Intelligent Transportation System (ITS)
A geo-spatial sensor network approach for safer travel

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A final year project submitted in partial fulfillment of the requirements for the degree Bachelors of Engineering in Geo-informatics

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CERTIFICATE

Certified that the contents and form of thesis entitled **"Intelligent Transport System (ITS) – A geo-spatial sensor network approach for safer highway travel"** submitted by Asjad Nomani, Muhammad Asfand, Awais Khalid, Jahanzaib Nisar, Ramsha Bakht and Zohaib Butt have been found satisfactory for the requirement of the degree.

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DEDICATION

Dedicated to our parents, teachers, family and friends who had supported us throughout and never gave up on us. Without them we would not be what we are today.

ACKNOWLEDGEMENTS

Thanks to Almighty Allah for giving us knowledge, power and strength to accomplish this task. We learned a lot from this project and this will certainly help us in our forthcoming life.

We would like to give a big thanks to our supervisor Dr. Salman Atif who guided us throughout. With his expert knowledge and experience we made an innovative and successful project. He went beyond the call of duty on numerous occasions for us and we cannot thank him enough.

We would also like to thank Shahab Ahmed for his help in our project. We will also like to thank our whole class for their support.

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LIST OF ABBREVIATIONS

Abbreviation	Explanation
GIS	Geographic Information System
RS	Remote Sensing
ITS	Intelligent Transportation System
POI	Point of Interest.
GIS-T	GIS for Transportation
LAN	Local Area Network
WAN	Wide Area Network
DBMS	Database Management System
OTS	One-Time Programmable
GPS	Global Positioning System
URL	Universal Resource Locator
API	Application Programming Interface
SDK	Software Development Kit
IDE	Integrated Development Environment
XML	Extensible Markup Language
POI	Point Of Interest
DHT	Digital-output humidity & temperature sensor
OpenCV	Open Source Computer Vision Library
BGS	Background Subtraction
OSM	Open Street Map
HTML	HyperText Markup Language
CSS	Cascading Style Sheets
app	Application

ABSTRACT

This work describes our Final Year Project titled “Intelligent Transportation System”. Intelligent Transportation Systems (ITS) are advanced applications which aim to provide innovative services relating to different modes of transport and traffic management. They enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.

Transportation allows societies and businesses to operate efficiently and provides a form of quick and safe transit. However, it has drawbacks in the form of crashes, traffic, system failures and resources required to maintain the system. One of the most dangerous results of system failures is fatal road accidents. Such risks can be mitigated with a Traffic Management System that provides real-time traffic analytics.

The system provides users with the highest level of travelling efficiency ranging from accident hotspots that need to be avoided, temperature and humidity conditions on the road, chances of fog being present and an emergency response system in case of an accident. There is a vast application of this system which would help users to improve their quality of travel along with

The architecture of the system is based on client server system. Here we have more than one client i.e. android and PC. To manage our server, we will be using Apache and Geoserver. All the connections to the server will be through internet.

For a developing country such as Pakistan, a system such as this would help improve economic production of goods and services whilst maintaining the safety of travelers. Such a system is new to Pakistan and with the development, would provide a futuristic form of travelling. The use of GIS in this system is the backbone for the proper functionality.

Chapter 1

INTRODUCTION

1.1 BACKGROUND INFORMATION

ITSs are systems, in which people, roads and vehicles are linked through the network utilizing, advanced information technology (Berghout & 1999).

Looking at the history of Intelligent Transport System, we find that there are three phases.

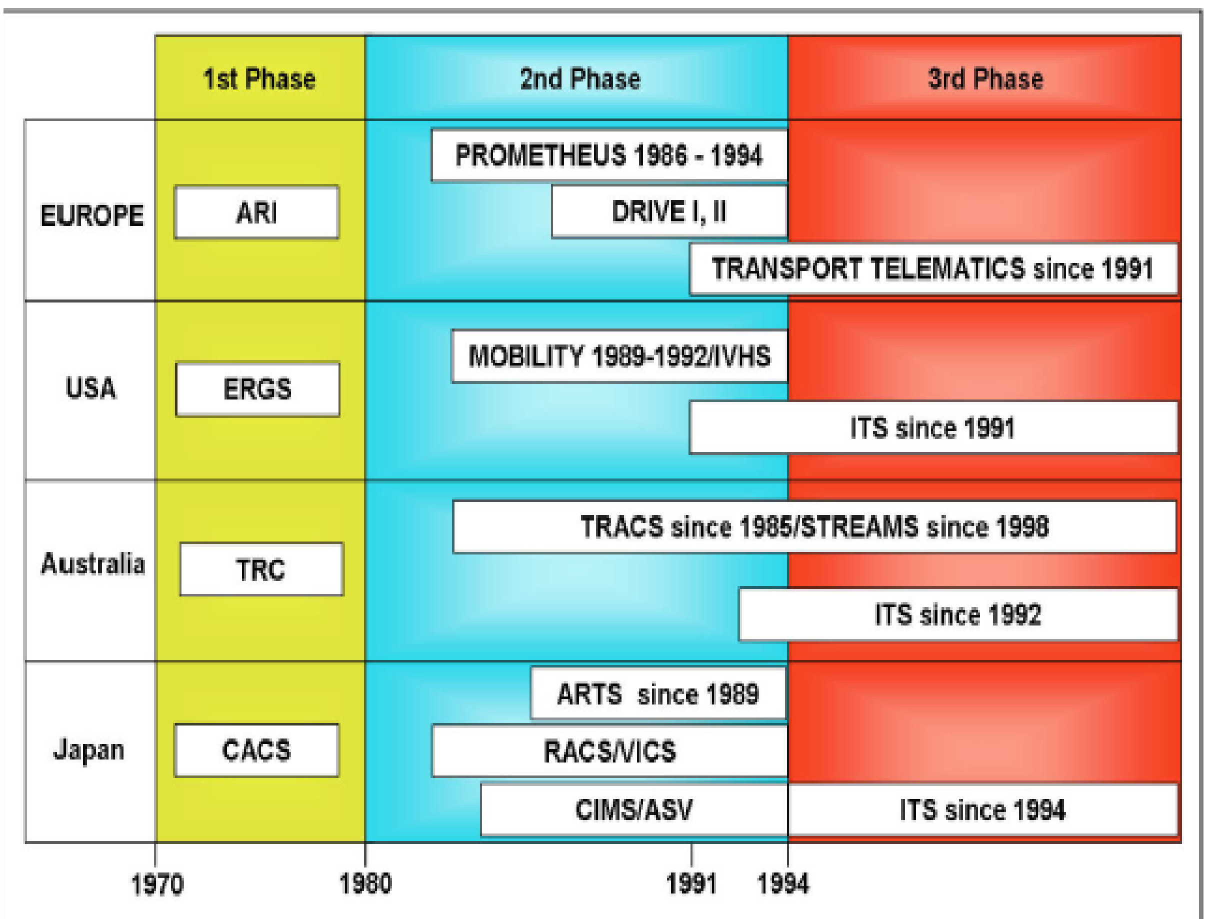


Figure 1.1 Phases of ITS

1.1.1 Phase 1

The first phase is from 1970 till 1980 and the beginning of ITS research. From the beginning of the 1970's, several European companies have developed systems that transmit a code at the start of the message. In 1974 ARI was introduced which was a highway radio system using FM to reduce traffic congestion in Germany.

ITS research began in the United States by a government sponsored in-vehicle navigation and route guidance system – ERGS. The Ministry of International Trade and Industry (MITI) in Japan funded the Comprehensive Automobile Control System (CACS) in 1973. These systems shared a mutual goal on route guidance and were based on central processing systems with huge central computers and communications systems. These systems never resulted in practical application due to limitations.

1.1.2 Phase 2

The second begins from 1981 till 1994 and in this phase the conditions for ITS development were determined. Information processing was made cheaper from technological reforms, such as the advent of mass memory. Research began alongside development efforts which were directed at practical use. At the time there were two projects which were being run in Europe: the Program for a European Traffic System with Higher Efficiency and Unprecedented Safety (PROMETHEUS) set up by auto manufacturers and the Dedicated Road Infrastructure for Vehicle Safety in Europe (DRIVE), set up by the European Community. PROMETHEUS started in 1986 and was initially a part of the EUREKA program.

ERTICO (European Road Transport Telematics Implementation Coordination Organization) was created in 1991 with the support of EC as a private-public partnership, and is open to all European organizations or international organizations operating substantially in Europe with an interest in ITS.

Work on the RACS project began in 1984 in Japan and this formed the basis for current car navigation systems. A second generation traffic management system was installed in Australia in 1985 and this was called TRACS.

The USA the Mobility 2000 group was formed in 1989 and led to the formation of IVHS (Intelligent Vehicle Highway Systems) America in 1990; its functions were to act as a Federal Advisory Committee for the US Department of Transportation. IVHS program was defined as an integral part, became law in order to develop "a national intermodal transport system that is economically sound, to provide the foundation for the nation to compete in the global economy, and to move people and goods in an energy-efficient manner"

ITS America was established in 1991 as a non-profit organization to substitute the use of advanced technologies in surface transportation systems. The goal was to improve the safety, security and efficiency of the United States transportation system utilizing ITS. ITS enabled people and goods to move in a safer and efficient manner through a state-of-the-art, multi-modal transportation system.

1.1.3 Phase 3

In 1994 the third phase of ITS began; this occurred when the practical applications of earlier programs were grasped, under-stood, and intelligent transportation systems were being thought of in intermodal terms rather than simply in terms of automobile traffic. ITS have gained recognition as crucial elements in the national and international information technology hierarchy.

The IVHS program (USA) was renamed the ITS (Intelligent Transportation Systems) in 1994 which indicated that other than car traffic, other modes of transportation receive attention. It is because of this that during the first world congress in Paris, the term - Intelligent Transport Systems (ITS) was accepted.

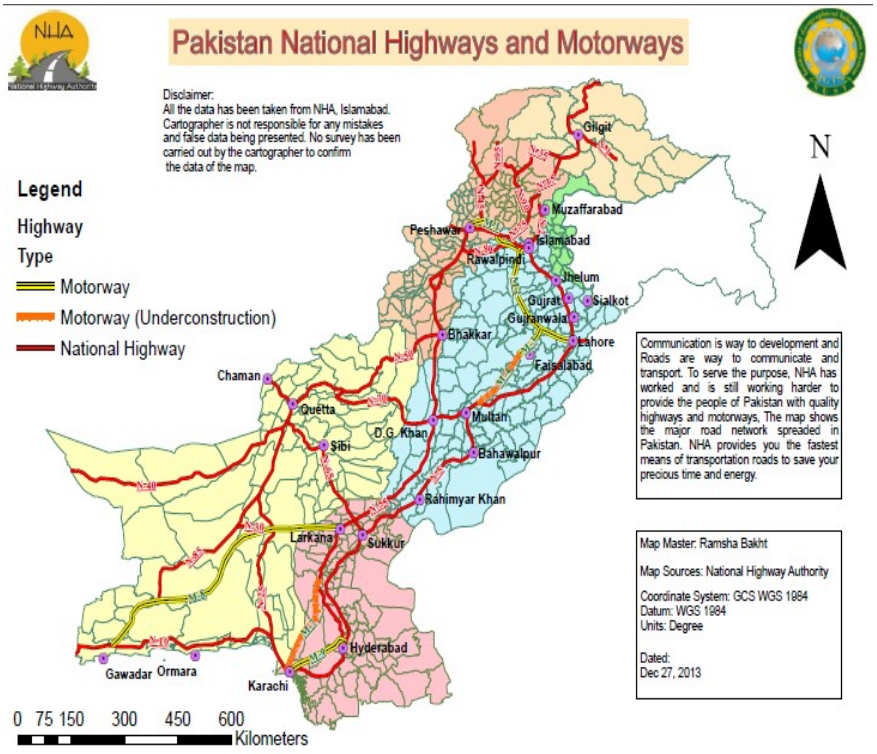
In 1994 ITS Japan was established and it promoted research, development and implementation of ITS. ITS Japan became a Part of a Global Advanced Information and Telecommunications

Society. VICS (Vehicle Information and Communication System) and ATIS (Advanced Traffic Information System) have been recently in operation in Japan. In April 1996 VICS started in Tokyo and Osaka by VICS Centre supported by Ministry of Construction, Ministry of Telecommunications and National Police Agency and expanding the service area.

In 1998 in Australia, the TRAC and South East Freeway's systems combined to create STREAMS Version 1. STREAMS Version 3 was implemented in 2007. Streams is an Integrated Intelligent Transport System which offers vehicle priority, motorway management, traffic signal management, incident management, traveler information and parking guidance.

The founder's meeting took place of an Intelligent Transport Systems Association also known as ITS Poland on April 26, 2007. The objectives of the association was to form a corporation of knowledge for the elevation of the ITS solutions, as a means to improving transport efficiency and safety, keeping in mid the natural environment protection. ITS Poland collaborates with similar organizations in Europe and worldwide.

Transportation is a vital sector of Pakistan's economy which contributes to 10% of the GDP. Presently the road network is approximately 258,000 kilometer. It is the need of Pakistan to have an effective transport system if they ever want to become internationally competitive. It should be done while keeping in the mind that service levels to increase and cost to decrease. The current road network all over Pakistan is not that efficient. Road conditions are not satisfactory which result in high depreciation rates of vehicles and high fuel consumptions. Due to ever increasing traffic density and rash driving there are a lot many numbers of road accidents some of which also lead to death. Analyzing the prevailing conditions we come to know that there are a huge number of reported road accidents in all provinces of Pakistan. Moreover, it takes quite longer to travel from a source to the destination. On international level time is considered as money. So the time delays taken from source to destination are converted in terms of money which leads Pakistan's economy to loss.



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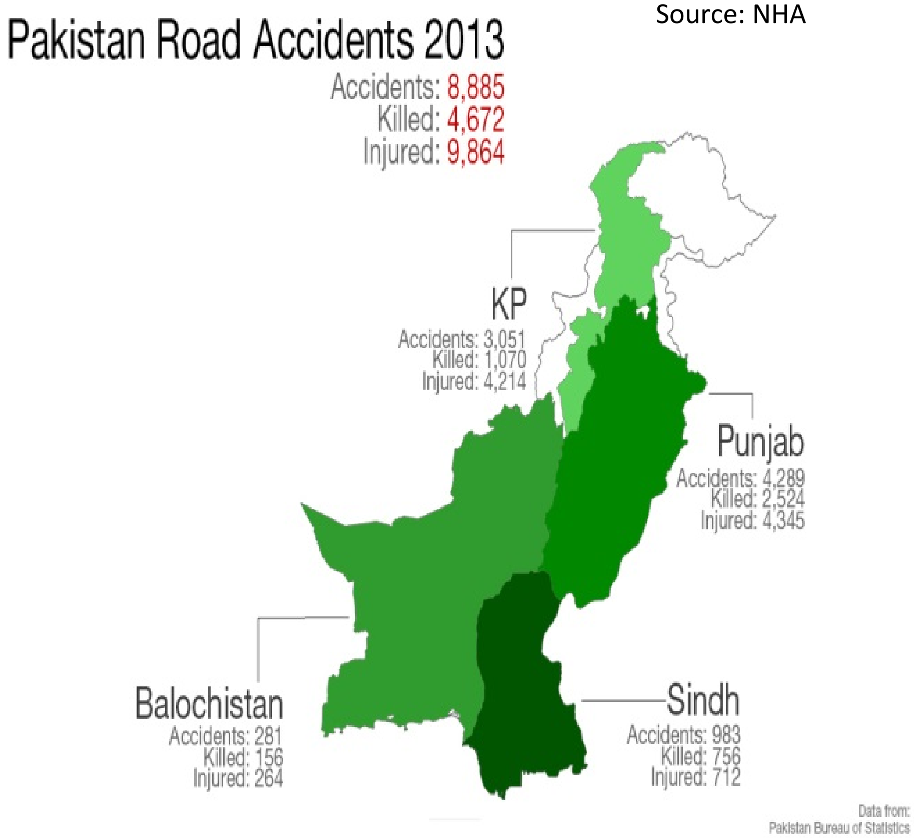


Figure 1.1.3 Need of the Project

1.1.4 GIS in Transportation

Geographical Information Systems (GIS) is widely been used for input, manage and analyze the geographical data. Potential applications of GIS are in the field of transport, disaster management, land use planning, remote sensing, resource allocation, modelling etc. When GIS is applied to transportation, it's mostly known as GIS-T (Geographical Information Systems for Transportation)

A number of GIS-T models have been applied in different countries' transport sectors. GIS-T models have various applications in transport which include ITS, routing, networking, traffic modeling and control, traffic DEM analysis, identification of accident hotspots, vehicle dispatching, site selection and services analysis, representation of traffic density patterns, infrastructure planning etc. All of these fields have their respective data requirements.

With the progress of the internet facilities e.g. LAN, WLAN, 2g, 3g, 4g etc. , the implementations of Web-GIS GIS-T applications can be found commonly for example different websites such as Google and MapQuest are frequently used by users to find route directions. Many cell phones have built in programs for driving directions, shortest/most suitable route etc.

GIS-T studies have employed two essential types of data models that are Field-based and object-based. The object-based data models are mostly applied to Transport Applications where features are represented as point, polyline and polygons while field-based are typically used of Network Analysis which takes input as input the real world features that vary continuously like precipitation, temperature, road network etc.

For dealing with any GIS-T or GIS, the first step is to create a database that would all the data and would also keep the metadata of the data. Mostly used are the Relational databases which we call Database Management Systems (DBMS). The loaded to a DBMS can come from various platform like importing the existing data, direct digitizing and producing maps or getting images like satellite imagery, aerial photos etc. Creation of a DBMS is crucial to GIS and GIS-T.

An ITS consists of a number of components. The major components of an ITS where GIS will be involved are Advance Traffic management, which will use the real time traffic data and user's preferences, Advance Traveler Information System, in which GPS will be used to get the user's position and data about route congestions, fog and rain data and all problems arising due to these effects which would be vulnerable to safe driving. Advance Emergency Response System in which traveler's position will be fetched using GPS and quick response be aided to the travelers via patrol cars etc.

The monitoring end, the traveler's position is mapped as a point and all nearby Points of interests (POI's) are shown which is again achieved by using GIS. These days some LiDAR data collection techniques are used to find out road geometries in accident analysis.

1.1.5 Importance of ITS in Pakistan

As mentioned earlier that effective transport system is a requirement for Pakistan to become internationally competitive. It is a major need of current era. It allows societies and business to operate efficiently and provides a form of quick and safe transit. Transportation is a daily need in one's daily life cycle. But everything has pros and cons. It has drawbacks in the form of crashes, system failures, traffic jam and resources required to maintain the system. Major problem is in the form of fatal road accidents which can lead to injuries and sometime deaths of people and other living being involved in it. To mitigate these problems we need a system which can provide real time traffic analytics and that's where ITS come to play. It will connect the highway users and the officials in an interactive manner providing its users with reduce chances of accidents, enhancing road management and services in cases of emergency and other mechanical issues (like car heat up, tire worn out etc.) with efficient timings.

The main purpose of an ITS is to maximize user utility. It provides officials with a system that would facilitate in operations and management of highways. It incorporates various technologies to provide a complete control network to the authorities. It is a user friendly system too, providing a user segment which would get information from the control network and display information useful for the user using the highway network. Some of the operations it performs are:

- Mapping Highways
- Unified Communication and Collaboration
- Tolling records and car identification

- Real time data collection and management
- Multimedia Command and Control
- Emergency Communications
- Incident detection and traffic management
- Incorporating data from multiple sensors i.e. temperature, humidity and motion sensors

1.2 OBJECTIVES

The goal of this project is to develop an Intelligent Transport System which would facilitate all travelers on highways in Pakistan. The main objectives of our project are:

1. To provide safer highway travel.
2. To provide efficient highway management.
3. To provide quick emergency response.

To achieve the first objective we would provide the users with information regarding the condition of the roads. The user will be provided with information such as fog levels, areas of high accident probability and temperature and humidity conditions. Furthermore accident hot spots will be identified where appropriate measures can be taken to mitigate the problem.

The second objective will be achieved by providing highway authorities with an efficient method to monitor and manage the highway system. Cameras will be installed, that will monitor the cars that pass thorough different check points and record their number plates. Weather units will also be installed that will monitor the weather conditions and update and display real time condition of the highway without the need of having personal in the field which will save time and money.

The third objective will be achieved by developing an application and a monitoring system that would inform the authorities if any accident has occurred of if there is any emergency on the road. Users will be able to send a distress signal using a mobile application when in an emergency.

1.3 LITERATURE REVIEW

Robert L. Bertini in *Integrating Geographic Information Systems and Intelligent Transportation Systems* to *Improve Incident Management and Life Safety* explained that GIS efficiently supports modeling for the analysis of best suited planning alternatives and for traffic control and vehicle dispatch in real time. Intelligent Transportation Systems (ITS) involves various applications of information and communication technologies for operation and planning of transportation systems. This enhances safety and mobility.

Reginald R. Souleyrette, Ph.D, Principal Investigator Associate Director for TP/IS, Center for Transportation Research and Education Associate Professor of Civil Engineering issued a final report on *Applications for Interactive Transportation Planning GIS (TPGIS*) in 1996.

This paper discusses a Bicycle route planning application which was developed using GIS. The paper also reviewed previous analytical attempts being carried out for the ease and suitability of bicycle travel paths; as a result of which new areas where identified where development and research were required.

A case study carried on the City of Ames, *The Methodology Improves Data Integration,* used GIS visualization tools to show the cost efficient and timely model development. The visualization via these tools provided enhanced model calibration and better visualization. The data sources were CAD files, aerial photographs, and statistical data and georeferenced images. GIS has proved to be an effective tool in the field of transport. Successful efforts have been made to link GIS packages with Transport for forecasting and scenario analysis.

R.A.Ganorkar, P.I.Rode, Ashtashil V. Bhambulkar issued an International Journal of Engineering Research and Applications (IJERA) of *Applications of GIS in Transport* and concluded that there are abundant evidences of satellite based remote sensing and GIS technology being applied in a number of fields of civil engineering. Satellites having sensors of high spatial and spectral resolution can go a long way in providing useful information required for civil engineering applications. The field of transportation and its management require the handling of multiple forms of spatial data GIS and simulation models contributed to the identification and evaluation of potential solutions for Transportation problems during the past decade.

GIS tools have extended the number of ways useful information can be represented. As the use of GIS dataset is gaining more and more popularity these days, many spatial datasets are available of internet. The journal evaluates many applications of GIS in Transport which include optimum routes, travel time, travel distance and cost for defined paths and for the optimum paths were determined for few transport services. Optimal routing for emergency services, however, earned the top priority.

GIS Applications and Integration on Transportation Planning and Design Projects, a paper by Yancey Molner explained ample integrating solutions for efficient data processing in field of transport. The idea is to maximize the accuracy of the data while minimizing the cost. He, by his research, suggested that CAD and GIS data together can play an important role in varying levels of data integration depending on the business needs:

1. Import/Export or Direct Read
2. Extract, Translate, Load (ETL) Process
3. Application Interoperability
4. Shared Enterprise Databases

He explained that data quality is a very important part of any GIS carried project and presented the value of managing data graphically:

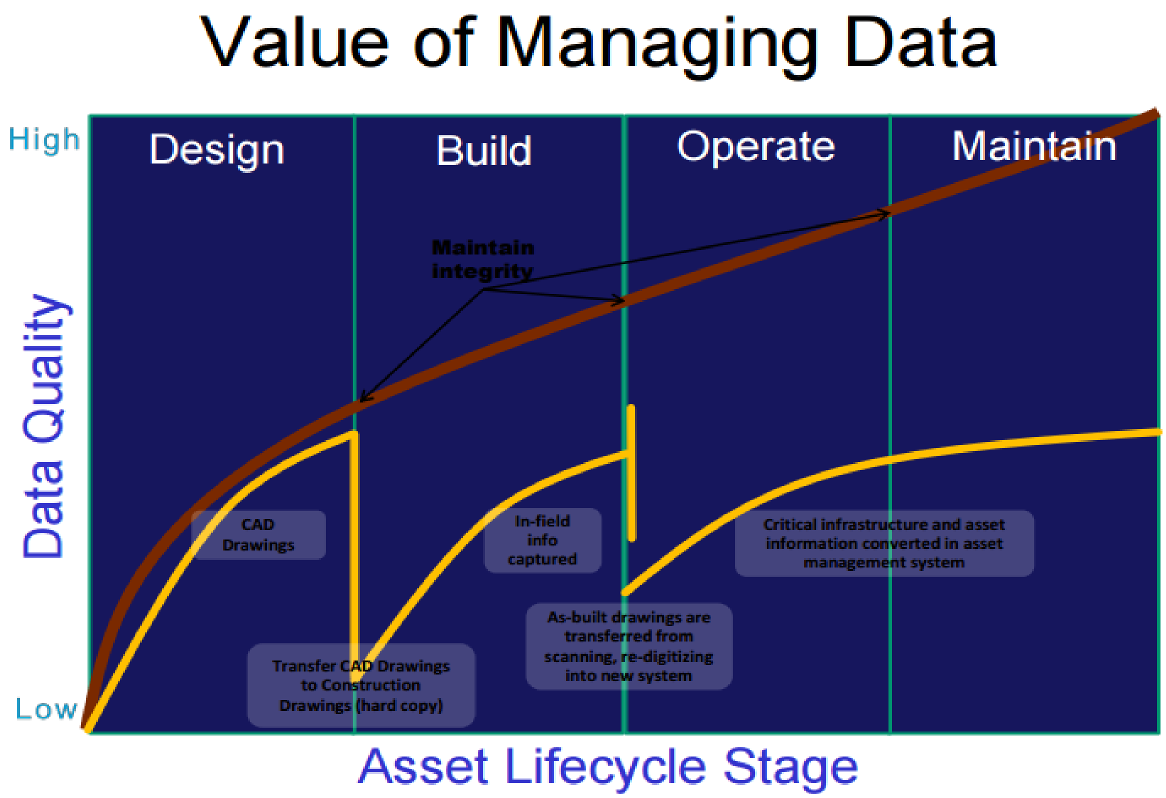


Figure 1.3. Value of Managing Data

Andrea Grygo, Duluth -Superior Metropolitan Interstate Council, issued a paper of "*GIS in transport planning"* and deduced a Travel Demand Model (Transportation Model) Predict travel changes Computerized network (Network Analyst) on following preferences:

1. Level of Service
2. AADT (traffic volume)

The travel model used GIS for spatial data analysis, GIS tools, such as selection by location, buffer, visualization and optimum route analysis.

1.3.1 Spatial Data Analysis

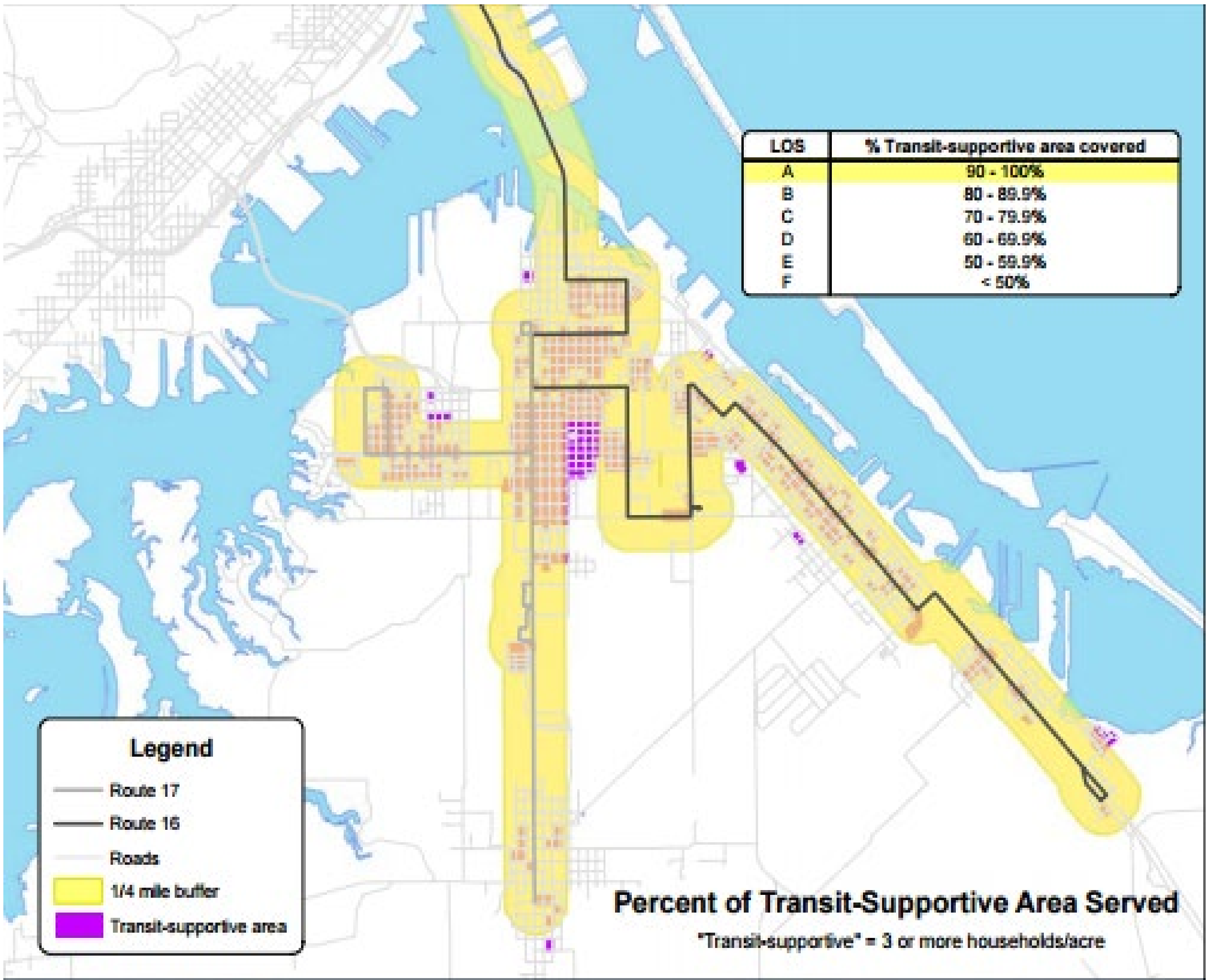


Figure 1.3.1.a Spatial Data Analysis

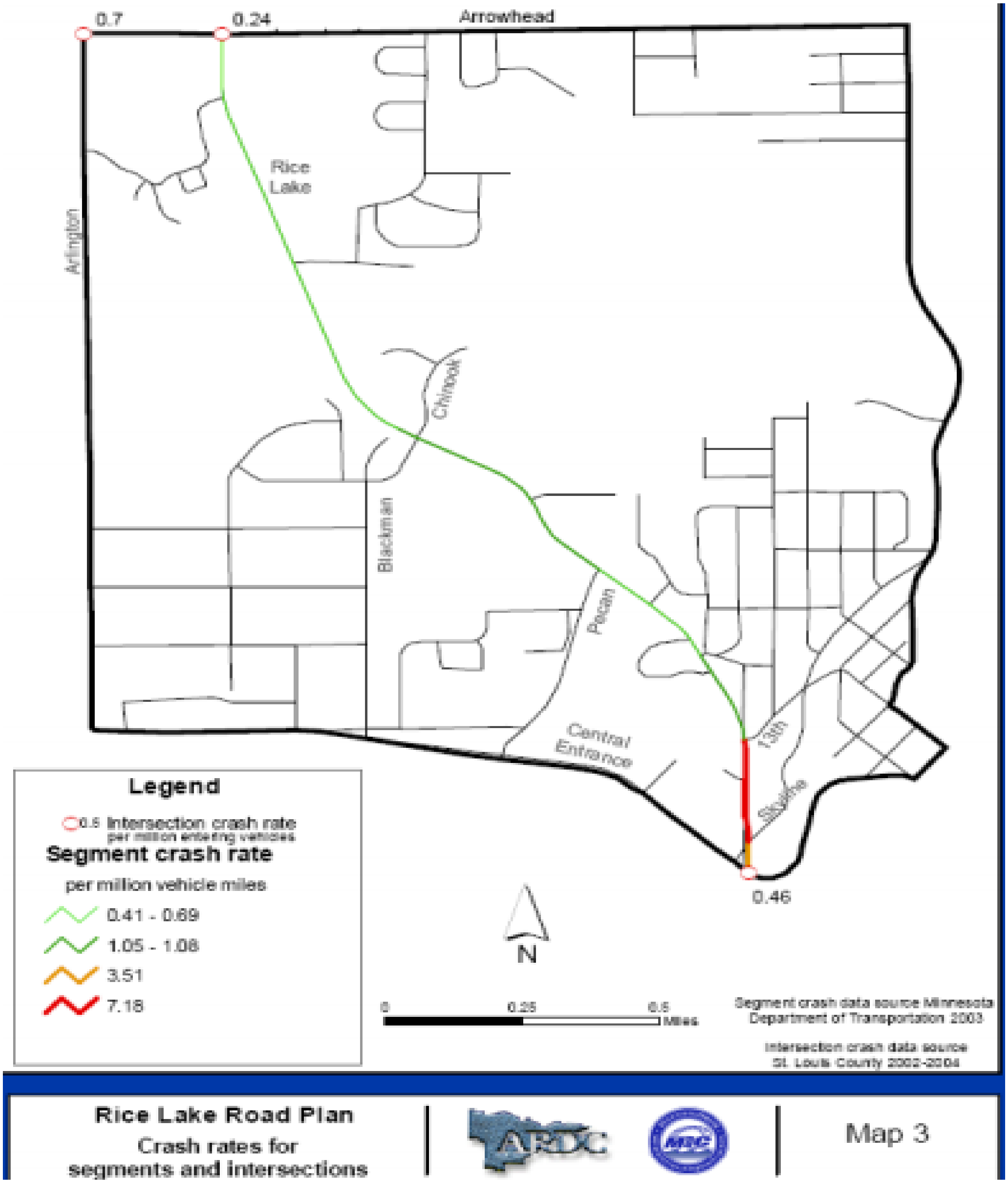


Figure 1.3.1.b Spatial Data Analysis

1.3.2 GIS Tools

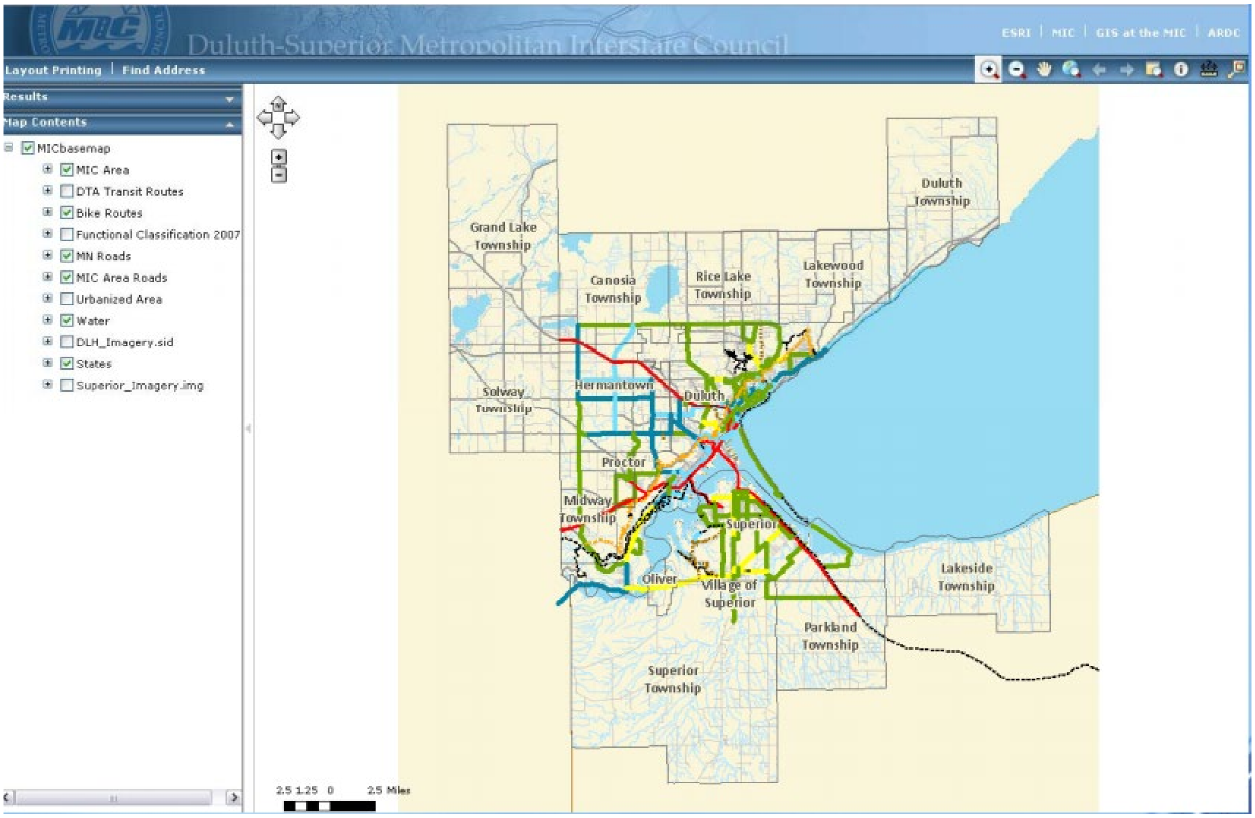


Figure 1.3.2 GIS Tools

1.3.3 Visualization

Figure 1.3.3 Visualization

In *Advancing Highways with Communication Solutions-- Cost-effective ways to address growing demands on highway infrastructure*, Alcatel Lucent said that a highway network communications support a broad range of ITS applications and provided the following summary of benefits per annum:

1. Emission reduction: $20.2 million;
2. Fuel consumption reduction: $10.4 million;
3. Incident-delay reduction: $152 million;
4. Secondary crash reduction: $1.6 million;
5. Motorist assistance: $3.0 million.

A Case Study-Rural Road of Isoarta-Antalya concluded that the aim of traffic accident analysis is to investigate the cause of accidents, to identify the hotspots, improve road features and to enhance traffic safety.

1.4 STUDY AREA

Our study area is a Motorway 1 (M1) section from Islamabad to Peshawar. The selected section is 169km long which falls about 73km if length in the Punjab province and the remaining 95km in Khyber Pakhtunkhwa. M1 has become a vital link to Afghanistan and Central Asia. In future, the Islamabad to Peshawar motorway is expected to take off the major traffic density from the N5.

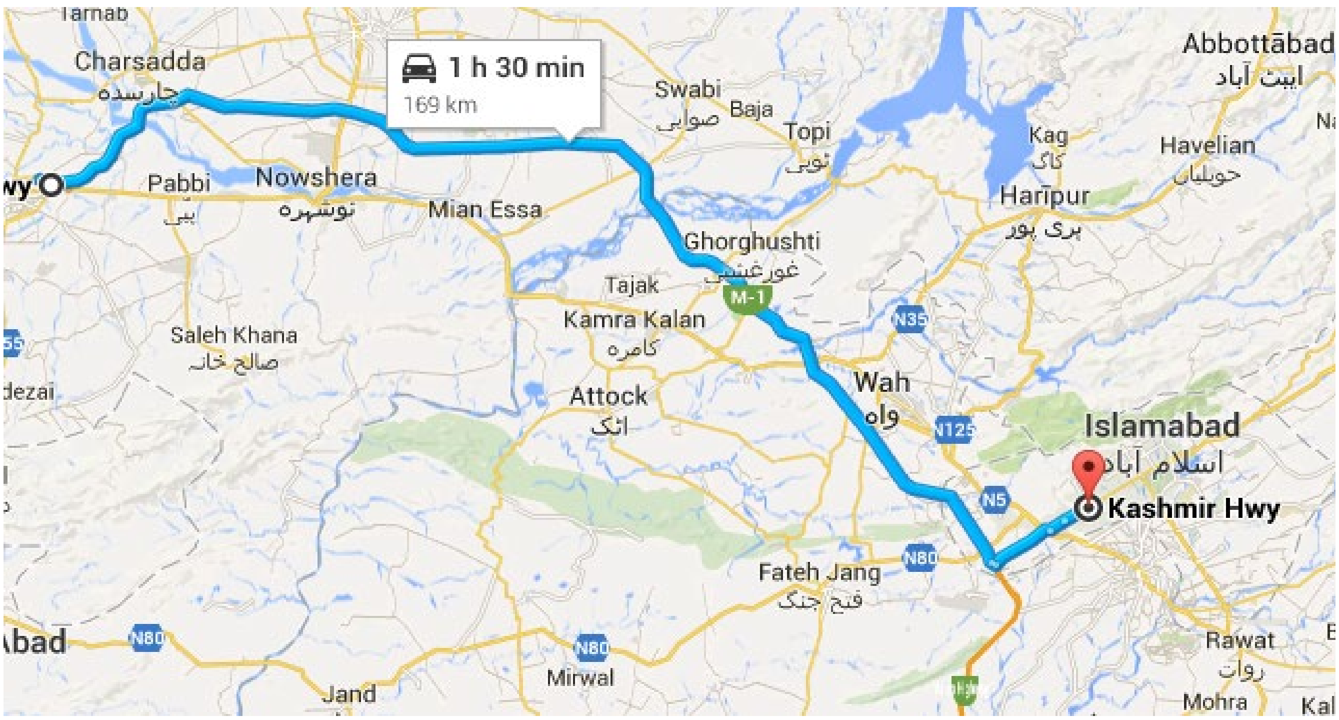


Figure 1.4 Study Area Map

Figure 1.4.1 View of Study Area

Chapter 2

MATERIALS AND METHODS

Methodology

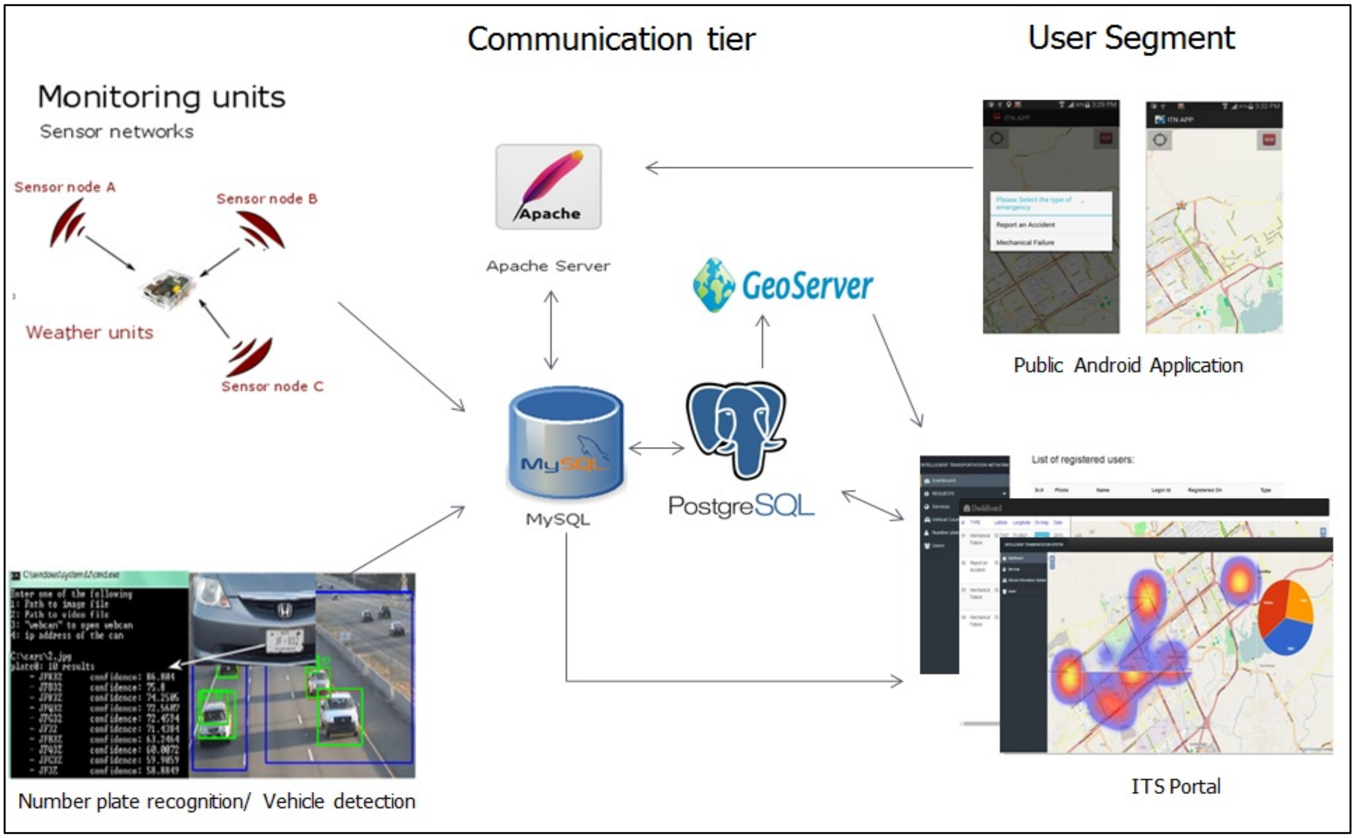


Figure 2.1 Methodology

Our Intelligent transportation system consists of 3 main segments:

1. The monitoring segment
2. The communication segment
3. The user segment

The monitoring segment includes the weather units and image classification for vehicle count and number plate detection

The communication segment includes apache server, Postgres, MySQL and GeoServer.

The user segment includes the web portal and the android application for the users.

2.1 Monitoring Segment

2.1.1 Weather Unit

The weather unit is used to log temperature and humidity data continually. It consist of two parts, a transmitter node and a receiver node.

Transmitter node is used to transmit the humidity and temperature data to the receiver node in real time which then logs the data into a MySQL database from where the data is used in various parts of ITS. Transmitter node consists of:

1. Arduino UNO
2. DHT 22 sensor
3. RF 315/433 MHz Transmitter
4. RF 315/433 MHz Transmitter

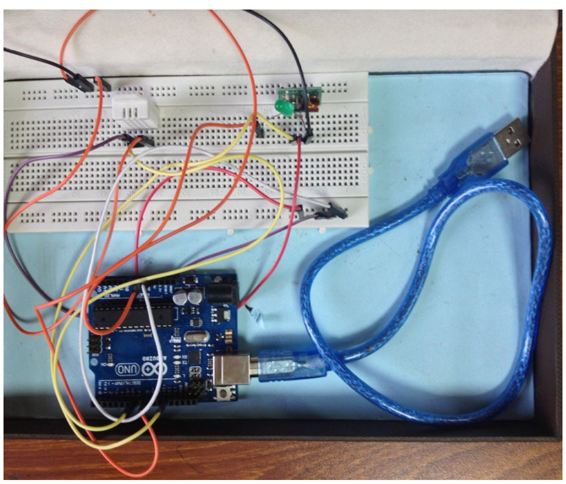


Figure 2.1.1.a Transmitter Node

Figure 2.1.1.b Arduino Uno

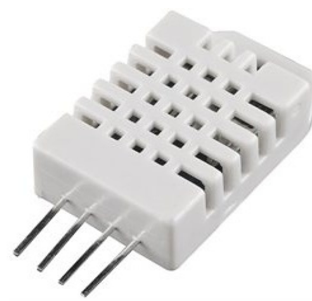


Figure 2.1.1.c DHT-22

Figure 2.1.1.d RF Transmitter

Receiver Node is used to receive temperature and humidity data from the transmitter node. It is connected to the server, where the data is logged into MySQL in real time using python scripting. Transmitter node consists of:

1. Arduino UNO
2. RF 315/433 MHz Receiver

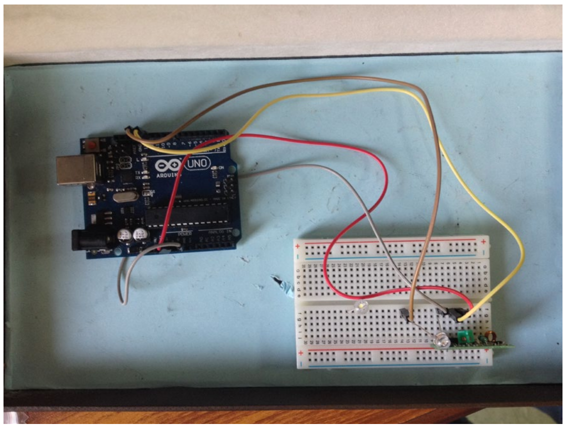


Figure 2.1.1.e Receiver Node

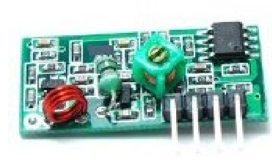


Figure 2.1.1.f RF Receiver

Specifications:

2.1.1.1 Arduino Uno

For our project we required a microcontroller to do our job. We picked Arduino Uno which had an ATmega328 chip on it. We picked Arduino Uno because of its specification some of which are as follow:

- 14 digital I/O pins (6 PWM outputs)
- 6 analog inputs
- USB connection
- Power jack.

More information about specification is given in the figure 2.1.1.1. Its use is very simple; connect it to computer with USB cable to power it or to program it or we can power it with an AC/DC adapter or battery. The Arduino software has a serial monitor. It allows simple textual data to be sent to and from the Arduino board. It also has a large library to use. It is programmable in C.

Technical specifications

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB
Flash Memory for Bootloader	0.5 KB
SRAM	2 KB
EEPROM	1 KB
Clock Speed	16 MHz
Lenght	68.6 mm
Width	53.4 mm
Weight	25 g

Figure 2.1.1.1 Tehnical Specifications of ArduinoUno

2.1.1.2 DHT- 22

DHT stands for Digital Humidity and Temperature. It is used to measure humidity and temperature by collecting the digital signals. It has a 8-bit single-chip computer. The sensor is temperature compensated and calibrated. It has 4 pins for easy connection. It is made in such a way that it is suited in all kinds of harsh application occasions. The Characteristics of DHT 22 are as follows:

Model	DHT22
Power supply	3.3-6V DC
Output signal	digital signal via single-bus
Sensing element	Polymer capacitor
Operating range	humidity 0-100%RH; temperature -40~80Celsius
Accuracy	humidity +-2%RH(Max +-5%RH); temperature <+-0.5Celsius
Resolution or sensitivity	humidity 0.1%RH; temperature 0.1Celsius
Repeatability	humidity +-1%RH; temperature +-0.2Celsius
Humidity hysteresis	+-0.3%RH
Long-term Stability	+-0.5%RH/year
Sensing period	Average: 2s
Interchangeability	fully interchangeable
Dimensions	small size 14*18*5.5mm; big size 22*28*5mm

Figure 2.1.1.2 Tehnical Specifications of DHT-22

2.1.2 Number Plate Detection

Number Plate Detection was done with the help of OpenCV and Tesseract. The numbers which are extracted are then stored in our MySQL database. From here it is linked with our web application from where different applications like stolen vehicle, vehicle tracking are made. Let's discuss what is OpenCV and Tesseract?

2.1.2.1 OpenCV

OpenCV stands for Open Source Computer Vision. It is a library for computer vision and machine learning. Computer vision includes methods for:

- Acquiring,
- processing,
- analyzing &
- understanding images & high-dimensional data

OpenCV has more than 2500 optimized algorithms which can be used as follow:

- Detect and recognize faces
- Extract 3D models of objects
- Track moving objects
- Identify objects
- Classify human actions in videos
- Track camera movements
- Stitching streetview images
- Robots navigation
- Produce 3D point clouds from stereo camera etc.

Importance of OpenCV can be determined by the fact that it has around 47 thousand of users and about 7 million downloads. Different companies, research groups and governmental bodies are using it in their different projects. For example following companies employ OpenCV:

- Google
- IBM
- Microsoft
- Yahoo
- Intel
- Honda
- Toyota
- Sony.

OpenCV is multilanguage i.e. it is supported by different programming languages which are as follows:

- C++/C
- Python
- Java
- MATLAB.

It is also supported by Windows, Linux, Android and Mac OS. For our project we have used latest version i.e. '2.4.11' of OpenCV. However a new version came out on June 2015 i.e. '3.0'. In fig 2.1 we are including highgui and imgproc header files.

```
//FOR opencv
#include "opencv2/highgui/highgui.hpp"
#include "opencv2/imgproc/imgproc.hpp"
```

Figure 2.1.2.1 Including OpenCV libraries in our program

Highgui is used to create and manipulate windows that can read, write & display images or read or write video from camera. Some of the functions provided by highgui are:

- imshow   Displays an image in the specified window
- namedWindow   Creates a window
- destroyWindow   Destroys a window
- MoveWindow   Moves window to the specified position
- ResizeWindow   Resizes window to the specified size
- VideoCapture   Class to capture from video files or cameras
- VideoCapture::open   Open video file or camera for video capturing
- VideoCapture::isOpened   Returns true if video capturing has been initialized
- VideoCapture::set   Sets a property in the VideoCapture

Imgproc is used for image processing. It contains variety of functions for image processing. Some of them are:

- findContours   Finds contours in a binary image.
- drawContours   Draws contours outlines or filled contours
- matchShapes   Compares two shapes
- equalizeHist   Equalizes the histogram of a grayscale image
- floodFill   Fills a connected component with the given color
- Sobel   Calculates the first, second, third, or mixed image derivatives using an extended Sobel operator

In figure 1.2, we are capturing the video using VideoCapture function from our webcam. If the camera i.e. webcam here, doesn't start capturing the video, it will return an error else it will go on to detect and show function which will read and print the number pates.

```
        if (filename == "webcam")
        {
            int framenum = 0;
            cv::VideoCapture cap(0);
            if (!cap.isOpened())
            {
                std::cout << "Error opening webcam" << std::endl;
                return 1;
            }


            while (cap.read(frame))
            {
                flip(frame,frame2,1);
                detectandshow(&alpr, frame2, "", outputJson);
                sleep_ms(10);
                framenum++;
            }
        }
```

Figure 2.1.2.1.a Reading from Webcam

In figure 2.3, detect and show function used in figure 2.2 is shown. Here the function first recognizes the number plate and then stores it in variable results. Then it shows the result with confidence level i.e. how true is the value. Later on we store the number with highest confidence in our database. We will discuss about MySQL database later on.

```
bool detectandshow( Alpr* alpr, cv::Mat frame, std::string region, bool writeJson)
{


    std::vector<AlprRegionOfInterest> regionsOfInterest;
    regionsOfInterest.push_back(AlprRegionOfInterest(0,0, frame.cols, frame.rows));

    AlprResults results = alpr->recognize(frame.data, frame.elemSize(), frame.cols, frame.rows, regionsOfInterest );


        for (int i = 0; i < results.plates.size(); i++)
        {
            std::cout << "plate" << i << ": " << results.plates[i].topNPlates.size() << " results";

            if(test!=results.plates[0].topNPlates[0].characters)
            {
                for (int k = 0; k < results.plates[i].topNPlates.size(); k++)
                {
                    std::cout << "    - " << results.plates[i].topNPlates[k].characters << "\t confidence: " << results.plates[i].topNPlates[k].overall_confidence;
                    if (templatePattern.size() > 0)
                        std::cout << "\t pattern_match: " << results.plates[i].topNPlates[k].matches_template;

                    std::cout << std::endl;
                }

            }
        }
```

Figure 2.1.2.1.b Detect and Show Function

Note: Here we are using openALPR i.e. automatic license plate recognition library with opencv to detect license plates. This library uses Tesseract as OCR engine for text extraction.

2.1.2.2 OpenALPR

OpenALPR stands for open source automatic license plate recognition library. It is the main library here. It is responsible for all the processing for license plate recognition. It works in following sequence:

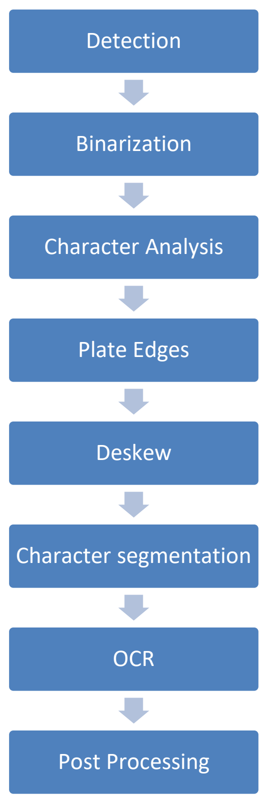


Figure 2.1.2.2 OpenALPR Flow Chart

1) Detect the potential license plate regions in an image or frame
2) Convert the plate region which was identified into black and white

3) Find character sized blobs in the plate region so that it becomes easy for detection
4) Detect the edges of the plate
5) De-skew the image i.e. transform the perspective to a straight on view
6) Perform character segmentation i.e. isolate the characters to process them individually.
7) Analyze each character image and provide multiple possible letters
8) Perform post processing in which a number of plate possibilities with good confidence and created.

2.1.2.3 Tesseract

Tesseract is an optical character recognition engine which can be used for various operating systems under the Apache 2.0 license. It is used to extract text from images. In our case, it is used to extract number plates from cars. It is probably the most accurate open source OCR engine available. It is widely used because it can read and convert a wide variety of image formats to text in different languages (over 60). It can do this with the help of Leptonica Image Processing Library. According to a report, it was considered one of the top 3 engines in the 1995 UNLV Accuracy test. Although it doesn't have a built-in GUI, it has a fully featured API. Figure 2.4 shows the Tesseract OCR architecture by Google.

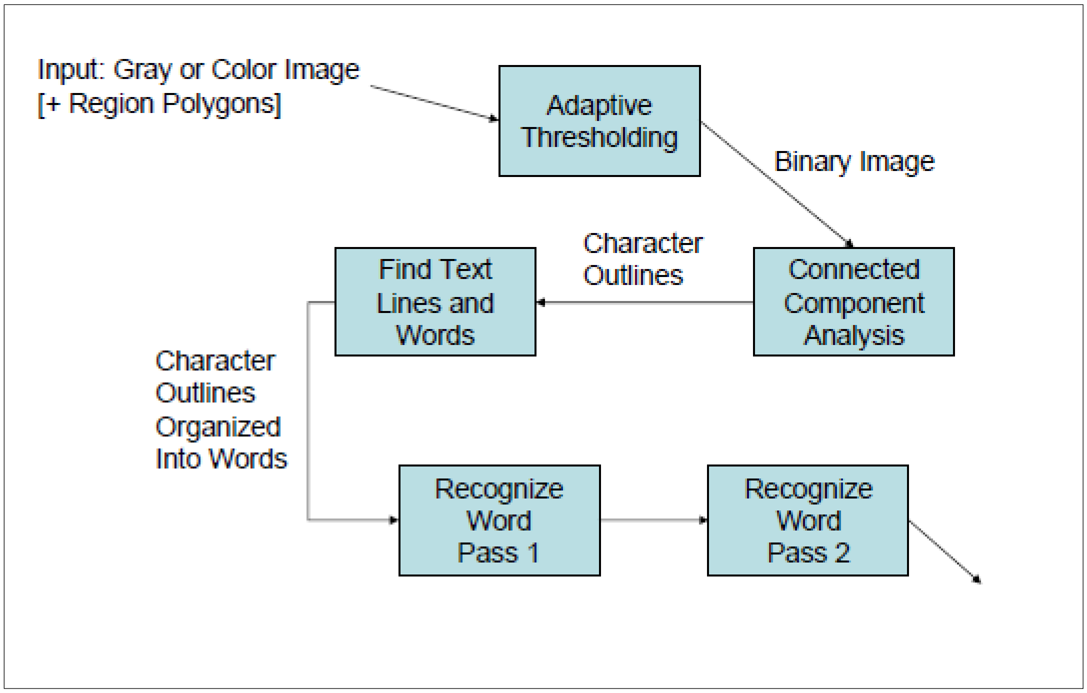


Figure 2.1.2.3 Tesseract OCR Architecture

Adaptive thresholding

First the input image passes through adaptive thresholding. Adaptive thresholding purpose is to classify the pixels as either dark or light. It takes into account spatial variations in illumination. The output of adaptive thresholding will be a binary representation of that image.

Connected component analysis

It is an algorithmic application where connected components subsets are uniquely labeled. It is used to detect connected regions in binary digital images in our case the license plate region. It works in following way:

1. Start from the first pixel in the image. Set current label to 1.
2. If it is a foreground pixel and unlabeled, then give it the current label and add it as the first element in a queue and move on to the next step. If it is a background pixel, then move on to next pixel and repeat this step.

3. Take out an element from the queue and check its neighbors. If a neighbor is unlabeled foreground pixel then give it the current label and add it to the queue. Repeat this step until queue gets empty.
4. Go to step 2 for the next pixel in the image and increment current label by 1.

It is also known as blob extraction or region extraction.

Find text lines and words:

Here blobs are organized into text lines. The main purpose here is to analyze the lines and regions for fixed pitch or proportional text. With the help of character spacing, text lines are broken into words. Text having fixed pitch is chopped or broken immediately by character cells. With the help of definite spaces and fuzzy spaces, proportional text is broken into words.

Recognize word pass 1:

After breaking down the text into words, it is time to attempt recognition of each word. Each word which turns out to be satisfactory is passed to an adaptive classifier as training data. The adaptive classifier's function is to more accurately recognize text lower down the page.

Recognize word pass 2:

After pass 1, some words are not recognized. To recognize them another pass called second pass is run over the page. Those words that were not recognized in the first pass are recognized again in the second pass.

2.1.3 Vehicle Counting

Vehicle tracking and counting is an important component of traffic analytics in an ITS. In our project we have a live, real-time stream of video where vehicles tracking and counting is done. Done with the help of:

- OpenCV,

- Background Subtraction &
- Blob Tracker.

This is a three step process. The steps are as follows:

1. Detection of moving objects
2. Vehicle tracking
3. Region of interest crossed by the object

2.1.3.1 Detection of Moving Objects

Firstly we need to detect the moving objects. This is done by Background Subtraction algorithm.

Background subtraction is a method to identify moving objects in a video frame that differs from the background model. Here image's foreground is extracted. The foreground can be anything like humans, cars or texts etc. A good model should have following characteristics i.e.

- React quickly to changes in background
- Adapt itself to accommodate changes occurring in the background
- Good foreground detection rate
- Processing time for background subtraction should be real-time.

Although there are some restriction in it i.e. it must be robust against changes in illumination and it should not detect non-stationary background objects and shadows of moving objects. There are different libraries for background subtraction but we used BGS library for the background subtraction as it is simple and easy to use.

2.1.3.2 Vehicle Tracking

For vehicle tracking, we used blob tracking algorithm.

A “blob”, in this context, is a shape identified within an image, which represents a single object. It allows detecting objects in front of the camera (i.e. blobs) and extracting the segmentation images, contour lines, and points of interest for these blobs. If the has one “hole” in it, it has an internal contour line, in addition to the external contour line.

Figure 2.1.3.2.a Segmented Image

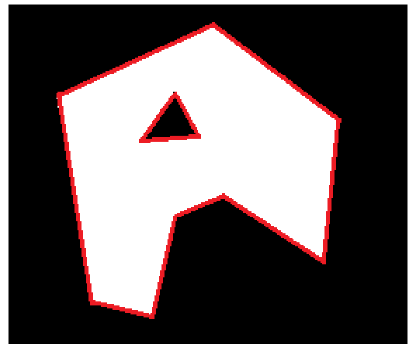


Figure 2.1.3.2.b Contour Lines

We used the blob module to track vehicles in front of the camera. We used cvBlob library which provides capabilities to get the centroid, the track and the ID of the moving objects. We can also set to draw a bounding box, the centroid and the angle of the tracked object.

2.1.3.3 Region of interest crossed by the object

The last step is comparatively simpler. As now the centroids of the moving vehicles have been identified, we just need to know whether the vehicles have crossed through the set target or not? For this we set a virtual line in our video stream and increment the count by 1 as one vehicle passes across the virtual line. As the count changes it is added to our SQL database with time so that we can retrieve information about at what time, how many cars have gone through this point.

2.2 User Segment

2.2.1 Mobile Application

We used Android as our OS for our mobile application. Android is designed primarily for touchscreen mobile devices such as smartphones and tablet computers. Android is been used in game consoles, digital cameras, regular PCs, and other electronics. As of 2015, Android has the largest installed base of all operating systems.

Android is an open source operating system. Online resources are available for development of different android based applications. Mostly application developers prefer to work with android platform as most of the resources available are free. Most attractive perk for developers in android is that there is no requirement of asking permission to publish the application in Google android market. On the other hand, a developer requires an approval from apple's app store to publish an application suggested by Butler (2011).

The mobile application for ITS will be used by the users for reporting an emergency or an accident with just a click of a button. It will also be able to display a map and show users their current location.

2.2.1.1 Android

Android applications are develop in java programming languages. Once installed in device application runs in its own Virtual Machine (VM) separated from other applications. Android system implements the system of least privilege that is each application has access to the components which are required by it. Application can ask for other components if required but the permission is only given the user at installation time. This is the way android makes it secure. Android applications are Built in java along with XML, java provides functionality and XML is used for layout and taking permission purpose.

Components of Android Application:

- **Activities**

  Activities are associated with the user interface. An android application can have multiple activities running and each activity is independent from other activity. An example would be that Facebook applications have multiple activities one to show main interface other to show messages.

- **Services**

  A service is a component that runs in the background without any intervention of the user. It works independently in the background. For example music can be play as a service while user is texting.

- **Content providers**

  Content provider is a way an app interacts with other and share as well as manipulate its data. But only apps with respective permissions can manipulate the data. Content Provider also helps the apps to read and write data.

- **Broadcast receivers**

  A broadcast receiver is a component that responds to system-wide broadcast announcements. Many broadcasts originate from the system—for example, a broadcast announcing that the screen has turned off, the battery is low, or a picture was captured.

2.2.1.2 Open Street Maps

Technological changes over the past 10 years, in combination with increased bandwidth and the ability to provide better tools for collaboration, have led to "crowdsourcing"—a term developed from the concept of outsourcing in which business operations are transferred to remote, many times cheaper locations. OSM follows the peer production model that created Wikipedia; its aim is to create a set of map data that's free to use, editable, and licensed under new copyright schemes. A key motivation for this project is to enable free access to current geographical information. OSM are used for both mobile and web based application development.

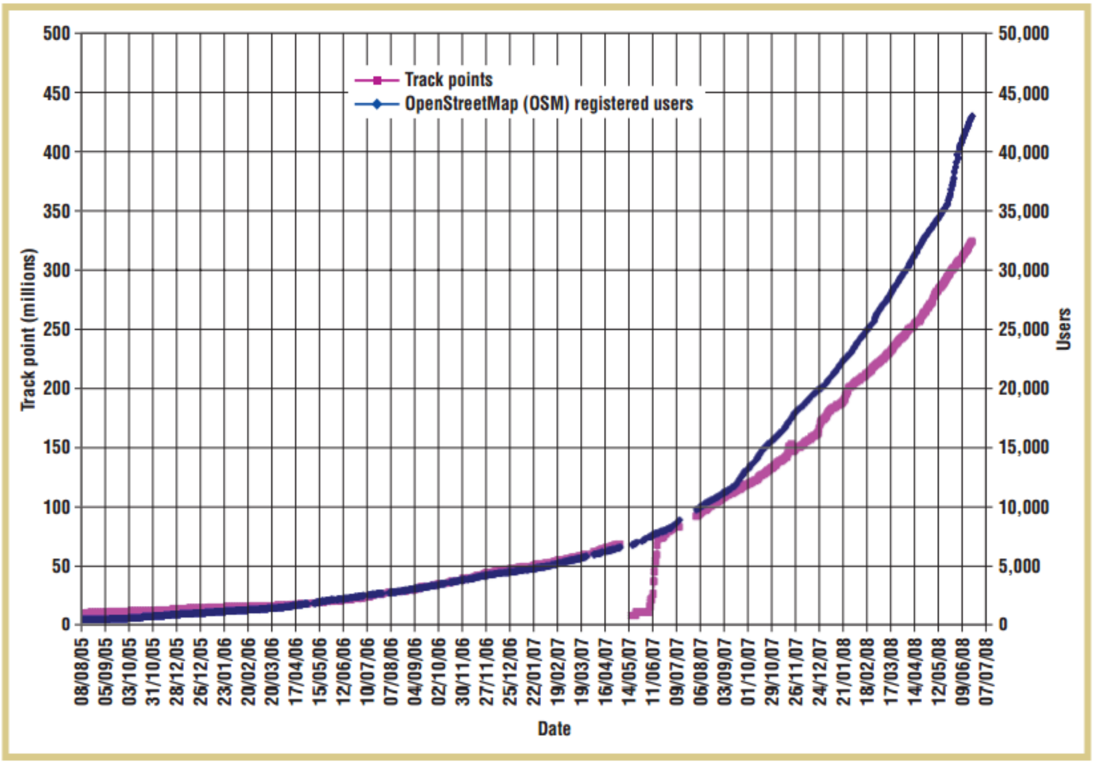


Figure 2.2.1.2 Graph of User and Contributions growth to OSM

2.2.1.3 Eclipse

In computer programming, Eclipse is an integrated development environment (IDE). It contains a base workspace and an extensible plug-in system for customizing the environment. Written mostly in Java, Eclipse can be used to develop applications in other programming languages.

Mainly eclipse is configured with java development tools, if other development tools are to be integrated then their plug-ins are installed with eclipse, considering to be multilingual complier. For android application development, android development tools (which can be freely downloaded) are installed in eclipse as a plugin. As the plug-in for android developments is installed, it can integrate all the APIs used in android application for different purposes such as Google API for mapping and routing purposes.

Eclipse can be further categorized for application development based on desktop and web based applications. For web based applications, Web IDE is available which supports development of client side web application supporting JavaScript, HTML and CSS etc.

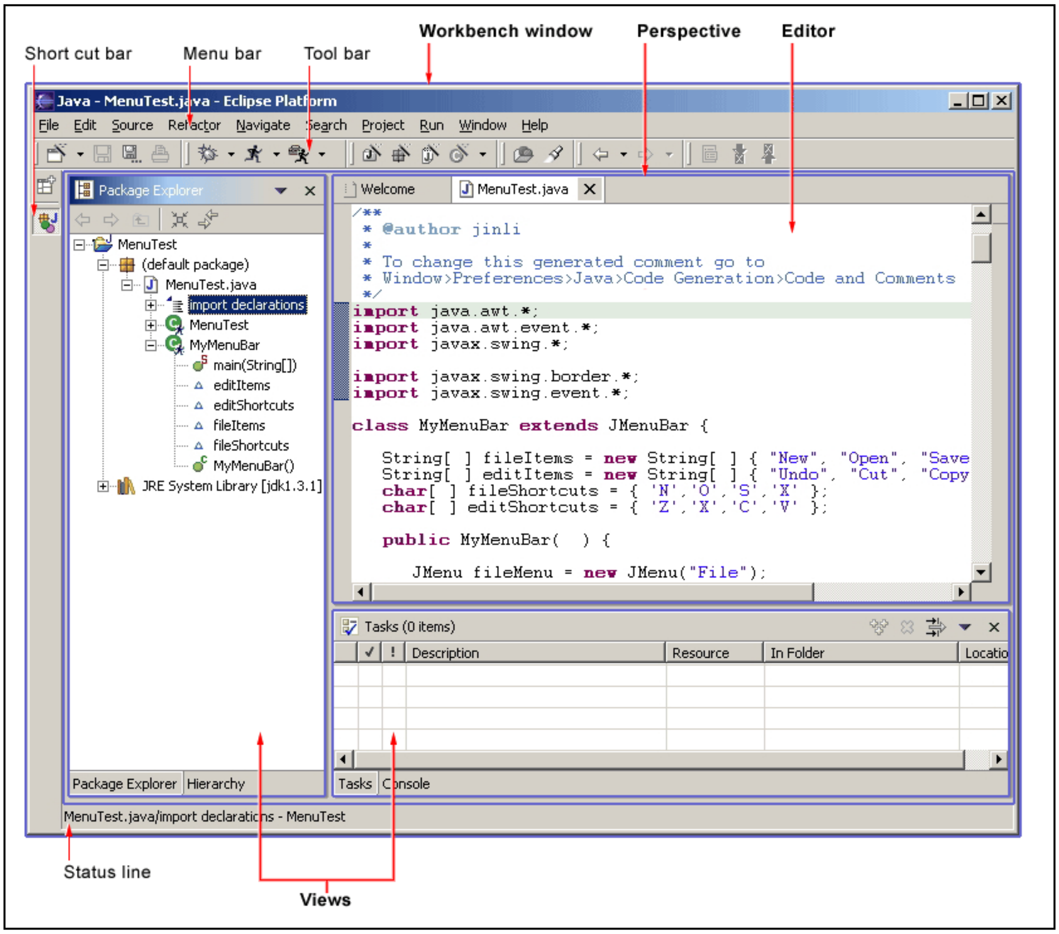


Figure 2.2.1.3 Overview of Eclipse Platform

2.2.1.4 Overview of the development of the android application

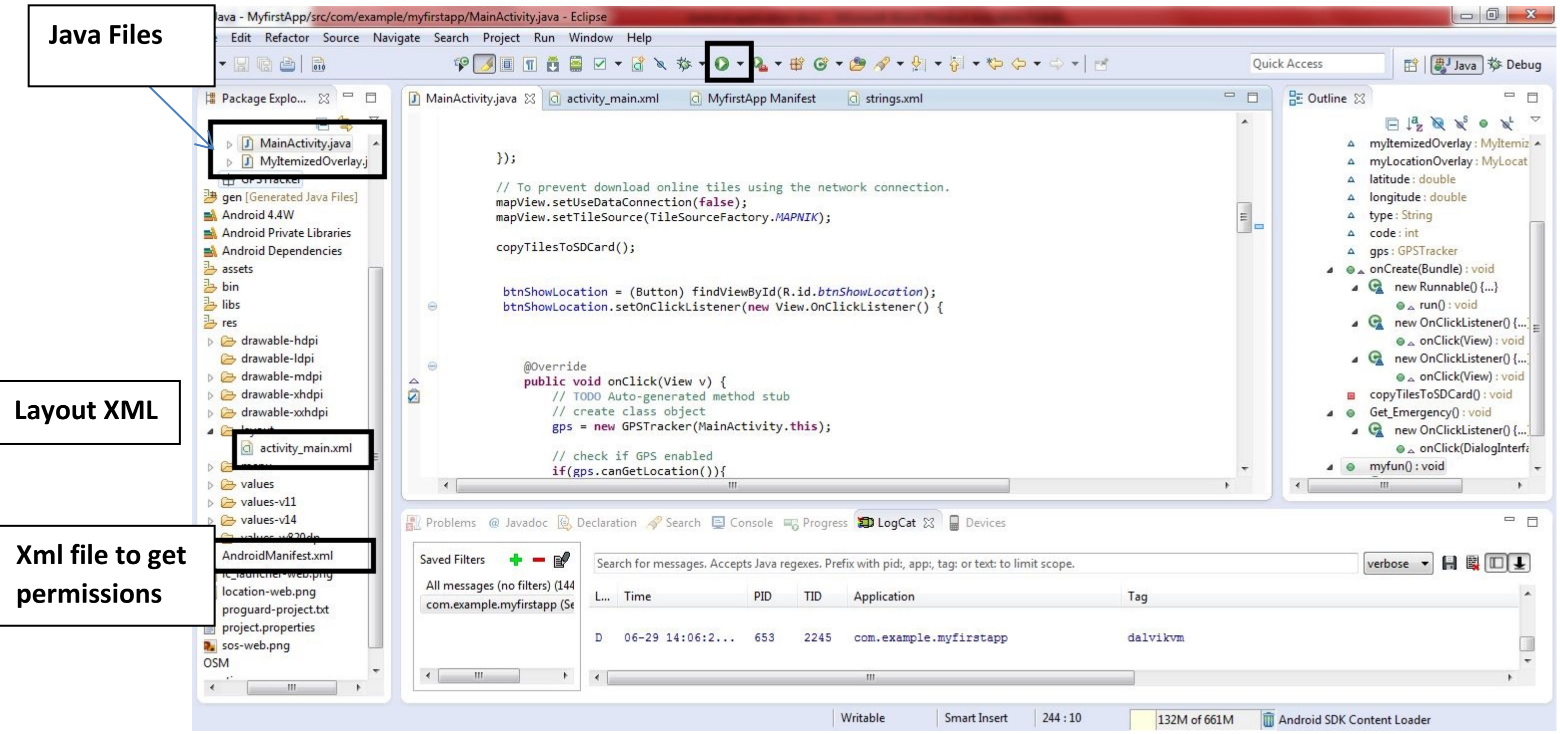


Figure 2.2.1.4 Showing Eclipse Developing Environment

ITS app runs on an android device with the collaboration of GPS built-in the devices and Wi-Fi or 3G connection. GPS is required to get the real time coordinates of a user and network would be the medium to send the distress signal. Once the connection with the satellites is established the user can get a high enough accuracy of less than a 50m. Now a user can locate its self on an open street map (OSM) and also he can send a distress call to the authorities by clicking on SOS button. Distress signal sent from device shows on portal that includes latitude, longitude and type of emergency information. By clicking on the location button it shows the requests location a OSM and also provides direction capabilities.

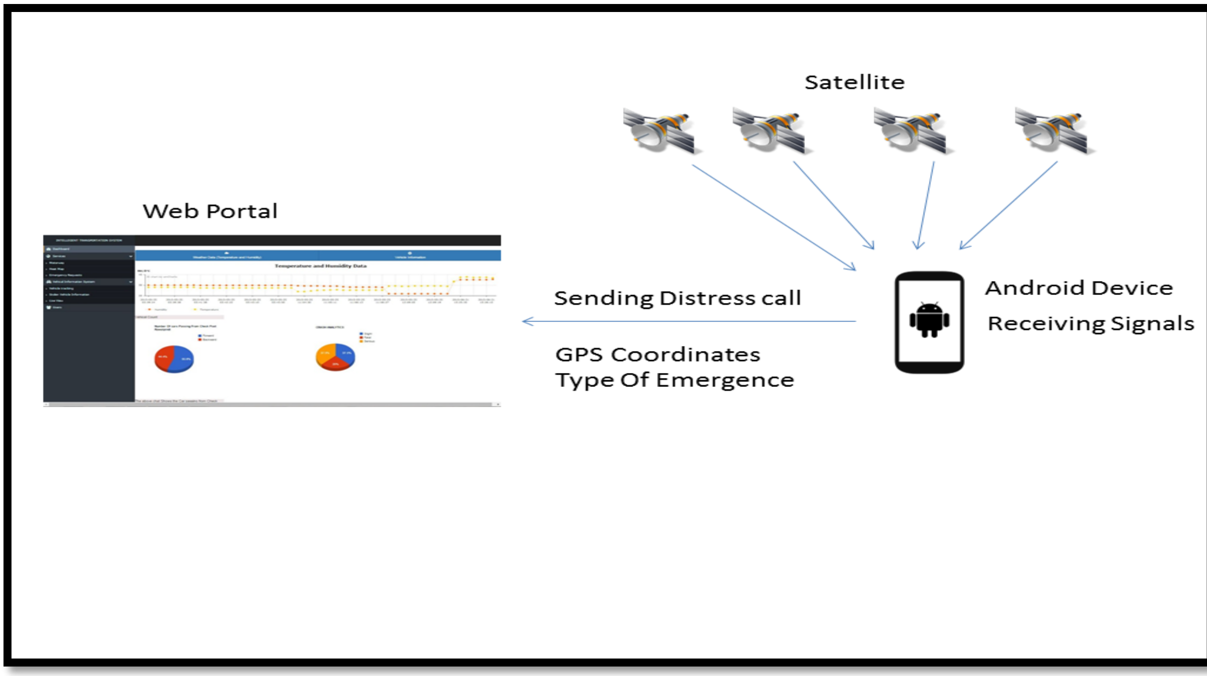


Figure 2.2.1.4.a Process Flow of Intelligent Transport System Android App

1) **USER PERMISSIONS**

In development of ITS app the first step is to get the user permissions to access the Network Both Wi-Fi and mobile data. Application also requires permissions to get location services that include **ACCESS_COARSE_LOCATION** which provide approximate location derived from network location sources such as cell towers and Wi-Fi and **ACCESS_FINE_LOCATION** services that allow an app to access precise location from location sources such as GPS, cell towers, and Wi-Fi. ITS uses open street maps which are Open Source maps. In mobile applications open street maps used are both online as well as offline depending upon user needs. In case the user of ITS app is not connected to high speed data like 3g or 4g he can send a distress signal with basic edge. But the user cannot locate because OSM requires Internet connectivity for this purpose. Keeping in mind this problem OSM used in ITS app are offline that can locate user on a basic map. So if the user does not have access to high speed internet he can still send distress signal from edge network. The OSM tiles are made from mobile atlas creator in .zip format and stored in SD card of mobile device which also requires **READ_EXTERNAL_STORAGE** permission. This is necessary because without permission the Application cannot access the device components.

These permissions are included in the android Manifest file in XML. Before a user installs ITS App he/she should agree to these terms otherwise app won't work properly.

```
    <uses-sdk
        android:minSdkVersion="8"
        android:targetSdkVersion="21" />
    <uses-permission android:name="android.permission.INTERNET"></uses-permission>
    <uses-permission android:name="android.permission.ACCESS_NETWORK_STATE"></uses-permission>
<uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION"></uses-permission>
<uses-permission android:name="android.permission.ACCESS_FINE_LOCATION"></uses-permission>
<uses-permission android:name="android.permission.ACCESS_WIFI_STATE"></uses-permission>
<uses-permission android:name="android.permission.READ_EXTERNAL_STORAGE" />
```

Figure 2.2.1.4.b Android manifest File Showing User Permissions

The snippet of android manifest file shows the different type of permissions which are discussed in the above paragraph needed to run ITS app efficiently on a mobile device.

2) **Layout:**

Once the permissions are taken we come toward the layout (UI) of the app. Interfacing of android app required OSM map over the whole app interface and two buttons one for the app to locate user on OSM map and second one to get the Emergency type and send distress signal back to authorities. Interfacing of app is also done in XML language. A file is generated in XML under Layout tab we call it activity_main.xml file. It contains the xml tags to make buttons and to create a Map view which contains the OSM tiles.

```
<Button
    android:id="@+id/btnSendLocation"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_alignBottom="@+id/imageButton2"
    android:layout_alignLeft="@+id/imageButton2"
    android:layout_alignParentRight="true"
    android:layout_alignParentTop="true" />
<Button
    android:id="@+id/btnShowLocation"
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:layout_alignBottom="@+id/imageButton1"
    android:layout_alignParentLeft="true"
    android:layout_alignParentTop="true"
    android:layout_alignRight="@+id/imageButton1"
    android:icon="@drawable/location"
    android:minWidth="50dp"
    android:shadowColor="#FF0000"
    android:textColor="#ffffff" />
```

Figure 2.2.1.4.c Buttons Generation XML tags

Above snippet shows two buttons tags former tag creates a button which when clicked on opens a dialogue box on screen and asks the user about the type of emergency he/she has and sends it to the database. Later creates a button which when clicked gets the gps coordinates (Functionality will be explained later) which are then used to locate the user on the OSM map. Now these buttons will overlay on a map view. Map view is predefined class in osmdroid library, a library used to create open street maps in android. OSMDROID is an open source library. It also includes a modular tile provider system with support for numerous online and offline tile sources and overlay support with built-in overlays for plotting icons, tracking location, and drawing shapes. Osmdroid Map view class is used in xml tags to create a screen view in which the open layers map would be opened.

```
<org.osmdroid.views.MapView
    android:id="@+id/map_view"
    android:layout_width="fill_parent"
    android:layout_height="fill_parent"
    android:clickable="true" />
```

Figure 2.2.1.4.d OSMDROID Map View Class

3) Functionality

Layout is created next step is to create functionality with each layout. Map view layout as explained above is created so that an osm map can be rendered in it. To explain this we come in java language. We have created a view as shown above with an id map_view. Id play a key role in android applications whenever a new layout component is created it has an initial id which uniquely identifies it from other layout components. To create an OSM we first need to initial **mapView** variable in our main activity class. Below is the code

```
final MapView mapView = (MapView) findViewById(R.id.map_view); //creating a new mapview variable
mapView.setBuiltInZoomControls(true);                  //Zoomin and zoomout controls
mapView.getController().setZoom(15);                   //setting the initial zoom scale
mapView.setMultiTouchControls(true);                   //turning on the muiltitouch controls
Drawable marker=getResources().getDrawable(android.R.drawable.star_big_on); //icon of a star that comes to show user location on OSM map
int markerWidth = marker.getIntrinsicWidth();
int markerHeight = marker.getIntrinsicHeight();
marker.setBounds(0, markerHeight, markerWidth, 0);
```

Figure 2.2.1.4.e Initializing and assigning parameters to mapView variable in mainactivity.java

In above code first we create mapView object of MapView class and assign that variable map_view id, which is the same id assigned in the layout. So that whatever changes are made in the mapView object results will affect the layout having map_view id. Now both mapView object and map_view id are interlinked with each other.

mapView.setBuiltInZoomControls(true) creates zoom in and zoom out controls on the screen.

mapView.getController().setZoom(15) functions sets the initial scle at which the map will be shown when the application starts.

mapView.setMultiTouchControls(true) enables the multi touch capability which enables the user to zoom in and out by using both fingers.

Drawable marker=getResources().getDrawable(android.R.drawable.star_big_on) draws a star as a marker at the location of user. Above mension parameters are necessary to load an OSM map in android.

Once the mapView and parameters are set we need to add these to map_view id layout and overlay properly. There are two layers first is osm layer which the base layer and other one is marker overlay which shows user location as a start shapped marker on OSM.Below code snippet shows how they are added.

```
myItemizedOverlay = new MyItemizedOverlay(marker, resourceProxy); // marker overlay
mapView.getOverlays().add(myItemizedOverlay);
myLocationOverlay = new MyLocationOverlay(this, mapView); // OSM overlay
mapView.getOverlays().add(myLocationOverlay);
```

Figure 2.2.1.4.d OSMDROID Map View Class

In above code we add marker and OSM over lay to myitemizedOverlay and myLocationOverlay respectively. mapView is done now we come to two buttons that are shown in **Figure 2.9** .

The second button having id as **btnShowLocation** shows the user location when clicked on First it checks wether GPS in on or off.If gps is off it shows an alert msg and opens the GPS settings.So that user can turn on gps. After that it uses the built-in function **canGetLocation()** which comes with the android package and through this function it gets the GPS coordinates and store then in latitude and longitude variables. It also creates a pop-up showing GPS coordinates of user.

```
btnShowLocation = (Button) findViewById(R.id.btnShowLocation);
btnShowLocation.setOnClickListener(new View.OnClickListener() {


   @Override
   public void onClick(View v) {
       // TODO Auto-generated method stub
       // create class object
       gps = new GPSTracker(MainActivity.this);

       // check if GPS enabled
       if(gps.canGetLocation()){

           latitude = gps.getLatitude();
           longitude = gps.getLongitude();

          // \n is for new line
          Toast.makeText(getApplicationContext(), "Your Location is - \nLat: " + latitude + "\nLong: " + longitude, Toast.LENGTH_LONG).show();
       }else{
          // can't get location
          // GPS or Network is not enabled
          // Ask user to enable GPS/network in settings
          gps.showSettingsAlert();
       }
       GeoPoint startPoint = new GeoPoint(latitude,longitude);
       myItemizedOverlay.addItem(startPoint, "startPoint", "startPoint");
       MapController mapController = (MapController) mapView.getController();
       mapController.setCenter(startPoint);
       mapController.setZoom(30);

   }
});
```

Figure 2.2.1.4.g Show User Location on Map Button Functionality

OnClick(View v) Is called whenever button show location is clicked first it tries to get coordinates from Getlocation() function if gps is not turned on it shows an alert box and navigates to gps setting . If gps is on and if enough satellites are in horizon it Shows User location on a map and shows coordinates as a pop-up message. Now it gets user location a geopoint is created in which latitude and longitude information are added as arguments. And it sets the map center to this new location .In this way user can get its location on a map.

To send user location to data base one should click on send my location button which has an id associated with it as **btnSendLocation.** Whenever user clicks on this button coordinates of user will be sent to server.

```
    btnSendLocation = (Button) findViewById(R.id.btnSendLocation);
    btnSendLocation.setOnClickListener(new View.OnClickListener() {
        public void onClick(View v)

        {
            Get_Emergency();


        }

    });





}
```

Figure 2.2.1.4.h   Send User Location Button Functionality

When user clicks on button having btnsendLocation it calls function **Get_Emergency** which creates an option menu from which user can select the type of emergency he/she is having on a motorway.

```
public void Get_Emergency()
{


    final CharSequence emergency[] = new CharSequence[] {"Report an Accident","Mechanical Failure"};

      AlertDialog.Builder builder = new AlertDialog.Builder(this);
      builder.setTitle("Please Select the type of emergency:");
      builder.setItems(emergency, new DialogInterface.OnClickListener() {
          @Override
          public void onClick(DialogInterface dialog, int which) {
              String sel=(String) emergency[which];

           type=sel;
           if(type=="Report an Accident")
           {
               code=1;
               myfun();
           }
           if(type=="Mechanical Failure")
           {
               code=2;
               myfun();
           }

          }

      });
```

Figure 2.2.1.4.i   Get Type of Emergency

There are two type of emergency user can have mechanical failure and Accident witnessed on motorway. **AlertDialog.Builder builder** creates a dialogue box having two emergency type options when user selects any of them it gets stored in in **type** variable. Now it's easy to send numeric vales from any device to server because they are short and does not requires heavy data charges. So these emergency types are converted into code '1' for "Reporting an accident" and code '2' for having a mechanical failure.

After storing the emergency type we have all the data we need to send in an emergency request signal. Latitude and longitude information from **GetLocation()** function and type of emergency from **Get_Emergency()** function.

Next step is to make a request string using Volley library a common library built in java to send HTTP request from a device.

```
//giving lat long to the string.
String lat = Double.toString(latitude);
String lon = Double.toString(longitude);

// Instantiate the RequestQueue.
 RequestQueue queue = Volley.newRequestQueue(this);
 String url ="http://53ad2de4.ngrok.com/fyp/latlong.php?"+"lat="+lat+"&lon="+lon+"&TYPE="+code;
```

Figure 2.2.1.4.j Get Type of Emergency

From the figure above, two variables **lat** and **lon** are used to store latitude and longitude information respectively. They are converted into double so that they can be concatenated with the string variable; code contains type of emergency information. So a request string having url as a name is generated as shown below.

String url
="http://53ad2de4.ngrok.com/fyp/latlong.php?"+"lat="+lat+"&lon="+lon+"&TYPE="+code;

To send this request, url is sent to http://53ad2de4.ngrok.com .which is a dynamic server having latitude,longitude and type of emergency information attached to it. This type of method in which information is sent in url is called get method.

```
// Request a string response from the provided URL.
StringRequest stringRequest = new StringRequest(Method.GET, url,
            new Response.Listener<String>() {
    @Override
    public void onResponse(String response) {
        // Display the first 500 characters of the response string.

    }
}, new Response.ErrorListener() {
    @Override
    public void onErrorResponse(VolleyError error) {

    }
});
// Add the request to the RequestQueue.
queue.add(stringRequest);
```

Figure 2.2.1.4.k Making a GETRequest to the NHA's Server

queue.add(stringRequest) sends the request to the NHA's server.

2.2.2.1 Web Portal

1) Android and distress call handling:

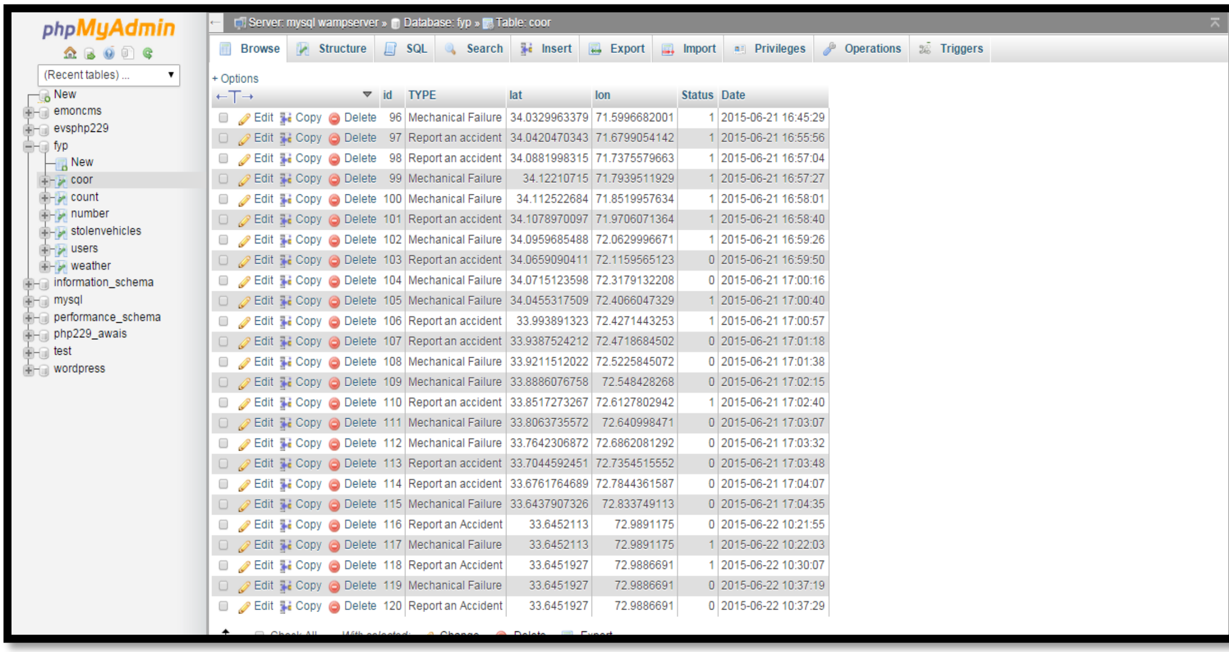
Android distress call gets handled by setting up a dynamic server by using open source software **ngrok** , it exposes the local webserver to the internet and make it easy for small apps to be tested.

```
Administrator: C:\Windows\system32\cmd.exe - C:/ngrok 80
ngrok                                                   (Ctrl+C to quit)

Tunnel Status                 online
Version                       1.7/1.7
Forwarding                    http://78121326.ngrok.com -> 127.0.0.1:80
Forwarding                    https://78121326.ngrok.com -> 127.0.0.1:80
Web Interface                 127.0.0.1:4040
# Conn                        0
Avg Conn Time                 0.00ms
```

Figure 2.2.2.1 ngrok Connected and Port 80 Exposed

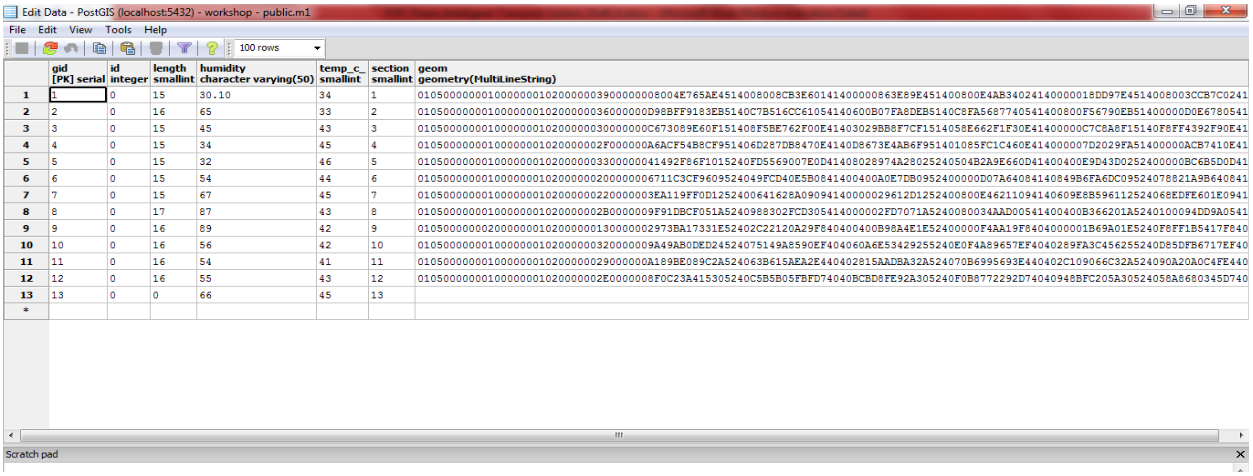
For temporary and testing use, above method is used to set up a server. Android devices sends distress signal in using HTTP GET method, in which request contains information in the url. From url the information is fetched and stored in the data base. This process requires server side programming. In our project this need was dealt with **hypertext preprocessor (PHP)** which is server side scripting language widely used in web application development.



id	TYPE	lat	lon	Status	Date
96	Mechanical Failure	34.0329963379	71.5996682001	1	2015-06-21 16:45:29
97	Report an accident	34.0420470343	71.6799054142	1	2015-06-21 16:55:56
98	Report an accident	34.0881998315	71.7375579663	1	2015-06-21 16:57:04
99	Mechanical Failure	34.12210715	71.7939511929	1	2015-06-21 16:57:27
100	Mechanical Failure	34.112522684	71.8519957634	1	2015-06-21 16:58:01
101	Report an accident	34.1078970097	71.9706071364	1	2015-06-21 16:58:40
102	Mechanical Failure	34.0959685488	72.0629996671	1	2015-06-21 16:59:26
103	Report an accident	34.0659090411	72.1159565123	0	2015-06-21 16:59:50
104	Mechanical Failure	34.0715123598	72.3179132208	0	2015-06-21 17:00:16
105	Mechanical Failure	34.0455317509	72.4066047329	1	2015-06-21 17:00:40
106	Report an accident	33.993891323	72.4271443253	1	2015-06-21 17:00:57
107	Report an accident	33.9387524212	72.4718684502	0	2015-06-21 17:01:18
108	Mechanical Failure	33.9211512022	72.5225845072	0	2015-06-21 17:01:38
109	Mechanical Failure	33.8886076758	72.548428268	0	2015-06-21 17:02:15
110	Report an accident	33.8517273267	72.6127802942	1	2015-06-21 17:02:40
111	Mechanical Failure	33.8063735572	72.640998471	0	2015-06-21 17:03:07
112	Mechanical Failure	33.7642306872	72.6862081292	0	2015-06-21 17:03:32
113	Report an accident	33.7044592451	72.7354515552	0	2015-06-21 17:03:48
114	Report an accident	33.6761764689	72.7844361587	0	2015-06-21 17:04:07
115	Mechanical Failure	33.6437907326	72.833749113	0	2015-06-21 17:04:35
116	Report an Accident	33.6452113	72.9891175	0	2015-06-22 10:21:55
117	Mechanical Failure	33.6452113	72.9891175	1	2015-06-22 10:22:03
118	Report an Accident	33.6451927	72.9886691	1	2015-06-22 10:30:07
119	Mechanical Failure	33.6451927	72.9886691	0	2015-06-22 10:37:19
120	Report an Accident	33.6451927	72.9886691	0	2015-06-22 10:37:29

Figure 2.2.2.1.a MySQL Database and Distress Call Data Stored in Tables

Another requirement is data base. Data base is required to store spatial as well as non-spatial data. Spatial data contains temperature and humidity data, Accidents data stored in postgres. Non Spatial data from android aap stored in MySQL. POSTGRES and MYSQL both are data bases only difference is the nature of data stored. Postgres is notorious for holding Spatial data whereas MySQL is widely used for non-spatial data. Both data base requires Structures query language (SQL) for data base interaction and transactions.



	gid [PK] serial	id integer	length smallint	humidity character varying(50)	temp_c_ smallint	section smallint	geom geometry(MultiLineString)
1	1	0	15	30.10	34	1	010500000001000000010200000039000000008004E765AE4514008008CB3E60141400000863E89E451400800E4AB34024140000018DD97E4514008003CCB7C0241
2	2	0	16	65	33	2	0105000000010000000102000000360000000D98BFF9183EB5140C7B516CC61054140600B07FA8DEB5140C8FA5687740541400800F56790EB51400000D0E6780541
3	3	0	15	45	43	3	0105000000010000000102000000300000000C673089E60F151408F5BE762F00E41403029BB8F7CF1514058E662F1F30E41400000C7C8A8F15140F8FF4392F90E41
4	4	0	15	34	45	4	01050000000100000001020000002F000000A6ACF54B8CF951406D287DB8470E4140D8673E4AB6F951401085FC1C460E414000007D2029FA51400000ACB7410E41
5	5	0	15	32	46	5	010500000001000000010200000033000000041492F86F1015240FD5569007E0D41408028974A28025240504B2A9E660D41400400E9D43D0252400000BC6B5D0D41
6	6	0	15	54	44	6	0105000000010000000102000000200000006711C3CF9609524049FCD40E5B0841400400A0E7DB0952400000D07A64084140849B6FA6DC09524078821A9B640841
7	7	0	15	67	45	7	01050000000100000001020000002200000003EA119FF0D1252400641628A09094140000029612D1252400800E46211094140609E8B59611252406 8EDFE601E0941
8	8	0	17	87	43	8	01050000000100000001020000002B0000009F91DBCF051A5240988302FCD305414000002FD7071A524008003 4AAD00541400400B366201A524010009 4DD9A0541
9	9	0	16	89	42	9	01050000000200000001020000001300000002973BA17331E52402C22120A29F840400400B98A4E1E52400000F4AA19F8404000001B69A01E5240F8FF1B5417F840
10	10	0	16	56	42	10	0105000000010000000102000000320000009A49AB0DED24524075149A8590EF404060A6E53429255240E0F4A89657EF4040289FA3C456255240D85DFB6717EF40
11	11	0	16	54	41	11	010500000001000000010200000029000000A189BE089C2A524063B615AEA2E440402815AADBA32A524070B6995693E440402C109066C32A524090A20A0C4FE440
12	12	0	16	55	43	12	01050000000100000001020000002E0000008F0C23A415305240C5B5B05FBFD74040BCBD8FE92A305240F0B8772292D74040948BFC205A30524058A8680345D740
13	13	0	0	66	45	13	
*							

Figure 2.2.2.1.b PostGIS database showing Temperature and humidity point data

Once the data has been fetched and stored in database, data visualization on a portal needs to be implemented. Portal is designed in bootstrap. Bootstrap is responsive cascading style sheet used to produce good interface of web application. It responsiveness makes it capable of adjusting to different screen sizes. Open layers are used to overlay data on OSM.

2.3 Communication Segment

2.3.1 MySQL

For our communication segment we require a database and for that purpose we have chosen MySQL. MySQL has been the mostly used database in the world. Some of its features due to which it is widely used are:

- It is open source
- Written in C and C++
- Reliable and easy to use
- High Performance
- Strong Data Protection

- Scalability and Flexibility

Facebook, Twitter, YouTube, Oracle and Yahoo! are some of the companies that have been using MySQL.

2.3.1.1 Apache

For our server, we have used Apache. We used Apache as it is an open source server and it can be used on a wide variety of operating systems e.g. Linux and Microsoft Windows. According to a statistics of 2013, more than 50% of servers in the world used was Apache. Some of its features are:

- Multi operating system
- Simple configuration
- IPv6 supported
- Caching
- Easy to use

2.3.1.2 PHP

As mentioned earlier, PHP is a server-side scripting language. It was designed to be used for web development. It has now become one of the most server side language. Initially PHP meant Personal Home Page but that has been changed to Hypertext Preprocessor. Some of the features of PHP are:

- General purpose scripting language
- Runtime execution
- Support for command-line scripting.
- Multi-OS and multi-server supported
- Accepted by most databases e.g. MySQL
- It is available free and is open source

2.3.1.3 GeoServer

To deal with geospatial data, we are using GeoServer. It is a tool to share one's geospatial data. GeoServer is being used all over the world. Because of its GUI, it is easy to work on with it. Some of its features are:

- Open Source
- Java based
- View and edit geospatial data
- Easy to use
- Interoperable
- User friendly GUI

It is used to view, edit, analyze and share data. Companies like Google and NASA are using it.

2.3.1.4 JavaScript

JavaScript is both client side and server side scripting language used in the development of web applications. It allow better interaction with the user. It is also considered an assembly language of the web. It also find its uses in game development, computer applications and mobile applications. Some of its features are:

- Multi-paradigm language
- Object oriented supported
- Handles date and time
- Can detect the user's pc specification
- Cross platform

2.3.1.5 PostgreSQL

To store our geospatial data, we are using PostgreSQL. It is an open source database system. It is used because of its reliability, data integrity and correctness. Some of its features are:

- Handles geospatial data

- Multi OS supported
- Support foreign keys
- Stores binary large objects
- Multi programming language interface
- A vast library
- Creation of own custom data types

2.3.1.6 jQuery

jQuery is a JavaScript library which is fast, cross platform and feature rich. It is a Document Object Model (DOM) manipulated library. It is used for client side scripting of HTML. It is an open source library. jQuery is the most popular library used for creating animations and building Ajax application with much simpler APIs. Some of its features are:

1. Open Source
2. Create your own user defined plugins.
3. Multi-platform supported
4. Cross Browser
5. Easy to use
6. Fast processing

2.3.1.7 AJAX

Ajax stands for Asynchronous JavaScript and XML. It is a group of techniques. It is used on the client-side for creation of Web applications. Some of its features are:

- Send and retrieve data to and from a server
- Allow user interaction

- Web pages are updated asynchronously
- Dynamic and Continuous User Experiences

The main use of Ajax is that it updates the content of a webpage without refreshing the whole page. Google Maps, YouTube, and Facebook uses Ajax.

2.3.1.8 HTML

HTML stands for HyperText Markup Language. It is the standard language to create web pages. It uses the concept of tags. All web browsers can read HTML files. It is the building blocks of all websites. It also supports images. Along with CSS (Cascading Style Sheets), styling of the webpage is done. Different sections of the document can be differentiated and style by using different tags and styling each tag differently in CSS.

2.3.1.9 OpenLayers

OpenLayers is an open source java script library which is used to load and display maps. It provides Open Geospatial Consortium (OGC) standards API for building web-based geographic applications. The main concept in OpenLayers is the map. It represents the view where information is rendered. The advantage of OpenLayers is that a map in OpenLayers can contain any number of layers. OpenLayers supports both raster and vector layer. It also supports extensions like PNG image, a KML file etc. Apart from showing the map, it also provides the controls which are used to interact with the map e.g. panning, zooming and selection etc. The current series of OpenLayers is 3 series. The OpenLayers 3 has the support for HTML5 with CSS3.

There are two types of layers while developing an OpenLayers application:

1. Base Layers
2. Non Base Layers

Base Layers: A base layer is any basic or background layer of a map. There can be multiple base layers but only one base layer can be made "active" at a time. The currently active base layer determines the available projection (coordinate system) and zoom levels available on the map.

Non Base Layers: Also known as Overlays, are displayed over the base layer. There can be numerous overlays layers and the layers can be switched between one another.

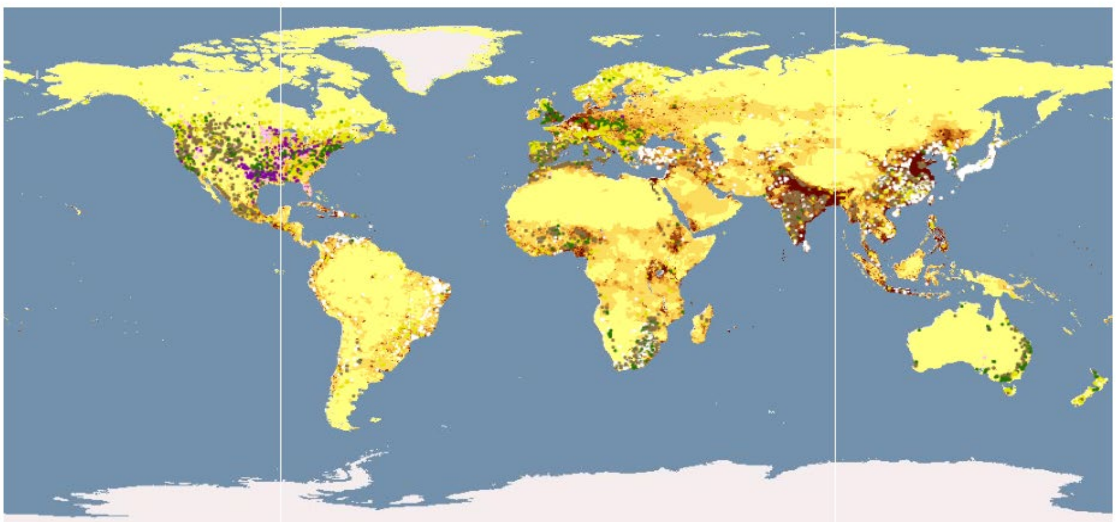


Figure 2.3.1.9 Example of OpenLayers

2.3.1.10 CSS

Cascading Style Sheets (CSS) is a style sheet language which is used for describing the details of other markup languages. Mostly used to change the style of web pages and user interfaces written in HTML and XHTML, the language can be applied to any kind of XML document. It is used to separate the designing of the webpage from its core coding. It was used in the designing of our portal.

2.3.1.11 WAMP

WAMP is the main server bundle we used, it stands for Windows Apache MySQL and PHP. It is used for web development and internal testing, but may also be used to serve live websites. The main server of the WAMP package is **Apache** which is used to run the web server in Windows. This allows the developer to test webpages in a web browser locally without publishing them live on the internet.

2.3.1.12 Google Charts

Google Charts API has been used to make few of the charts for the portal. It is a free tool developed by Google for making graphical charts in PNG format and data representation coded in a web page using a URL string.

These charts are very good for visualizing the data in a website. Some of the type of charts provided by Google charts API are Pie Charts, Line Charts, Area Charts. Colum Chart and Tree Maps. We are using Google Charts API because it is very user friendly and easy to use.

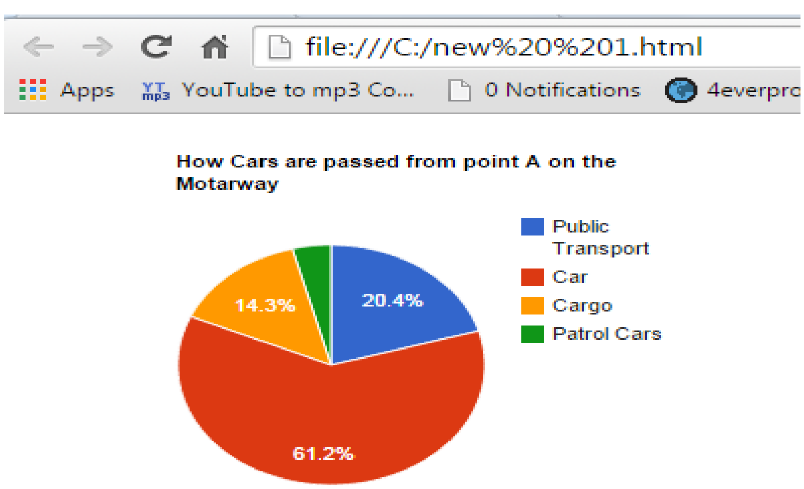


Figure 2.3.1.12 Example of Google Charts

2.3.1.13 amCharts

Another type of API we used to make some of the charts in our portal is amCharts. It's a JavaScript/HTML5 based advanced charting library that can suit any visualization need. The library supported by mobile devices and it uses Scalable Vector Graphics (SGV) to render charts. amCharts API can be used to modify and custom built your own charts, and unlike Google API it is more open source and code orientated. It is more complex than Google Charts API but offers more variety.

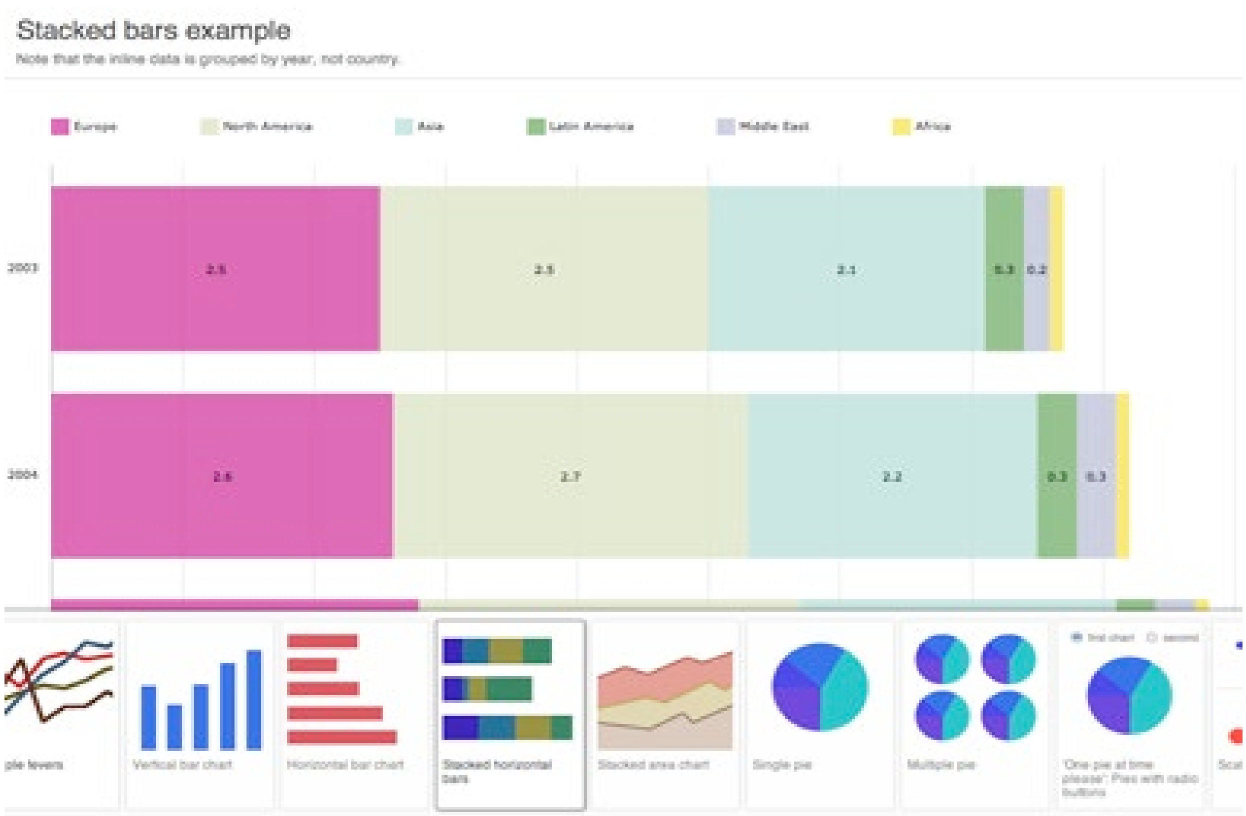


Figure 2.3.1.13 Example of amCharts

Chapter 3 Results

Android Application

Android application interface is shown below. There are two buttons on top corner i.e. left to locate user on Open Street Map and right to send Distress call (SOS button) to Highway Authorities web portal. The user location is show on the map using a star icon.

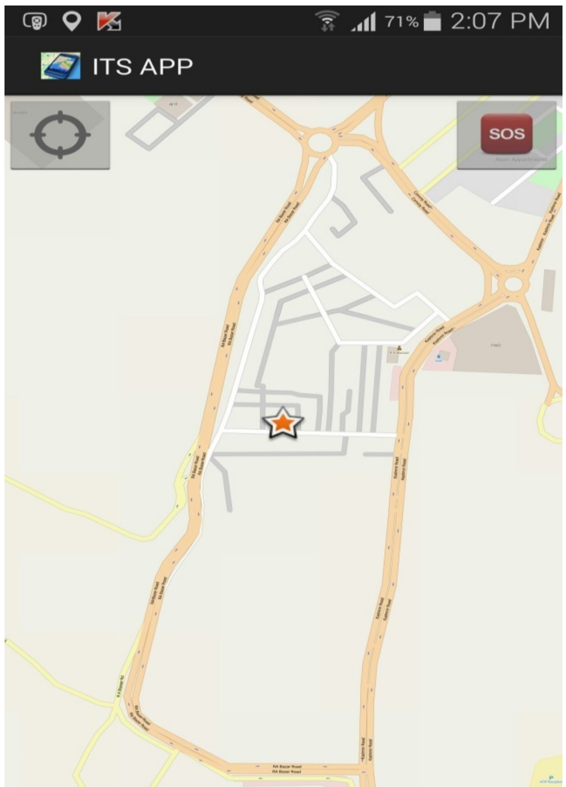


Figure 3 Locating User on a Map

When user clicks on the SOS button Selection menu appears. Through selection menu user picks the emergency type and sends information to the authorities. For now we have only provided two types of emergency responses but more can be added. Below is the screen shot of that application:

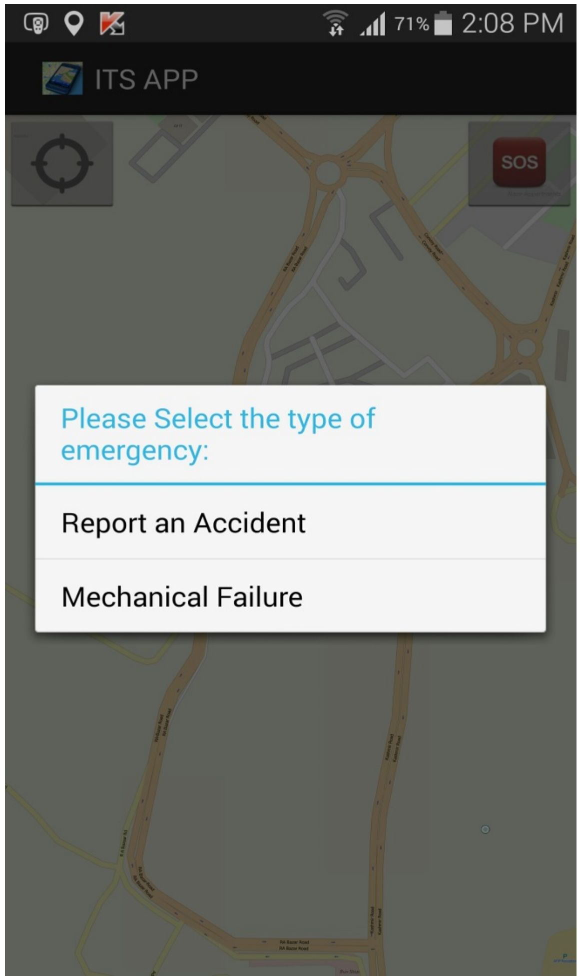


Figure 3.a User Selecting the Type of Emergency

The emergency response is sent to our MySQL database. Data from SQL database is visualized in tabular form on a web portal. It shows request's coordinates, Type of emergence, status, Map button and show route button. On click map button administration can view the location of request on the map and by clicking on show route button we can show the direction.

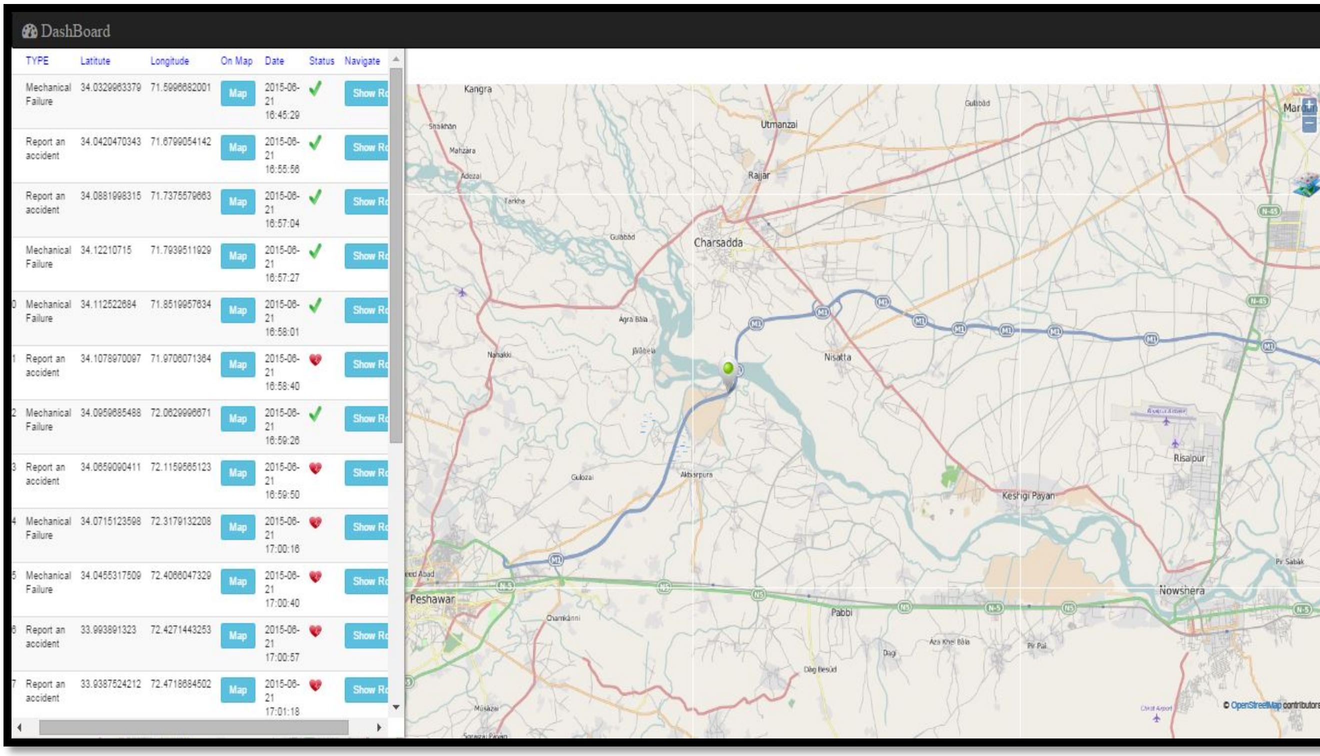


Figure 3.1.a Showing the request location on a map with green marker

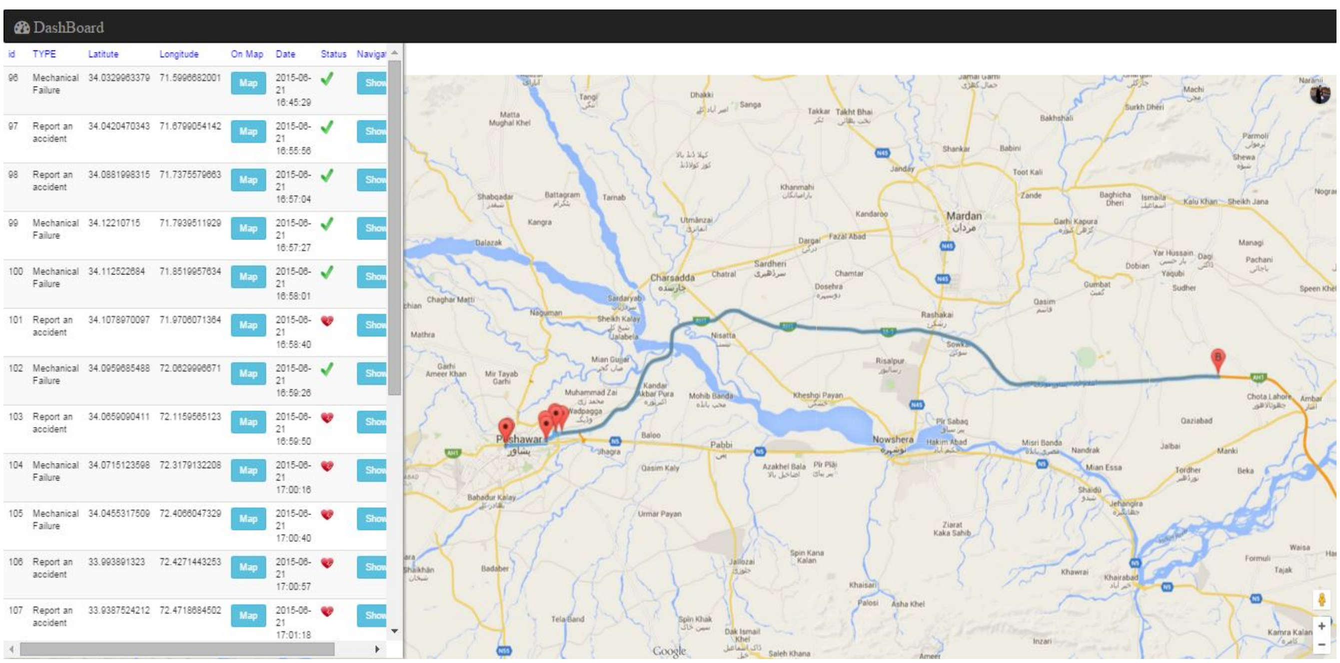


Figure 3.1.b Showing the route of Emergency Request from NHA Station

Figure 3.1.c Showing accident hotspots on the Web Portal

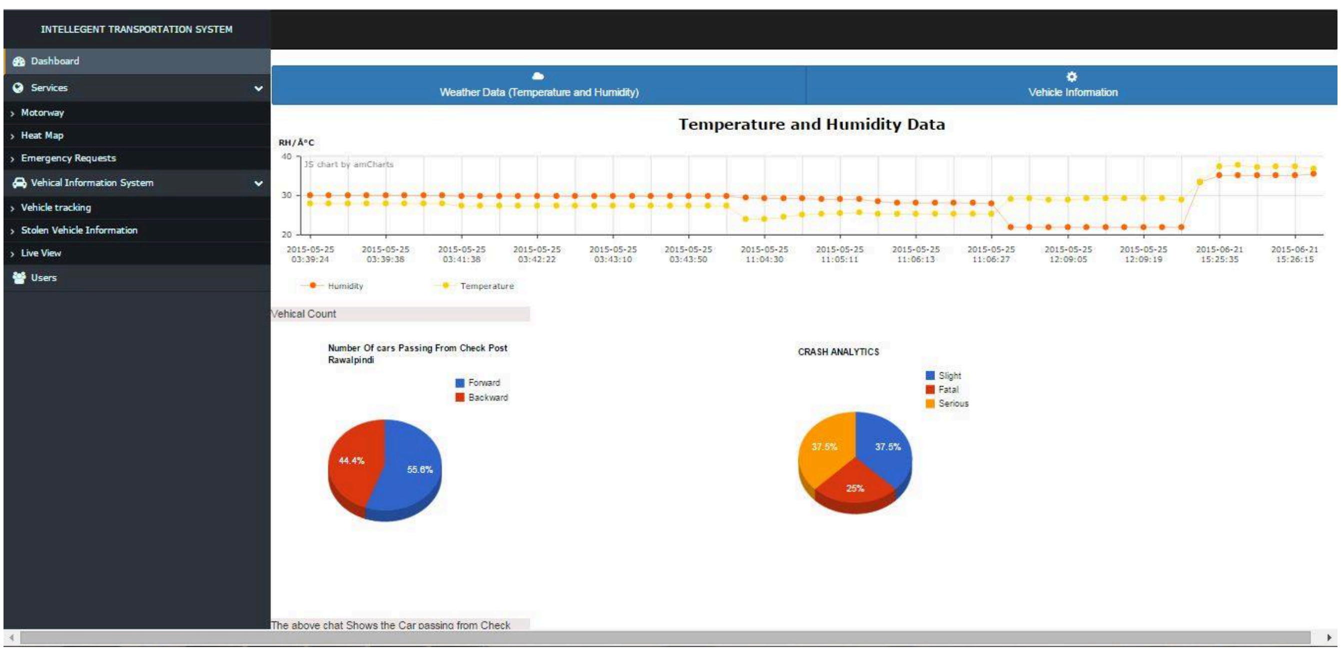


Figure 3.1.d Showing the Temperature/Humidity Graphs and Accident Graphs on the Web Portal

Number plate result

The image or video pass through Number Plate detection program will read the number plate and gives different number of possibilities of what could be the number. The number with the highest confidence is the required number. In the following image, the number of the car is YA583 which correctly identified with about 87% confidence.

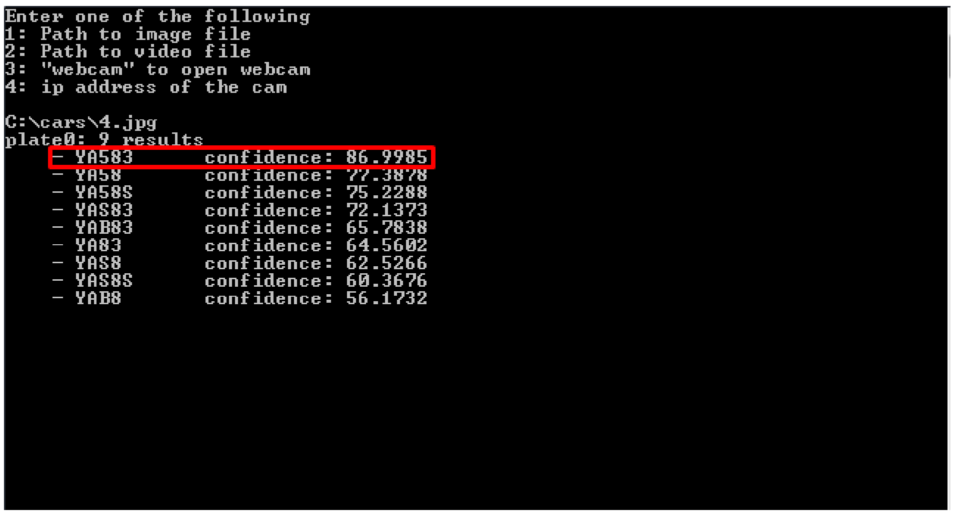


Figure 3.2.a Showing the Confidence Level of Recognized Number Plate

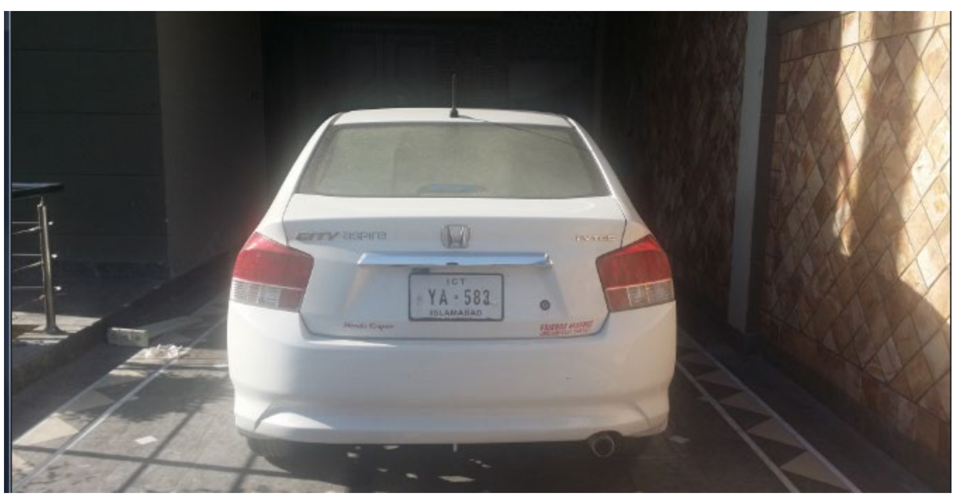


Figure 3.2.b Detecting Car's Number Plate

The number with highest confidence is then stored in our SQL database and from there it can be visualized through our web portal. Below is the screenshot showing Vehicle Information

System. Here we can search about whether a particular vehicle has passed or not and also to find out about the last station they entered. We can also check speed as distance between 2 stations is known and time is also recorded so using $Speed = \frac{Distance}{Time}$ we can also measure average speed of the car.

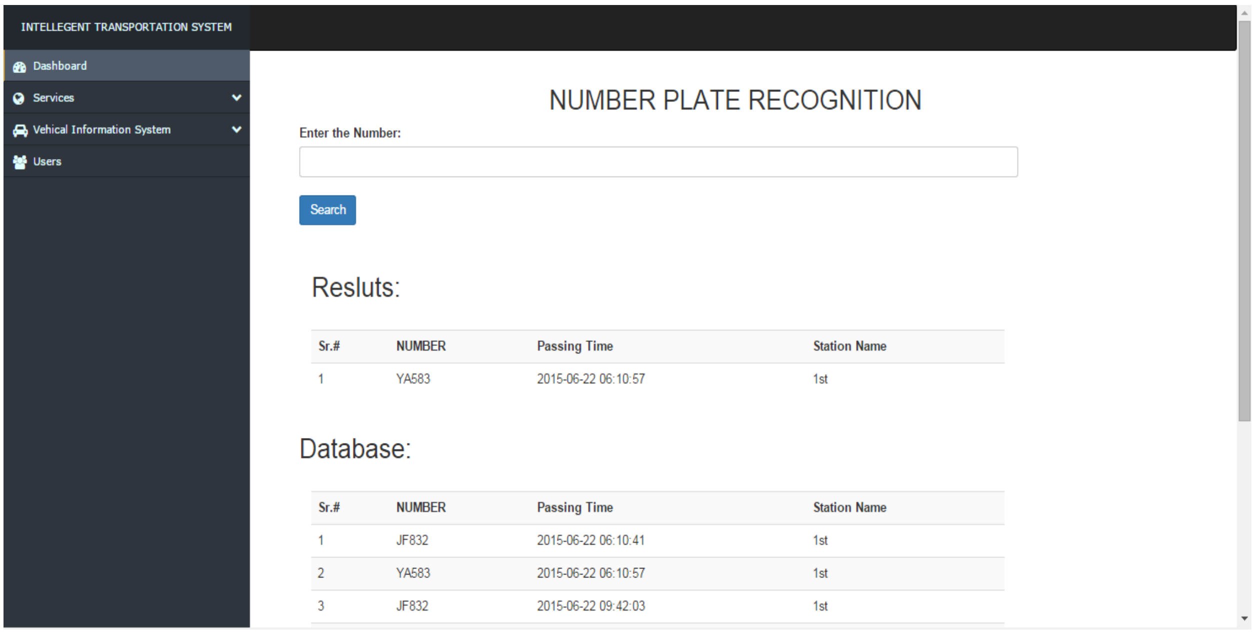


Figure 3.2.c Number plate Recognition on Web Portal

Also, we can use the data as stolen vehicle information system. We have created another database in which we store the license number of cars which were stolen or reported stolen at any time. E.g. for our test we specified that YA583 was stolen and when it came in front of our camera, system gave us a pop up that a car is found and status of YA583 is change to car found. When clicked on show route, it will give you the route to where it was seen. This way we can find or get an edge on finding stolen vehicles.

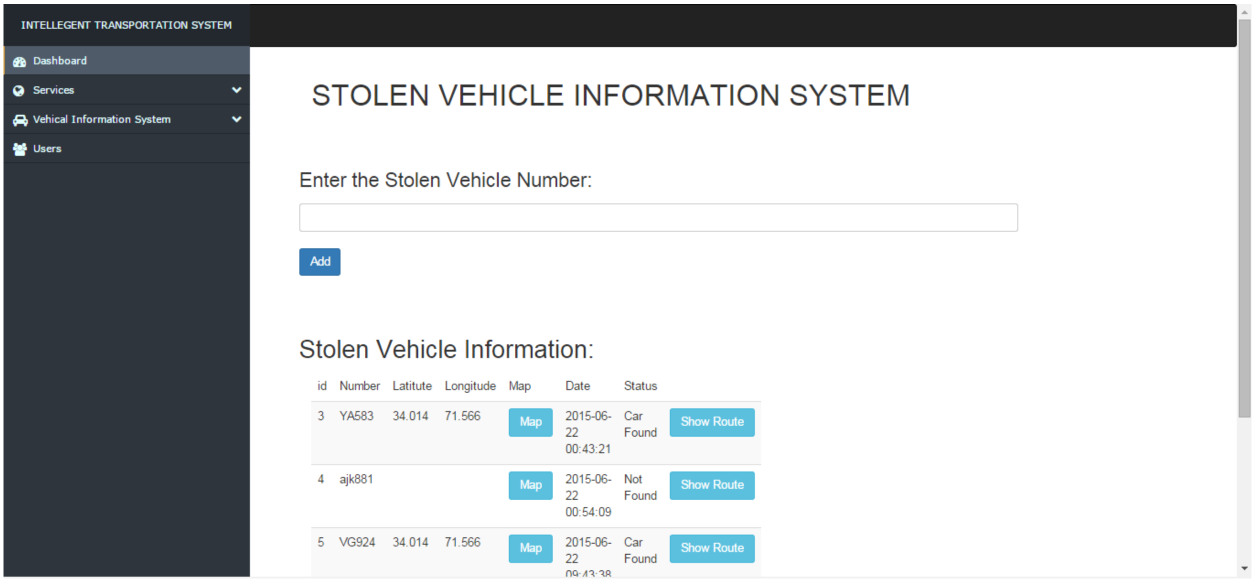


Figure 3.2.d Stolen Vehicle Information System on Portal

Chapter 4

RECOMMENDATION AND CONCLUSION

4.1 Recommendations

The ITS designed is still in its initial stage, however with further development it can be made into a comprehensive system that includes all aspects of transportation requirements. It is still not widely used in Pakistan and authorities are not fully aware of its benefits and potential.

It is recommended that awareness about ITS needs to rise and more students and faculty need to be aware of it. Furthermore, it is also recommended that transportation be taught in our curriculum so that more students can opt for such projects that aim to tackle the difficult transportation problems.

4.2 Conclusions

Developing and designing an ITS was a very big challenge because of such a vast scope of the project. Nevertheless we succeeded in developing a prototype ITS which shows the proof of concept. The system is designed in such a way as to make it easier to integrate further components of ITS which have not been included in this project.

ITS shows how different technologies such as cheap Arduino sensors, mobile devices, video classification libraries and web portals can be integrated to from a comprehensive system that can be used to make transportation safer and more efficient. Furthermore the data collected form ITS can be used to preform highway analytics further improving the system.

With the development and implementation of ITS we can provide increased safety for drivers, reduced traffic congestion, increased environmental quality, improved economic productivity and quick responses to crisis. An efficient transport system is a pre-requisite for Pakistan to become globally competitive, and growth must be achieved while increasing service levels and decreasing costs. .

4.3 Limitations

ITS is a very comprehensive and complete system and extreme care has been taken to make sure the objectives of the project are met, there are still many issues that need to be highlighted. The monitoring stations are in the prototype phase, to deploy the sensors on the field containers need to be made and precautions need to be taken to ensure the safety and reliability of the sensors. The system once deployed needs security from unlawful intrusions since the system will be collecting sensitive data. Security measures need to be implanted to avoid any such events. The scope of the project is considerable to be completely covered as a final year project, although care has been taken to make it as comprehensive and complete as possible there are still a few components that need to be further refined.

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