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EVALUATION AND ANALYSIS OF EXISTING RURAL ROADS ALIGNMENT USING DGPS

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ABSTRACT
In the present scenario, road connectivity is the main area of interest where the Government is focused. As a result a scheme called PMGSY has been emerged to provide better connectivity in the rural areas and thereafter to the Highways nearby. The alignment details of the laid roads can be obtained in the form of topographic sheets from the Department of Panchayath Raj and the Survey of India drawn to scale 1:50000. But these sheets were not scientifically up-graded and plotted.

With the advancement of technology, several tools and techniques are available which give us accurate and reliable information. DGPS technology is one such technique used for scientific up-gradation of the alignment data. This DGPS technology can be integrated with the GIS which provides us a powerful tool for data acquisition and data updating.

This work mainly focuses on evaluation and up-gradation of a few selected rural roads of the PMGSY scheme which are not properly updated to the standard format of topographic sheets by using GPS technology. Initially, ground control points were established over the existing alignment and the concerned topographic sheets were geo-referenced by using Arc GIS software. These geo-referenced maps were later used for plotting of the latitude and longitude points measured by DGPS survey. As a result, the obtained alignment by DGPS survey and the alignment available from topographic sheets of the Survey of India have been superimposed. The upgraded Auto-Cad maps were further detailed by reducing to a user defined scale. It is noted that, the scientific procedure recommended in the present work can be adopted for further detailing of the rural road network maps by the Department of Panchayath Raj and also by the Survey of India.

Keywords: DGPS Survey, GIS, Ground Control Points, Road Alignment and Rural Roads.

I.   INTRODUCTION

Rural Road connectivity is not only a key component of Rural Development in India; it is also recognized as an effective poverty reduction programme. Forty percent of the Habitations in the country are connected by All Weather Roads (AWR).

1.   Need Of The Present Work
Connectivity in the rural areas is less when compared to urban areas. Roads laid in rural areas particularly under the scheme of PMGSY are based mainly on providing connectivity to the nearby highways. Such rural roads maps after lying are not being scientifically upgraded and properly plotted on to the topographic sheets available from the department of Panchayath Raj and also the Survey of India maps.

Evaluation of the roads alignment and scientific up-gradation of such roads alignment can be effectively carried out by using DGPS technology. This technology has evolved as an important data acquisition tool and the mapping can be digitized by using GIS. This digital form of the data base can be used for various applications including civil engineering and revenue purposes. In addition, future updations and the data disseminations to the research community will be made simpler and easy.

2. PPK GPS Survey

PPK utilizes two or more receivers with at least one receiver kept stationery over base station. The data can be collected by moving the receivers (i.e. rovers) from point to point. Data is collected at both the reference station and at the rover receivers. The data is downloaded into the GPS software program to process the baselines. Multi channel tracking dual frequency receivers are used for this purpose. Necessary field calibration should be conducted to ensure base station and project control points have been set up correctly to meet or exceed the Minimum Horizontal or Vertical Accuracy Tolerances as required for the survey.

Fig. 1 GPS Base and Rover Setup

II.   OBJECTIVES OF THE STUDY

The following objectives are under taken for the present research work:
(a). Selection of Mandals for evaluation of existing alignment which are available with the Department of Panchayath Raj, under the Scheme of PMGSY
(b). To collect the selected roads inventory data and rough sketch maps from the respective Mandal offices and also relevant maps from the Survey of India (available at scale 1:50,000)
(c). To establish ground control points using DGPS by locating at land marks in the connecting villages of each road alignment
(d). To Geo-reference the Topo-Sheets, collected from the Survey of India, using the established ground control points and identifying the concerned roads of PMGSY
(e). To determine the latitude and longitude of the selected roads along their respective alignments by conducting DGPS survey
(f). Plotting of the processed data on the geo-referenced Auto-Cad maps and to evaluate the alignments of the selected roads with reference to the PMGSY roads
(g). Comparison of the alignment of the DGPS surveyed roads with the Survey of India maps
(h). Up-gradation of the above Auto-Cad topo-maps to user defined scale, which are enlarged by reducing the scale value.

III.   LITERATURE REVIEW

The recent advances in the field of GPS, made it to use in various fields. In view of the GPS capabilities, many research studies are carried out in India and abroad in the area of GIS/GPS based road information system. Some of the important research relevant to the present study is given in the following paragraphs.

1.   Applications of GPS Technology in the land transportation system

Mintsis et al., (2003) the Global Positioning System (GPS) allows the accurate positioning of an object using satellite signals. There are a lot of applications of this technology in many scientific fields all over the world. In the recent years, the rapid increase in the development of the GIS has led to the development of GPS/GIS applications. Therefore, the geometric and geographic information obtained by the use of GPS can be introduced to GIS database and thus the thematic maps can be produced. GPS technology can be used in mapping of transportation networks (e.g., road, rail) and results to the reduction in cost and to increase in the speed of the work. Such an application is the case of the National Board of surveys. They established, in June 1990, a special differential GPS (DGPS) project to assess the case where a vehicle equipped with a GPS receiver and dead reckoning devices were used to collect the numerical road location information attribute data while driving along the road of Finland. The overall results show that 1-3m accuracy was obtained at a speed of 60km/hr.

2.   Using Geo-Informatics for development of Rural Roads under PMGSY

Mishra and Naresh et al., (2009) Implementation of PMGSY scheme poses major challenges in front of nodal executing agency i.e. National Rural Road Development Agency (NRRDA). It was very difficult and hard to manage this giant project using traditional methods of project management as these methods are not only tedious and time consuming but also difficult to retrieve the desired information. So modern technology is being used for development of roads alignment.

3.   Information system for Rural Road network planning – A Case Study

Rao et al., (2003) the study was carried out for a community development block, which is a middle level spatial planning unit. For this purpose Rupauli block, in Purnia District of Bihar state has been considered. The block maps were digitised and the non-spatial data, prepared on MS-Excel, were incorporated to each of the villages. The Geographic Information System (GIS) has been used for planning of rural road connectivity for a community development block and the information system was developed for the villages and rural roads. This paper emphasizes on the accessibility approach in an integrated manner so as to provide an optimum link to each village with maximum benefit in terms of accessibility to a major village with minimum cost of construction.

Map preparation and Database

A Village and Road Information System (V&RIS) has been developed for Rupauli block with all the data and information as mentioned above. The development of V&RIS can further be used for development of network as well as for infrastructure development. Once the V&RIS is ready the physical locations of infrastructure facilities and utilities may be planned and translate all the technological developments on the ground in a systematic manner. Map forms the fundamental tool for road network planning. A base map with all features has been prepared in the scale of 1:50,000 in the GIS environment. A base map with the location of all the villages settlements and existing road network has been prepared with the help of toposheets, census maps and PWD road maps.

IV.   METHODOLOGY

The methodology followed in the present study is shown in the following steps. Major steps in the present study includes
(a). Selection of field areas for plotting ground control points by using DGPS equipment in static mode
(b). The obtained data is processed using Trimble Business Centre Software to obtain the coordinates of the GCP's
(c). By processing the data the latitude, longitude and elevation of the GCP's can be known
(d). These values are run in the Google earth software to get the areal image of the location chosen
(e). By using these GCP's the identified roads are to be studied in the Toposheets

(f). By using the Trimble equipment, a Post Processing Kinematic Survey is carried out on the selected roads and the data is processed

(g). The obtained data is used to prepare the road network

(h). The obtained network has to be updated to the topo-sheet using Geo-referencing alignment using Arc GIS

(i). Based on the observed deviation of the alignment the reliability of the PPK GPS system in road alignment can be evaluated

Procedure for executing DGPS PPK Survey

 Post Processed kinematic (PPK) surveys are generally used for mapping or for surveying points where only several cm of precision are needed, such as 1) mapping out a feature such as a falt scrap or a shoreline; 2) recording the locations of sample sites; 3) measuring the positions of markers such as stakes on a glacier to determine ice velocities. Occupation times for survey points are on the order of seconds. Data must be post-processed to achieve high-precision results; this requires a processing program such as Trimble Geomatics Office.

Study Area and Data Collection

Bhongir Mandal, Bibinagar Mandal and Yadagirigutta Mandal of Yadradri-Bhuvangiri district, Telangana had been taken as the study area to evaluate the rural road alignment. The descriptions about the study area and data collection details are shown below (Fig. 2).

Study Area description

Bhongir Mandal is in Yadradri district, Telangana in India. It is located about 51km from Osmania University. Bhuvanagiri, also known as Bhongiri or Bhongir, is the largest municipality in Yadradri district, Telangana state, India. The municipal area covers 9.63 km^2. The coordinates of Bhongir are 17°30'12.6" N and 78°53'21.12" E.

Bibinagar is located on Warangal Highway between Hyderabad and Bhongir. The coordinates of Bibinagar are 17°28'14.28"N and 78°47'40.68"E.Bibinagar is about 40km from Hyderabad.

Yadagirigutta is a census town in Yadradri district. It is popular for the Narasimha Swamy temple called as Yadagirigutta. It is about 60km from Hyderabad. The coordinates of Yadagirigutta are 17°35'11"N and 78°56'46"E.
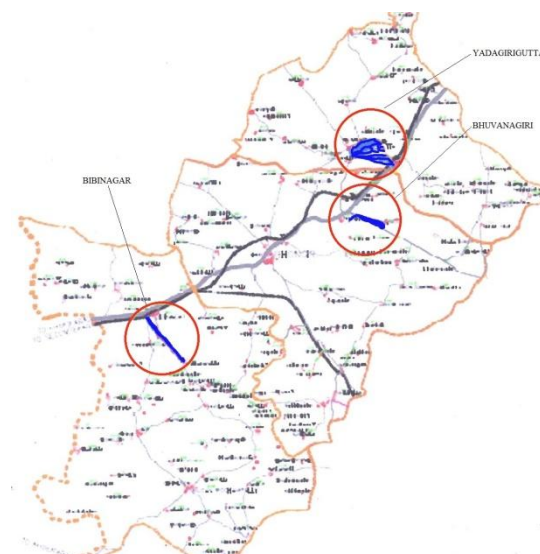

Fig. 2 Road networks of Bibinagar, Bhongir and Yadagirigutta

Data Collection

Hard Copy Maps Collection
The SOI toposheets and the core network map of the study area which includes road network and habitations have been collected from the Panchayath Raj Department of Waranagal District.
The Road Inventory data constitutes all the details of the road.

Road information data
The road information includes name of the road, type of the road whether i.e. Village (VR) or Other District Road (ODR), road link number given by NRRDA, construction details. This data has been collected from Panchayath Raj Department.

4.3 Collection of Toposheet
Based on the longitude and latitude coordinates of the study area the concerned toposheets are collected. The coordinates of the toposheets included in the study are:

- The Latitude and Longitude values of road connecting Kunuru and Raigiri fall in the range of 17°30' to 17°45' latitude and 78°45' to 79°0' longitude.
- The Latitude and longitude values of road connecting Brahminpally and Bibinagar fall in the range of 17°15' to 17°30' and 78°45' to 79°0'.
- The Latitude and Longitude values of road connecting Yadagirigutta and Wangapalli fall in the range of 17°30' to 17°45' and 78°45' to 79°0'.

V. EVALUATION AND ANALYSIS OF RURAL ROADS ALIGNMENT USING DGPS

The selected area was studied topographically by the topo-sheets available. Some of the required information was provided by engineering division office concerned to roads. After getting an idea about the area ground control points are taken from the selected roads. From the available topo-sheets, base stations are identified as initial step and within a radius of 20km to 30km control points are taken.

After getting the control points, the data is processed. The processed data gives the latitude, longitude and elevation of selected points as coordinates. These coordinates gives a clear idea about the area by using the Google earth software. In this software, the obtained latitude and longitude coordinates can be used to get the overall overview of selected area.

Establishing Ground Control Points
The Differential GPS (DGPS) technique is extensively used for a ground control point (GCP) establishment of medium and high resolution satellite imageries since this technique can provide accurate positioning results at the 1m level, provided the correction data age is less than 10 seconds, and the user is within 50km of the reference station. The DGPS technique generally provides an accuracy of better than 3m in horizontal component (approximately at 91% confidence level). If the distance between the receivers becomes large, the residual errors will become larger, and hence the positioning results become degraded.

In this project we have used the Trimble R3 equipment. The control points are taken in static mode. The base is fixed on a tripod in an open area exposed to free sky. The base is to be set into static mode and then the numbers of satellites which are available to transmit data are to be noted, the value should be greater than 4. After fixing the base station the rover along with antenna is to be taken to the site at which control points has to be taken. After reaching the point the antenna has to be made stand by setting the bubble.

The rover is to be operated in the static mode to start the survey. After starting the survey antenna along with the rover has to be kept fixed for10 minutes till the control point is clearly received by the rover. After 10 minutes the GCP is to be saved and then the setup has to be moved to the next point where GCP is required. All the GCP's

should be within a radius of 20-30km range of the base. The base can be removed by stopping the survey in static mode. After getting the control points, the data can be processed to get the exact latitude and longitude coordinates and elevation of the point.

The roads on which GCP's are taken are identified on the topo-sheets collected form Survey of India. Initially a preliminary survey was carried out on these roads to know the details of these roads.

Selection of Route
The selected road stretches are:
1. Brahminpally to Bibinagar
2. Kunuru to Raigiri
3. Wangapalli to Yadagirigutta

The above mentioned roads are surveyed in PPK mode. The survey is done along with the alignment of the road by recording the control points on either side of the road and survey is carried throughout the length of the road. The collected data is processed using the Trimble Business Centre Software. The output of the processed data is shown below:

Table 5.1 Processed Data Showing Latitude and Longitude Values of road stretch Wangapally to Yadagirigutta:

POINT ID	LATITUDE	LONGITUDE	HEIGHT
Gutta base	17.58005	78.84759	356.664
W rover end	17.58683	78.94564	358.088
W1l	17.57517	78.98344	315.211
W1r	17.573	78.98079	314.116

VI.   ANALYSIS OF DATA USING GEO-REFERNCING

Georeferencing
The toposheets are collected from the Survey of India and the latitude and longitude values of the toposheets on the four sides of the toposheets are identified. The values are key components in geo- referencing.

After the identification of the toposheet coordinates, the output data of the PPK survey in shape file format should be given as input to geo-reference the output data. After completion of the process of geo-referencing the identified coordinates are to be marked on to the toposheets. The latitude and longitude values of the topo-sheets considered for the analysis of road connecting Bibinagar and Brahmanapally are:
17°30' and 78°45' on top left corner
17°30' and 79°0' on top right corner
17 °15' and 78°45' on bottom left corner
17°15' and 79°0' on bottom right corner

These values imply that the toposheets is identified between the latitude value of 17°15' to 17°30' and a longitude value of 78°45' to 79°0'. The output (Latitude and Longitude) values of the PPK survey along the road connecting Bibinagar and Brahmanapally should fall in the range of values observed in the above toposheet.

Similar is the case with the remaining two study areas. The output (Latitude and Longitude) values of the PPK survey along the road connecting Kunuru and Raigiri fall in the range of 17°30' to 17°45'latitude and 78°45' to 79°0' longitude.

The output (Latitude and Longitude) values of the PPK survey along the road connecting Yadagirigutta and wangapally fall in the range of 17°30' to 17°45' latitude and 78°45' to 79°0' longitude.

The output files are run through the Arc GIS software for Geo referencing on the concerned topo-sheets. The control points identified after processing the PPK survey data are geo-referenced on the topo-sheets. After identifying these points on the topo sheets the control points are joined using polyline, showing the alignment of the particular road and any deviation if observed.

Table 6.1 Data showing Deviations in Coordinate Values of road stretch Wangapally to Yadagirigutta

POINT ID	ORIGINAL LATITUDE	ORIGINAL LONGITUDE	DEVIATED LATITUDE	DEVIATED LONGITUDE
W5l	17.57566	78.98252	17.57563	78.98269
W5r	17.57571	78.98257	17.57564	78.98274
W6l	17.57576	78.98226	17.57569	78.98234
W6r	17.57582	78.98227	17.57535	78.98248

The alignment of the roads can be clearly observed using the Google earth software which serves as a cross check as the GCP's taken along the road are clearly visible along the road on either sides of the road.

In case of Yadagirigutta road the deviation observed in the alignment is shown below (Fig. 3):
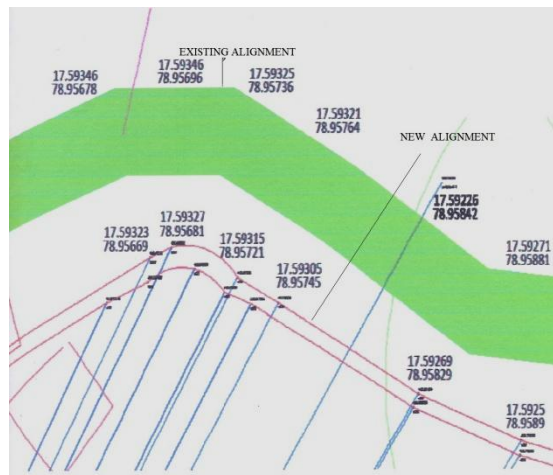

Fig. 3 Latitude and Longitude values showing Deviation in alignment

VII.   SUMMARY AND CONCLUSIONS

Summary
The integrated GIS/GPS systems have a wide range of applications in the land transportation systems (road and rail) and offer a lot of benefits (e.g., improved accuracy of spatial data, speed of data transmission, low cost). It is proposed to combine the GPS technology with other technologies for the maximization of the efficiency of the system and the reduction of application costs. In order to maximise the benefits from the implementation of information technologies (informatics, communications) in the transportation sector the two systems (information and transportation) must be fully integrated. Therefore it is a challenge for the transport sector to take advantage of the GPS/GIS technologies and to increase its potential. The experience gained so far from the wide ranges of applications of GPS/GIS technology in the transportation sector show that this is a realistic target.

In the present study DGPS tool is used for data up-gradation of the existing rural road alignments covered under the PMGSY scheme. Based on the observed output of the alignment the reliability of the PPK GPS system in road alignment is evaluated.

Conclusion

The following conclusions are made from the present study:

(a). In case of road connecting Brahmanapally and Bibinagar, the maximum amount of deviation observed was 34.024m, for the road connecting Wangapalli and Yadagirigutta the maximum deviation observed was 21.214m and for the road connecting Kunuru and Raigiri the maximum deviation observed was 9.82m

(b). The Geo-referenced output from PPK survey on to the toposheets collected from SOI done by using Arc GIS hasn't shown the exact alignment and both the alignments were not to the same grid.

(c). The up-graded Auto-Cad maps were further detailed by reducing to a user defined scale. It is noted that, scientific procedure recommended in the present work can be adopted for further detailing of the maps by the Department of Panchayath Raj and SOI

(d). The deviation in the alignment of the road can be evaluated to a maximum extent and the points at which deviation occurred can be identified conveniently by reducing the scale of the maps

(e). From the study, it is found that the effective rural road alignment can be developed using integration of GIS and GPS. This method of forming alignment consumes less time and results shown are very effective

(f). The output (latitude and longitude)values given by DGPS is very reliable and when run in Google earth showed the exact coordinates and areal image of the study area is obtained which gave an over view of the study area.

VIII.   SCOPE FOR THE FUTURE WORK

The present study is adopted only for three Mandal roads, which can be extended to district and state to form the alignment of roads. Using DGPS the alignment of the road network can be formed and the entire road network can be digitized in GIS environment. This digitized information about road network can be uploaded to web. This web rural road information system can be viewed from any place in the web which can be useful for the planners, engineers for the planning, management and maintenance of the roads.

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