A Rapid and Cost-Effective Technique for Planimetric Mapping of Small Villages in Developing Countries

Speaker

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1. Introduction

- -Land Development activities emphasis the need for up to date large-scale planimetric maps.
- - For producing planimetric maps many techniques can be used such as:
  - Traditional photogrammetry,
  - Satellite photogrammetry and
  - Terrestrial surveying using total station instruments.
- - Mapping specifications and Detailed guidelines

1. Introduction

Table (1-1) Large-scale mapping and the ground resolution (after Schnurr, 2004)

Mapping Scale	Ground Resolution*	Typical applications
1 : 1000	0.2m	Urban cadastre, detailed engineering design
1 : 2000	0.4m	Rural cadastral and boundary demarcation
1 : 5000	1m	Town planning

* Based on 0.2mm pen thickness

1. Introduction

-Development of residential rural areas in Egypt using Geographic Information Systems (GIS) to performs the planning, development, and management of such areas.

-GIS should be based on reliable and recent geo data that needs very efficient and cost-effective surveying and mapping technique.

-This paper summarizes various methods used for mapping of small villages in Egypt and concentrates on the most-suitable surveying technology that can be proposed to reach the required objectives with reasonable consumed time, money and effort.

2. Review of Surveying techniques

2.1 Field Surveying Using Total Station

- Field surveying using total station among the control stations is performed.
- Control stations using GPS technique is usually performed to tie field surveys into country mapping system.
- Such terrestrial surveying technique requires using a large number of traverse points through the irregular narrowed streets.

2. Review of Surveying techniques

2.1 Field Surveying Using Total Station

-The main mapping activities require about 5 days
(The crew consists of one surveyor and two prism-men)
-GPS control surveys will require one-day crew
crew consists of two surveyors)

Figure (2.1) Case study area

2. Review of Surveying techniques

2.2 Aerial Photogrammetric and Satellite Photogrammetric Techniques

- Aerial Photogrammetric is the common method and used with GPS with the aid of terresterial total station for cadastral mapping

-Advantages of using high resolution satellite image over aerial photographs are:

- High resolution satellite image cover approximately 100 km^2 on the ground (this area require 30 photographs of scale 1:16,000).
- The satellite image can be delivered very fast (two weeks after ordering) when compared to aerial photographs production process that might take 4-6 months.

2. Review of Surveying techniques

2.2 Aerial Photogrammetric and Satellite Photogrammetric Techniques

-Disadvantages of using high resolution satellite image over aerial photographs are:

- The information content of the satellite images would produce topographic maps up to scale in the range of 1:6,000 to 1:10,000

2. Review of Surveying techniques

2.2 Aerial Photogrammetric and Satellite Photogrammetric Techniques

Table (2-1) Types of imagery sources for large-scale mapping

Platform	Imagery/]system	Resolution	Imagery control method	Typical Mapping
Satellite	IKONOS Quick bird	1.0m 0.7m	"Level 3" GPS "Level 3" GPS	1: 6,000 -1:10,000 1: 5,000 - 1: 6,000
Fixed wing aircraft	1:12,000 VAP 1:3,000 VAP	0.25m 0.06m	"Level 4" GPS "Level 4" GPS	1: 5,000 1: 1,000

Table Key:

VAP: Vertical Aerial Photography (typically scanned at 20 um)
Resolution: The ground pixel size
"Level 3" GPS: Carrier smoothed differential code GPS (0.4-0.8m
"Level 4" GPS: Double differenced carrier phase GPS (0.01-0.06m)

2. Review of Surveying techniques

2.2 Aerial Photogrammetric and Satellite Photogrammetric Techniques

-The airborne methods, when used for planimetric mapping in developing countries, is usually cheaper than that based on aerial photos.

- The cost of mapping of villages in rural areas using high-resolution imagery is relatively high when compared with GPS based solutions due to :

- The need for GPS technique for control measurements,
- the need for field visit to delineate the separated house blocks that may be obscured,
- the high costs of the high resolution imagery (especially if such images is not on the archive, and the small villages to be surveyed of limited extent)

2. Review of Surveying techniques

2.2 Aerial Photogrammetric and Satellite Photogrammetric Techniques

- In addition, the requirements for large scale mapping specifications (1:2,500 for current case study) can not be reached at the current time using high resolution satellite imagery technique.

2. Review of Surveying techniques

2.3 The proposed Technique – Kinematic GPS and Linear Measurements

- The GPS kinematic positioning technique was suggested to collect streets centerline data due to different factors:

- The available GPS receivers and their capability to perform precise kinematic survey,
- the time permitted to finalize the project,
- the required map scale and consequently the allowable accuracy required

2. Review of Surveying techniques

2.3 The proposed Technique – Kinematic GPS and Linear Measurements

- The proposed technique depends on using two GPS dual frequency receivers (Timble 4000SST receivers) .
- The rover receiver was set on small van with its antenna held elevated by 3 m pole to avoid loss of lock on satellite signals.
- Additional linear measurements were required for street widths to complete the required planimetric mapping
- The time required to fix GPS carrier phase ambiguities ranges from one epoch solution to several minutes of observations based on baseline length, multipath effects, environmental effects as well as signal obstruction status.

3. Experimental Setup

- The main characteristics of the case-study area are:
  - ➢ The area is flat, plain and margined by farms.
  - ➢ There are very dense continuous house blocks with narrow streets widths
- Control Surveys was held using traditional GPS static technique
- Ground surveys using total station was undertaken in the main road of the area and in some intersected street portions among GPS control stations

3. Experimental Setup

- Solving the data storage problem (two one-hour missions)
- Lessen the loss of lock problem by preparing a well-defined procedure where the number of satellites tracked was noticed.
- When the number of satellites dropped below four, the van was stopped at any nearest location that has relatively open satellite view
- This procedure insures fixing the loss of look problem at many locations directly in the field.

3. Experimental Setup

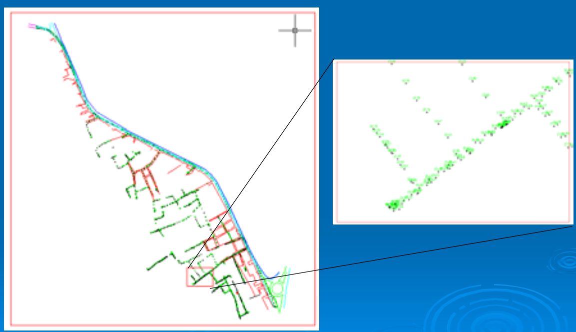

Figure (3.1) The kinematic GPS results with enlarged portion shown in the right frame.

4. Accuracy of the Proposed Technique

- The precision estimate of kinematic GPS positioning was evaluated by occupying many locations for certain period of time and it was found to be about ± 2cm.
- The main source of error for GPS kinematic survey results of street centerlines comes from imprecise navigation of the van along the centerlines

4. Accuracy of the Proposed Technique

Table (4.1) Comparison of GPS kinematic surveys and total station results for selected street centerline locations.

Location ID	Error (m)	Location ID	Error (m)	Location ID	Error (m)
1	0	8	-0.04	15	0
2	0.17	9	0	16	-0.07
3	-0.28	10	0.07	17	-0.15
4	-0.18	12	0.41	18	-0.21
5	-0.05	12	0.19	19	0.11
6	0.06	13	0.26	20	0.2
7	0.12	14	0.09	21	0

The discrepancies between the two techniques were ranging between 0.0 and 0.41 m with a mean of about ± 16 cm.

Thank You

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Conclusions

- The research reviews the utilized methods for mapping process of residential rural areas in Egypt that are kilometers apart .
- The comparisons among different methods lead us to the importance of using GPS technique to be the key used technology in the mapping of such areas
- The proposed methodology illustrates the high quality for gathering kinematic GPS data while reasonable precision (about ± 16 cm) is acquired for street centerline data after detecting most of anomalous data.
- Interactive software modules that rely OTF solution are now available on the next to assess the GPS solution and provide feedback about the gained precision at different locations..
- The proposed technique can be used for producing dynamic maps and GIS database by connecting the GPS for producing the spatial database component and attach the attribute data to build the final comprehensive GIS database.