GEOGRAPHIC INFORMATION SYSTEM FOR PLANNING AND DEVELOPING ROAD/RAILS

MAIN PROJECT REPORT

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CERTIFICATE

This is to certify that the main project entitled **GEOGRAPHIC INFORMATION SYSTEM FOR PLANNING AND DEVELOPING ROAD/RAILS** submitted by **Sanal Davis, Shaheer V M, Sharath K S, Sherlin N G** and **Sijo M C** to the **Department of Computer Science and Engineering, Government Engineering College, Sreekrishnapuram** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Computer Science and Engineering under Calicut University is a Bonafide record of the work carried out by them.

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Date :

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It is with great enthusiasm and the spirit we are bringing out this project report. We also feel that it is the right opportunity to acknowledge the support and guidance that came in from various quarters during the course of completion of our project. Above all we owe our gratitude to the Almighty for showering abundant blessings upon us.

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ABSTRACT

Geographic Information System(GIS) is a computer based information sysyem that enables storing, modeling, manipulation, retrieval, analysis and presentation of geographically referred data. IN a GIS, different types of features are contained in seperate layers. Each layer deals with a different topic-Roads,places,patterens of people, soil landscape data, or ecological zones; linked to both descriptive information(attribute) and geographic references(location). Layers can be combained, to see how attributes and locations intract or influence each other. The suitability of the GIS for road planning and management lies in the fact that all the data in this field is normally geographically refered.

The aim of the project is to estimate the amount of earth to fill an area over to remove from an area, in order to widening a road between two points on a map. This information helps in estimating the cost as well as labour charge for road developments. The elevations of different points on a map can be easily obtained. The elevation of the areas between these two points is calculated help of an open source Geographic Information System(GIS) tool.

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1 INTRODUCTION

Road transport is one of the most common mode of transport. Roads in the form of trackways, human pathways etc. were used even from the pre-historic times. Since then many experiments were going on to make the riding safe and comfort. Thus road construction became an inseparable part of many civilizations and empires. Scope of transportation system has developed very largely. Population of the country is increasing day by day. The life style of people began to change. The need for travel to various places at faster speeds also increased. This increasing demand led to the emergence of other modes of transportation like railways and travel by air. While the above development in public transport sector was taking place,the development in private transport was at a much faster rate mainly because of its advantages like accessibility, privacy, flexibility, convenience and comfort. This led to the increase in vehicular traffic especially in private transport network. Thus road space available was becoming insufficient to meet the growing demand of traffic and congestion started. In addition, chances for accidents also increased. This has led to the increased attention towards widening the road to support the traffic system.

1.1 Motivation

Traditional methods used in transportation planning have relied largely upon the individual skill of the engineer to develop one or more transportation alternatives on a contour map. The engineer then calculates the sum of construction, transport and road maintanance costs for each alternative. This can be expensive and time consuming task. The major cost component in the construction and the development of a road is earthwork. The existing methods(conventional methods) for estimating earth work volumes for straight roadway selections are the average end-area method and the prismoidal method. The average end-area method averages the earth work calculated at two successive road cross-section. The prismoidal method is based on an assumption that the ground profile between roadway stations is linear. The average end-area method tends to overestimate the volume while the prismoidal method provides a more precise volume calculation for linear profiles. During the last few decades there has been increasing interest in computer-aided analysis of road design as it provides quick evaluation of alternatives in a more systematic manner. Recently,computer-aided road design systems employing Digital Elevation Models(DEM) have become more attractive with the advent of high resolution DEM data.

There are open source GIS systems existing, the requirement was to find the most suitable GIS software that can be further developed for the application of road planning. Also the suitability of the architecture and compatibility with the existing digital map formats was very important. Thus the objective of the system was to uderstand the issues and challenges in integration of road planning system with the existing or available data. A road planning system with GIS is likely to increase the efficiency and spatial accuracy of the work.

1.2 Contribution

The project can be classified into two parts. The first part was the study existing GIS system and its architecture etc. This part includes the study of how a GIS software can be used for efficient road planning and development and how the existing data can be used for this purpose. The second part is the design andimplementaion. The design and implementation of the system has been done for Linux environment using python languages with the support of QGIS. The application can be used to estimate the earth work needed for the widening of arbitrary roads.

2 PROBLEM DEFINITION

At present scenario, architects takes measurement of desired location manually for developing roads/rails. It causes increase in cost due to travelling and other charges. Also, measurements can go wrong which means it cannot be accurate. For eliminating these, application were developed for calculating measurements using GRASS GIS. The main drawback of this application is that user has to know about GIS and its working.

Our proposed system solves this problem. An application is created for developing road/rail with QGIS working as backend. Any user can use it without knowing the QGIS and its working. Its cost effective and time saving to the architects.

There are three ways to create application in QGIS. They are:

1. **Using Python console:** For scripting, it is possible to take advantage of integrated Python console. It can be opened from menu: *Plugins* → *Python Console*. The console acts as a non-modal utility window.

2. **Using Plugins in Python:** QGIS allows enhancement of its functionallity using Plugins. This is possible with C++ and Plugins written in Python.

3. **Standalone application using QGIS API:** With PyQGIS, certain scripts can be created for automating task. Also, various GUI components can be incorporated into application by adding the *qgis.gui* module.

3 BACKGROUND

A good undestanding of Geographic Information System, types of existing maps and basics of road planning was essential for the design and implementation of the software.

3.1 Geographic Information System

A GIS application is used to open digital maps on our computer, create new spatial information to add to a map, create printed maps customised to our needs and perform spatial analysis. People and their environments are more interconnected than ever, and GIS is in many cases the most appropriate mechanism for analyzing and rectifying emergency situations. GIS can facilitate critical decision-making before a disaster or emergency impacts an area and throughout the disaster process.

GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. It is a powerful software technology that allows a virtually unlimited amount of information to be linked to a geographic location. Gis allows a user to run analysis, simple and/or complex, on may different features within the map area.

A GIS stores information about the world as a collection of thematic layers that can be linked together by geography.Geographic information contains either an explicit geographic reference such as a latitude and longitude or national grid coordinate, or an implicit reference such as an address, postal code, or road name.An automated process called geocoding is used to create explicit geographic references from implicit references (descriptions such as addresses). These geographic references can then be used to locate features, such as a business or forest stand and events, such as an earthquake, on the Earth's surface for analysis. General purpose GISs perform certain tasks.

1. Input of data
2. Map making
3. Manipulation of data
4. File management
5. Query and analysis
6. Visualization of results

Input of Data Before geographic data can be used in a GIS, the data must be converted into a suitable digital format. The process of converting data from paper maps or aerial photographs into computer files is called digitizing. Modern GIS technology can automate this process fully for large projects using scanning technology; smaller jobs may require some manual digitizing which requires the use of a digitizing table.

Map Making Maps have a special place in GIS. The process of making maps with GIS is much more flexible than are traditional manual or automated cartography approaches. It begins with database creation.Existing paper maps can be digitized and computer-compatible information can be translated into the GIS. The GIS-based cartographic database can be both continuous and scale free. Map products can then be created centered on any location, at any scale, and showing selected information symbolized effectively to highlight specific characteristics.

Manipulation of Data It is likely that data types required for a particular GIS project will need to be transformed or manipulated in some way to make them compatible with your system.GIS technology offers many tools for manipulating spatial data and for weeding out unnecessary data. File Management For small GIS projects it may be sufficient to store geographic information as simple files. When data volumes become large and the number of data users becomes more than a few, that it is best to use a database management system (DBMS) to help store, organize, and manage data.

Query and Analysis Once you have a functioning GIS containing your geographic information,ask simple question to analyse the given information.GIS provides both simple point-and-click query capabilities and sophisticated analysis tools to provide timely information to managers and analysts alike. Visualization For many types of geographic operations, the end result is best visualized as a map or graph. Maps are very efficient at storing and communicating geographic information. While cartographers have created maps for millennia, GIS provides new and exciting tools to extend the art and science of cartography. Map displays can be integrated with reports, three-dimensional views, photographic images, and with multimedia.

Different Types of GIS Files:

1. Shapefiles

2. Raster Data

3. Feature Classes

Shapefiles: Shapefiles are the files that make up a map. Shapefile, is a popular geospatial vector data format for geographic information system software. Shapefiles spatially describe features: points, lines, and polygons, representing, for example, water wells, rivers, and lakes. Each item usually has attributes that describe it. A shapefile is a digital vector storage format for storing geometric location and associated attribute information. Shapefiles are simple because they store the primitive geometric data types of points, lines, and polygons. They are of limited use without any attributes to specify what they represent. Therefore, a table of records will store properties/attributes for each primitive shape in the shapefile.Three individual files are mandatory to store the core data that comprise a shapefile: .shp, .shx, and .dbf.

Raster data: Raster data model stores spatial information by representing the geographic space with grids.The structure of raster data therefore consists of grids of cells that are made up of pixels.In its simplest form, a raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid) where each cell contains a value representing information, such as temperature. Rasters are digital aerial photographs, imagery from satellites, digital pictures, or even scanned maps. Data stored in a raster format represents real-world phenomena, such as thematic data (also known as discrete), representing features such as land-use or soils data. Continuous data, representing phenomena such as temperature, elevation or spectral data such as satellite images and aerial photographs.

The advantages of storing the data as a raster are:

- A simple data structureA matrix of cells with values representing a coordinate and sometimes linked to an attribute table
- A powerful format for advanced spatial and statistical analysis
- The ability to represent continuous surfaces and to perform surface analysis
- The ability to uniformly store points, lines, polygons, and surfaces
- The ability to perform fast overlays with complex datasets

Feature Class: It is similar to a shapefile with one big difference is that it is located within a geodatabase. Feature classes are homogeneous collections of common features, each having the same spatial representation, such as points, lines, or polygons, and a common set of attribute columns.

Core Features of GIS:

1. Raster and vector support

2. Integration with QGIS
3. Extensible plugin architecture
4. Digitizing tools
5. Print composer
6. Python language bindings
7. OGC support (WMS, WFS)
8. Overview panel
9. Spatial bookmarks
10. Identify/Select features
11. Edit/View attributes
12. Feature labeling
13. On the fly projection

Advantages of GIS:

1. Exploring both geographical and thematic components of data in a holistic way.
2. Stresses geographical aspects of a research question.
3. Allows handling and exploration of large volumes of data.
4. Allows integration of data from widely disparate sources.
5. Allows analysis of data to explicitly incorporate location.
6. Allows a wide variety of forms of visualisation.

Limitations of GIS:

1. Data are expensive.
2. Learning curve on GIS software can be long.
3. Shows spatial relationships but does not provide absolute solutions.
4. Origins in the Earth sciences and computer science. Solutions may not be appropriate for humanities research.

3.2 GIS Architecture

An architecture model provides the framework of what kind of system is to be built and the functions that can be incorporated in that system. GIS has three major functions to perform:

- Data Storage and Management
- Business Logic: Analysis of the Data/Information.
- Presentation or display of information and data.

An architecture model of the GIS will depend on the handling of these functions between the server and the client. Broadly we can classify GIS into these three models.

1. Desktop Based GIS System where all the tasks mentioned above i.e. Data Storage, analysis and display are performed by the same machine at the same place can be referred to as Desktop Based GIS system.

2. Web Mapping Application A Web mapping application allows the user on the Web browser to search, retrieve, interact, and manipulate data stored in a central place across the network. The user can do one of the three things search for data on the network through a query, conduct data analysis, or retrieve and edit from the data repositories. The strength of this model is the client-side components which are usually platform independent, requiring only an Internet browser to run. This model allows distributed clients to access a central server and a central database remotely.

3. Cient-server GIS framework A client-server GIS framework is a system on its own. The client can only communicate with its own server. All user requests from the client are handled by a single application server that manages one or more GIS servers and data servers. The system is composed of four main components - a client, an application server, a GIS server and a data server. A single-server system with only one GIS server and data server does not scale well and is weak in fault tolerance with a large amount of user requests. A multiserver system with multi GIS servers and data servers has good scalability and fault tolerance. The strength of the multi-server system is the restricted client/server GIS framework as it allows distributed clients to access a specific server remotely but the weakness is that it

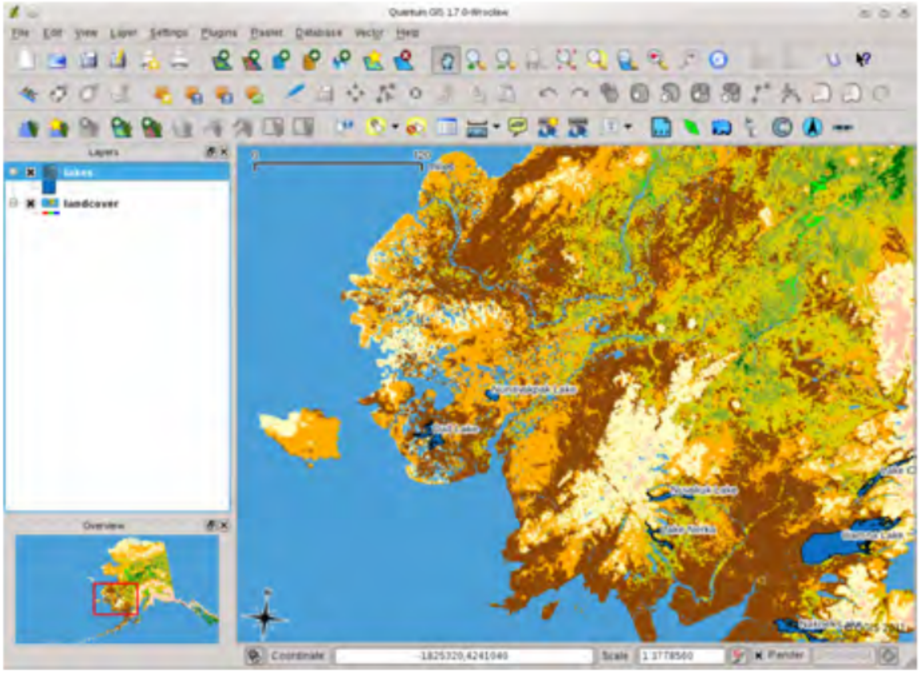

Figure 1: QuantumGIS Deskop Tool

is platform dependent and requires related softwares at the the client end that can interact with the server and may not be inter-operable with different systems

3.3 QuantumGIS Deskop Tool

The classic QGIS desktop application offers many GIS functions for data viewing, editing, and analysis. The major features include:

1. Direct viewing of vector and raster data in different formats and projections. Supported formats include PostGIS and SpatiaLite. most vector formats supported by the OGR library, including ESRI shapefiles, MapInfo, SDTS and GML.raster formats supported by the GDAL library*, such as digital elevation models, aerial photography or landsat imagery,GRASS locations and mapsets,online spatial data served as OGC-compliant WMS , WMS-C (Tile cache) and WFS.

2. Mapping and interactive exploration of spatial data. Tools include on-the-fly re-projection print composer overview panel spatial bookmarks identify/select features edit/view/search attributes feature labeling vector diagram overlay advanced vector and raster symbology graticule layer map decorations like north arrow, scale bar and copyright label.

3. Create, edit and export spatial data using: digitizing tools for vector features field and raster calculator.The georeferencer plugin GPS tools to import and export GPX format, convert other GPS formats to GPX, or down/upload directly to a GPS unit

4. Perform spatial analysis, including:

    - map algebra
    - terrain analysis
    - hydrologic modeling
    - network analysis

5. Publish your map on the internet using QGIS Server or the Export to Mapfile capability.

3.4 Types of maps

The QGIS support raster as well as vector maps. Raster maps are basically scans of a normal paper map. Vector maps are vector-based collection of Geographic information system (GIS) data about Earth at various levels of detail. For our application the raster maps are used.

3.4.1 Raster Maps

QGIS raster map layers can be conceptualized, by the QGIS programmer as well as the user, as representing information from a paper map, a satellite image, or a map resulting from the interpretation of other maps. Usually the information in a map layer is related by a common theme (e.g., soils, or landcover, or roads, etc.). QGIS raster data are stored as a matrix of grid cells . Each grid cell covers a known, rectangular (generally square) patch of land. Each raster cell is assigned a single integer attribute value called the category number. For example, assume the land cover map covers a state park. The grid cell in the upper-left corner of the map is category 2 (which may represent prairie); the next grid cell to the east is category 3 (for forest); and so on. In addition to the raster file itself, there are a number of support files for each raster map layer. The files which comprise a raster map layer all have the same name, but each resides in a different database directory under the mapset.

The advantges of raster map are:

- Direct copy of familiar paper product, with same accuracy and reliability.

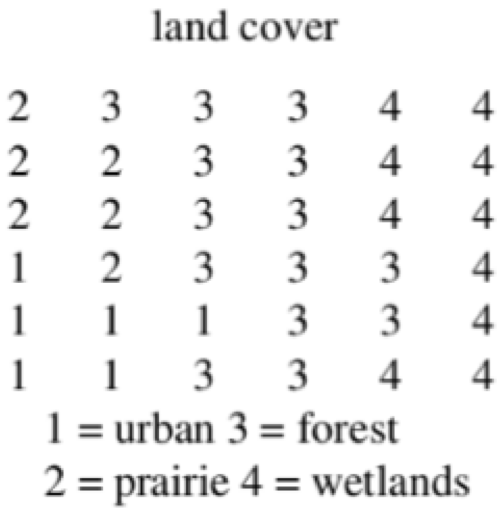

Figure 2: A conceptual raster representation

- Cheaper and simpler to produce, widely available.
- Does everything paper chart does, and more.
- Can emulate most vector functions.
- Can add alarms manually.

- **Raster File Format:** The programmer should think of the raster data file as a two-dimensional matrix (i.e., an array of rows and columns) of integer values. Each grid cell is stored in the file as one to four 8-bit bytes of data. An NxM raster file will contain N rows, each row containing M columns of cells. The physical structure of a raster file can take one of 3 formats: uncompressed, compressed, or reclassed.

  1. Uncompressed format: The uncompressed raster file actually looks like an NxM matrix. Each byte (or set of bytes for multibyte data) represents a cell of the raster map layer. The physical size of the file, in bytes, will be rows*cols*bytes-per-cell.
  2. Compressed format: The compressed format uses a run-length encoding schema to reduce the amount of disk required to store the raster file.
  3. Reclass layers: Reclass map layers do not contain any data, but are references to another map layer along with a schema to reclassify the categories of the referenced map layer. The reclass file itself contains no useful information. The reclass information is stored in the raster header file.

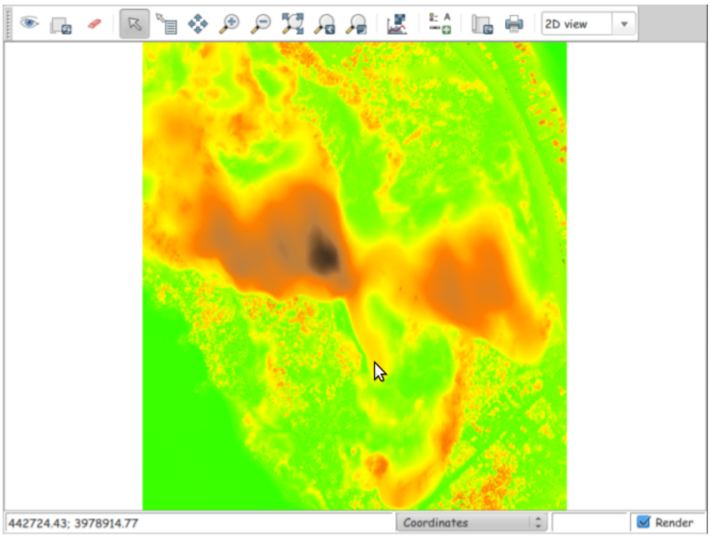

Figure 3: A sample raster map

- **Raster Header File:** The raster file itself has no information about how many rows and columns of data it contains, or which part of the earth the layer covers. This information is in the raster header file. The format of the raster header depends on whether the map layer is a regular map layer or a reclass layer.

- **Raster Category File:** The category file contains the largest category value which occurs in the data, a title for the map layer, an automatic label generation capability, and a one line label for each category.

- **Raster Color Table Format:** The QGIS raster color tables and associated programming interface have undergone a fairly major revision to resolve problems presented by raster maps that have a large range of data values. The previous design used arrays to store a color for each data value between the minimum and maximum values in the raster map. This array structure was also reflected in the format of the color table file-each color stored as a single line in the color file.

- **Raster History File:** The history file contains historical information about the raster map: creator, date of creation, comments, etc. It is generated automatically along with the raster file. In most applications, the programmer need not be concerned with the history file.

- **Raster Range File:** The range file contains the minimum and maximum values which occur in a raster file. It is generated automatically for all new raster files

3.4.2 Vector Maps

The Vector Map (VMAP), also called Vector Smart Map, is a vector-based collection of Geographic information system (GIS) data about Earth at various levels of detail. VectorMap is designed to preserve and make available the results of past collecting and distribution modeling activity. The utility of VectorMap will increase as more records and models are added. Contributions are encouraged, especially from individuals and organizations with digitized, georeferenced records and those involved in ongoing mosquito surveillance. QGIS vector maps are stored in an arc-node representation, consisting of nonintersecting curves called arcs. An arc is stored as a series of x,y coordinate pairs. The two endpoints of an arc are called nodes. Two consecutive x,y pairs define an arc segment. There are two types of vector maps. They are:

- Level 0 (low resolution): Level 0 provides worldwide coverage of geo-spatial data and is equivalent to a small scale (1:1,000,000). The data are offered either on CD-ROM or as direct download, as they have been moved to the public domain.
- Level 1 (global coverage at medium resolution): Level 1 data are equivalent to a medium scale resolution.

The advantages of vector map are:

1. Display layers selectively.
2. User can tailor chart display.
3. Zoom in and out.
4. Set own safety and alarm depth.
5. Interrogate for additional information.
6. Can rotate.
7. Easier to integrate with other data, radar displays.

3.4.3 DEM

There is no common usage of the terms digital elevation model (DEM), digital terrain model (DTM) and digital surface model (DSM) in scientific literature. In the most cases the term digital surface model represents the earth's surface and includes all objects on it. In contrast to a DSM, the digital terrain model represents the bare ground surface without any objects like plants and buildings.

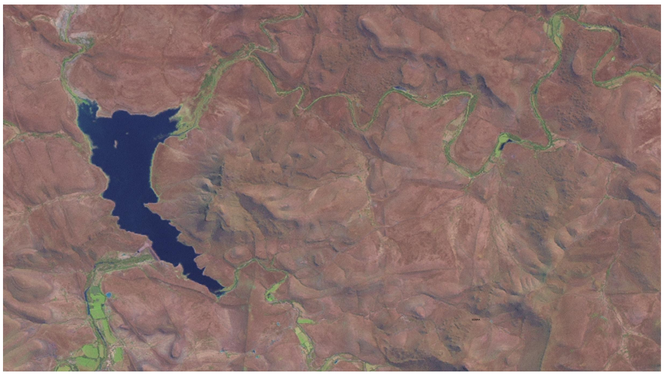

Figure 4: Data Elevation Model

Surfaces represented by a Digital Surface Model include buildings and other objects. Digital Terrain Models represent the bare ground. The term Digital Elevation Model is often used as a generic term for DSMs and DTMs, only representing height information without any further definition about the surface. Other definitions equalise the terms DEM and DTM or define the DEM as a subset of the DTM, which is also representing other morphological elements. There are also definitions which equalise the terms DEM and DSM. In the Web definitions can be found which define the DEM as a digital regularly spaced GRID and a DTM as a real three-dimensional model (TIN). Most of the data providers (USGS, ERSDAC, CGIAR, Spot Image) use the term DEM as a generic term for DSMs and DTMs. All datasets which are captured with satellites, airplanes or other flying platforms are originally DSMs (like SRTM or the ASTER GDEM). It is possible to compute a DTM from high resolution DSM datasets with complex algorithms (Li et al., 2005). In the following the term DEM is used as a generic term for DSMs and DTMs.

Heightmap of Earth's surface (including water and ice) in equirectangular projection, normalized as 8-bit grayscale, where lighter values indicate higher elevation. A DEM can be represented as a raster (a grid of squares, also known as a heightmap when representing elevation) or as a vector-based triangular irregular network (TIN). The TIN DEM dataset is also referred to as a primary (measured) DEM, whereas the Raster DEM is referred to as a secondary (computed) DEM. DEMs are commonly built using remote sensing techniques, but they may also be built from land surveying. DEMs are used often in geographic information systems, and are the most common basis for digitally-produced relief maps. The DEM could be acquired through techniques such as photogrammetry, LiDAR, IfSAR, land surveying, etc. (Li et al. 2005). While a DSM may be useful for landscape modeling, city modeling and visualization applications, a DTM is often required for flood or drainage modeling, land-use studies, geological applications, and much more.

4 DESIGN

- **Input:** Raster and Vector maps of required location.

4.1 Algorithm for loading a map

Step 1 : Load GUI application using PYQT4.

Step 2 : A new window is loaded with suitable QGIS buttons.

Step 3 : Load the vector map of the desired location.

Step 4 : Load the raster map of the desired location.

Step 5 : Zooming and zoom out can perform using appropriate buttons.

Step 6 : Stop.

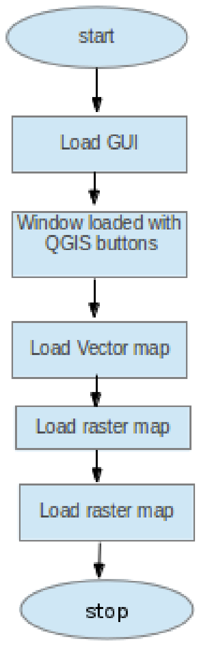

Figure 5: Algorithm for loading a map

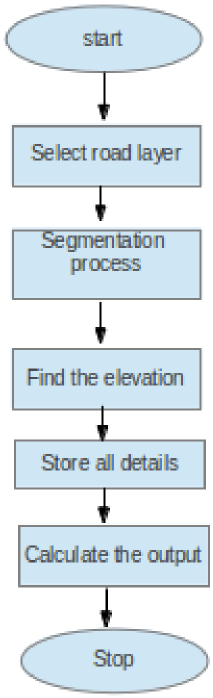

Figure 6: Algorithm for calculation

4.2 Algorithm for calculation

Step 1 : Select a road layer.

Step 2 : Read the width(w) of the road to be extended.

Step 3 : Segmentation process will start.

Step 3.1 : Divide the road into different segments of equal length.

Step 3.2 : Find the perpendicular line of length equal to width(w) from starting and ending points of each segment.

Step 3.3 : Divide the perpendicular lines into different segments of equal length.

Step 4 : Finding x & y co-ordinates & store it in array.

Step 5 : Take any 2 perpendicular lines & imagine it as a rectangle.

Step 6 : Length & breadth are calculated using the x & y co-ordinates.

Step 7 : Then find the area of the rectangle.

Step 8 : Find the elevation of each vertex of the selected rectangle.

Step 9 : Finding the volume of the selected region by finding the average of elevation & adding it to the area.

Step 10 : Stop.

5 IMPLEMENTATION

- Using Qt creater, buttons are added.
- When a button is clicked corresponding events are invoked.
- After loading the map, we can select the segment.
- By providing the required width of road, cut and fill volume are obained.

```
Download the QGIS source code from this site.
"git clone git://github.com/qgis/Quantum-GIS.git"

compile version of QGIS
mkdir -p ${HOME}/apps
cd Quantum-GIS
mkdir build-master
cd build-master
ccmake ..

set the CMAKE_INSTALL_PREFIX to somewhere you have write access to
(I usually use ${HOME}/apps). Now press 'c' to configure, 'e' to
dismiss any error messages that may appear and 'g' to generate
the make files. Note that sometimes 'c' needs to be pressed several
times before the 'g' option becomes available. After the 'g'
generation is complete, press 'q' to exit the ccmake interactive
dialog
```

Now on with the build:

```
make
make install
After that you can try to run QGIS:
$HOME/apps/bin/qgis
Inorder to execute the application, install following packages

sudo apt-get install bison cmake doxygen flex git graphviz
grass-dev libexpat1-dev libfcgi-dev libgdal1-dev libgeos-dev
```

```
libgsl0-dev libopenscenegraph-dev libosgearth-dev libpq-dev
libproj-dev libqt4-dev libqt4-opengl-dev libqtwebkit-dev
libqwt5-qt4-dev libspatialindex-dev libspatialite-dev libsqlite3-dev
pkg-config pyqt4-dev-tools python python-dev python-qt4 python-qt4-dev
python-sip python-sip-dev txt2tags xauth xfonts-base xvfb
```

1. **Platform:** Ubuntu 12.04
2. **Languages used:** Python
3. **Tools used:** QGIS Desktop 1.8.0 Lisboa, Tkinter

The map is created by using the QGIS Desktop tool - QGIS 1.8.0 Lisboa.

Code for Elevation

```
def getElevation(self, point):
#point is QgsPoint
print point.x()
print point.y()
choosenBand = 0
attr = 0
if QGis.QGIS_VERSION_INT >= 10900: # for QGIS >= 1.9
# this code adapted from valuetool plugin
ident = self.demLayer.dataProvider().identify(point, QgsRasterDataProvider.IdentifyFo
if ident is not None and ident.has_key(choosenBand+1):
attr = ident[choosenBand+1].toDouble()[0]
if self.demLayer.dataProvider().isNoDataValue ( choosenBand+1, attr ):
attr = 0
else:
ident = self.demLayer.identify(point)
try:
attr = float(ident[1].values()[choosenBand])

except:
pass
return attr
```

Code for Calculation

```
fvol = 0
cvol = 0
for i in range(p-1):
for j in range(q-1):
area=calcArea(i,j,i+1,j+1,xCord,yCord,elev)
vol=calcVol(i,j,i+1,j+1,area,xCord,yCord,elev)
if j==0:
rvol=vol #storing the volume of road to compare with other volumes....
else:
tempvol=rvol-vol #finding the difference in volume
if tempvol<0:
cvol+=(tempvol*-1) #adding to cutt volume
elif tempvol>0:
fvol+=tempvol #adding to fill volume
```

6 ANALYSIS & RESULT

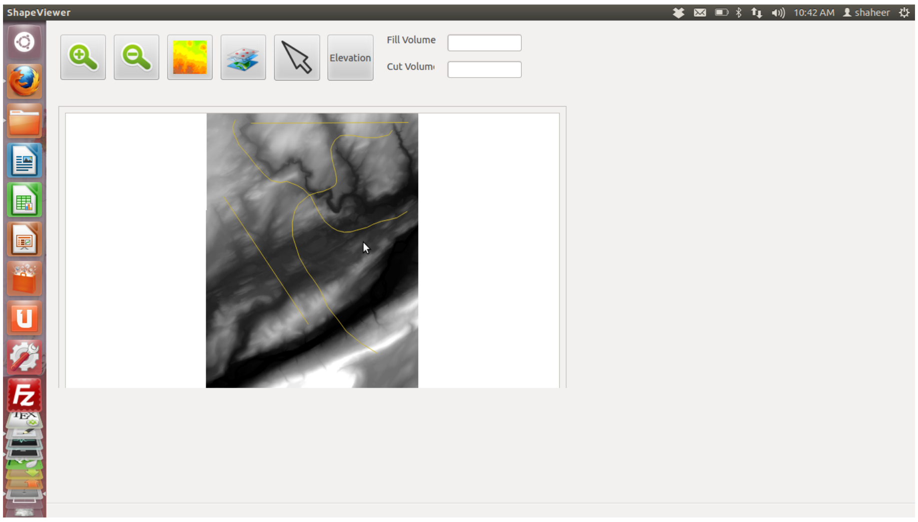

Figure 7: Input window

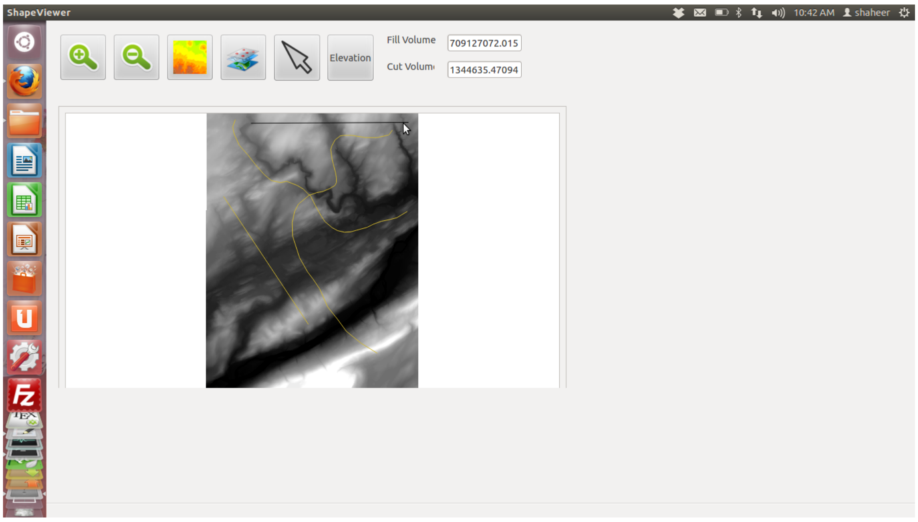

Figure 8: Output window

7 CONCLUSION & FUTURE SCOPE

7.1 Conclusion

The GIS based road planning system introduced in this project is very useful in road widening applications to calculate the earthwork required and thus the cost associated with earthwork with accuracy and speed than conventional methods. The cost and the amount of earth moved or to be filled can be calculated apriori to the actual work. This method may significantly decrease road design time and effort, both in the field and in the office. An engineer in the field equipped with a GPS unit would need to make fewer field measurements in order to complete road design earthwork calculation, which means a greater number of alternatives could be examined. If a high resolution DEM covers an area, a field engineer would need only a series of road center points in order to calculate cut and fill volumes. At the time of marking the road location on the ground for construction, the engineer would have final design elevations available at every point within the road template. This method assigns design elevations to all cells within the road template and calculates cut and fill volumes from the difference between design and surface elevations. This method is believed to be more accurate and efficient than traditional road design methods. Although it is felt that this is a more accurate method of determining earthwork than traditional road design methods, this assumption has not been field tested. A field test would include a comparison of time and accuracy of computerized road design cut and fill volumes with earthwork volumes generated using traditional methods. These should be validated with actual volumes measured during road construction activities.

7.2 Future scope

At this point, this method only applies to straight road segments and does not deal with horizontal or vertical curves. This model also does not take insloping, outsloping, curve widening, or turnouts into consideration. However, these modifications would be relatively easy to implement.

References

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[5] Introduction to Quantum GIS (Titan) Version 0.8.0 Author: Gary Watry