

Open Source Geospatial Technology for Urban Frame Surveying

¹Reedhi Shukla*, ²Sampath Kumar P*, ³Lesslie A, ⁴Shaik Mobina,
⁵Arulraj Murugavel, ⁶ Kamini J, ⁷Jayanthi SC
National Remote Sensing Centre, Indian Space Research Organization, Hyderabad, India

Abstract

Urban survey is always been a tedious task and traditional practices of surveying is time consuming. Urban Surveys till now have been using the paper maps and these maps will be of no use once the new survey has to be started. The latest advances in the geospatial technologies has given a new approach towards surveys. Geo-web technologies will help in making the use of technologies for collecting survey data in geospatial format and storing in database for whole survey lifespan. These data is made available to user using web based technologies through web portal, which allows online editing and updating of the data. The data is collected in GIS format using mobile app and stored in the geospatial database. The data is made available on the QGIS software for further editing. All the processes of present survey methods is made online with restricted access and authenticated verification of data. The geospatial application for the surveying has provided complete solution as an alternative to present traditional practices. The geo-web application is developed using open source tools and technologies, so cost wise also it is turn out to be best solution in the present scenario.

Keywords

Geo-web application, Urban Surveys, Postgis, Postgres, Geoserver, OpenLayers

Date of Submission: 28-04-2023

Date of acceptance: 12-05-2023

I. Introduction

Urban survey plays a vital role in role in conducting sample surveys on various socio-economic indicators (Urban Frame Survey (UFS), 2022). The study done by (Ragheb, et.al, 2015) has mentioned the importance of surveys for urban planning and urban management. The traditional paper-based maps are prepared manually using sketch maps, which become unusable because urban scenario keeps on changing with time. In order to keep maps updated with time, manual redoing of the task was required, making it subjective and time consuming. The recent open-source geospatial technologies will help to develop the system and make survey easy and user-friendly using digital environment. The combination of mobile app and geo web application allows the surveying data to be collected in GIS format, facilitating the preparation of geospatial maps.

This paper will provide information regarding the application and methodology which is developed to aid in urban frame surveying. (Harish Chandra Karnatak et.al, 2012) has also given good knowledge about web based application developed using spatial mashup using open source GIS, mobile applications, web services in web 2.0, Geo-RDBMS, and XML, which are central to intelligent geo web services. The application is divided into three components first the mobile application, second is a geo-web application, and third is the GIS Plug-in for Quantum GIS software. The mobile application field has been rising tremendously with the drastic increase in the number of mobile apps on various mobile phones and tablets. As per the (Kishore Baktha, 2017) study mobile applications are essential as they provide functionalities that can serve useful purposes such as finding a location, collecting attributes and taking geo-tagged photos. The mobile applications facilitates the collection of field data in GIS format. The Geo-web application, available 24 x 7 will allow authenticated data visualization and role-based data verification. The Quantum GIS plugin will provide enhanced GIS tools for editing GIS field data for making final geo-spatial maps. This application is a way towards digital GIS based Urban Surveying using Geo-spatial technologies.

Data Used

The data used in the application is spatial data features and the corresponding attribute from field data collected using the mobile application and satellite data is used as background in Web Map Services (wms) service format.

Background work

Web GIS technology is great way for geoscientist to visual interaction of GISdata and produce the maps dynamically (AA Alesheikh et.al, 2002). It also allows dynamic updating of the maps with proper authentication control without any hassle. (Chakraborty Debasish, 2015)also give the study on the use of open source geospatial tools and technology for sharing the geospatial data and developing the web based application for sharing geospatial information in cost effective manner in comparison to commercial GIS software .(Rakesh Malhotra, 2013)study is about how data from different sources like mobile, web, databases can be combined using scripting and mashups and served over the web in a user-friendly environment for creating reports and multiple analysis related to urban planning. Raster and vector can be served to multiple clients over internet using map servers over web (Chakraborty Debasish, 2015). The performance of any web portal will be dependent of how the data is stored at the backend. (Rakesh Malhotra, 2013) has given a fairly good knowledge about different data bases, and how best and effectively the data organization should be done in order to serve the GIS data over web without delay and failures. The data base and web based technology together is giving powerful way for the dissemination of GIS data. With the development of new techniques in GIS, the web based portals are not only providing the visualization of data as GIS is becoming a power tool for spatial analysis, editing of GIS data over web (Shimonti Paul, 2018). Multiple JavaScript libraries like open layers are available as open source which provides a user-friendly solution for the visualization of GIS data over web. Open layers allows the data visualization in WMS and WFS format. Storing of GIS data plays a crucial as security and availability of data to multiple users needs to be addressed in an effective manner. Multiple opensource data bases are available but we have taken postgresql and postgis into consideration for the storage of vector data. Postgres and Postgis has good support for carrying spatial data analysis and query based outputs. Postgis provides very good feature for testing valid and invalid geometry and is capable of handling over 3000 of the most common spatial reference system definitions that are handled by the PROJ projection library as mentioned in (Data Management, 2022,PostGIS 3.3.3 dev Manual).All the visualization spatial data is done in WMS format, the vector data is published using geoserver. According to (GeoSolution ,2022) geoserver is opensource and very robust solution for publishing, managing and disseminating the Geospatial data. (GeoSolution, 2022) also showcase that geoserver provides supports for many geospatial data formats and helps in generating maps without much of the efforts. (Sun, Lisheng et.al, 2015) has done study to minimize the response time of serving geospatial data over web and given a process GeoWebCache will allows to create tile based service to create better user experience. Geoserver has given a very good support for GeoWebCache. (Chandniha et.al, 2017) has taken open layer frame in marine information monitoring system for displaying the maps over web. The approach discussed in this paper will focus on development of geospatial web based application for carrying out the urban frame survey using open source tools and technology .The main of this application is to provide frame work in web domain which facilitated surveyors to collect the geo-tagged field data, spatial data visualization and data editing in authenticated manner and spatial data creation in QGIS software(Chakraborty Debasish, 2015) .The application also provides tools for user management also which allows creation of new surveyor id and activation and deactivation of new surveyors in fully automated manner.

II. Methodology

The application is designed for urban surveyors for carrying out the urban frame survey using geospatial application in a user friendly manner. The application is divided into three components mobile app, geo-web application and QGIS plug-in.

The first application component is mobile app which allows surveyor to collect the survey locations in mobile along with the field photographs. The mobile app is designed with robust automated authentication system for carrying out the survey. The data once landed to server it is organized in postgresql and postgis. The spatial database makes data accessible for developing interactive query based geo-web application. For the development of robust backend database system postgresql and postgis are found to be best open source options for dealing and organizing the geospatial data.

The second component geo-web application allows the data visualization, editing and approval and user management based on privilege based authentication control. Geoserver is used for publishing of spatial data in (WMS) format for sharing, and visualization of spatial data in application using php and openlayers (Burdziej, J,2012). The application allows the editing and storing of multiple attributes data online over web. Auto data verification module facilitates the accuracy check of the data, based of which data can be accepted or rejected. The Rejected data needs to be corrected and re-submitted for further approval. After complete data

editing and approvals data will be locked for any modifications and saved in database in spatial format. Along with spatial data visualization and analysis the application has some unique feature of user-management also. The application allows creation of user logins based on towns in automated manner, it also allows the activation and deactivation of user using a user management tool in the application.

The third component of the application is developed as QGIS plug-in. The Quantum GIS is powerful GIS software having all GIS functionalities. This plug-in facilitates visualization of satellite data along with field data on the QGIS based on proper authentication control. The QGIS allows editing of spatial data and create proper maps with the help of field data. Once the Maps are finalized the user can upload the map in the server. After uploading of map, it is published in WMS format using geoserver, it can be further used for visualization in service format. The overall methodology is explained and shown in Fig 1.

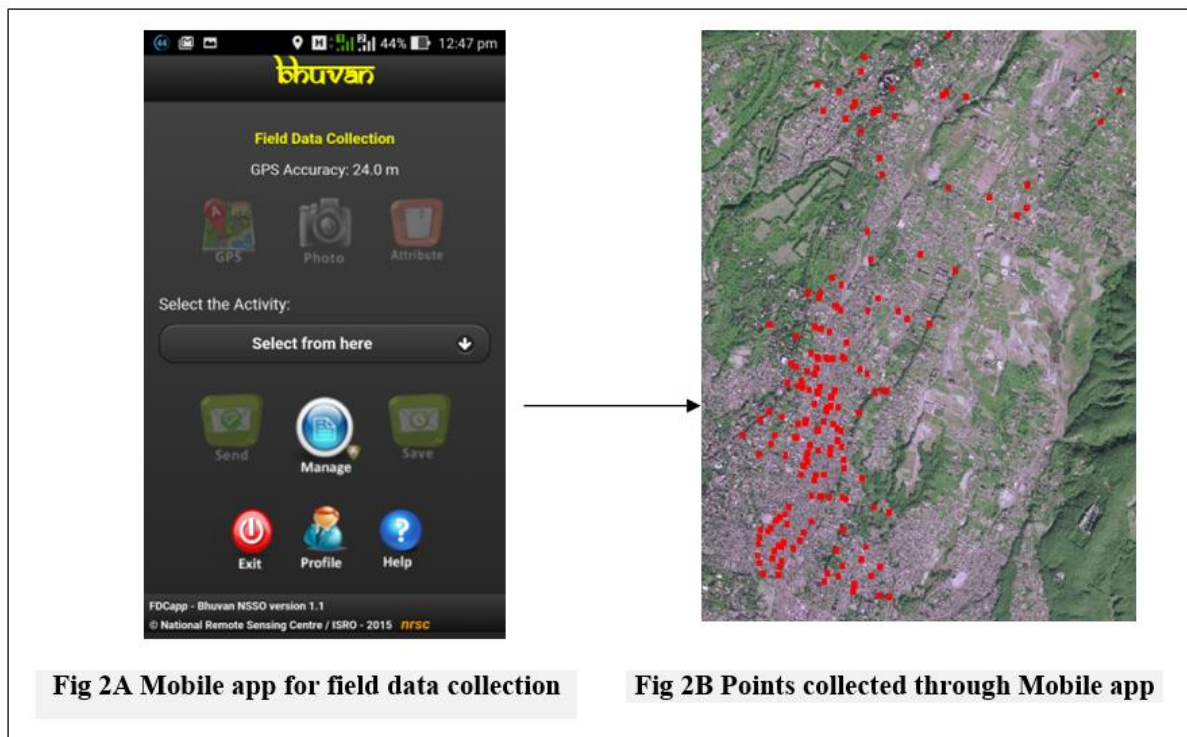
III. Results and Discussions

The application mainly provides modules for field data visualization, attribute editing, and data validation with approval and rejection modules, of the field data with satellite as background as shown in Fig 2A and Fig 2B. Along with spatial data management, the application also facilitates user management for auto-activating and deactivating users and creating new surveyors based on selected towns.

The data from the field is collected using mobile app and data is received at server end in near real time. The application is developed at server end to read and organize mobile data in postgresql data base. Once the data is organized in the data base it has to be published in the geoserver in WMS format. Scheduler is developed in php at which reads the data from the postgresql database and publish it in geoserver in automate manner. After the publishing of the data it can be visualized in the geoweb portal along with legend as shown in Fig 3. The left side panel showcases the attribute visualization and online editing of the selected attributes and saves it back to the database. The finalized IV boundary and block boundary is shown Fig 4.

The portal also provides a user management facility that allows automatic activation and deactivation of user, visualization of logging activity. To create a new surveyor (new user) 'User creation Page' module allows district and town selection and creates the new surveyor for the corresponding town, as shown in Fig 5. The portal also has given a module for user activating and deactivating, and resetting passwords Fig 5A and clearing registered unique id by a simple click as shown in Fig 5B

This application has a unique feature of QGIS plugin for visualization of field data and satellite data stored in a server. The purpose of the plugin is the online editing of spatial features using Quantum GIS. QGIS is open source GIS software that allows spatial data visualization, editing, and analysis (Aditya Dutt, 2021). Users use QGIS tools to create new maps by editing the spatial data boundaries collected from field keeping satellite data as background. The plugin allows the uploading of data with authentication back to server as shown Fig 6A and Fig 6B.



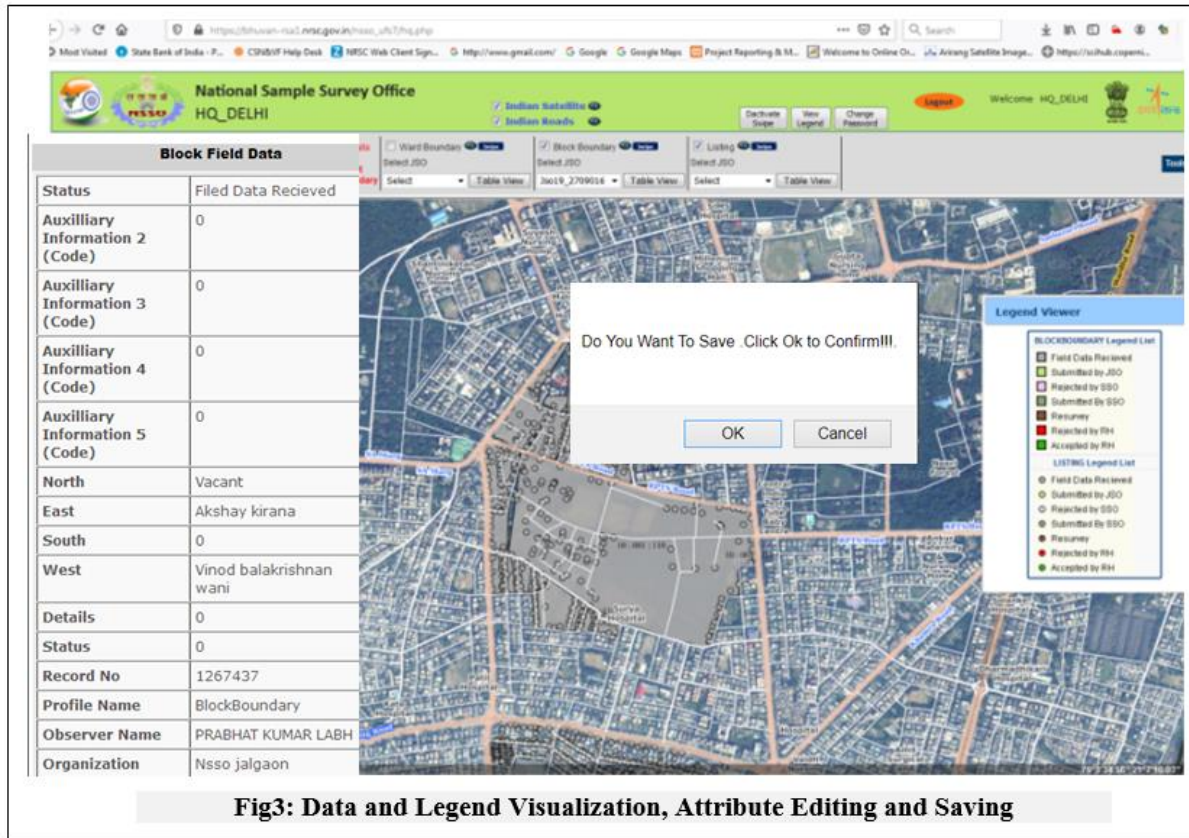


Fig3: Data and Legend Visualization, Attribute Editing and Saving

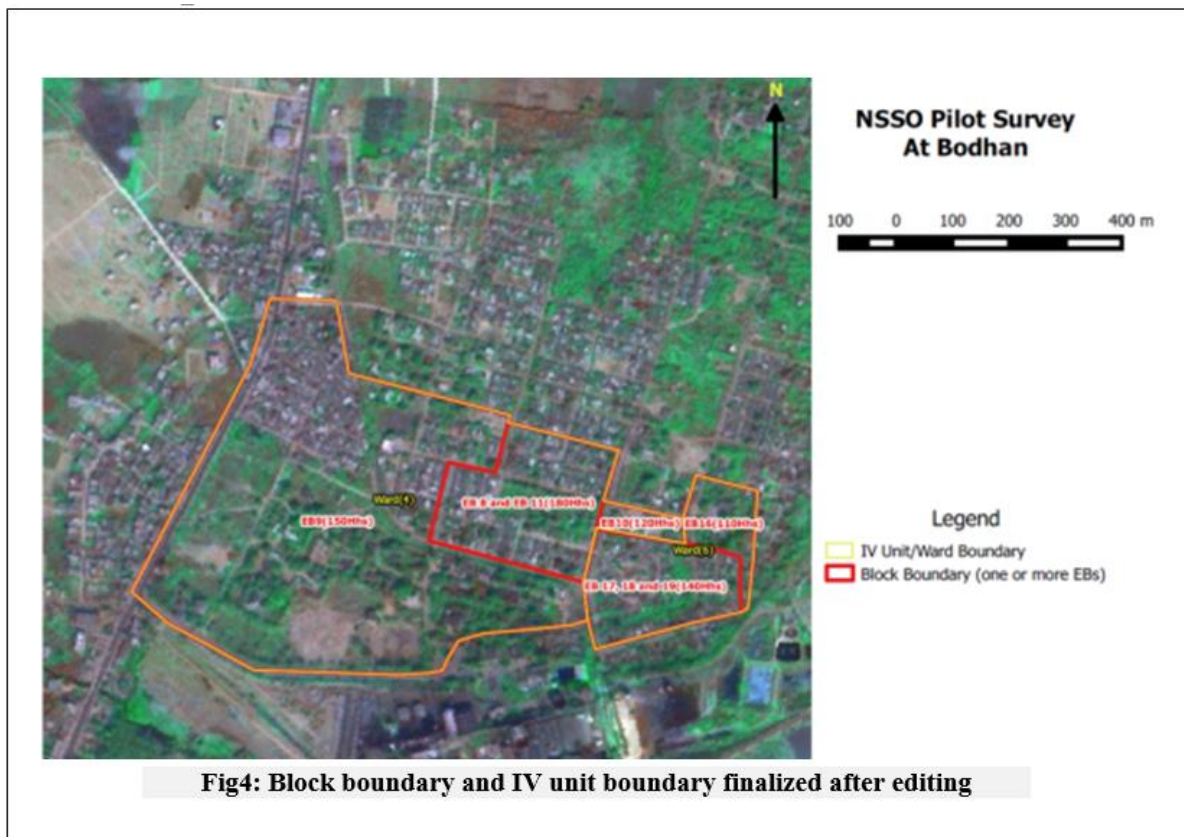


Fig4: Block boundary and IV unit boundary finalized after editing

Select JSO Reporting Officer	Select	Suggested SSO Id --->	SSO2_2719002	Create SSO
JSO_Id	JSO Reporting Officer Userid			
JSO1_2719002	SSO1_2719002			

Fig5: New user Creation

User_Id	User_Name	Designation	State_Code	District_Code	Town_Code	GID	Status	Enable_User	Reset Password	Reset Password
JSO1_2703008	JSO1	JSO	MAHARASHTRA	JALGAON	JALGAON MC	12318	Active	DeActivate User	Reset password	Reset password
JSO1_2715011	JSO1	JSO	MAHARASHTRA	NANDED	NANDED WAGHALA MC	11736	Active	DeActivate User	Reset password	Reset password
JSO1_2719001	JSO1	JSO	MAHARASHTRA	AURANGABAD	AURANGABAD MC	10396	Active	DeActivate User	Reset password	Reset password
JSO1_2719002	JSO1	JSO	MAHARASHTRA	AURANGABAD	AURANGABAD	12976	Active	DeActivate User	Reset password	Reset password
JSO1_2719005	JSO1	JSO	MAHARASHTRA	AURANGABAD	KHULDABAD	12957	Active	DeActivate User	Reset password	Reset password
JSO1_2719010	JSO1	JSO	MAHARASHTRA	AURANGABAD	ANANTPUR	12974	Not Activated	Activate User	User Not Activated	Password Not Set

Fig 5B: Clearing of registered Id

Fig 5A: User Activation and Deactivation

Fig 6: Data Upload QGIS Plugin

IV. Conclusion

This approach described in the paper provides how geospatial technology enables an efficient and effective approach for urban frame surveying compared to traditional techniques. In recent years GIS is becoming very popular for spatial data analysis and location-based surveys now, multiple departments are shifting from traditional paper based maps to gis based data (French S P et.al, 1990). The methodology explained in this paper showcases the power of open-source geospatial technology for conducting urban frame surveys. The application provides an end-to-end solution for collecting survey data, visualization, analysis, editing, verification, and validation without much manual effort. The data is well-secured in a database and can be used multiple times for spatial data analysis and time series analysis for population prediction and urban growth. (Shimonti Paul, 2018) also gives the knowledge about use the spatial query-based system and its role to provide an easy way to analyse a city and its growth pattern.

The unique authenticated application enables fully automated user creation and secure data storage. The application has fully translated the web service concept into the use and given a great approach towards the geo-web application for conducting urban frame surveying in a more user-friendly manner.

This application has a greater role in carrying out collecting and analysing the socio-economic indicators at national level which enable the Government officials to make assertive decision and policy making for the economic growth of country.

Acknowledgement

The authors are highly obliged to the Director, NRSC, Hyderabad, India for his keen interest in this work. Authors also express their gratitude to Deputy Director, Remote Sensing Applications Area of NRSC for his guidance and encouragement.

References

- [1]. AA. Alesheikh, H.Helal, HA Behroz (2002), "Web gis: technology and Its application", International Society for Photogrammetry and Remote Sensing, Symposium on Geospatial Theory, Processing and Application, Volume XXXIV Retrieved from <https://www.isprs.org/proceedings/XXXIV/part4/pdfpapers/422.pdf>
- [2]. Aditya Dutt (2021), Retrieved from <https://towardsdatascience.com/a-practical-guide-to-working-with-geospatial-data-using-qgis-part-1-561056a5a3b3>
- [3]. Burdziej, J. A (2012), "Web-based spatial decision support system for accessibility analysis—concepts and methods", Applied Geomatics, Volume 4, pp. 75–84, DOI: 10.1007/s12518-011-0057-x, Retrieved from <https://doi.org/10.1007/s12518-011-0057-x>
- [4]. Chakraborty Debasish (2015), "Web Based GIS Application using Open Source Software for Sharing Geospatial Data", International Journal of Advanced Remote Sensing and GIS, Volume 4, Issue 1, pp. 1224-1228. DOI:10.23953/cloud.ijarsg.109
- [5]. Chapter 4, Data Management (2022), PostGIS 3.3.3 dev Manual, Retrieved from "https://postgis.net/docs/using_postgis_dbmanagement.html"
- [6]. Chandniha Drsurendra, Goel Manmohan, Rathore D.S, Arora Manohar, Gupta R (2017), "The application of Open-Layers on web gis for spatio-temporal data publishing", Concepts and Applications of Web GIS ,pp.48-72..
- [7]. French, S. P., & Wiggins, L. L. (1990). "California Planning Agency Experiences with Automated Mapping and Geographic Information Systems", Environment and Planning B: Planning and Design, Volume 17, Issue 4, pp.441–450. <https://doi.org/10.1068/b170441>
- [8]. GeoSolution (2022), Retrieved from <https://geosolutionsgroup.com/technologies/Geoserver/>
- [9]. Kishore Baktha (2017), "Mobile Application Development: All the Steps and Guidelines for Successful Creation of Mobile App: Case Study", International Journal of Computer Science and Mobile Computing, Volume 6, Issue 9, pp. 15-20
- [10]. Karnatak Harish, Shukla Reedhi, Sharma Vinod, Murthy Y.V.S, Veerubhotla, Bhanumurthy (2012), "Spatial mashup technology and real time data integration in geo-web application using open source GIS – a case study for disaster management". Geocarto International, Volume 27, pp. 1-16, DOI:10.1080/10106049.2011.650651.
- [11]. Malhotra, Rakesh, Gurmeet Virk, Felix Nwoko, And Amanda Klepper (2013), "Web-Based Geospatial Technology Tools for Metropolitan Planning Organizations", Southeastern Geographer, Volume 53, Issue 3, pp.296–309, DOI: {10.1353/sgo.2013.0027}
- [12]. RaghebAhmed, ElFayoumi Mohamed (2015), "The Evolution of Traditional Urban Survey using Applicable Surveying Techniques", International Journal of Multidisciplinary Educational Research, Volume5, Issue 1, pp.37-47
- [13]. Shimonti Paul (2018), Geospatial World, Urban planning and GIS, retrieved from "<https://www.geospatialworld.net/blogs/gis-in-urban-planning/>"
- [14]. Sun Lisheng, He Dongzhi, Zhao Pengfei (2015), "A Research of Publishing Map Technique Based on Geoserver", Asian Journal of Applied Sciences, Volume 8, Issue: 3, pp. 185-195, DOI: 10.3923/ajaps.2015.185.195.
- [15]. Urban Frame Survey (UFS) (2022), Retrieved from "<https://mospi.gov.in/web/mospi/urban-frame-survey-ufs>"