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URBAN PLANNING

Need for comprehensive urban information system

A model proposal for development authorities

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The need – environment of an Urban Information System has undergone a sea change over the last few years. Couple of years back the requirements of information system was designed and projected primarily from the planners community. They were satisfied if the physical information was supplied on a scale of 1:5000/1:10000.

Presently the demands are coming from urban engineers involved in detailed design of water supply and sewerage systems, traffic and transportation (including fire and police), electricity and power and revenue authorities that are concerned with the land/property related matters. Comparatively new entrants are the professionals from the telecommunications (diggers for fibre cables) and other utility-infrastructure personnel who have started looking at the third dimension of the town (heights of buildings) for mobile cell communications. There are hosts of other users who need accurate urban information.

Need/Function	Scale	Height/Contour interval (Mts)	Remarks
Planning: Master Plan/ structure Zoning plans	1:4000 to 1:5000	2 to 5 mts	Legal Document
Engineering plans	1:2000 to 1:4000	0.5 metres/Dtr bench marks	Frequent revision
Housing plans	1:1000 to 1:4000	——do——	
Water supply, Sewerage	1:1000 to 1:2000	spot heights + bench mark	
Traffic junction plans	1:1000 to 1:2000		
Transportation Routes	1:5000 to 1:10000	2 mts	
Road & Highways	1:2000 to 1:10000	1 mt	
Regulatory functions			
Revenue Authorities	1:1000 to 1:4000	-	Checking encroachments property matters
Unauthorized construction, encroachment, squatter settlement, monitoring	1:2000 to 1:4000		
Other Departments Ground water Drainage Inventory of trees, Parks environmental themes Heritage monuments Police / fire Tourism	1:10000 to 1:25000 1:10000 to 1:25000 1:4000 to 1:10000 1:1000 1:2000 Large Scale 1:10000 to 1:20000		

Table –1

The upshot of all the above information is that the Urban Information System (UIS) which is being designed in 2010 must cater to all the future requirements which should be presented in the most user friendly manner. This is the main genesis of the present day GIS hence the title of Comprehensive Urban Information System.

What is mentioned above is the perspective of the proposed detailed design and the contents of the proposal have been influenced by the factors enunciated in the following paragraphs.

Requirements and scale matrix of different users

The table below indicates the needs/ functions in terms of the scale of maps and information on elevations. For digital maps the scale depicts the density of information and the inherent accuracy linked with that scale.

Determination of scale, elevation and contents of database

A glance at the above table clearly indicates that the design of database should cater to the present and future needs of the various stakeholders (users) of the database. This database should also take care of the various 'attributes' as defined in the technology of Geographic Information System (GIS). For example in housing function, apart from the spatial location of the housing, the ownership, tax status, number of inhabitants, usage (residential/commercial), etc should also be stored in the database for the benefit of the end user of GIS.

It is very evident that all the required information need not be built as one project. The urban database can be designed on the 'evolved' basis. The

priority information needed by most of the users can be collected first. The remaining information and attributes can be acquired in a phased manner. This direction of thinking has led us to first create the essential information through proper aerial photography field work surveys for ground controls and photogrammetry which will act as a foundation to link any other spatial information to be collected in subsequent phases.

Objectives of the Proposal

To establish computer based (digital) database for the area covered by development authority utilizing the modern technologies of:

- Aerial photogra
- Photogrammetry; Orthophoto and stereo restitution
- Geographic Information System and Satellite Imagery

To design the information retrieval system which is friendly to the functioning departments who will utilize the database. To keep database updated to the time cycle of 4-6 months.

To provide a link to the people by establishing information – kiosks, where the general public could obtain information of their interest like hotels, hospitals, milk booth etc. through the use of internet.

Technical proposal

Methodology

In particular, we propose to use aerial photography a well proven technology of photogrammetry which is productively and commercially being utilized for many urban projects. The other technology of Global Positioning System etc. will support the preparation of digital database and the processing of photogrammetry. The basic steps involved in the above methodology would be:

- Orthophoto

It is proposed that the whole of development authority and 2.kms on all sides should be covered with aerial photography on scale of 1:8000. this will form the input for generation of orthophoto. The above scale has been selected in order to produce accurate base –maps of up to 1:2000 scale. These base maps can also be utilized for cadastral purposes.

- Urban vector maps
  Development authority will be interested in almost all the physical features. Keeping this in view a scale of 1:8000 for aerial photography is proposed as optimum which will be used for producing 1:2000 scale vector maps. The security clearance from the Ministry of Defence will be taken by National Remote Sensing Centre, Hyderabad (NRSC).

  All the aerial photographs will be processed in NRSC photogrammetric processing laboratories where negatives/diapositives and contact prints will be prepared. The scanning of images will be carried out on high precision (up to 7-14 microns resolution) photogrammetric scanner for subsequent orthophoto generation and vector mapping in digital / analytical photogrammetric instruments.

- Quality control & Quality Assurance
  NRSC have an internal quality assurance plan that guarantees a final product comparable to international standards. The quality objectives are as follows:
  -that the quality of products and consultancies satisfies the expectations of the client as stipulated in the contract the specifications and the technical standards.
  -to deliver elegant reliable products in a format optimal for the client
  -high quality and minimum cost

- smallest size of ground object on aerial photography
  Taking 20 microns (1 micron=1mm/1000) as the resultant resolution of aerial negative; the minimum size of object on the ground which will be visible is.
  20 (microns) X 8000 (scale)
  =160 mm or 16 cms on orthophoto.

  It means that most of the distinct manholes will be visible on the aerial photograph.

  The aerial photography for whole area of development authority at 1:8000 scale for urban areas will be delivered through National Remote Sensing Center (NRSC), Hyderabad who will liaise with the concerned development authority for obtaining necessary flying clearances.

  It, therefore, implies that project formulation sanctions, etc. should finish well before start of good photographic flight season.

  The modern camera which NRSC uses is fitted with Global Positioning System (GPS) and Image Motion Compensation (IMC) device. This entails significant reduction of field control and improves the quality of aerial photography. The quality of aerial photography will adhere to world contemporary level.

- Ground control for photogrammetric process

  Photogrammetry stipulates a minimum number of ground control points at proper location with respect to the incidence of aerial photographs (model) on the ground. These ground control points are marked very accurately on the aerial photographs and form the first and most important input to the process of photogrammetry.

Pre-pointing/signalization of ground control points

As mentioned earlier the ground control points form the first input to photogrammetry. In that, these control points are used to orient the aerial photographic model (stereoscopic model) for scale elevation and accuracy. We wish to identify some ground points in the town which are

identifiable on aerial photographs. The special requirements, if any, by users agencies for identifying certain fixed points can also be taken care of.

Accuracy standards to be followed

Generally the photography is covered in strips with 60% overlap in the fore and off and 20% as the side overlap in near square or rectangular blocks. The requirement of the ground control is based on the photographic coverage of the each block.

- Photogrammetric accuracy & contour intervals

  Planimetric The requirement of Planimetric accuracy is generally met in photogrammetric plotting and is seldom critical. An accuracy of 20 cm in plan can be expected on 1:8000 scale photography. However, the mean square error in planimetry i.e. no more than 10% of points should have errors more than 0.25 mm on the scale of mapping will be adhered to.

  Contours Generally accepted tolerance is that only 10% of all check points may have an error large than half the contour interval. Maximum error in height of the control points that should be expected is 1/5th of contour interval and that is 20 cm for 1 meter interval.

- Aerial triangulation and photogrammetric plotting / mapping

  This is a photogrammetric operation in which initial field control (as mentioned earlier) is augmented by a set of procedures on photogrammetric instruments. The result is that the photographs (stereo models) will have control points at optimum places. These control points obtained after aerial triangulations are used for automatic orientation of models in analytical / digital photogrammetric instruments before carrying out photogrammetric plotting/mapping.

The digitization of all the physical details of the map and elevation is done mechanically while plotting. Thus in present day photogrammetry and machines available with NRSC and other agencies, the map output can be obtained as hard copy as well as in digital form.

It is quite possible to generate digital terrain model (DTM) for subsequent generation of orthophoto and input to GIS .NRSC etc. have state – of – the art photogrammetric equipment with adequate manpower which can be in operation round the clock..

Monumentation of ground control points:

It is the normal practice to provide some permanent pillars (X,Y,& Z co-ordinates) at suitable places in the city which not only will help in the model but will be most valuable for any future references. These references have a tendency to come up in land oriented legal disputes. The permanent pillars also are ideally useful for location of engineering projects on the ground.

A suitable design on the survey pillar appropriate to the city and the location of the pillar will be evolved in consultation with the development authority.

The cost of construction etc of the pillars will be included in the proposal

Urban Digital Orthophoto

Orthophoto by definition is an aerial photograph, which has been scaled and does not have geometric distortions (tilt and relief distortions). Photogrammetric process is carried to the stage of Aerial Triangulation which then helps in framing the digital terrain model of the overlapping photographs (model). The DTM generation will be carried out in two phases. In phase I, the automatic terrain extraction will be processed which will be followed by manual editing to incorporate the break lines and rectifying the inconsistency of contours to fit the terrain. The resultant DTM is made as an input to generate dimensionally accurate orthophoto.

Digital Database – contents and format

Database will have the following information, the list is just suggestive and can be modified as per the requirements of development authority.

a. **Physical Information**
   All topographical features subject to the scale of 1:1000, contours at 1 metre contour interval, spot height at 100 meter grid, ground control and GPS stations.

b. **Building**
   Building roof, Building, Heights of buildings especially high rise buildings, Industry/commercial area / Business sheds, Retaining Wall, Chimney, Brick Kiln, etc.

c. **Road**
   Metalled/consolidated road, Unmetalled/unconsolidated road, Parking, Traffic Island / Boulevard, Traffic fence, Internal road, Road centre line, Road various/Path, Road Bridge

d. **Drainage**
   Rivers (>3 mts wide-2 lines), Steams (<3 mts-single line), Edge of Drain/ Ditch, Bottom of Drain/Ditch, Canal Bed, Canal Bank, Well, Lake/ Pond/tank, Marshy land/Bogs

e. **Physical Boundaries**
   Landuse boundaries, Fence, Hedge, Slope top, Slope bottom, Plantation Line, Garden, Forest Area, Rocking/ quarry area, Mining areas, Wasteland

f. **Others**
   Power line, Poles, Electric/ Telephone poles, Transformers, High tension pylon, High tension line, Pylon base, Railway track, Telecommunication tower

g. **Land Use Information**
   Type of soils, Ground water table, Water logged areas, Sport/ Golf course, Trees & Vegetation - Mast

h. **Slums and squatter areas**

The roof area of the slum cluster with open spaces lane etc.

i. **Water supply & sewerage (Based on local records)**
   Water supply lines, Manholes, Sewerage junction etc.

Note: the above list provides an idea about items which can be picked up by aerial photography. Similar objects can also be suggested by development authority.

Basic information attribute to be supplied by the development authority (not included in cost)

Socio-Economic Data
Plot ownership and other attributes, Property ownership and other attributes, Agricultural/villages inhabited area socio economic data will be collected/

Collated by local authorities for information

Boundaries (with pillars if any)
Urban ward, Defence land, Government land, Names of localities and important land marks

Any other information (attribute) desired by development authority

Revision and Updating of urban digital data

Preparation of Urban Information System will entail major efforts in generation of physical database. This is a common scenario in all developing countries as all the information required for GIS is not readily available. After the data base is prepared through the photogammetric process it will be incumbent on the authorities to update the data base. Major physical changes take place on the periphery of the town. Town will have a lot of changes in buildings roads parks drainage land –use and infrastructure and a host of underground utilities. It is therefore suggested that digital database should be kept updated with the help of field visits aerial photographs/high resolution satellite imagery and verification by ground surveying techniques.

Geographic information system

GIS is basically a comprehensive spatial decision support system based on (a) geo-referenced digital data base (b) computer hardware/software (c) non –spatial attribute data. Spatial data is obtained from satellite imagery aerial photography/photogrammetry field surveying and ground visits.

Today GIS can be applied conveniently for land suitability analysis landscaping land use modeling (forecast) environmental impact assessment of human settlements, urban growth, location allocation of utilities/facilities, traffic planning, air pollution studies and hazard studies etc.

Preparation of the digital database is 70-80% of total efforts for the establishment of the GIS. The digital data base once complete will be a big fillip towards establishment of GIS. A separate proposal meant for the establishment of GIS could be prepared.

Functions that development authority urban information would perform

It is our objective to establish an operational and dynamic urban information system which will be greatly facilitated not only by the generation of a detailed digital data base but also which can easily be accessed updated and analysed for different purpose. It is proposed that the geographical information system will cater the data requirements of all the departments within development authority. The provision of a common database and access to it by the various departments of planning, property, finance, engineering, industry, personnel and that of marketing and rural development will not only increase efficiency and productivity but also go a long way for future decision support system. With readily accessible and accurate information, the three broad functions of planning, revenue and that of engineering within the development authority would get streamlined. The detailed physical information contents of the database will have great utility to the various departments.

The section below indicates the possibilities that exist within each of the departments.

The engineering department would not only be able to have a complete grasp of the existing situation but also plan for the design of new roads and facilities. Detailed utility mapping showing the exact spatial location of the water supply lines, the sewage network, the telephone and electricity supply lines would go a long way in providing optimal services and increasing revenues. The detailed spatial database would also provide the ideal basis for the monitoring operations and maintenance of existing assets.

The planning department would require detailed land use maps which would not only help in the preparation of the new

master plan but also help in the process of monitoring. The contents of same database can be used to develop an approval system wherein the process of building / plan sanctions can be approved on – line or with minimal paper work.

With respect to revenue and cadastral management system the detailed base map can be used as a base to develop a monitoring mechanism with the details of the properties, their current value and the rate of taxation, etc. This will give a clearer understanding of the current status of properties related to their various aspects and thereby help in initiating processes for revenue collection.Once a detailed digital database is created the contents of this would be used to develop web-based application. The web based applications can not only be used to inform and interact with the public but also reduce paper work, increase efficiency and if necessary limit direct contact with the public to a minimum. In terms of streamlining internal procedures the contents of the database with linkages to the various functioning units within the authority would provide the ideal platform to develop a corporate information system for developing both monitoring mechanisms within the organization and also providing information to the public if required.

Map updation and maintenance system

A modern coordinated cadastral system requires regular maintenance. To keep the records up-to-date and without losing the reliability of data the cadastral maps have to be updated from time to time. A program of renovation would be required to be incorporated into the regular surveys replacing the coordinating points which are lost, disturbed or become invalid.

Land information technologies – regulating the city

Regular monitoring

Encroachment of government land and unauthorized construction are very much a common feature of any urban centre. By comparing the base maps of different epochs of time one can get the handle on the extent of encroachment and its location. The technology of producing the base – maps will be suitably designed to get authentic extent of the encroachment.

Environmental monitoring

This function in managing a city has recently gained a major dimension. The fact is that public perception of a city administration is judged mainly by the way environment is officially monitored. The agency will provide the following information about the city regarding environmental parameters: Inventory of all tress and vegetation (type location) as a Bench Mark study. Any subsequent change will be measured with respect to this Bench Mark Survey. Establishment of urban village boundary (Lal Dora) Village boundary determines the land –use of the urban village. This should be clearly established on the map in an unequivocal manner. The assistance of development authority will be requested in this regard.

Products and deliverables

Vector map of urban areas

- One set of Negatives, Diapositives and Contact Prints storage of these items, following the security norms of the Ministry of Defence can also be done by NRSC
- Digital vector maps
- Hard copies of maps of urban areas on scale of 1:2000 scale
- Field control data with description of monumented (pillars) stations

Other relevant records/notes

Orthophoto product

- Photographic copy of Orthophoto on 1:2000 / 1:5000 scale
- Digital ortho-photos (optional)
- Other relevant records/ notes

Training and Education

The users will be imparted training and education for effective operation and management of all the database maps and cadastral information. To achieve this a specially designed training program will be arranged for the staff of user departments for use and managing the systems. An estimated 50 staff from user departments will be arranged in GPS/Survey/Database training on a mutually agreed cost sharing basis.

Financial aspect of the proposal

(Pertains to preparation of digital data base for development authority)

The cost of the proposal will depend on the following:

- Technical activities
- The managerial decisions about the phases for the production and its strategy.

The technical activities have already been explained in the body of the proposal. Some explanation is however necessary to understand the production phases.

Strategy of production phases / scheduling of investment by development authority

Decision about these phases becomes important to reduce the budget allocation per year. For example aerial photography (which is not costly) should be ordered for the whole area of development authority. Similarly field control (GPS operations and leveling) is also essential for the whole area. Once these two items are done, the process of aerial triangulation can proceed in NRSC office.

After incurring this cost the decision by development authority can be taken to spread the cost of mapping to a longer period of more than one financial year by asking for photogrammetric mapping of only a small portion of the town. This is being suggested as the major cost of mapping lies in the photogrammetric plotting.