ASHESI UNIVERSITY COLLEGE

EMBEDDING INFORMATION ABOUT ROAD SURFACE QUALITY INTO

GOOGLE MAPS TO IMPROVE NAVIGATION

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Thesis

ASHESI UNIVERSITY COLLEGE

Embedding Information about Road Surface Quality into Google

Maps to Improve Navigation

By

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DECLARATION

I hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: ……………………………………………………………………….

Candidate's Name: ………………………………………………………………………..

Date: ……………………………………………………………………………………

I hereby declare that preparation and presentation of the dissertation were supervised in accordance with the guidelines on supervision of thesis laid down by Ashesi University College.

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Date: ……………………………………………………………………………………

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ABSTRACT

One key tool for navigation is a map; it helps users to identify locations and features of a particular area. Anecdotally, Google Maps is one of the most commonly used navigation tools. Google Maps indicates the specific locations of a user and gives possible routes to a desired destination. Among the features indicated on the map are roads. They show where to move from one point to the other; but the map provides no indication of road surface quality. In some countries such as Ghana, not all roads indicated on the map are good. There are some poor roads, which when encountered by motorists while driving, results in bad driving experience. However, motorists can only tell on Google Maps the various routes to their desired destination without knowing the nature of the roads. Therefore, having a feature that would show the road surface quality on Google Maps would help motorists especially in Ghana plan their routes or even plan to reduce their speed on a given road due to the nature of the road.

The focus of this project is to design a "road surface quality" feature that would be embedded into Google Maps to assist motorists determine the quality of roads during navigation. Ultimately, the road surface quality information would be obtained by crowdsourcing this information from many users running a mobile application that classifies roads based on accelerometer readings. Crowdsourcing is a method of obtaining information from a large group of people. The application for road classification is being developed by a colleague, Delali Vorgbe, but the specifics of how the classification is done are outside the scope of this work. This thesis focuses on how the information gathered about the road surface quality would be displayed on the map to the users, and whether having this information improves the navigation of users. The premise of this thesis is that when motorists continually provide their road data, the road surface quality information would accurately reflect the state of the road on the map. This feature on the map would then have an impact not only on motorists but on the nation as a whole. This is because when motorists know the road surface quality ahead of time, it would help them

decide in advance the best, safest and most comfortable route to use. They can also plan to drive carefully on the poor roads if no other routes are available.

Contents

LIST OF ACRONYMS

Acronym	Meaning
API	Application Programming Interface
DECADE	Dynamic Exploratory Cartography for Decision Support
EDA	Electronic Design Automation
GIS	Geographical Information System
GPS	Global Positioning System
GPRS	General Packet Radio Services
HTML	Hyper Text Markup Language
SDSS	Spatial Decision Support System
POI	Point Of Interest

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1: INTRODUCTION

1.1 Introduction

A Geographical Information System (GIS) is a system that is use for representing and examining any object on earth. It is a way of gathering, storing, and managing any type of data with spatial components [1]. It is regarded as a form of decision support system, also referred to as spatial decision support system (SDSS), which has a database, and user interface to support decision makers. A map is considered a GIS since it is the visual representation of coordinates of locations in geographical areas that help users to make decisions. Google Maps is one of the well-known web-based applications that provide mapping services and detailed information about geographical regions. The road surface quality on GIS could be a feature that would be used by motorists for route planning and reducing speed on poor roads for safety. Having this feature on GIS is important because, it would help motorists know ahead of their journey to help reduce unnecessary road accidents in Ghana. However, most GIS systems do not provide the extra information about the quality of roads that are displayed on their maps. This project is therefore focused on designing road surface quality feature as an information tool that would aid motorists to know ahead of their journeys the road surface quality they would be encountering. This feature is embedded into Google Maps since it is the most commonly used geographic tool for decision-making in navigation [2].

Routes in North Legon, Ghana, are used as a test bed to demonstrate the road surface quality feature on Google Maps. The roads in North Legon

were used because the routes in these locations are of varying that is, good, satisfactory and bad roads.

1.2 Background

Statistics have shown that Ghana loses over two hundred and thirty million dollars ($230,000,000) yearly due to road accidents, with more than 1600 deaths [3]. About four (4) people die daily on roads all over Ghana [3]. Analysis can be made that, one major reason for these fatalities is due to the unawareness of the road surface quality ahead of their journey.

The road surface quality could be classified based on the condition of the road. These conditions include: tarred and smooth, tarred but bumpy, un-tarred but smooth (dusty) and un- tarred and bumpy. Unfortunately, many roads in Ghana fall under the latter three road surface quality classifications above. There remain as well, a high percentage of poor roads, especially the un-tarred ones. There have been rampant issues reported on how the bad road negatively affects motorists and the nation as a whole. Roads that are un-tarred but smooth (dusty) get destroyed in the long run due to floods from heavy rains or when trucks with heavy loads pass over them frequently. When motorists ply these roads, they end up with dust clogging and choking the internal parts of their vehicles. Motorists also tend to inhale the dust, and this often leads to severe respiratory disorders such as asthma, or pneumoconiosis [4]. Pneumoconiosis is the accumulation of dust in the lungs that makes the tissue not function properly. [4]. Continuous use of roads of this kind by motorists could eventually lead to death.

Tarred but bumpy roads are also another category of roads that could serve as a danger to motorists. This is because this type of road does not encourage fast and smooth movement of vehicles. Motorists tend to drive slowly and end up causing or being caught up in traffic when using roads of this nature. The real danger, threats and points for concern are that, both passengers and drivers end up inhaling smoke while sitting down in traffic for long periods. Tarred but bumpy roads also increase the wear and tear on the vehicle.

According to the Ministry of Roads and Highways, the estimated budget for roads in year 2012 was GHC 217,668,890 and year 2013, was GHC 223,741,550, indicating an increase of 2.7% for road construction and maintenance [5]. In addition, educational programs have been organised by the government to help curb road accidents. Evidently, the government is committed to road construction, maintenance and road safety. Measures like speed ramps and road signs have been put in place to assist motorists; yet the number of road accidents increases yearly [3]. Traffic wardens employed by the government check up on motorists who do not adhere to road regulations. All these measures have been employed as a means to drastically reduce the occurrence of road accidents.

Having said these, the question remains: could there be an immediate solution to help minimize the above issues experienced when motorists are driving whilst the government continues to address road surface quality problems? This research project focuses on a better approach to helping motorists know and decide the best routes to use based on the quality of roads ahead of their journey.

1.3 Problem Statement

Roads do not just lead us to our various destinations but play a significant role in our everyday lives by serving as the links that connect us to the people we constantly need to be in touch with. Roads are also a major contributing factor to economic development in Ghana where roads are used in transporting goods and services from one place to another.

In spite of the above benefits, the qualities of some roads have led to bad driving experience of motorists. The comfort and speed of driving is primarily determined by the road surface quality. A tarred smooth road is undeniably the best road every driver would want to drive on. However, there are cases where motorists encounter roads that are filled with potholes, bumps and dust leading to several discomforts. Such discomforts include headaches, backaches and upper respiratory irritations. Another major problem caused by bad quality roads is road accidents. This happens when motorists tend to dodge potholes and accidently run into other vehicles, claiming lives and properties in the process. Vehicles are damaged when they pass over such roads leading to excessive wear and tear of mechanical parts.

All these problems encountered could be attributed to the fact that, motorists are not aware of the nature and the quality of the roads they would be plying before or during their journey.

1.4 Research Questions

In addressing the identified problems, the main question that would need to be answered is as follows;

Does having information on road surface quality improve the navigation experience of motorists using modified Google Maps on roads?

1.5 Objectives of the project

The aim of this project is to provide an efficient approach to informing motorists ahead of time about the quality of roads. In achieving that, the following specific objectives will be addressed:

1. To identify and implement an intuitive method of embedding road design quality information onto a map.

2. To investigate whether or not the road quality information improves the navigation of motorists using the modified Google maps.

3. To identify a method of combining road quality information from multiple users plying a given road to come up with a reliable estimate.

1.6 Scope of project

1.6.1 Focus Locality

This research does not make use of all the roads in Ghana due to time and logistical constraints. Therefore, for demonstration purposes, the researcher focuses on roads in some areas, specifically in North Legon. This is because the roads in these locations are of varying quality, as described above in the background.

1.6.2 Information gathering

A colleague, Delali Vorgbe, is developing an android application that determines the classification of the quality of roads that would be

crowdsourced from road users. Crowd sourcing helps to gather information from a large group of people using the application on their mobile devices. This technique aids in gathering large amount of information needed for feedback on the road surface quality.

1.6.3 Technology

The information on road surface quality was embedded onto the map for users. This project was not to build a new geographical information system from scratch but to embed the information about the road surface quality into an existing GIS system, Google Maps. Google Maps was used for this project because it is the most commonly used, free and easy to use to develop the information design.

1.7 Motivation

The ability to use technology to assist motorists to be aware of the kind of roads they would encounter ahead of their journey is the motivation of the project. The excitement in developing this system stems from the possibility that bad driving experience and discomforts caused on these roads would face a major reduction which would help the government channel their resources into other projects. Developing such a system, the researcher learnt how to use Google Maps API for the first time that helped contribute to the researcher's personal skills.

1.8 Outline of thesis

This thesis is organised into five chapters as follows:

Chapter 1: Introduction gives a general introduction to the research and its relevance. It comprises the overview of the project, research objectives, problem statement, and scope of the research.

Chapter 2: Literature Review outlines the related work in Information Design, Geographical Information Systems and Crowd Sourcing and critically analyse their importance relating to this project.

Chapter 3: Implementation describes the methods that were used to address the implementation of embedding the road surface quality and how the research question was answered.

Chapter 4: Experimentation and Results presents how the road surface quality application tested.

Chapter 5: Conclusion and Recommendation presents the discussion and conclusion drawn from experimentation.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction to chapter

This section reviews academic articles on map design, information design, geographical information system and crowdsourcing which are related to this project. The researcher will point out similarities, differences and establish certain key relation between the articles and this project.

2.2 The nature of Geographical Information System

The use of maps has made Geographical Information System and geospatial technologies an important decision-making tool for navigation [6]. Indeed, maps are the most efficient means of communicating geographical information [7]. Maps provide the localization of geographic objects, showing spatial relations and patterns, and also deliver useful orientation information [7]. In recent years, a number of research projects on geographical data visualization on mobile devices have focused on how best to represent and interact with maps on small displays. The use of maps on small displays differs from using paper maps in a mobile setting or viewing maps on a desktop computer. This motivated most researchers according to Stefano et al. [7] to propose ideal solutions for the adaptation of map contents for mobile devices [7].

2.3 Map-based support for spatial decision making

One key important attribute associated to GIS is the spatial decision support [14]. Researchers' main concerns have been focused on developing decision support capabilities on GIS that could be incorporated on maps with multiple criteria decision model. Maps have become a

graphical key through which users make their decision choice and assign priorities to decision criteria [14]. Then again, an active area of research for development of application is Multiple Criteria Decision (MCDM) for spatial decision. Finding solutions to problems distinguished by multiple choice alternatives that are evaluated by means of performance is the main objective of MCDM [14]. Spatial decision analysis with analytical map tools has been little reconnoitred in the field of research [14].

An experiment was conducted in the city of Munich, of a well detailed map of the area and the same map was adapted for mobile devices. The mobile device map adapted features provided the users' with information on the routes. The adapted map only had relevant information such as street names and point of interest (POIs) [7]. A comparison of the original map and the adapted features for mobile devices was made and based on the users' preference; the use of the adapted features for mobile devices was preferred to the original map. Nonetheless, the use of maps as an analytical tool in spatial decision has not been extensively explored [8]. A developed software, DECADE (Dynamic Exploratory Cartography for Decision Support) [8] integrated with GIS demonstrates how a decision maker using a map makes decisions based on routes and other features on the map to get to a particular destination [7]. Over the past decade, the notion of EDA (Electronic Design Automation) has spread from data to cartography [2]. Cartographers have recognised the demand for software that supports the use of interactive, dynamically alterable thematic maps [6] and facilitating visual thinking about spatially referenced map data.

2.4 Existing Geographical Information System

ArcView software [6]is a desktop application that allows users to visualize, manage and analyse GIS data [9]. GIS consists of five components namely; Hardware, Software, Data, People and Method [1]which is shown below in Figure 2.0.
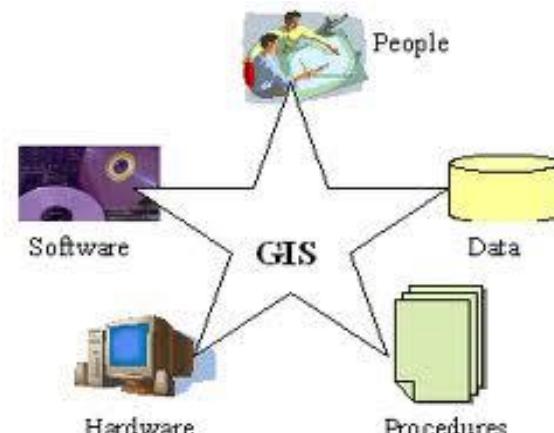
Figure 2.0: Components of GIS [9]

Hardware

This component describes where the GIS information can be accessed.

Software

GIS software provides functions and tools needed to store, analyse and display geographic information. Geographical information displayed on GIS can be manipulated by providing methods that can embed the information

Data

Possibly the most important component of a GIS is the data. A GIS integrates spatial data with other resources. In the case of this dissertation, this information is of relevance.

People

The people involved in the use of the GIS is the developer and the users of the application.

Method

A successful GIS operates according to a well-designed plan that focuses the use symbols and colour scheme to communicate information to people.

According to research, GIS makes use of two maps namely; reference and thematic maps [9]. Many research trends make use of reference maps [9] that display information on ArcView [6]. The use of the Google Maps application was more advantageous than the ArcView technology because of the efficient portability of Google Maps, unlike the ArcView technology, which is made only for desktop computers. Google Maps is well adapted for mobile devices, making it very convenient for people [2]. The map design on the ArcView makes use of symbols and different colour scheme, to indicate information displayed to users [6].

Research have indicated the relevance of having governmental information displayed on GIS to boost the development and economic growth of a nation that is closely related to available transportation system. Good road surface quality promotes industrial and socio-economic development [8]. To provide safety and comfort to road users, a

comprehensive maintenance schedule must be formulated and adopted to ensure roads are in good condition at all times to prevent any road accidents.

This project adapts to this ideal because the application to detect road surface quality would benefit not only the motorist but also the nation, especially the government. This is because as information about road surface quality has been embedded into the map, the application would help keep track of roads that need to be reconstructed and maintained. The update of road surface the quality can be done through crowdsourcing where users submit the classification of roads on their mobile devices.

2.6 Crowdsourcing Geographical Information System Data

According to article titled *GPS Based Vehicle Navigation System Using Google Maps*, Global Positioning Systems (GPS) is being used for a variety of applications, with a focus on developing an enhancement of GPS based on a vehicle navigation system using Google Maps [2]. This system helps locate the routes in which buses are travelling and displaying the current position of vehicles on a displayed map. This method helps monitor the public transport in real time. According to ChakradharaRoa et al., in India, public transport was not managed properly. As such, these researchers were led to propose a solution to the problem. The solution proposed was to design an embedded application which is used for tracking and positioning any vehicle by the use of GPS and GPRS (General Packet Radio Services) [2]. When requests are sent by users' to the number at the modem, the system automatically sends a return reply to that mobile

indicating the position of the vehicle in terms of the latitude and longitude. As the vehicle is travelling on the route, the information displayed is a green line on the map with the GPS as shown in figure 2 below.

Figure 2.1: Route tracked [2]

This serves as an aspect of information design [10] where users' of the vehicle is informed that the vehicle is being tracked which is displayed onto a map. The information displayed indicates an effective design where it is not just a matter of making text pretty or entertaining, but for shaping understanding and clarifying meaning. Information design [10] adds seeing to reading to make complex data easier to understand and to use. In Emerson's work [10], it clearly states key principles in ensuring that information design clearly communicates to its audience [10]. This is information shows its relevance because many users' of upgraded GIS data need to understand the information being displayed to them. It is also interesting to note that, Emerson's principles [10] were generally targeted for the print media which is in many aspects very different for the screen or display technology used by mobile devices [10]. The information design [10] can be related to the map design [6] in the sense

13

that they both discuss how to effectively communicate information to users, which is of relevance to this project.

The article titled *Reducing Travel Time by Incident Reporting via Crowd sourcing* talks about how travel time of end users can be reduced to provide them with an optimal route for a particular trip. It focuses on recurring congestion where incidents are spontaneous due to events like accidents and road maintenance. The congestion update is reported by motorists who witness the incident instantly by sending text messages from their mobile devices [**11**]. The purpose of this crowdsourcing data was to help reduce travel time by informing motorist ahead of time so they can decide on the best routes to take. Motorists use their mobile devices to send text message when they encounter any incident [**11**]. Then, the crowd sourced data was embedded into Google Maps. Another article *Gathering and Utilizing Crowdsource Pedestrian Flow Data from Mobile Devices* [**12**]talks about how travel time of end users can be reduced to provide them with an optimal route for a particular trip. The congestion update is instantly reported by motorists who witness the incident, by sending text messages from their mobile devices. The gathered data is then displayed to users' on GIS which helps them plan their route to navigate.

CHAPTER 3: IMPLEMENTATION

3.1 Introduction to chapter

This chapter describes the implementation process of how the road surface quality information was embedded into Google Maps to effectively communicate the quality of roads to motorists in Ghana. A qualitative approach was used to understand whether the modified Google Maps improves the navigation of users. The chapter also outlines the various implementation processes that led to answering the research question and objectives of the project stated in chapter 1.

3.2 Implementation Approach

3.2.1 Representation of road surface quality

The road surface quality feature was represented on Google Maps by the use of symbols and colors. The symbols indicated the roads and the colors communicated the quality of roads depending on the surface of the road. Symbols were used in order to prevent the confusion of distinguishing between routes that Google Maps provides and the overlaid route information that the modified Google Maps provides. The colors were also used to help easily communicate the road surface quality that motorists ply. The symbol used was a line with three different colors to represent each road quality descriptor, i.e. green, yellow and red. The road quality descriptors were: good, satisfactory and bad. Below is an illustration of how the road quality was embedded into Google Maps:

- Good road   ————————
- Satisfactory road   ————————
- Dangerous road   ————————

The figure below demonstrates a prototype of how the road surface quality was represented on Google Maps. The green line indicates a good road as indicated in the above categories. The illustration shows one route that has the road surface quality information represented.
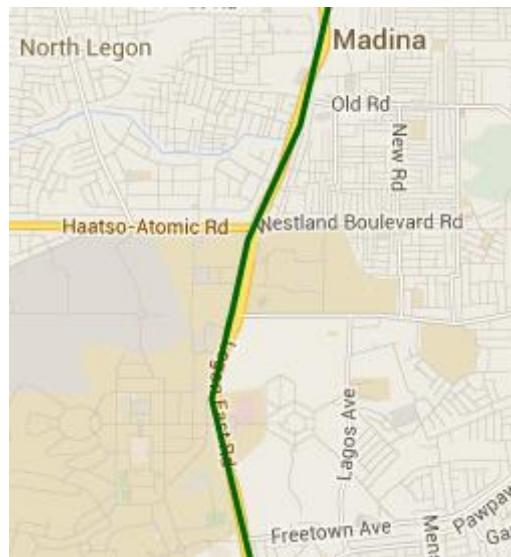
Figure 3.0: Prototyped Good road

3.2.2 Technology

The road surface quality feature was implemented using Google Maps. Google Maps has an Application Programming Interface (API) that gives specifications for procedures, data structures, classes and variables that can be used to communicate with Google Maps [**13**]. These functions were used to embed the road surface quality feature into Google Maps. The information can be accessed on both desktops and mobile devices.

3.2.2.1 Google Maps API Access

In order to start the development of the road surface quality application using Google Maps, a Google account had to be created. This allowed the

researcher obtain an API console key[1] which allows Google to contact the user of the map service about the application if necessary. The Google Maps API was used to load Google Maps with the API console key obtained.

3.3 Development

The main IDE used in the development of the application was Notepad++. HTML[2] was used to add custom user interface. HTML was useful because this application was using Google Maps which is a web application. As mentioned in chapter 1, the research sought to focus on the road network in one specific locality in Accra. Thus, Google Maps was used to first of all get the map representation of the focus locality. The identified routes used were in North Legon, which was the focus locality. Pictures of the various quality of roads; good, satisfactory and bad were taken to serve as a guide in embedding the right nature of the road into Google Maps to have the modified version. The good roads were the smooth and tarred ones which were color coded as green, the fair roads were the tarred but bumpy (potholes) ones which were color coded as yellow and the bad roads were the untarred ones which were color coded as red. Below are the sample pictures of the three main categories of the road surface quality in North Legon.

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[1] https://code.google.com/apis/console
[2] https://developers.google.com/apps-script/guides/html/

Figure 3.1: Good road

Figure 3.2: Satisfactory road

Figure 3.3: Bad road

In developing, Google Maps API[3] which had a list of functions was used to embed the quality of roads by using color coding. Some methods used were "*strokeColor()*" for color coding the line and "*Polyline()*" for drawing the line. For a particular route, first, the longitude and latitude were obtained before color coding the lines. This was done for about thirty (30) routes in the focus locality. The routes color coded in North Legon were from Wisconsin International University College through to Abibitumi Kasa School junction. Below is the initial development of the modified Google Maps web application which shows the different categories of road surface quality in some parts of North Legon.
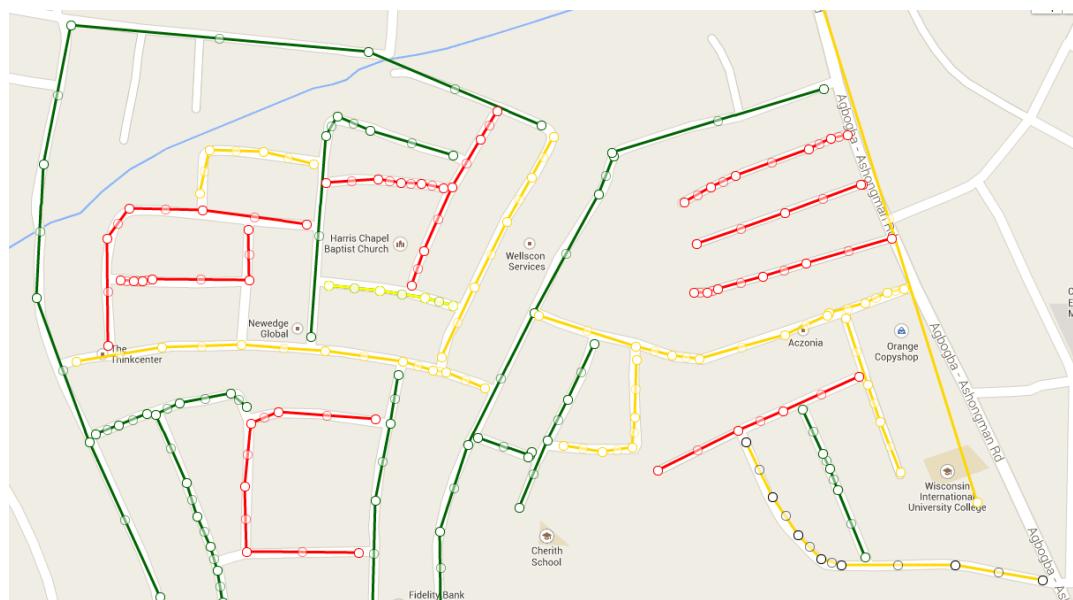
Figure 3.4: Initial development of the modified Google Maps in some parts of North Legon

After completing the core functionalities of this application, a usability test was conducted and some features needed to be added to enhance usability and user interaction. The first development did not include

[3] https://developers.google.com/maps/documentation/javascript/reference

functionality for the current position of the user. However, the final development included the current position. The current location feature helped users to know their current position in real time. In doing that, a method in Google Maps API called "*navigator.geolocation()*" was used to obtain the longitude and latitude of the user's location. This added feature was based on users' feedback on the initial development.

For the initial development, it was difficult for users to identify their current location on the map. Therefore, in order to solve this, another method called "*marker()*" was used to identify the exact location of a user with an image. Not only does users' see a maker showing their initial position, but also a moving marker presenting the users' current location as they move.

Finally, when the colored lines (road surface quality), were incorporated into the initial development, users could easily alter the original position of the colored lines when they accessed the application on their mobile devices. Nonetheless, in the final development, the colored lines were made static to ensure that users' are unable to interfere with the design. The method "*draggable()*" and "*editable()*" were set to false to achieve that.

After adding the new features, users were able to use the application without having any difficulty with identifying their current location. Users' were not able to alter with the position of colored lines. Below is an image of the final development.
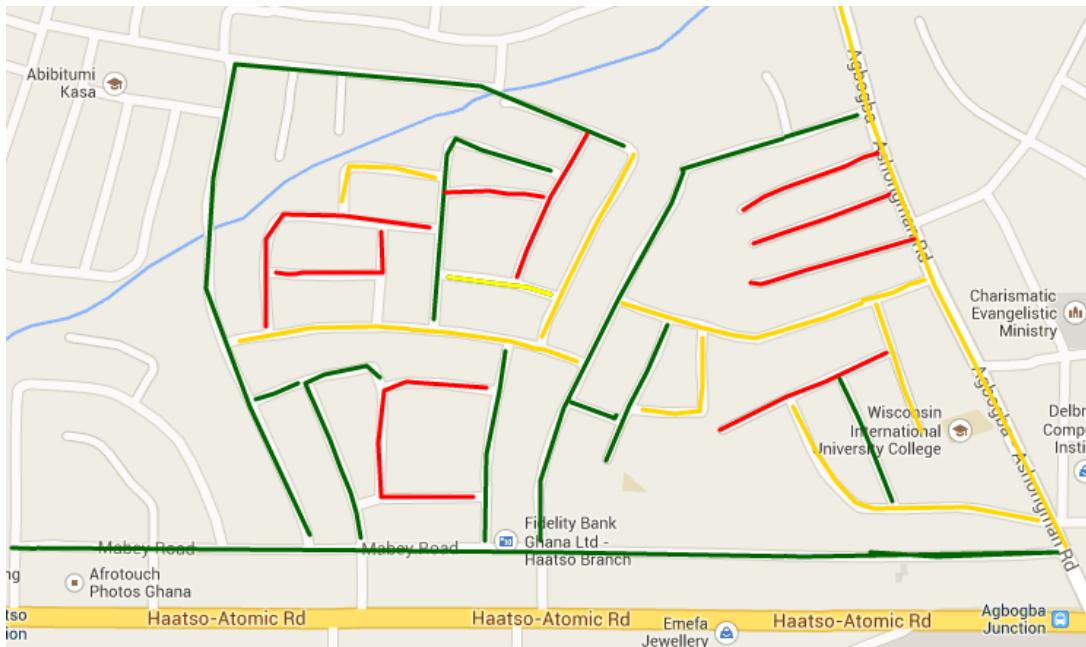
Figure 3.5: Final development of modified Google Maps

3.4 Deployment of modified Google Maps

After development, the application was deployed into Google services using Google Plugin for Eclipse. The plugin helped to create, test, and upload the application to Google App Engine from Eclipse. The Google Plugin[4] for Eclipse downloaded for this project was Eclipse 4.3 (Kepler) latest version. The Eclipse IDE for Java EE Developers includes all of the components needed for web application development. After installing Eclipse, a new project was created containing the code in HTML. The application was deployed to Google App Engine at the URL ashroadquality.appspot.com where users of the application were able to access it on their mobile devices while navigating on the routes.

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[4] http://d1.google.com/eclipse/plugin/4.3

3.5 Crowdsource road surface quality data

A colleague, Delali Vorgbe is developing a mobile application that will determine and classify the quality of roads based on accelerometer readings. This application will make it possible to crowdsource road surface quality information from users driving on various roads in the country. After crowdsourcing the road surface quality data, a statistical approach will be used to extract only true and reliable data from the data pool before embedding onto Google Maps. The statistical method, mode, which is the most frequently occurring data set, will be used to determine the reliable classification of quality for any given road. This is important as it will prevent the data representation from being influenced by outliers. Below is an illustration of the processes that will be involved right after gathering the data and the process of extraction before the representation. Below is an illustration of crowdsourced data from multiple users of particular roads.

Table 3.0: Crowdsourced road surface quality data

	Good road	Satisfactory road	Bad road
Road 1	2	1	3
Road 2	4	2	2
Road 3	1	3	6
Road 4	2	6	3

This internal process has been illustrated using a simple graph shown in Figure 3.6.

Graph showing hypothetical crowdsourced road surface quality data
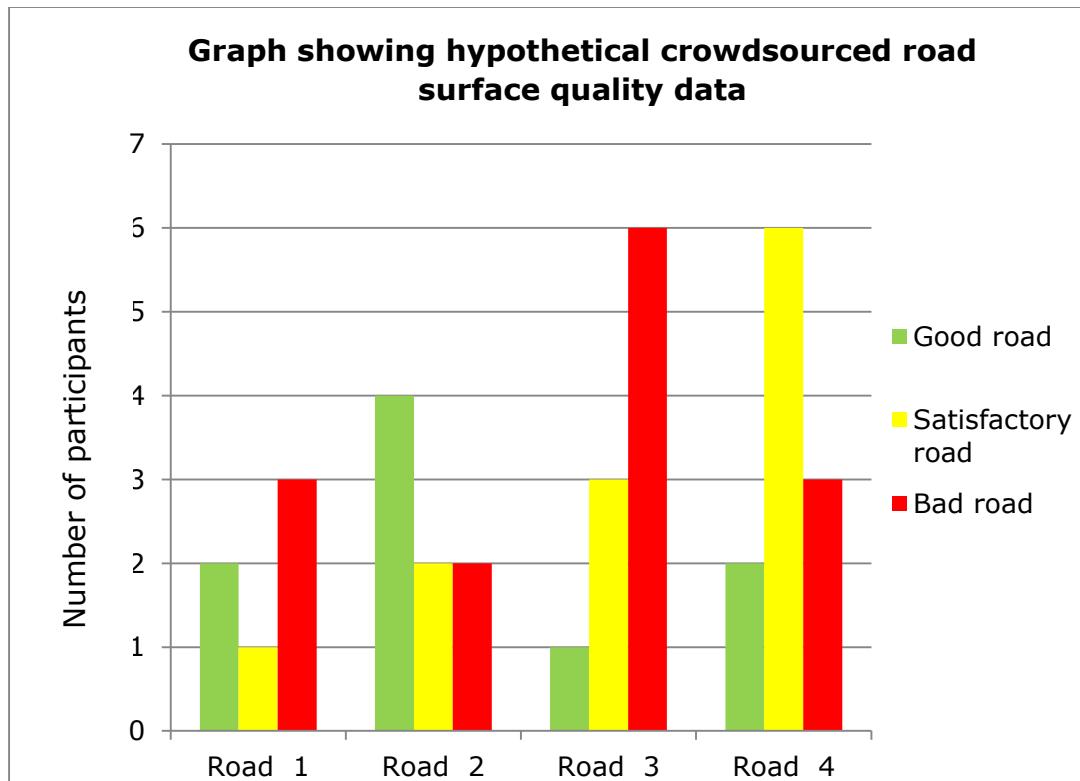
Figure 3.6

From the graph, it shows clearly the quality of each given road. The most frequent submission of the various roads will be selected as the road quality, and this information will be represented into Google Maps.

3.6 Experimentation and results

In collecting data for this project, interviews were conducted. The interviews enabled the researcher to understand the navigation decisions of users of the application. Each user was interviewed to find out how easy it was to use any of the maps to navigate and decisions that were made as to which route to use. This helped compare which of the maps

improved the navigation of users. However, based on the interviews, the researcher was able to draw conclusions about whether the modified Google Maps improve the navigation of users. There was a comparison of the use of the regular Google Maps and the modified Google Maps. This helped determine the preferable map by users and then conclude on whether or not the modified Google Maps improves navigation of users on roads. The main tool for collecting data therefore is the interview guide contained in Appendix 1 of this report.

CHAPTER 4 – EXPERIMENTATION AND RESULTS

4.1 Purpose of Experimentation

A usability test was carried out to know whether or not participants understood the design of the application. Participants were asked if the information on the map easily conveyed the road surface quality. The testing was also to investigate if the participants would prefer a different design to relay the information on road surface quality that would be easily understood by every participant of the application. The purpose of testing was to answer the research question of whether or not the modified Google Maps improves the navigation of motorists.

4.2 Experimentation

The usability test was carried out through a field test. The selected locality was North Legon where there are different routes that lead to a selected location. That way, the participants were able to make decisions as to which route they wanted to use to their destination. During the test, participants were given a starting point and ending point to navigate. As such, participants had to make a choice on which routes to use to get to their end location. Within North Legon, the locality selected for the modified Google Maps to be used was between Wisconsin International University College and Abibitumi Kasa School junction. The locality selected for the regular Google Maps to be used was between Africa Institute of Organization Development and Solid Rock Foundation. An illustration of the start and end location in relation to the localities is shown below:

Table 4.0 Locality for Experiment

Point		Locality
A	Start Point	Wisconsin International University College
B	End Point	Abibitumi Kasa School Junction
C	Start Point	Africa Institute of Organization Development
D	End Point	Solid Rock Foundation

Below are images for the locations used.
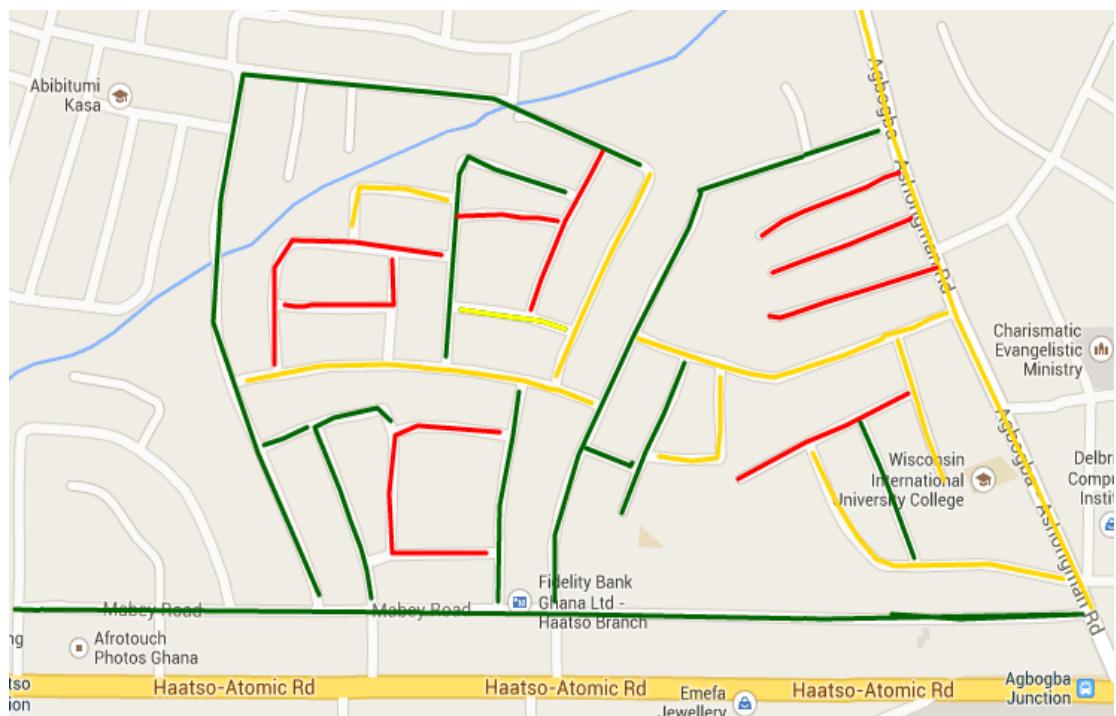
Figure 4.0: Modified Google Maps from Wisconsin International to Abibitumi Kasa School Junction
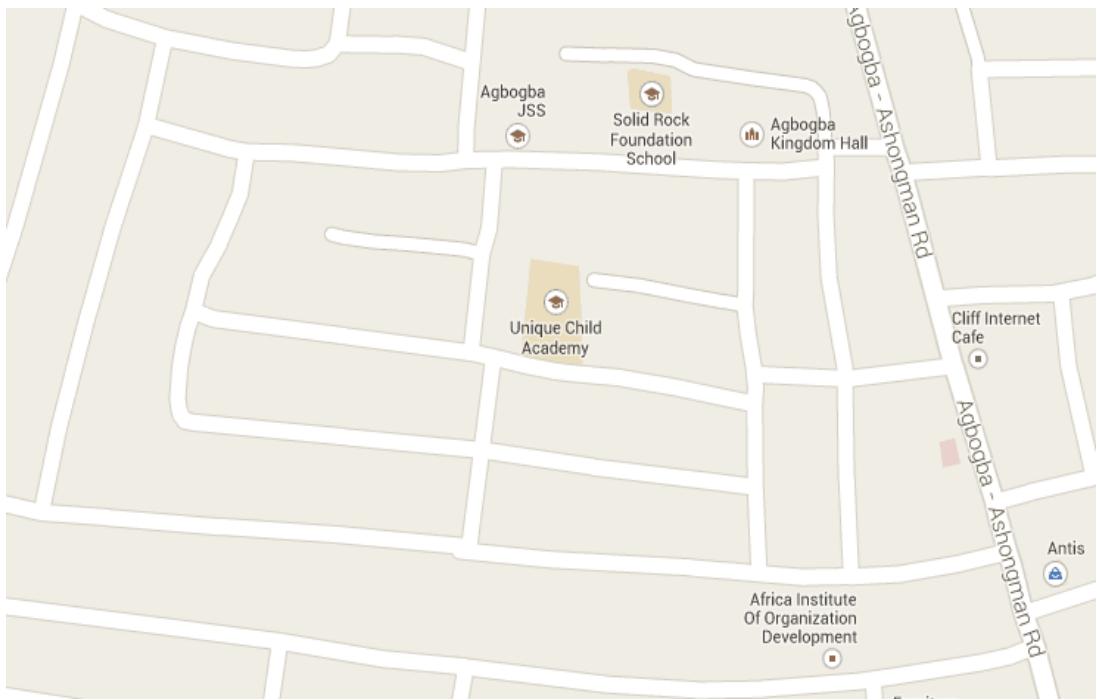
Figure 4.1: Regular Google Maps from Africa Institute of Organization Development to Solid Rock Foundation

4.2.1 Criteria for Selecting Participants

The participants were selected based on the following criteria:

- **Familiarity**: The selected participants were not familiar with the given routes

- **Experience with Google Maps**: The participants had to have experience with the use of Google Maps

- **Driving Experience:** The participants had to be comfortable with driving

The experiment involved ten (10) selected participants. These participants included students, commercial drivers and workers. This group of people was selected because they represented the kind of participants for which the application is intended. The ten (10) participants were split into two groups, of five (5). Group 1 was first exposed to the regular Google Maps

(experiment 1), while Group 2 was exposed to the modified Google Maps (experiment 2). The groups swapped routes after their initial use of the two applications. At the end of the experiments, both groups had used both the regular and modified Google Maps for navigation within two different given localities.

Below is an illustration of the experiments that were carried out.

Table 4.1: Illustration of Experiment

Route	Experiment 1 – Regular Google Maps	Experiment 2 – Modified Google Maps
A -> B	Group 1	Group 2
C -> D	Group 2	Group 1

4.3 Findings

While the participants were navigating, the researcher observed the test participants' interaction and navigation decisions and later interviewed them using an interview guide found in Appendix 1. The researcher was looking out for the following:

- Whether the modified Google Maps design was understood by the participants
- Whether participants considered the road surface quality on the map when making navigation decisions
- Whether the modified Google Maps improved the participants' navigation and what their changes were
- Whether there were times participants turned around because they were confused.

Below is a summary of some responses of the participants.

Driver A

Driver A found the use of Google Maps very useful when he needed directions. He said Google Maps has a lot of features that aided him to get to a specific location but did not inform him on road surface quality that he will be encountering ahead of his journey. He was concerned about the extra information when navigating because it would have helped him to be more careful when driving. In so doing he would not have to send his car for repairs as often as he does. Finally, he said: "I am not saying the regular Google Maps is not good but I tend to prefer this modified Google Maps more because I am able to dodge all these bad routes".

Driver B

This driver said he felt a complete difference after using the modified Google Maps before the regular Google Maps. He said the modified Google Maps made him navigate slowly on the routes because he was not used to the application. However, he thinks that with time he will get familiar with it if implemented. He said again that this modified map was good because it helped him to avoid using a bad route that he had not foreseen during navigation.

Worker A

Worker A was excited about the application because it helped him plan his route right from the beginning to his destination. "One really important thing that I liked about the application was that even if there were no

good roads, this application helped me drive carefully on the routes" he said. This was relevant for this driver because, he was able to foresee the road surface quality based on the information on the modified Google Maps.

Worker B

Worker B also considered the quality of roads when he used the modified Google Maps. He decided to navigate by choosing good, satisfactory and bad routes in order to have an experience of navigating with all the road surface qualities. He said this application helped him limit his speed based on the road surface quality. For the regular Google Maps, there was no indication of road quality and there were times where he bumped into potholes that he felt could have affected his car tyre.

Student A

Student A saw the need to have the road surface quality on maps because it helped her navigate in a well-mannered way. This is because even when she knowingly navigated on the bad roads, she slowed down because she hated the fact that the car shook when she entered into a pothole without knowing ahead of time. However this application solves that problem of entering into a pothole that can even lead to accidents because it rather informs you of the road surface quality ahead of time. Google Maps does help in providing directions to locations but does not provide detailed information on the nature of routes leading to destinations. "I will be glad if this is implemented because it is helpful," she said.

Student B

Student B said that the modified Google Maps made him drive carefully compared to the regular Google Maps. With the regular Google Maps he said it did not have information on the road surface quality and therefore navigated on the routes whether good or bad. But the modified Google Maps got him to plan his routes carefully so as to avoid bad routes.

4.3.1 Data Analysis

The following are the data gathered after the experiment with ten (10) participants, in which each of them had the chance to use both applications with a given start and end location for navigation.

Table 4.2: Responses for from interviews

Questions	Regular Google Maps		Modified Google Maps	
	Yes	No	Yes	No
Understood visual design of routes	10	-	10	-
Easy use of application	8	2	8	2
Improved navigation	6	4	8	2

In the table above, respondents had to choose a "Yes" or "No" in response to the questions. Figure 4.3 is a graphical representation of these responses.
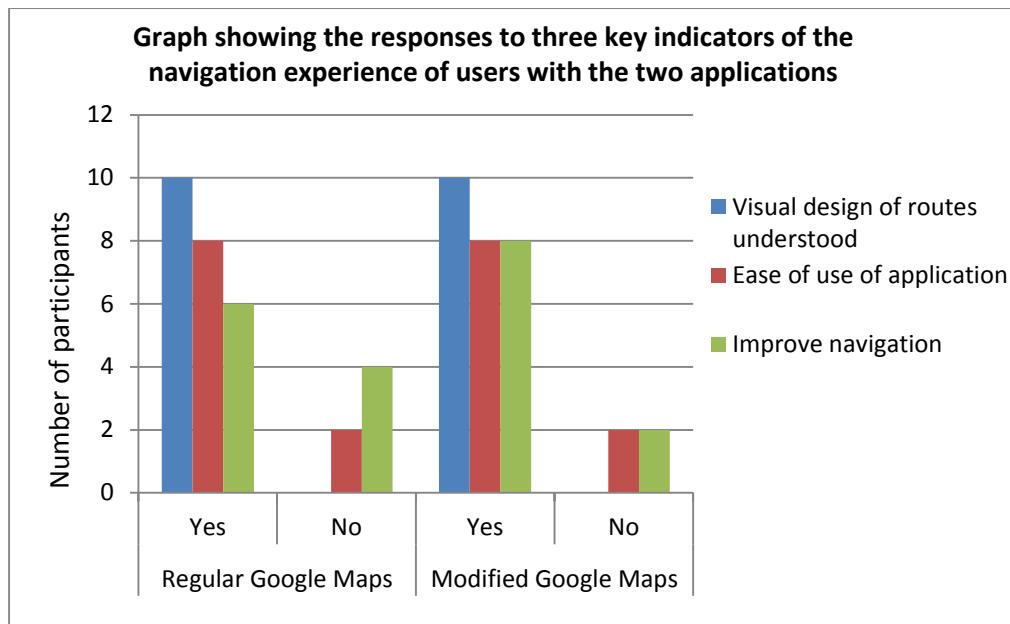
Figure 4.3

From the above graph, all participants said the visual representation of the routes on regular Google Maps was understood and the representation of the road surface quality on the modified Google Maps was also understood. Participants were able to interpret the colors of the road surface quality on the modified Google Maps. They understood the red color as bad routes, yellow color as satisfactory routes and green color as good routes. 80 percent of the participants said it was easy to use Google Maps and the modified Google Maps for navigation. 80 percent of the participants mentioned that the modified Google Maps provided improved navigation. However, only 60 percent considered that regular Google Maps provided improved navigation. This shows that, out of the ten participants, there were 20 percent more that preferred the modified Google Maps. These participants took into consideration the road surface quality while navigating on the various roads to be able to get to their

destination. In doing that, it helped them know ahead of time the quality of road they would be encountering throughout their entire journey.

Also, participants found the modified Google Maps exciting because the modified Google helped them drive very carefully on even bad roads. For the 60 percent of participants that said the regular Google Maps improved their navigation, their basis for navigation was based on the use of shortest routes to their end goal location. Others that had no improvement in navigation said all they cared about was simply getting to their goal destination regardless of the length of the route.

Below is the graph for participants' overall rating of their navigation experience on the routes with both applications.

Table 4.3: Results for navigation experience

Overall Navigation Experience Rating	Regular Google Maps	Modified Google Maps
Excellent	5	8
Satisfactory	4	1
Bad	1	1
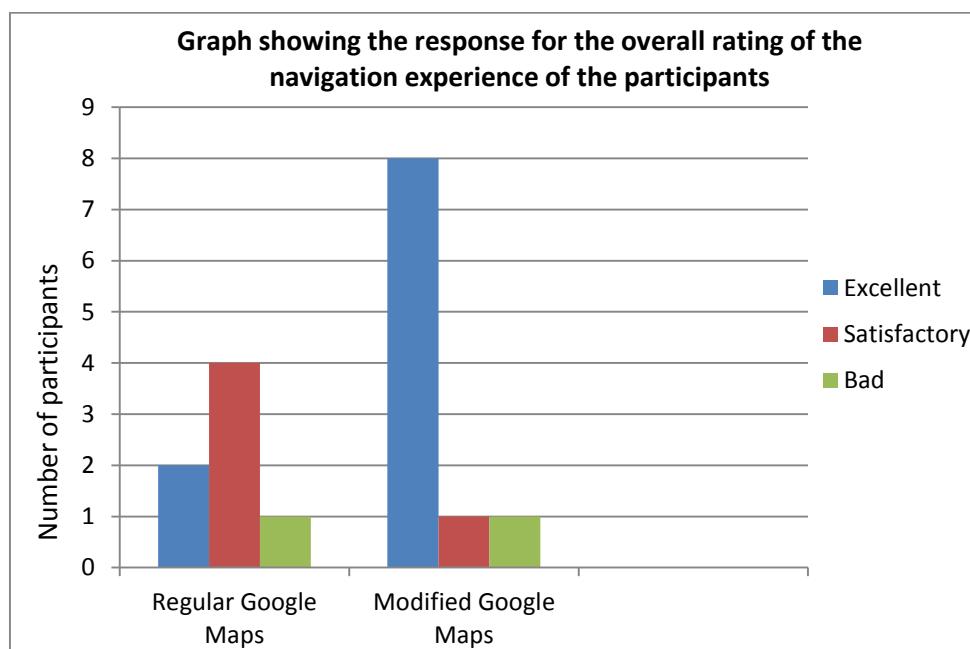
Figure 4.4

From analysing Figure 4.4, participants rated the application based on their navigation experience on the route and also how it changed their navigation route during the course of their journey. According to the data collected, 80 percent of the participants had an excellent navigation experience on their routes using the modified Google Maps. However, only 50 percent had an excellent navigation experience using regular Google Maps. Many realized the importance of having the road surface quality on maps. Also participants did not care about the distance rather; the main factor they considered was the road surface quality they were driving on.

4.3.2 Observation

From observation, five factors influenced the overall navigation experience of the participants. Two of these factors influenced their overall experience during the use of regular Google Maps while three of the factors influenced their experience in the use of the modified Google Maps.

Table 4.4 is a summary of the number of participants that were influenced by those factors:

Table 4.4: Navigation decision

Reasons for choice of navigation	Regular Google Maps	Modified Google Maps
Shortest routes	7	0
Just Navigating	3	0
Good roads	0	6
Satisfactory roads	0	1
Bad roads	0	3
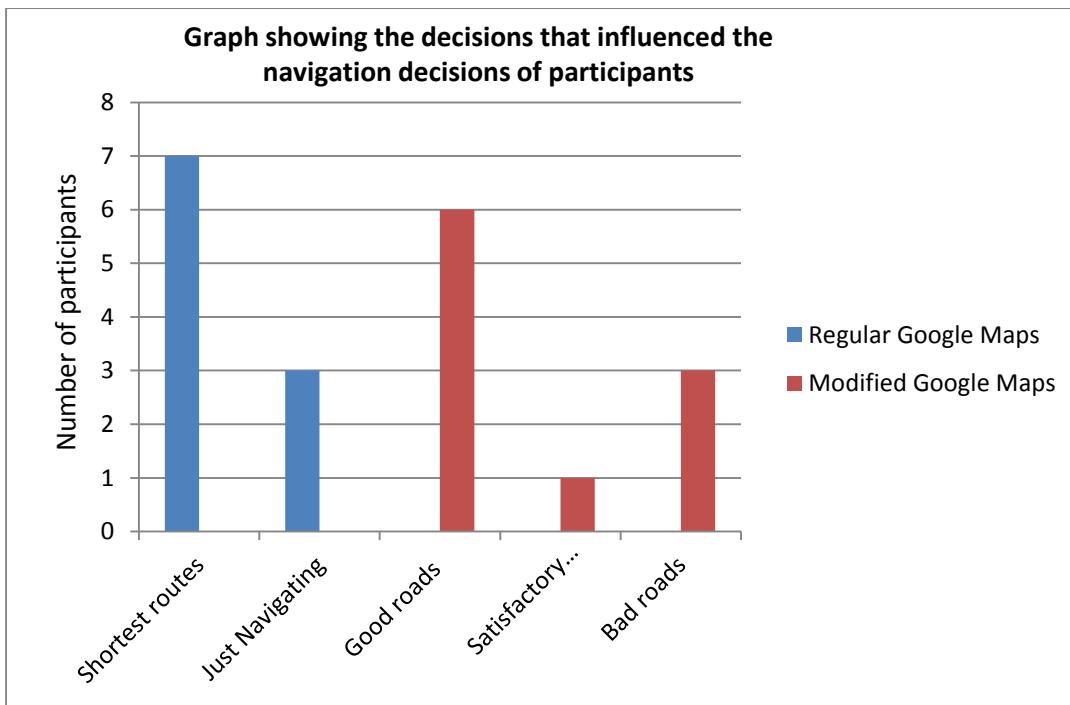
Figure 4.5

60 percent of the participants considered using only good routes for navigation of the modified Google Maps. Most of these participants made this choice to prevent their cars from developing faults and also to prevent the discomfort in their bodies when using bad roads. Since the participants were looking out for the road surface quality during their navigation, they considered the good routes in order to plan during and ahead of their journey. This influenced their overall rating of their navigation which majority of the users considered to be excellent as shown in Figure 4.4.

Also from observation, 70 percent of the participants made a decision on the route to take by considering the shortest route to their destination when they used the regular Google Maps. The rest of the participants just navigated to get to their destination without considering the length of the route to their destination.

CHAPTER 5 – CONCLUSION

5.1 Conclusion

The aim of this research was to investigate whether information about road surface quality on Google Maps would improve the navigation of road users, especially motorists. In order to do this, this research investigated a variety of Geographical Information Systems that existed and decided to embed this quality of road feature into a map. Already existing GIS systems are ArcView and Google Maps. ArcView is a desktop application that helps visualize, analyse, and make decision based on a particular data [1]. Google Maps is GIS mostly used for directional purpose, tracking positions and locations using POI and GPS [2].

Data indicating the different road surface quality was embedded as extra information into a GIS system to help improve user navigation. The implementation of the extra information was embedded into the GIS, Google Maps and this was successfully done with the guidelines from the Google Maps API. The major question after implementation was whether having the quality of roads feature improves the navigation of users. In this research, improved navigation focused on the decisions that users made as to whether they considered the information about the quality of roads during their navigation.

Based on the tests conducted and the data analysis performed, this research was able to show that having the quality of roads on maps can improve navigation. Users with the modified Google Maps made decisions based on the quality of roads right from the start location before the journey began to determine the best route to commute on. It was

interesting to also note that most users with the regular Google Maps made navigation decisions based on shortest route to their destination and this was not the case for the users of the modified Google Maps.

Having tested both maps, users indicated the importance and relevance of the modified map. The information on quality of roads helped users decide the best routes to use if available and even know how well to navigate on bad routes to avoid any accident. Apart from the modified Google Maps significantly reducing accidents due to the poor nature of roads in Ghana, it is hoped that this application will contribute to the development of Ghana's road infrastructure. Given that the system captures the quality of roads in the country, the government can keep track of roads that need to be maintained and constructed. Different sectors of the economy will be positively affected by government's use of this application, especially the agricultural sector that loses millions of cedi annually due to poor road infrastructure.

5.2 Future Work

There are a number of features that will need to be implemented to get the system to a standard level for a large-scale use. This application was implemented to help users plan their routes ahead of time and during their journey. According to the users, features they suggested were voice aided interface and time interval at which they were approaching any bad road. This would help notify users ahead of time the road surface quality they would be plying. This will help them not lose concentration when driving so that any unnecessary accidents are avoided.

With this application, the researcher found question that could be further researched into which is, how best can the road surface quality information be updated on Google Maps? And also, is it possible to have a more efficient way of collecting data that will be displayed on the map? These questions were posed to help further study of this research.

Finally, the researcher will like to propose a design concept on how the modified Google Maps can display the road surface quality data in real time. This can be done using the technique of crowdsourcing as stated in the literature. This will help update the displayed road surface quality information on maps and also keep track of roads changed over time.

Therefore this research further recommends a follow-up whereby possible features could be investigated for implementation.

APPENDIX

Appendix 1

<u>Interview guide questions for participants</u>

Interview Questions on the Use of Google Maps for Navigation

Section1: Regular Google Maps

Please respond by drawing a circle around your answers

1. Is it easy to use Google Maps for your navigation?
   a. Yes
   b. No
2. Was the design of the routes easily understood on Google Maps?
   a. Yes
   b. No
3. Did you encounter any difficulty identifying the routes to your destination?
   a. Yes
   b. No
4. On what basis did you select your route from among the other routes provided for your destination?
   a. Shortest route
   b. Easy to identify route
   c. Others
5. What is your rating experience for the use of regular Google Maps
   a. 1 - Bad
   b. 2 - Satisfactory
   c. 3 - Excellent
6. Were there times you lost your way because you were confused about the directions you were following?
   a. Yes
   b. No

Section 2: Modified Google Maps

7. Was it easy to use the modified Google Maps?
   a. Yes
   b. No
8. Was it easy to understand the design of the quality of roads?
   a. Yes
   b. No.
9. On what basis did you choose the route you selected from the other routes provided?
   a. Shortest route
   b. Quality of road
   c. Others
10. Did this modified Google Map improve your navigation?
    a. Yes
    b. No
11. Were there times you lost your way because you were confused about the directions you were following?
    c. Yes

          d. No

12.What is your rating for this modified Google Maps
          a. 1 - Bad
          b. 2 - Satisfactory
          c. 3 - Excellent

Appendix 2

HTML and Java Script Code for Initial Prototype for embedding the quality of roads feature into Google Maps

```html
<!DOCTYPE html>

<html>

  <head>

    <meta name="viewport" content="initial-scale=1.0, user-scalable=no" />

    <style type="text/css">

      html { height: 100% }

      body { height: 100%; margin: 0; padding: 0 }

      #map-canvas { height: 100% }

    </style>

    <script type="text/javascript"
src="https://maps.googleapis.com/maps/api/js?key=AIzaSyAoewcFgT3syjf8WFr6PHObuPpYkroolGI&s
ensor=false">

    </script>

    <script type="text/javascript">

     var bMap;

          var poly1; var poly2; var poly3; var poly4;

          var canvas = document.getElementById("map-canvas");

          function initialize() {

      var mapOptions = {

        center: new google.maps.LatLng(5.6697999,-0.1893128),

        zoom: 15,

        mapTypeId: google.maps.MapTypeId.ROADMAP

      };

      bMap = new google.maps.Map(document.getElementById("map-canvas"),  mapOptions);

                  var latlngArr = Array(

                  new google.maps.LatLng(5.668476031297684, -0.18811117036136693,false),

                  new google.maps.LatLng(5.670324063169123, -0.18903401017314536,false),

                  new google.maps.LatLng(5.672300204760333, -0.19004268067328667,false),

                  new google.maps.LatLng(5.674810152605306, -0.1910084358291897,false),

                  new google.maps.LatLng(5.677944136251059, -0.1918560938331666,false),

                  new google.maps.LatLng(5.679241803948201, -0.19218876770628412,false),

                  new google.maps.LatLng(5.681678010992604, -0.19289719070741285,false),

                  new google.maps.LatLng(5.686719166115784, -0.19450683593754547,false));

              var polyOptions = {

                      draggable:false,
```

```
                        editable:false,

                        strokeColor: "#FFD700",

                        map:bMap,

                        path:latlngArr

                };

poly1 = new google.maps.Polyline(polyOptions);

                var latlngArr = Array(

                new google.maps.LatLng(5.668561442273317, -0.19583593232425756,false),

                new google.maps.LatLng(5.6694427533941045, -0.19584137669767188,false),

                new google.maps.LatLng(5.670494884560802, -0.19550349831706626,false),

                new google.maps.LatLng(5.672086678680951, -0.19469899552314018,false),

                new google.maps.LatLng(5.673507647959803, -0.19391595040133325,false),

                new google.maps.LatLng(5.673967750136865, -0.19373372009886225,false),

                new google.maps.LatLng(5.674012499889906, -0.19375622238464985,false),

                new google.maps.LatLng(5.674783235506319, -0.19118089675907868,false));

        var polyOptions = {

                        draggable:false,

                        editable:false,

                        strokeColor: "#006400",

                        map:bMap,

                        path:latlngArr

                };

                poly2 = new google.maps.Polyline(polyOptions);

                var latlngArr = Array(

                new google.maps.LatLng(5.668390620309392, -0.19098649842533177,false),

                new google.maps.LatLng(5.668330651440399, -0.18999791077271766,false),

                new google.maps.LatLng(5.668395732034461, -0.18824999519802077,false),

                new google.maps.LatLng(5.668332184958108, -0.1920108945885204,false),

                new google.maps.LatLng(5.668396754379464, -0.19564304794619147,false),

                new google.maps.LatLng(5.668441504564591, -0.2036048889160611,false));

        var polyOptions = {

                        draggable:false,

                        editable:false,

                        strokeColor: "#006400",

                        map:bMap,

                        path:latlngArr

                };

                poly3 = new google.maps.Polyline(polyOptions);

                var latlngArr = Array(
```

```javascript
                    new google.maps.LatLng(5.674348006431471, -0.19461284501346654),
                    new google.maps.LatLng(5.675227548753513, -0.19671416214600868),
                    new google.maps.LatLng(5.675548858430863, -0.20033066460109694),
                    new google.maps.LatLng(5.673872813815952, -0.20065934579338318),
                    new google.maps.LatLng(5.672260822149819, -0.2007519925922452),
                    new google.maps.LatLng(5.67052070997419, -0.20010434970311053),
                    new google.maps.LatLng(5.668652476131444, -0.19924213009267078));
        var polyOptions = {
                        draggable:false,
                        editable:false,
                        strokeColor: "#006400",
                        map:bMap,
                        path:latlngArr
        };
                poly4 = new google.maps.Polyline(polyOptions);
                var latlngArr = Array(
                new google.maps.LatLng(5.671177147281743, -0.19529949052127904),
                new google.maps.LatLng(5.671362734099431, -0.1957700245727665),
                new google.maps.LatLng(5.6713841825820746, -0.19593338698746265),
                new google.maps.LatLng(5.671491041605977, -0.1962898684512311),
                new google.maps.LatLng(5.6716193490839855, -0.1972388657720785),
                new google.maps.LatLng(5.671694466658499, -0.19825709585688855),
new google.maps.LatLng(5.671668159252087, -0.19922168176140076),
                new google.maps.LatLng(5.671492383426616, -0.20026136951832996));
        var polyOptions = {
                        draggable:false,
                        editable:false,
                        strokeColor: "#FFD700",
                        map:bMap,
                        path:latlngArr
        };
                poly5 = new google.maps.Polyline(polyOptions);
                var latlngArr = Array(
                new google.maps.LatLng(5.672372894193515, -0.19020329339298314),
                new google.maps.LatLng(5.672323602040011, -0.19040560654298133),
                new google.maps.LatLng(5.672195582251289, -0.1906762573182732),
                new google.maps.LatLng(5.672079567288357, -0.19110768876737438),
                new google.maps.LatLng(5.672048962761558, -0.1911314244462119),
                new google.maps.LatLng(5.671816932753354, -0.19165096459039432),
```

```
                new google.maps.LatLng(5.671523693544153, -0.19269004487887287),

                new google.maps.LatLng(5.671569247595011, -0.1930218303921265),

                new google.maps.LatLng(5.671678859526758, -0.19346090426586215),

                new google.maps.LatLng(5.672047551640511, -0.1946394594231151));

        var polyOptions = {

                        draggable:false,

                        editable:false,

                        strokeColor: "#FFD700",

                        map:bMap,

                        path:latlngArr

        };

                poly6 = new google.maps.Polyline(polyOptions);

                var latlngArr = Array(

                new google.maps.LatLng(5.67423056751459, -0.19088993890079564),

                new google.maps.LatLng(5.674181275519858, -0.19109225205079383),

                new google.maps.LatLng(5.6740532561434645, -0.1913629028260857),

                new google.maps.LatLng(5.673733686797954, -0.19225016260043049),

                new google.maps.LatLng(5.673595254615216, -0.19255431761882846),

                new google.maps.LatLng(5.673414117275337, -0.192869201473286));

        var polyOptions = {

                        draggable:false,

                        editable:false,

                        strokeColor: "#FF0000",

                        map:bMap,

                        path:latlngArr

        };

                poly7 = new google.maps.Polyline(polyOptions);

                var latlngArr = Array(

                new google.maps.LatLng(5.6736326962941055, -0.19070754868778295),

                new google.maps.LatLng(5.673626109359635, -0.19072747162476844),

                new google.maps.LatLng(5.6732852351323295, -0.19164813284419324),

                new google.maps.LatLng(5.6729123318324515, -0.19271899776845203));

        var polyOptions = {

                        draggable:false,

                        editable:false,

                        strokeColor: "#FF0000",

                        map:bMap,

                        path:latlngArr

        };
```

```
        poly8 = new google.maps.Polyline(polyOptions);
        var latlngArr = Array(
        new google.maps.LatLng(5.672981443009395, -0.19035349709781713),
        new google.maps.LatLng(5.6726746419621055, -0.19139140814638722),
        new google.maps.LatLng(5.6725239104517335, -0.19191841029760326),
        new google.maps.LatLng(5.672368472431885, -0.19246086111081695),
        new google.maps.LatLng(5.672325451387257, -0.192597976066736),
        new google.maps.LatLng(5.67233047369785, -0.19275654869466052));
var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#FF0000",
                map:bMap,
                path:latlngArr
};
        poly9 = new google.maps.Polyline(polyOptions);
        var latlngArr = Array(
        new google.maps.LatLng(5.672020576164555, -0.19091139657291478),
        new google.maps.LatLng(5.671211987684268, -0.1906403896222173),
        new google.maps.LatLng(5.670772994946881, -0.1904914751016804),
        new google.maps.LatLng(5.670163180436174, -0.19024600105672107));
var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#FFD700",
                map:bMap,
                path:latlngArr
};
        poly10 = new google.maps.Polyline(polyOptions);
        var latlngArr = Array(
        new google.maps.LatLng(5.668860380588557, -0.1885188661316306),
        new google.maps.LatLng(5.669043284498706, -0.18957962787681026),
        new google.maps.LatLng(5.669034013859204, -0.1909622547040044),
        new google.maps.LatLng(5.669113454888027, -0.19120429810755013),
        new google.maps.LatLng(5.669406423056184, -0.19148925685522045),
        new google.maps.LatLng(5.6698595363051485, -0.1917956732751236),
        new google.maps.LatLng(5.670526175934275, -0.19212354736714587));
var polyOptions = {
                draggable:false,
```

```
                    editable:false,

                    strokeColor: "FFD700",

                    map:bMap,

                    path:latlngArr


        };
        poly11 = new google.maps.Polyline(polyOptions);


        var latlngArr = Array(
        new google.maps.LatLng(5.671315939461122, -0.19075046403202123),
        new google.maps.LatLng(5.670891697931393, -0.19167035788393605),
        new google.maps.LatLng(5.670666231634445, -0.19221881770727123),
        new google.maps.LatLng(5.670184533118844, -0.1931964309731029));
var polyOptions = {
                    draggable:false,

                    editable:false,

                    strokeColor: "#FF0000",

                    map:bMap,

                    path:latlngArr

};
        poly12 = new google.maps.Polyline(polyOptions);
        var latlngArr = Array(
        new google.maps.LatLng(5.6691379660283605, -0.19067536217960424),
        new google.maps.LatLng(5.669941503951878, -0.1910051700482427),
        new google.maps.LatLng(5.670207149165961, -0.19110301875707592),
        new google.maps.LatLng(5.670388015247284, -0.19118412961972808),
        new google.maps.LatLng(5.670921200187401, -0.19143690185933337));
var polyOptions = {
                    draggable:false,

                    editable:false,

                    strokeColor: "#006400",

                    map:bMap,

                    path:latlngArr

};
        poly13 = new google.maps.Polyline(polyOptions);
                    var latlngArr = Array(
        new google.maps.LatLng(5.669735841906843, -0.1948810659149558),
        new google.maps.LatLng(5.670543311446009, -0.19453098571830196),
        new google.maps.LatLng(5.671030490179472, -0.1942881938824712),
```

46

```javascript
                    new google.maps.LatLng(5.6717112478823815, -0.19396890716939197));
        var polyOptions = {
                    draggable:false,
                    editable:false,
                    strokeColor: "#006400",
                    map:bMap,
                    path:latlngArr
        };
            poly14 = new google.maps.Polyline(polyOptions);
            var latlngArr = Array(
            new google.maps.LatLng(5.670483185883936, -0.19434462411197728),
            new google.maps.LatLng(5.670406485305286, -0.19386917660403924),
            new google.maps.LatLng(5.670457900763648, -0.1935010174565832),
            new google.maps.LatLng(5.670816963630169, -0.19347280234194386),
            new google.maps.LatLng(5.6715190742183115, -0.1934539230385326));
        var polyOptions = {
                    draggable:false,
                    editable:false,
                    strokeColor: "#FFD700",
                    map:bMap,
                    path:latlngArr
        };
            poly15 = new google.maps.Polyline(polyOptions);
            var latlngArr = Array(
            new google.maps.LatLng(5.671550818457886, -0.19582520348819799),
            new google.maps.LatLng(5.672387925535346, -0.19542654719339225),
            new google.maps.LatLng(5.6731823262569385, -0.19502789089847283),
            new google.maps.LatLng(5.673717265753695, -0.19472370459129706),
            new google.maps.LatLng(5.674209499689203, -0.1944624336281322));
        var polyOptions = {
                    draggable:false,
                    editable:false,
                    strokeColor: "#FFD700",
                    map:bMap,
                    path:latlngArr
        };
            poly16 = new google.maps.Polyline(polyOptions);
                var latlngArr = Array(
            new google.maps.LatLng(5.672415599394483, -0.19618998391422338),
```

```
            new google.maps.LatLng(5.672825653684395, -0.19603809084878776),
            new google.maps.LatLng(5.673598701247596, -0.1956930787341662),
            new google.maps.LatLng(5.674176345428761, -0.19534597708275214),
            new google.maps.LatLng(5.674519111338927, -0.1951490791359447));
    var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#FF0000",
                map:bMap,
                path:latlngArr
    };
        poly17 = new google.maps.Polyline(polyOptions);
        var latlngArr = Array(
        new google.maps.LatLng(5.671796373670436, -0.1974130712250144),
        new google.maps.LatLng(5.674219261519894, -0.1972254970587528),
        new google.maps.LatLng(5.674454209675555, -0.1970938326360283),
        new google.maps.LatLng(5.674283670821213, -0.19669592097739041),
        new google.maps.LatLng(5.673985298045985, -0.19568552093892322));
    var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#006400",
                map:bMap,
                path:latlngArr
    };
        poly18 = new google.maps.Polyline(polyOptions);
        var latlngArr = Array(
        new google.maps.LatLng(5.671689610547383, -0.19988070351871556),
        new google.maps.LatLng(5.6729808132797075, -0.19988624840152625),
        new google.maps.LatLng(5.673343877346242, -0.1996258379460869),
        new google.maps.LatLng(5.673322806145841, -0.19873439982870877),
        new google.maps.LatLng(5.6731525483223075, -0.1974665077248119));
    var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#FF0000",
                map:bMap,
                path:latlngArr
    };
```

```
      poly19 = new google.maps.Polyline(polyOptions);
      var latlngArr = Array(
      new google.maps.LatLng(5.673525933510926, -0.19876490456852025),
      new google.maps.LatLng(5.674048792937311, -0.1986485691402322),
      new google.maps.LatLng(5.674027721762636, -0.19799316541616463),
      new google.maps.LatLng(5.673878535328096, -0.19738067703633533));
var polyOptions = {
            draggable:false,
            editable:false,
            strokeColor: "#FFD700",
            map:bMap,
            path:latlngArr
};
      poly20 = new google.maps.Polyline(polyOptions);
      var latlngArr = Array(
      new google.maps.LatLng(5.672479657190085, -0.19973049981388158),
      new google.maps.LatLng(5.6724633278767636, -0.1995723397144502),
      new google.maps.LatLng(5.672468351161116, -0.19945709495914343),
      new google.maps.LatLng(5.672489774099884, -0.19934688820853808),
      new google.maps.LatLng(5.672479801215664, -0.19815899001287107),
      new google.maps.LatLng(5.67308849060145, -0.19817461090474353));
var polyOptions = {
            draggable:false,
            editable:false,
            strokeColor: "#FF0000",
            map:bMap,
            path:latlngArr
};
      poly21 = new google.maps.Polyline(polyOptions);
      var latlngArr = Array(
      new google.maps.LatLng(5.668550765902065, -0.19666205270084447),
      new google.maps.LatLng(5.669815599655619, -0.19663263863412794),
      new google.maps.LatLng(5.670750238238677, -0.19644237624333982),
      new google.maps.LatLng(5.671337576810128, -0.19635070877461658));
var polyOptions = {
            draggable:false,
            editable:false,
            strokeColor: "#006400",
            map:bMap,
```

```
                    path:latlngArr
};

        poly22 = new google.maps.Polyline(polyOptions);

        var latlngArr = Array(

        new google.maps.LatLng(5.6691913478284475, -0.1968337140777976),

        new google.maps.LatLng(5.669204535844254, -0.19819229806012117),

        new google.maps.LatLng(5.669986421197815, -0.19822050637094435),

        new google.maps.LatLng(5.670750238238677, -0.19813753234075193),

        new google.maps.LatLng(5.6708837626983195, -0.19781274886884148),

        new google.maps.LatLng(5.67080376057282, -0.1966296585121654));

var polyOptions = {

                    draggable:false,

                    editable:false,

                    strokeColor: "#FF0000",

                    map:bMap,

                    path:latlngArr

};

        poly23 = new google.maps.Polyline(polyOptions);

        var latlngArr = Array(

        new google.maps.LatLng(5.668593471385964, -0.19848595483097142),

        new google.maps.LatLng(5.668970441240363, -0.19854665108891822),

        new google.maps.LatLng(5.669261999989198, -0.19862880501909785),

        new google.maps.LatLng(5.66963159005711, -0.1987931128794571),

        new google.maps.LatLng(5.67002912657547, -0.198928609550876),

        new google.maps.LatLng(5.670857001535567, -0.19929624663518553),

        new google.maps.LatLng(5.67099052597049, -0.19901437850751336),

        new google.maps.LatLng(5.67111066979884, -0.19839064682105345),

        new google.maps.LatLng(5.670953229169046, -0.19819606857686267));

var polyOptions = {

                    draggable:false,

                    editable:false,

                    strokeColor: "#006400",

                    map:bMap,

                    path:latlngArr

};

        poly24 = new google.maps.Polyline(polyOptions);


        var latlngArr = Array(

        new google.maps.LatLng(5.672415599394547, -0.19719849450382299),
```

```
            new google.maps.LatLng(5.672344162276681, -0.1965725452539573),

            new google.maps.LatLng(5.672263711639284, -0.19603030288794798),

            new google.maps.LatLng(5.672170329154087, -0.19568552093892322));

    var polyOptions = {

            draggable:false,

            editable:false,

            strokeColor: "#006400",

            map:bMap,

            path:latlngArr

    };

        poly25 = new google.maps.Polyline(polyOptions);

        var latlngArr = Array(

        new google.maps.LatLng(5.672415599394547, -0.19719849450382299),

        new google.maps.LatLng(5.672344162276681, -0.1965725452539573),

        new google.maps.LatLng(5.672263711639284, -0.19603030288794798),

        new google.maps.LatLng(5.672170329154087, -0.19568552093892322));

    var polyOptions = {

            draggable:false,

            editable:false,

            strokeColor: "#FFFF00",

            map:bMap,

            path:latlngArr

    };

        poly26 = new google.maps.Polyline(polyOptions);


        var latlngArr = Array(

        new google.maps.LatLng(5.673654048848408, -0.1972306810120017),

        new google.maps.LatLng(5.673689374656604, -0.19659400292607643),

        new google.maps.LatLng(5.673649149433125, -0.196317517325042),

        new google.maps.LatLng(5.673640953039248, -0.19607321823218626),

        new google.maps.LatLng(5.673590275891072, -0.1958035381355785));

    var polyOptions = {

            draggable:false,

            editable:false,

            strokeColor: "#FF0000",

            map:bMap,

            path:latlngArr

    };

        poly27 = new google.maps.Polyline(polyOptions);
```

```
        var latlngArr = Array(
        new google.maps.LatLng(5.670579272896582, -0.1953853212097556),
        new google.maps.LatLng(5.670358366839764, -0.19474864312383033),
        new google.maps.LatLng(5.6704035520870235, -0.19472964958822558),
        new google.maps.LatLng(5.670344678213735, -0.19477356987385974));
    var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#006400",
                map:bMap,
                path:latlngArr
    };
        poly28 = new google.maps.Polyline(polyOptions);


        var latlngArr = Array(
        new google.maps.LatLng(5.67062197823037, -0.20003090722354955),
        new google.maps.LatLng(5.67072136221507, -0.1997482807275901),
        new google.maps.LatLng(5.6708678185473715, -0.19940842705159412));
    var polyOptions = {
                draggable:false,
                editable:false,
                strokeColor: "#006400",
                map:bMap,
                path:latlngArr
    };
        poly29 = new google.maps.Polyline(polyOptions);
         navigator.geolocation.getCurrentPosition (function (pos)
        {
         var lat = pos.coords.latitude;
         var lng = pos.coords.longitude;
         var mylocation = new google.maps.LatLng(lat,lng);
         var marker = new google.maps.Marker({
         position:mylocation,
         title:"currentlocation",
         map:bMap
         });
         bMap.setCenter(mylocation);
         });
}
```

```
                navigator.geolocation.watchPosition (function (pos)

                    {

                        var lat = pos.coords.latitude;

                        var lng = pos.coords.longitude;

                        var mylocation = new google.maps.LatLng(lat,lng);

                        var marker = new google.maps.Marker({

                        position:mylocation,

                        title:"currentlocation",

                        map:bMap

                        });

                        bMap.setCenter(mylocation);

                        });

                function update(){

                        document.getElementById("zoomVal").innerHTML = "Zoom: "+bMap.getZoom();

                        var latlngObj = bMap.getCenter();

                        document.getElementById("latlng").innerHTML = "Center: (" +
latlngObj.lat()+","+latlngObj.lng()+")";

                        document.getElementById("polyCod").innerHTML =
"Polyline1"+poly1.getPath().getArray() +"<br>"+"Polyline2"+poly2.getPath().getArray()
+"<br>"+"Polyline3"+poly3.getPath().getArray() +"<br>"+"Polyline4"+poly4.getPath().getArray()
+"<br>"+"Polyline5"+poly5.getPath().getArray() +"<br>"+"Polyline6"+poly6.getPath().getArray()
+"<br>"+"Polyline7"+poly7.getPath().getArray() +"<br>"+"Polyline8"+poly8.getPath().getArray()
+"<br>"+"Polyline9"+poly9.getPath().getArray() +"<br>"+"Polyline10"+poly10.getPath().getArray()
+"<br>"+"Polyline11"+poly11.getPath().getArray()
+"<br>"+"Polyline12"+poly12.getPath().getArray()
+"<br>"+"Polyline13"+poly13.getPath().getArray()
+"<br>"+"Polyline14"+poly14.getPath().getArray()
+"<br>"+"Polyline15"+poly15.getPath().getArray()
+"<br>"+"Polyline16"+poly16.getPath().getArray()
+"<br>"+"Polyline17"+poly17.getPath().getArray()
+"<br>"+"Polyline18"+poly18.getPath().getArray()
+"<br>"+"Polyline19"+poly19.getPath().getArray()
+"<br>"+"Polyline20"+poly20.getPath().getArray()
+"<br>"+"Polyline21"+poly21.getPath().getArray()
+"<br>"+"Polyline22"+poly22.getPath().getArray()
+"<br>"+"Polyline23"+poly23.getPath().getArray()
+"<br>"+"Polyline24"+poly24.getPath().getArray()
+"<br>"+"Polyline25"+poly25.getPath().getArray()
+"<br>"+"Polyline26"+poly26.getPath().getArray()
+"<br>"+"Polyline27"+poly27.getPath().getArray()
+"<br>"+"Polyline28"+poly28.getPath().getArray()
+"<br>"+"Polyline29"+poly29.getPath().getArray();;;;;;;;;;;;;;;;;;;;

            }

            google.maps.event.addDomListener(window, 'load', initialize);

    </script>

 </head>

 <body>

        <div id="zoomVal"></div>

        <div id="latlng"></div>

        <div id="polyCod" style=display:none></div>

    <div id="map-canvas"  onmouseup='update()'/>
```

```
    </body>
  </html>
```

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