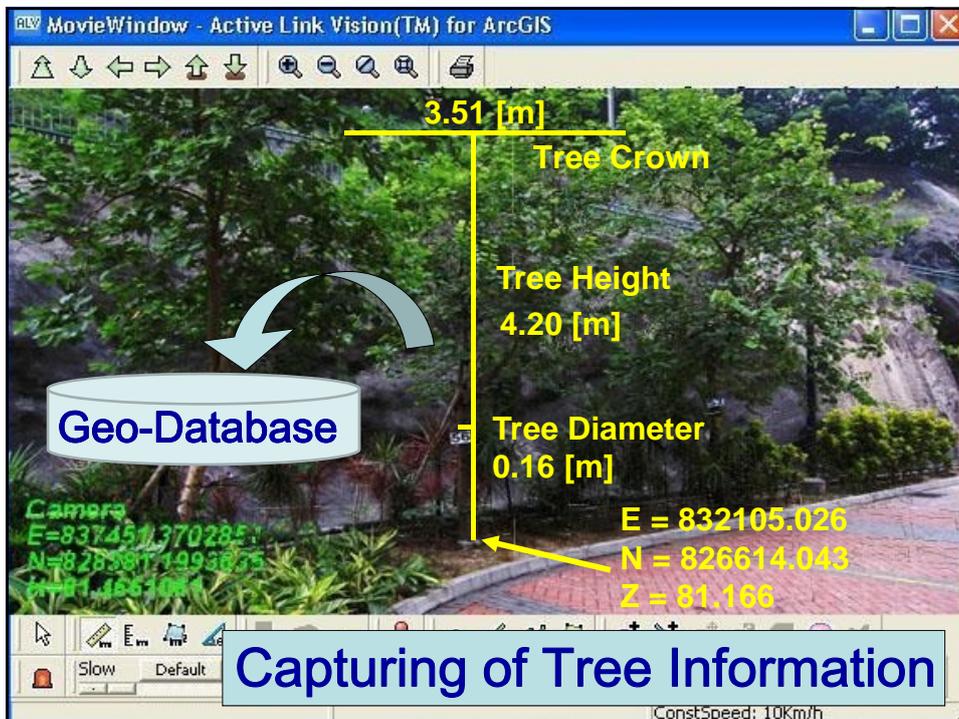
- Measure X, Y, Z of physical features on 3D Geo-referenced Image
- Insert 3D objects, e.g. buildings, trees, etc
- Collect inventory, e.g. tree information, street furniture, etc
- Update 2D Map and geodatabase automatically
- Integration with GIS

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ALV Measurements



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ALV MovieWindow - Active Link Vision(TM) for ArcGIS

3.51 [m]
Tree Crown

Tree Height
4.20 [m]

Tree Diameter
0.16 [m]

Geo-Database

Camera
E=837457.370285
N=828387.1993875
H=81.1661084

E = 832105.026
N = 826614.043
Z = 81.166

Capturing of Tree Information

ConstSpeed: 10km/h

Tree - Microsoft Internet Explorer

General Information

Search > Advanced Search > Search Result > View Detail



Manage Photo

| | |
|-----------------------|------------------------|
| Tree Reference Number | 23-0342 |
| Species Name | ARAUCARIA HETEROPHYLLA |
| Chinese Name | 異葉南洋杉 |
| Common Name | Norfolk Island Pine |
| Family Name | ARAUCARIA |
| Tree Height (M) | 16.99 |
| Tree Diameter (M) | 0.35 |
| Tree Crown (M) | 5.16 |
| Planting Site | PLANTING STRIP/RAISED |
| Planted Since | Apr-92 |
| Tree Health | GOOD |
| Tree Form | EXCELLENT |
| Amenity Value | GOOD |
| Tree Status | Notable Tree |
| Data Revised On | N/A |

Tree Characteristics of ARAUCARIA HETEROPHYLLA

| | |
|------------------|--------|
| Origin | Exotic |
| Flowering Season | |
| Flower Colour | |
| Growth Form | |
| Growth Rate | |

Special Feature

| | |
|-------------------------|--|
| Evergreen | |
| Deciduous | |
| Invasive Root System | |
| Poisonous Parts | |
| Bear Thorn/Prickle/Spin | |
| Scent | |

Site Requirement

| | |
|------------------|--|
| Open site | |
| Sunny Site | |
| Light Shady Site | |
| Shady Site | |

Retrieve Trees Information from GIS including location, size, health condition, species and characteristics for further analysis

ALV Insert Object



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Summary

| Site Name | Lei Muk Shue Estate |
|-------------------------------|-----------------------|
| Area (sq. m) | 94,958 |
| Distance by Vehicle (m) | 2,314 (15 routes) |
| Distance by Scooter (m) | 4,166 (43 routes) |
| Distance by Roving-Person (m) | 220 (7 routes) |
| Number of Housing Blocks | 11 |
| Number of Control Traverses | 67 |
| Number of Control Points | 180 |
| | Pre-mark Post-mark |
| | 125 |
| Number of Trees Digitised | 828 |
| Data Size of Video (GB) | 44.7 |

MMS Survey (3D Geo-referenced Model)

Fo Tan Cottage Area



- Integration with Local Mapping Authority 3D Spatial Data
- Integration with Design Model from BIM
- Flythrough of MMS 3D Geo-referenced Model
- Skyline Analysis (in ArcScene)



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Fo Tan 3D Model



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Summary

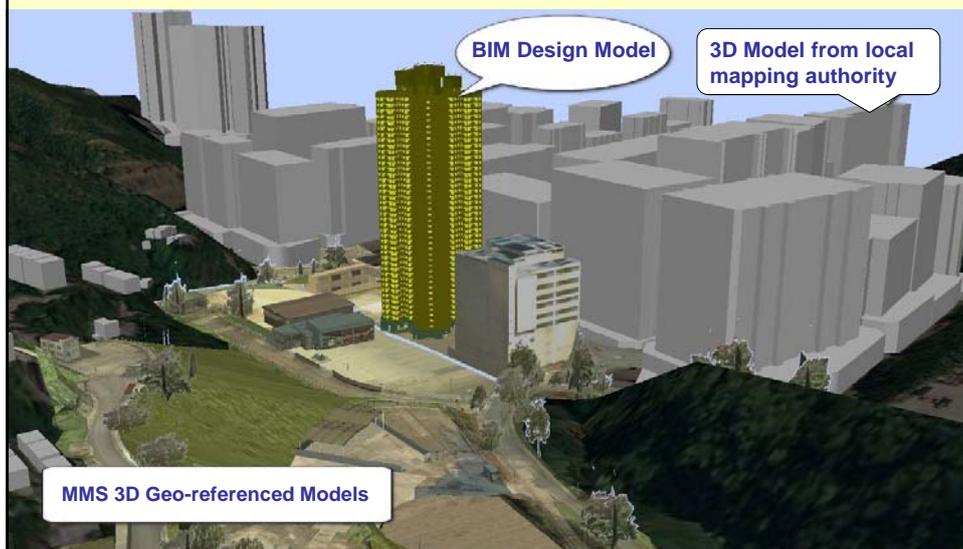
| Site Name | Fo Tan Cottage Area |
|-------------------------------|----------------------|
| Area (sq. m) | 109,760 |
| Distance by Vehicle (m) | 4,684 (28 routes) |
| Distance by Scooter (m) | 0 |
| Distance by Roving-Person (m) | 800 (16 routes) |
| No. of Housing Blocks | 0 |
| No. of Control Traverses | 46 |
| No. of Control Points: | |
| <i>Pre-mark:</i> | 100 |
| <i>Post-mark:</i> | 133 |
| Number of Trees Digitised | 48 |
| Data Size of Video (GB) | 29.1 |

Fo Tan Skyline Analysis

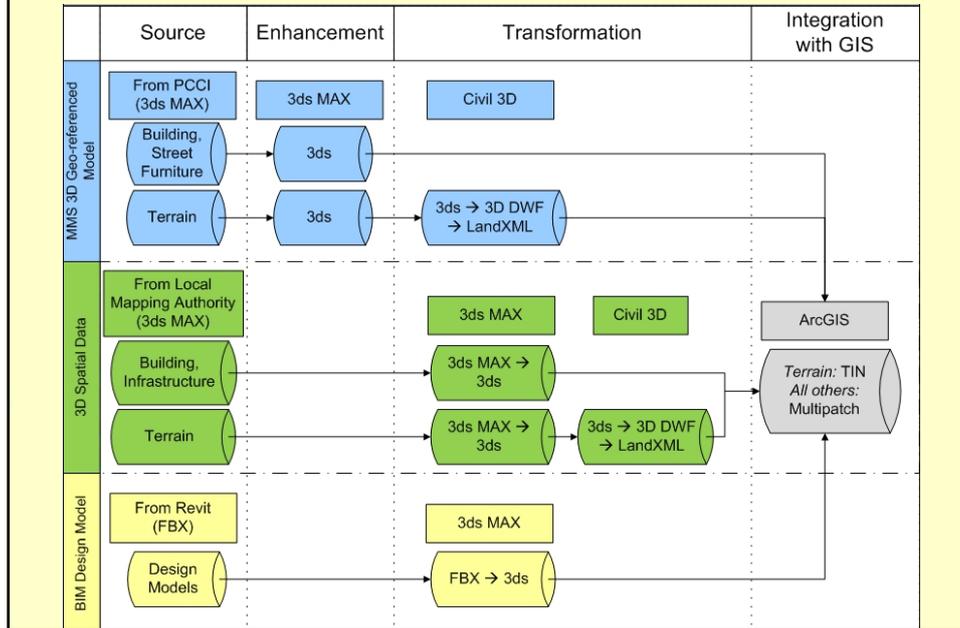


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Integration of 3D Models from Different Sources in GIS



Workflow of Model Integration



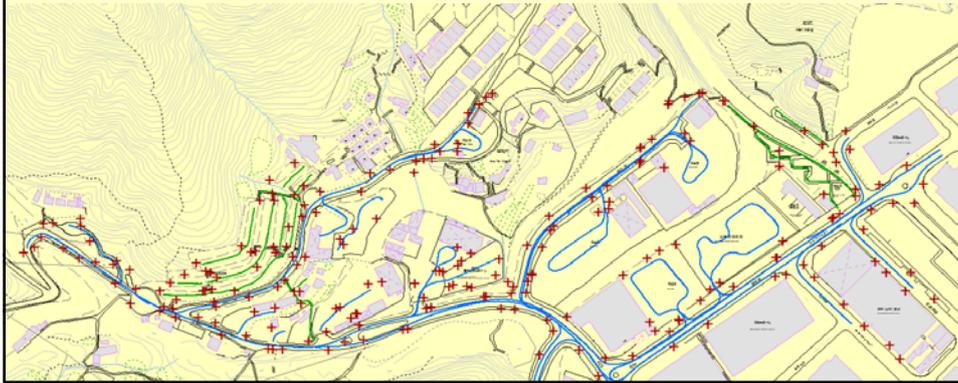
Problems Encountered



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Large No. of Ground Control Points

| Number of GCPs | | | |
|---------------------|----------|-------------|------------|
| | Pre-mark | Post-mark | Total |
| Fo Tan Cottage Area | 100 | 133 (+133%) | 233 |



| Number of GCPs | | | |
|---------------------|----------|--------------|------------|
| | Pre-mark | Post-mark | Total |
| Lei Muk Shue Estate | 180 | 125 (+69.4%) | 305 |

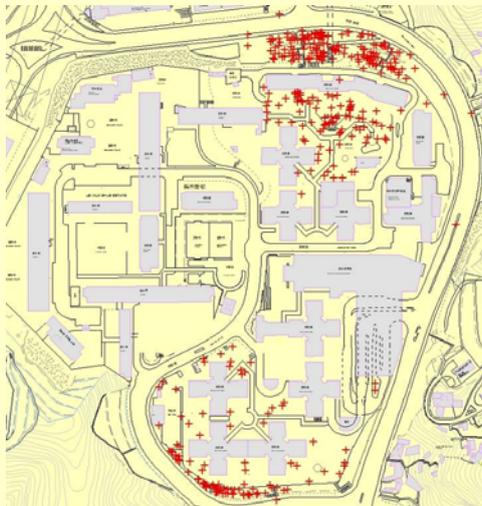
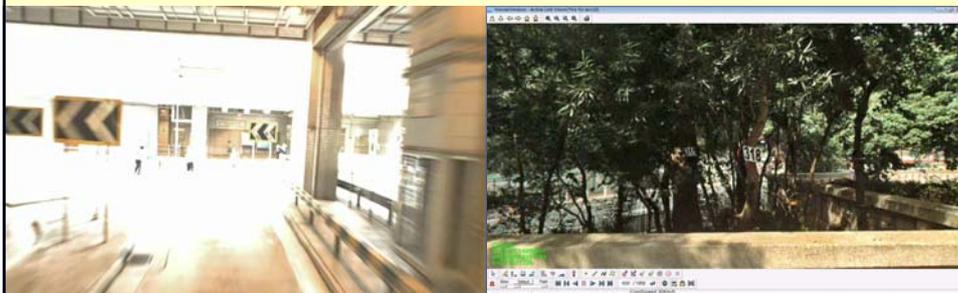


Image Quality



Over-exposure Image

Under-exposure Image

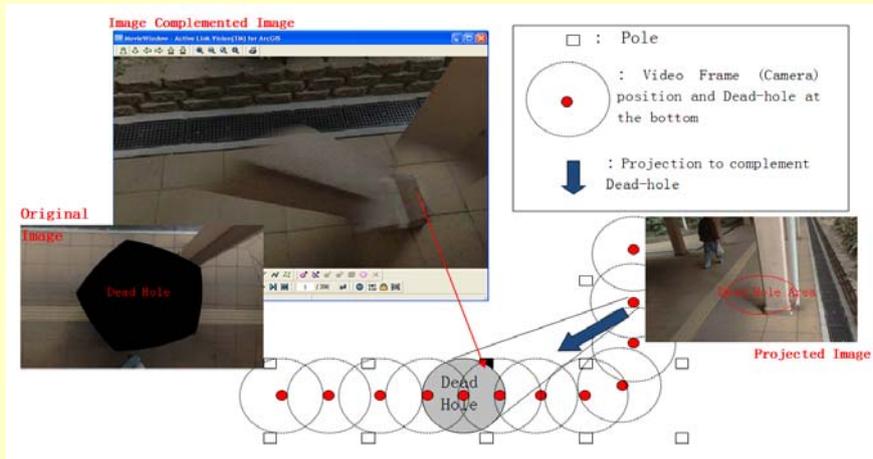


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Dynamic Moving Objects

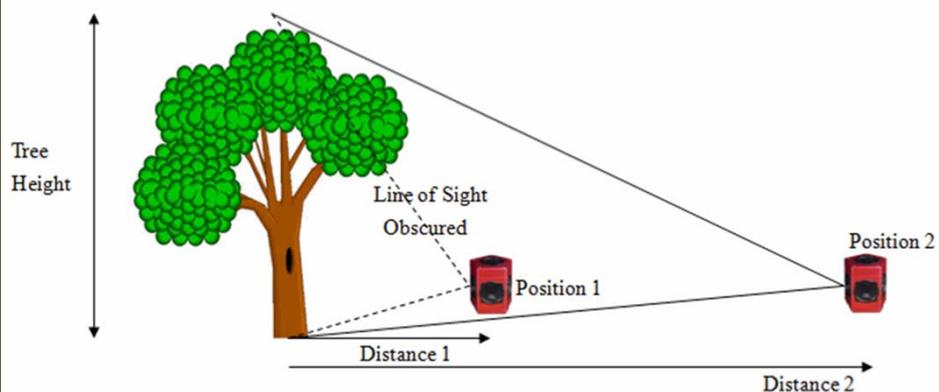


Limitation of Image Compensation



Automatic Projection Technology

Site Constraints



Effects of Camera Position on Measurement of Tree

Survey Accuracy Analysis

| Summary | Horizontal Accuracy (m) | | Vertical Accuracy (m) | |
|--------------------------|-------------------------|-------------|-----------------------|-------------|
| | Tree | Checkpoint | Tree | Checkpoint |
| Number of points | 477 | 97 | 43 | 105 |
| Maximum Diff. | 0.40 | 0.15 | 0.50 | 0.46 |
| Average of Squared Diff. | 0.05 | 0.02 | 0.03 | 0.01 |
| RMSE | 0.23 | 0.14 | 0.18 | 0.09 |

Image Quality Comparison

3D Spatial Data from Local Mapping Authority

Mobile Mapping System Survey



Summary

- 3D Visualization become basic requirements on construction projects
- MMS Technology has become mature. A variety of choice of instrument and methodology is available in market. Market competition makes the technology become more affordable in price and more friendly in user experience.

Advantages of MMS

- Capture complete up-to-date location information efficiently
- Physical features appear on the 3D Geo-referenced Image can be viewed, measured and collected by different users in the office
- Formation of complex 3D model for presentation purpose, 3D Analysis and Cross Sectioning



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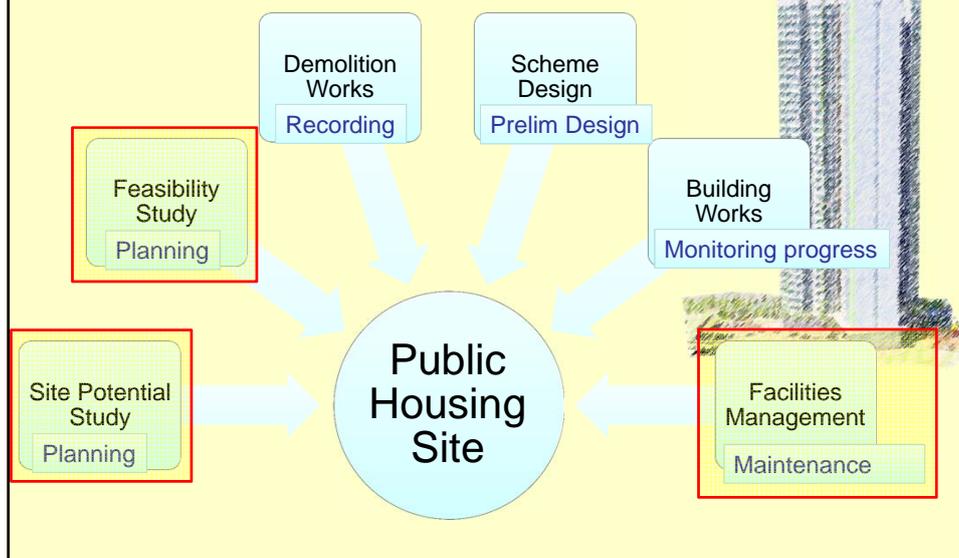
Limitations of MMS

- Survey accuracy up to 30 cm
- Accuracy degraded if camera-to-object distance greater than 30m
- Unable to capture blocked objects
- Visible features at the rear of the image may not be able to measure
- Dependency on daytime and weather



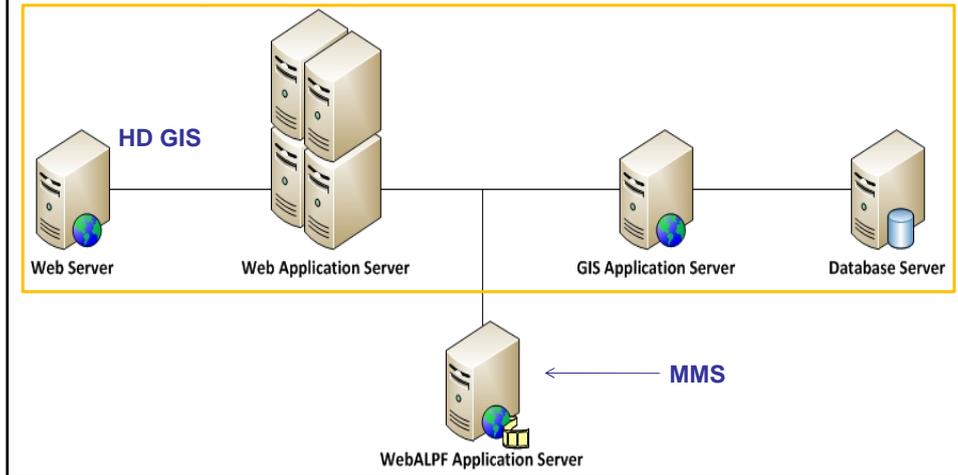
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Possible Applications of MMS Survey in Public Housing Site



The Way Forward

- Convert the Lei Muk Shue Tree Survey from Desktop to Web-based and Integrate it with the Department's GIS



Thank You !



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