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DEVELOPMENT OF WEB-BASED DATABASE FOR AFRICAN GEODETIC REFERENCE FRAME(AFREF), CORS AND IGS

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DEVELOPMENT OF WEB-BASED DATABASE FOR AFRICAN GEODETIC REFERENCE FRAME (AFREF), CORS AND IGS

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A Dissertation Submitted to the Department of Geospatial Sciences and Technology in Partially Fulfilment of the Requirements for the Award of Science in Geomatics (BSc. GM) of Ardhi University

CERTIFICATION

The undersigned certify that they have read and hereby recommend for the acceptance by the Ardhi University a dissertation title **``Development of web-based database for African Geodetic Reference Frame (AFREF), CORS and IGS''** in partial fulfillment of the requirements for Award of Bachelor of Science Degree in Geomatics of Ardhi University

…………………….

Dr. Elifuraha Saria

(supervisor)

Date………………

DECLARATION AND COPYRIGHT

I, KIRIA, PETRO A, hereby declare that the contents of this dissertation are results of my own study and findings to the best of my knowledge, it has not been presented anywhere for Diploma, Degree or any other professional award in any institution of Higher Learning.

……………………….

Kiria, Petro A

Date…………………….

(candidate)

DEDICATION

This study is dedicated to my loving family, whose unwavering support and encouragement have been the driving force behind my pursuit of knowledge. I am grateful for their patience, understanding, and belief in my abilities throughout this journey.

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ABSTRACT

African Geodetic Reference Frame (AFREF) is a system of coordinates used to reference positions on the Earth's surface in the African continent, it provides a common reference system for geospatial data and is used in various applications such as navigation, surveying, mapping, and satellite positioning. It is a key component of the global geospatial infrastructure that provides high-precision geodetic data and products. Web databases is an organized collection of logically related data and its description, designed to meet the information needs of an organization, it provides an efficient way to store, retrieve and analyze data in web format. This study aims on producing a web-based database for African Geodetic Reference Frame (AFREF), Continuous Observing Reference Stations (CORS) and International GNSS stations (IGS that enable seamless data sharing, analysis, and visualization across multiple users and organizations. To fulfill the aim of this research data were downloaded from https:// www.unavco.org, https:// www.noaa.gov and https://www.igs.org then downloaded data were cleaned to obtain required stations installed in African continent followed by planning, designing and deployment of the database using HTML and JavaScript computer language. The study has been successful in producing a web-based system that can be accessible to the user, the system includes IGS/CORS switch that enable user to switch IGS or CORS stations according to what they need, zoom-in-out tool, search tool and the management dashboard where the user can provide comments to the database developer.The language used in this database is English and not all people are capable of reading and understanding English and I would recommend study should be done to provide translation to the users. Also, the stations displayed in the database are 158 CORS and 26 IGS stations which are not only stations installed in African continents therefore recommend that the further study to include all the stations and feed on all other missing information in this database.

Keywords: Web databases, geographical information, African Geodetic Reference Frame, Continuous Observing Reference Stations, International GNSS stations, data availability, geodetic infrastructure, Laravel 10, Laravel breeze, JavaScript, HTML.

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LIST OF ACRONYMS ABBREVIATIONS

AFREF- African Geodetic Reference Frame

ITRF- International Terrestrial Reference Frame

SEGAL-Space and Earth Geodetic Analysis Laboratory

AGREFI- African Geodetic Reference Frame Initiative

ODC- Operational Data Centre

GNSS-Global Navigation Satellite System

IGS- International GNSS stations

CORS- Continuous Observing Reference Station

DBMS- Database Mismanagement System

URL-uniform Resource Locator

HTTP- Hyper Text Transfer Protocol

HTML- Hyper Text Markup Language

API- Application Programming Interface

ORM- Object Relation Mapping

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Geospatial reference frames are essential components of modern technology, providing a stable and accurate basis for positioning, navigation, and mapping. The African Geodetic Reference Frame (AFREF) is a system of coordinates used to reference positions on the Earth's surface in the African continent. It is a geodetic reference frame based on the International Terrestrial Reference Frame (ITRF) and is maintained by the African Geodetic Reference Frame Initiative (AGREFI). The AFREF provides a common reference system for geospatial data and is used in various applications such as navigation, surveying, mapping, and satellite positioning. It is a key component of the global geospatial infrastructure that provides high-precision geodetic data and products.

Several efforts have been made in recent years to improve geodetic infrastructure in Africa and establish Geodetic reference frame for African continent, this effort have been led by national geodetic organizations, international partnerships, private companies, and others, previous research has shown that the use of CORS and IGS stations can significantly improve the accuracy and reliability of geodetic measurements, especially in areas where traditional surveying techniques are limited.

Continuous Operating Reference Station (CORS) is a network of permanent, ground-based GPS (Global Positioning System) receivers that continuously collect GPS data. The data is then processed and made available to users, typically in real-time, to support a variety of applications such as surveying, mapping, engineering, and scientific research. CORS stations are strategically located to provide coverage over a specific geographic area and can be used to determine precise positions on the Earth's surface. The data collected by CORS stations is used to support various geodetic and geospatial applications and can also be used to improve the accuracy of GPS-based positioning and navigation systems.

The International GNSS Service (IGS) is a global collaboration of organizations that operate and exchange GNSS (Global Navigation Satellite System) data to support various geodetic and geospatial applications. The IGS was established in the 1990s and is responsible for generating and distributing high-precision products and services based on GNSS data, including GPS (Global

Positioning System) and GLONASS (Global Navigation Satellite System). The IGS operates a global network of GNSS stations that continuously collect GNSS data and make it available to the scientific community and other users. The data and products provided by the IGS are used in various applications such as geodetic reference frames, geophysical research, navigation, and precision agriculture. The IGS is a widely recognized and respected provider of GNSS-based geodetic products and services.

Database is an organized collection of logically related data and its description, designed to meet the information needs of an organization, it provides an efficient way to store, retrieve and analyze data (Elmasri, 2010). Database Mismanagement System (DBMS) is a software system that enables the use of a database approach, the primary purpose of DBMS is to provide a systematic method of creating, updating, storing and retrieving data stored in a database. It enables users and application programmers to share data and it enables data to be shared among multiple application rather than propagated and stored in new files for every new application (Mullins, 2000)

The realization of AFREF have vast potentials for geodesy, mapping, surveying, geoinformation, natural hazards mitigation, earth sciences, etc. Its implementation provides a major springboard for the transfer and enhancement of skills in surveying and geodesy and especially GPS technology and applications. The traditional geodetic techniques based on best-fitting (local) datum has serious limitations in terms scientific applications due to its inability to provide sufficient knowledge of the earth's centre and its gravity field (Wannacott, 2006).

There are previous researches on the application of IGS and CORS installed in African continent and the application of web-based database in managing spatial data and enhancing collaboration. These researches are as follows;

Research on the potential of Continuously Observing Reference Stations (CORS) in Ethiopia where by the research determines reliability and accuracy of CORS installed in Ethiopia for geodetic purpose. The result show that CORS provide continuous GNSS observations, enabling real-time positioning and monitoring of crustal movements and other geodynamic processes (Tesfaye, S. et al., 2019).

Research on the integrating IGS Data into Regional Geodetic Reference Frames where by research highlighted the importance of incorporating IGS data into regional geodetic reference frames to improve the accuracy of GNSS positioning (Zhang, X et al., 2019). Therefore integrating IGS data into the proposed web-based database for Africa could enhance the reliability and coverage of geodetic information on the continent.

A research on development of a web-based GNSS Data management system where by the research develop web baased GNSS management system in Korea, providing users with real-time GNSS data from multiple stations (Choi et al,. 2019) the result show that web-based databases can be used as essential tools for managing geodetic data effectively. Such systems demonstrate the feasibility of establishing web-based databases for geodetic data in Africa.

A research on development of a web-based geodetic database for the Hellenic geodetic reference network which discusses the data collection, integration, and quality control processes, along with the design of the user interface of the geodetic network (Sarris et al., 2020) therefore this research provide insight to the development of web-based database for AFREF.

Based on different studies, this research focus on development of web-based database for CORS and IGS installed in African continent by providing a database which include station information such as station name, receiver type installed, date of receiver installation, station status, antenna height, receiver satellite constellation(multi-constellation), receiver update information and also provide link to download station data.

1.2 Problem statement.

Recently, there are many online maps that provide information about the CORS network in Europe, North American and the Australasian region. For instance, the US National Geodetic Survey maintains a CORS map of all permanent GNSS stations in North American and some other selected countries. When it comes to Africa however the situation is vastly different. Some information is available from International GNSS Service (IGS), the African Geodetic Reference Frame (AFREF) and Space and Earth Geodetic Analysis Laboratory (SEGAL) maps, moreover there is deplorable death of metadata concerning CORS installations. It is difficult to find a single database that offers information for both CORS and IGS in Africa (Boschetti et al,. 2016).

Therefore, this research aims to develop the unified geographical web- based database for both CORS and IGS installed in the African continent which serves as valuable resource for geodetic researchers, geospatial professionals, and will contribute to the development of sustainable geodetic infrastructure in Africa.

1.3 Research objectives

1.3.1 Main Objective

The main objective of the research is to develop a unified African geodetic reference frame associated geo-database that contains information of CORS and IGS stations.

1.3.2 Specific Objective

I. To develop a web-based database that stores information on the positions and orientations of GNSS stations, as well as other relevant information such as site metadata, instrument information.

II. To promote international collaboration and the exchange of information between geodetic organizations and experts.

III. To support the sustainable development of geodetic infrastructure and geospatial technology in the region, and to support other geospatial applications, such as satellite navigation, remote sensing, and geo-hazard monitoring.

1.4 Scope and Limitations

This research will focus on development of geo-database which will provide links to where data can be downloaded, also will provide access to the database management for authenticated persons. The database will be for African CORS and IGS only, without including other continents CORS and IGS.

1.5 Significance of the research

This research has the following benefits.

I. Enhance geospatial data accessibility; it will provide more comprehensive web-database which will support various geospatial applications.

II. Increase data efficiency; the unified database would reduce the need of multi-database, making data access and use more efficient.

III. Better natural resources management and improve disaster response.

IV. Improve support for international collaboration and data sharing.

V. Improve the ability to support geodetic research, land surveying and mapping activities in the region.

VI. Enhance ability to monitor and study Earth's geodynamic processes, such as tectonic plate movement and volcanic activities.

1.6 Beneficiaries

I. Scientific community: Researchers in geophysics, geodesy, earth science, and related fields can use the geo-database for their studies and analysis.

II. Surveyors and engineers: The geo-database can be used by surveyors and engineers for positioning and mapping which can be useful in various fields, including construction, transportation and land management.

III. National mapping organizations can use the database to improve their mapping accuracy as well as updating their geographical information system.

CHAPTER TWO

LITERATURE REVIEW

This chapter aims to explore and synthesize existing research, studies, and developments related to the development of a web-based database catering specifically to the African geodetic context. By examining relevant literature, this review seeks to identify the current state-of-the-art methodologies, challenges, and best practices concerning the establishment and maintenance of such a database.

2.1 African Geodetic Reference Frame (AFREF)

The African Geodetic Reference Frame (AFREF) was conceived to unify the patchwork of geodetic reference frames and vertical datums in the 54 countries in Africa. A common reference frame is intended to make it easier to coordinate planning and development activities within countries and across national boundaries, all georeferencing requires a uniform coordinate reference frame, yet each of the 54 countries in Africa has its own geodetic reference frame. In addition, some countries have more than one reference frame based on different datums. This patchwork of reference systems and frames in Africa makes it difficult to coordinate planning and development activities within countries and across national boundaries. The African Geodetic Reference Frame (AFREF) was conceived in 2000 to unify Africa's geodetic reference frames and vertical datums (Wannacott, 2006). The development of AFREF involved the collaboration of many African countries, international organizations and Geodetic experts which helps to insure is relevance and applicability to African continent (Boschetti, et al,, 2016), it was developed to provide modern Geodetic Reference frame for Africa, which is necessary for accurate positioning and mapping data, the project involves the collection of data from various sources, such as satellite observation and terrestrial surveying (Nahmias et al., 2012)

The application of AFREF is diverse and includes surveying, mapping, navigation and geosciences. For example, AFREF is being used to improve the accuracy of cadastral surveys, which are critical for land management and planning (Nahmias et al., 2012). AFREF is also being used to support the development of infrastructure such as roads, airports and ports by providing accurate positioning data for construction and maintenance (Boschetti, et al,, 2016). In addition, AFREF is being used in the study of tectonic processes and sea-level changes in Africa, which have important implications for natural resources management and disaster reduction (Boschetti, et al,, 2016). AFREF is also essential for climate research, as it provides a consistent reference frame for accurate monitoring of atmospheric changes (Klos et al., 2017)

2.2 Operational data Centre

In 2009 the AFREF Operational Data Centre (ODC) was established to process the data from the permanent GNSS base stations. By the end of 2015 there were approximately 65 stations in total contributing data to the ODC. On any given day, there are approximately 45 stations streaming open data (free of charge and openly available) to the ODC. The results of two weeks of measurements at 50 stations in December 2012 were processed into an initial reference frame for ITRF 2008 Epoch 2012 Day 340 23h 59s (GPS Week 1717). Four processing centers, either in Africa or with African affiliations, processed the collected data and computed a set of static AFREF coordinates. The centers involved are; HartRAO in South Africa, SEGAL (UBI/IDL) in Portugal, directorate of Surveys & Mapping in Tanzania and Ardhi University in Tanzania

2.3 African Geodetic Reference Frame CORS network

The African CORS (Continuously Operating Reference Stations) network is a geodetic infrastructure established in Africa to support high-precision GNSS (Global Navigation Satellite System) positioning and mapping activities. The CORS network is composed of permanent GNSS receivers and supporting infrastructure, such as antennas, data communication systems, and data processing centers.

The development of the African CORS network was initiated in the early 2000s, with the objective of providing a high-precision GNSS positioning reference system that is compatible with international geodetic reference frames. The network is designed to cover the entire African continent and provide data that is accessible in real-time or near-real-time (Businger et al, 2015).

The African CORS network is part of the global International GNSS Service (IGS) network, which provides high-precision GNSS data and products to the scientific community and the public, it helps data Infrastructure development in Africa (T.Olaninyi et al., 2021). The African CORS network also collaborates with other regional GNSS networks, such as the European Reference Frame (EUREF) and the South American Reference Frame (SIRGAS), to provide a globally compatible reference system.

2.4 African Geodetic Reference Frame IGS network.

The IGS is a global network of reference stations that provides high-precision, Real time GPS/GNSS data to support various applications including geodesy, surveying and navigation. The IGS has several active stations located across the African continent, including in countries such as Algeria, Egypt, Kenya, Morocco, South Africa and Uganda.

The IGS has also supported the development of the African CORS network and the development of African Geodetic Reference Frame (A.M.Hashim et al, 2019), also the IGS product is used to improve the accuracy and consistency of African Geodetic Reference Frame (Tsoulis, 2019)

2.5 Web-based database.

A web-based database is a database that is accessible over the internet through a web browser, it allow user to access and manage data from anywhere with internet connection, making it a convenient and flexible option for many organizations, can be secured with passwords and encryption to protect data from unauthorized access, they can be accessed from the range of devices including laptops and tablets which provides greater flexibility to the users and also allows data update in real time. (S.O. Adeoye et al, 2020)

2.6 Database and Database Management System (DMS).

Database is an organized collection of logically related data and its description, designed to meet the information needs of an organization, database provides an efficient way to store, retrieve and analyze data (Elmasri, 2010).

A Database Management System is a software system that enables the use of a database approach. The primary purpose of DBMS is to provide a systematic method of creating, updating, storing, and retrieving the data stored in a database. It enables end users and application programmers to share data and it enables data to be shared among multiple applications rather than propagated and stored in new files for every new application (Mullins, 2000)

A DBMS manager manages three important things: the data, the database engine that allows the database to be accessed, locked and modified and the database schema which defines the database logical structure. These three foundations help to provide concurrency, security, data integrity, and uniform administration procedures. Typical database administration talks supported by the DBMS include change management, performance monitoring/tuning and backup and recovery. Many DBMS are also responsible for automated rollbacks, restarts and recovery as well as logging and auditing activity.

The DBMS is perhaps most useful for providing a centralized view of data that can be accessed by multiple users, for multiple locations, in a controlled manner. A DBMS can limit what data the end user sees, as well as how that end user can view data, providing many views of a single database schema. End users and software programs are free from understanding where data is physically located or on what type of data storage media it resides because the DBMS handles all requests (Elmasri, 2010).

The DBMS can offer both logical and physical data independence. That means it can protect users and applications from needing to know where data is stored or having to be concerned about changes to physical structure of data (storage and hardware). As long as programs use the application program interface (API) for the database that is provided by the DBMS, developers won’t have to modify programs just because changes have been made to the database.

2.7 Database design.

Database design is the design of the database structure that will be used to store and manage data rather than the design of DBMS software (Gunjalu, 2014). Once the database design is completed the DBMS handles all the complicated activities required to translate the designer’s view of structure into structure that are usable to computer.

Database design is made much simpler when we use models. A database model is a collection of logical constructs used to present the data structure and the data relationships found within the database i.e., simplified abstraction of real-world events or conditions. If the models are not logically sound, the database derived from them will not deliver the database system promise to effective information drawn from an efficient database.

CHAPTER THREE

METHODOLOGY

The development of a web-based database for the African Geodetic Reference Frame (AFREF), Continuously Observing Reference Stations (CORS), and International GNSS Stations (IGS) is a complex and multifaceted undertaking that requires a systematic and well-defined approach. In this chapter explain the database design, data collection methods, data processing procedures, and database development strategies that will be employed to achieve the objectives of this research. The summary of this methodology is shown on the work-flow chart in Figure 3.1 below.

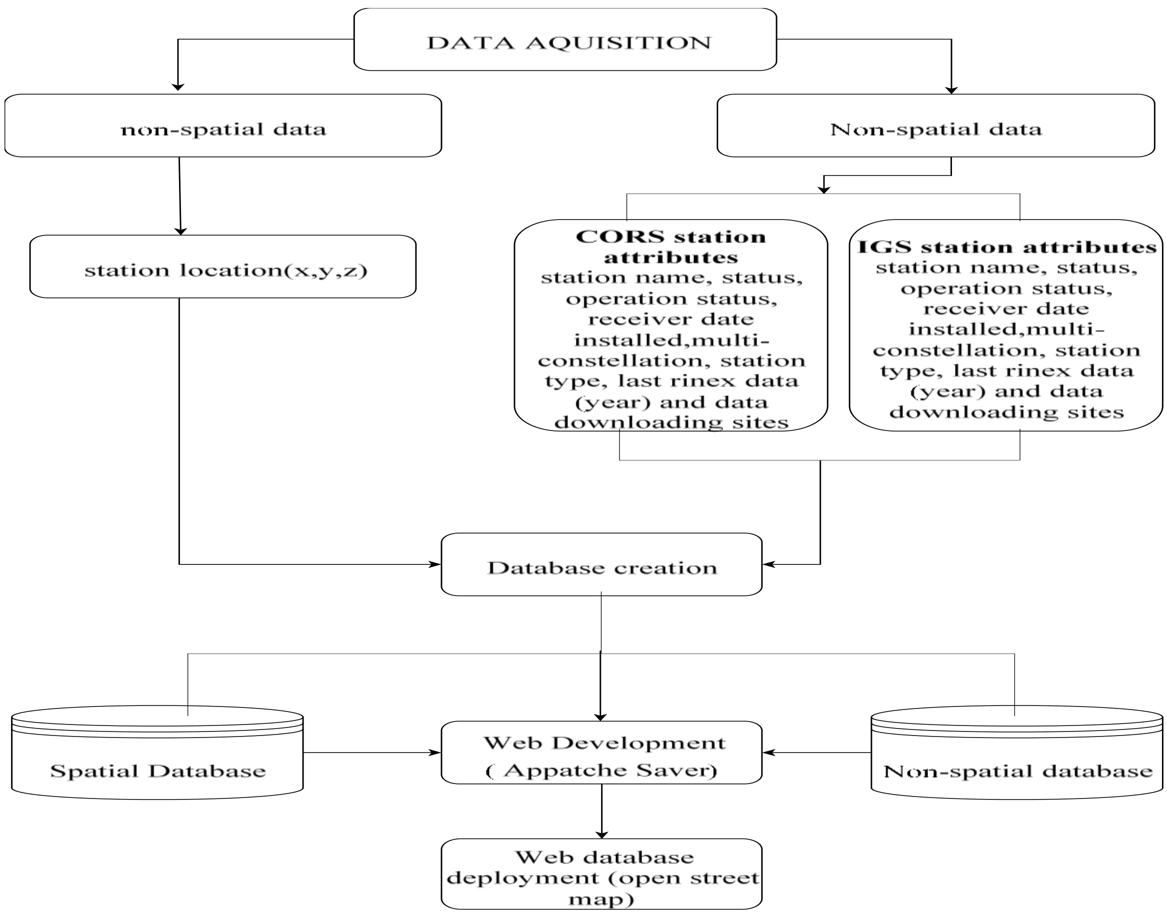


Figure 3.1 Work flow chart.

3.1 Data collection

Data consisting of required information about IGS and CORS in Africa were collected in various sites which are https:// www.unavco.org, https:// www.noaa.gov and https://www.igs.org, data downloaded are in excel.csv format. The sample data are shown in the Tables 3.1 and Table 3.2 below,

Table 3. 1 Downloaded IGS data from https://www.igs.org

Station Name	Receiver Name	Receiver Satellite System	Antenna Name
ABMF00GLP	SEPT POLARX5	GPS+GLO+GAL+BDS+SBAS	TRM57971.00
ABPO00MDG	SEPT POLARX5	GPS+GLO+GAL+BDS+QZSS	ASH701945G_M
AC2300USA	SEPT POLARX5	GPS+GLO+GAL+BDS+QZSS	TRM59800.99
AC2400USA	SEPT POLARX5	GPS+GLO+GAL+BDS+QZSS	TRM159800.00
ACRG00GHA	JAVAD TRE_3S	GPS+GLO+GAL+BDS+IRNSS+SBAS	SEPCHOKE_B3E6
ACSO00USA	SEPT POLARX5	GPS+GLO+GAL+BDS	TRM59800.80
ADIS00ETH	LEICA GR50	GPS+GLO+GAL+BDS+SBAS	LEIAR20
AGGO00ARG	SEPT POLARX5TR	GPS+GLO+GAL+BDS+SBAS	LEIAR25.R4
AIRA00JPN	TRIMBLE ALLOY	GPS+GLO+GAL+QZSS	TRM59800.00
AJAC00FRA	LEICA GR50	GPS+GLO+GAL+BDS+QZSS+SBAS	TRM115000.00
ALBH00CAN	SEPT POLARX5	GPS+GLO+GAL	TRM59800.00
ALGO00CAN	SEPT POLARX5	GPS+GLO+GAL	AOAD/M_T
ALIC00AUS	SEPT POLARX5	GPS+QZSS+GLO+GAL+BDS	LEIAR25.R3
ALRT00CAN	ASHTECH UZ-12	GPS	ASH701945D_M
AMC400USA	SEPT POLARX5TR	GPS+GLO+GAL+BDS	TPSCR.G5C
ANK200TUR	TRIMBLE NETR9	GPS+GLO+GAL+BDS	TRM115000.00
ANMG00MYS	TRIMBLE NETR9	GPS+GLO+GAL+BDS+QZSS	JAVRINGANT_DM
ANTC00CHL	TRIMBLE NETR9	GPS+GLO	ASH700936D_M
ANTF00CHL	STONEX SC2200	GPS+GLO+GAL+BDS+SBAS	STXSA1500
AREG00PER	SEPT POLARX5	GPS+GLO+GAL+BDS+SBAS	TRM59800.00

AREQ00PER	SEPT POLARX5	GPS+GLO+GAL+BDS	JAVRINGANT_DM
ARHT00ATA	JAVAD TRE_3 DELTA	GPS+GLO+GAL+BDS+QZSS+IRNSS	JAVRINGANT_DM
ARUC00ARM	SEPT POLARX5	GPS+GLO+GAL+BDS+QZSS	ASH701945C_M
ASCG00SHN	TRIMBLE ALLOY	GPS+GLO+GAL+BDS+SBAS	TRM59800.00
ASPA00USA	SEPT POLARX5	GPS+GLO+GAL	TRM55971.00
ATRU00KAZ	LEICA GR10	GPS+GLO+GAL+SBAS	LEIAR25.R4
AUCK00NZL	TRIMBLE ALLOY	GPS+GLO+GAL+BDS+QZSS	TRM115000.00
BADG00RUS	JAVAD TRE_3 DELTA	GPS+GLO+GAL	JAVRINGANT_DM
BAIE00CAN	TPS NET-G5	GPS+GLO	TPSCR.G3
BAKE00CAN	TPS NET-G3A	GPS+GLO	TPSCR.G3
BAKO00IDN	LEICA GR50	GPS+GLO+GAL+BDS+QZSS+SBAS	LEIAR20
BAMF00CAN	SEPT POLARX5	GPS+GLO+GAL+BDS	SEPCHOKE_B3E6
BARH00USA	LEICA GR30	GPS+GLO	LEIAR10
BAUT00DEU	JAVAD TRE_3 DELTA	GPS+GLO+GAL+BDS+SBAS	LEIAR25.R3
BELE00BRA	TRIMBLE NETR9	GPS+GLO+GAL+BDS	TRM115000.00
BLYT00USA	SEPT POLARX5	GPS+GLO+GAL+SBAS	TWIVC6150
BNOA00IDN	TRIMBLE NETR9	GPS	TRM59900.00
BOAV00BRA	TRIMBLE NETR9	GPS+GLO+GAL+BDS	TRM115000.00
BOGI00POL	JAVAD TRE_G3T DELTA	GPS+GLO+GAL	TPSCR.G5
BOGT00COL	JAVAD TRE_3 DELTA	GPS+GLO+GAL+BDS	JAVRINGANT_DM
BOR100POL	TRIMBLE NETR9	GPS+GLO+GAL+BDS+QZSS+SBAS	TRM59800.00
BRAZ00BRA	TRIMBLE NETR9	GPS+GLO+GAL	TRM57971.00

Table 3.2 Downloaded CORS data from https:// www.unavco.org

Station name	Type	Status	Operational status	Site city	Site state	Region
7ODM	GPS	Installed	Operable	Mentone	California	SW
AB01	GPS	Installed	Operable	Atka	AK	AK
AB02	GPS	Installed	Operable	Nikolski	AK	AK
AB04	GPS	Installed	Operable	SAVOONGA	AK	AK
AB06	GPS	Installed	Operable	FALSE PASS	AK	AK
AB07	GPS	Installed	Operable	Sand Point	AK	AK
AB08	GPS	Installed	Operable	Mekoryuk	AK	AK
AB09	GPS	Installed	Operable	WALES	AK	AK
AB11	GPS	Installed	Operable	Nome	AK	AK
AB13	GPS	Installed	Operable	Chignik Lagoon	AK	AK
AB14	GPS	Installed	Operable	DILLINGHAM	AK	AK
AB15	GPS	Installed	Operable	Nyac	AK	AK
AB17	GPS	Installed	Operable	UNALAKLEET	AK	AK
AB18	GPS	Installed	Operable	KOTZEBUE	AK	AK
AB21	GPS	Installed	Operable	ADAK	AK	AK
AB22	GPS	Installed	Operable	ILIAMNA	AK	AK
AB25	GPS	Installed	Operable	McGrath	AK	AK
AB27	GPS	Installed	Operable	kobuk	AK	AK
AB28	GPS	Installed	Operable	Anchorage	AK	AK
AB33	GPS	Installed	Operable	Coldfoot	AK	AK
AB35	GPS	Installed	Operable	Cape Yakataga	AK	AK
AB36	GPS	Installed	Operable	Manley Hot Spring	AK	AK
AB37	GPS	Installed	Operable	Paxson	AK	AK
AB39	GPS	Installed	Operable	Fort Yukon	AK	AK
AB41	GPS	Installed	Operable	Eagle	AK	AK

3.2 Data cleaning

Since the downloaded data covers world IGS and CORS, in this stage downloaded data was filtered to obtain data that covers African continent only. Filtering process was done by taking the csv format downloaded data in excel software and selecting the country column in the data then using filter tool in software to filter for a specific county in Africa. Those which are beyond African continent are taken as outliers. The sample cleaned data for IGS and CORS are shown in the Table 3.3 and Table 3.4 respectively below;

Table 3.3 Filtered IGS data

Station Name	Latitude	Longitude	Height	country	Receiver Name
ACRG00GHA	5.641	-0.207	83.792	GHANA	JAVAD TRE_3S
ADIS00ETH	9.035	38.766	2439.55	ETHIOPIA	LEICA GR50
BJCO00BEN	6.385	2.45	31.127	BENIN	TRIMBLE NETR5
DEAR00ZAF	-30.665	23.993	1322.122	SOUTH AFRICA	TRIMBLE ALLOY
HNUS00ZAF	-34.425	19.223	63.459	SOUTH AFRICA	TRIMBLE ALLOY
HRAG00ZAF	-25.89	27.685	1407.788	SOUTH AFRICA	JAVAD TRE_G3TH DELTA
HRAO00ZAF	-25.89	27.687	1414.744	SOUTH AFRICA	SEPT POLARX5TR
JCTW00ZAF	-33.951	18.469	84.013	SOUTH AFRICA	TRIMBLE NETR9
JPRE00ZAF	-25.732	28.283	1387.738	SOUTH AFRICA	TRIMBLE NETR9
MAL200KEN	-2.996	40.194	-20.507	KENYA	SEPT POLARX5
MFKG00ZAF	-25.805	25.54	1311.294	SOUTH AFRICA	TRIMBLE ALLOY
MOIU00KEN	0.288	35.29	2201.932	KENYA	JAVAD TRE_3 DELTA
NKLG00GAB	0.354	9.672	31.89	GABON	SEPT POLARX5
MBAR00UGA	-0.601	30.738	1338.053	GABON	JAVAD TRE_3 DELTA
PRE300ZAF	-25.746	28.224	1414.248	SOUTH AFRICA	NOV OEM6
PRE400ZAF	-25.746	28.224	1414.248	SOUTH AFRICA	NOV OEM6
RABT00MAR	33.998	-6.854	90.539	MOROCCO	JAVAD TRE_3 DELTA
RBAY00ZAF	-28.796	32.078	32.206	SOUTH AFRICA	TRIMBLE ALLOY

Table 3.4 Filtered CORS data

Name	Station type	Status	Operational status	Site city	Site state
OLO1	GPS	Installed	Operable	Arusha	Tanzania
OLO5	GPS	Installed	Operable	Arusha	Tanzania
OLO6	GPS	Installed	Operable	Arusha	Tanzania
OLO7	GPS	Installed	Operable	Arusha	Tanzania
OLO8	GPS	Installed	Operable	Arusha	Tanzania
OLO9	GPS	Installed	Operable	ARUSHA	Tanzania
TANZ	GPS	Installed	Operable	Dar es Salaam	Tanzania
BMCL	GPS	Installed	Operable		
MBAR	GPS	Installed	Operable	Mbarara	Uganda
SUTH	GPS	Installed	Operable	Sutherland	South Africa
HRAO	GPS	Installed	Operable	Krugersdorp	South Africa
MAUA	GPS	Installed	Operable	Maun	Botswana
ZAMB	GPS	Installed	Operable	Lusaka	Zambia
ABPO	GPS	Installed	Operable	Antananarivo	Madagascar
MOIU	GPS	Installed	Operable	Eldoret	Kenya
IWAW	GPS	Installed	Operable		Rwanda
BNZA	GPS	Installed	Operable		Rwanda
KMBR	GPS	Installed	Operable		Rwanda
NYBA	GPS	Installed	Operable		Rwanda
RUBO	GPS	Installed	Operable		Rwanda
KANZ	GPS	Installed	Operable		Rwanda
BYAH	GPS	Installed	Operable		Rwanda

3.3 Database design

This stage involves database planning and analysis and design of database structure models and routes. A database schema below is the logical representation of structure and organization of the database, it defines how data is organized and how different data elements are related to each other, as shown in the Figure 3.2 below.

Figure 3.2 Database schema

3.3.1 Planning and analysis.

This involves determining the purpose of the database, the information it store and the users who will access it. It also involves analyzing the database requirements in terms of the data storage, retrieval and security.

The purpose of database is to provide information about CORS and IGS installed in Africa continent, this information includes; station name and type (IGS or CORS), date of station installed, Site to download station data, type of the receiver installed, station status, country which station is installed, available constellations

This information will be stored in excel.csv and individual format, and will be in a unique format such that other excel.csv data cannot be uploaded to the database unless they are in specified format.

Database will be hosted in google servers and users will freely access the database through provided link, database will use Laravel Breeze to provide a secure authentication system to enhance database security and ensure that only authorized users can manage database and access system information.

3.3.2 Database structure design

This stage involves designing of the important four parts of the web-based database which are; station database, user database, user interface database (layout), database routes as well as the database models.

3.3.2.1 Design of the stations database

By using Laravel 10 web-framework, JavaScript computer language is used to create command for station database and the attribute included are station name, station type, status, latitude and longitude, antenna name, height, antenna date installed, clock-type, receiver elevation cut-off and clock input frequency.

The database system allows creation and management of stations through a dedicated database so as to ensure that all station data is kept in one central location, making it easy to manage and retrieve. Also allows station data importation in both single and bulk formats using a dedicated form or excel so as to reduce errors when creating or updating station data. The station database designed by using JavaScript computer language is shown in APPENDIX A, and a sample piece of code is shown in Figure 3.3;

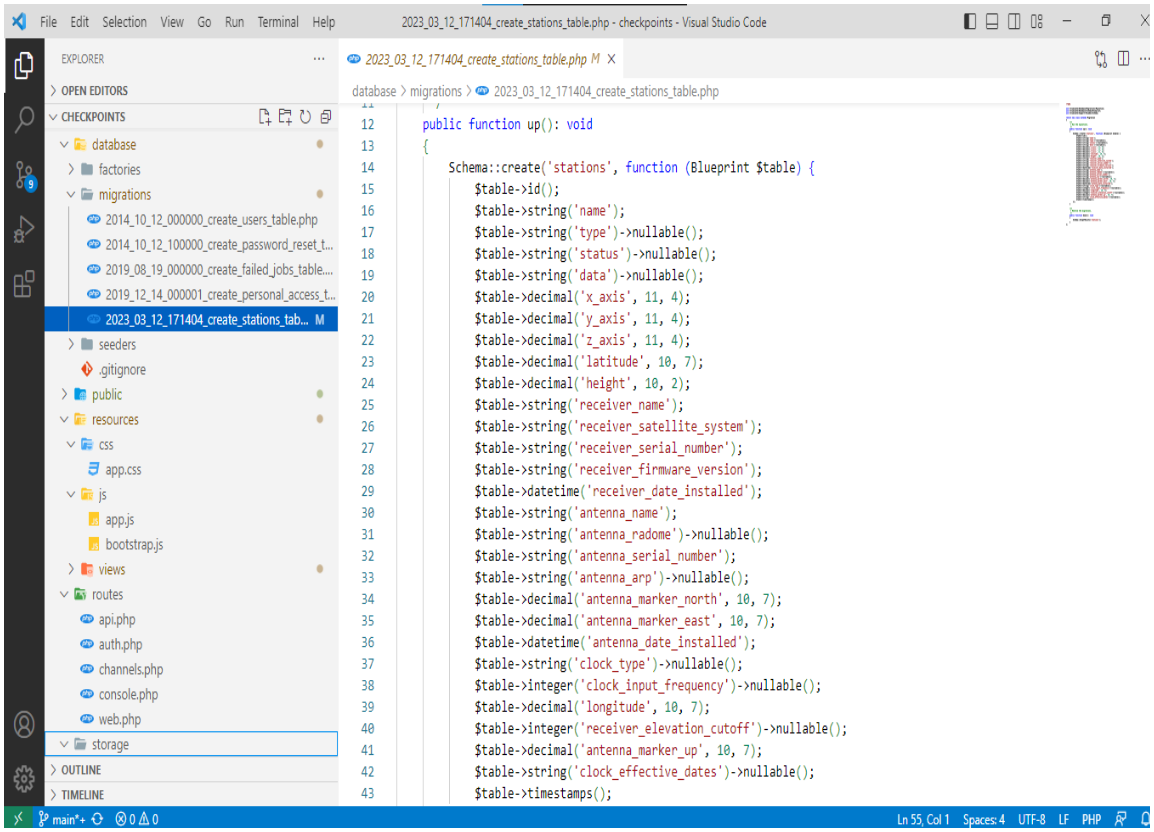


Figure 3.3 Station database structure; JavaScript and HTML computer code.

Figure 3.3 shows generation of the database to store station attributes using JavaScript and HTML computer languages, where HTML used to create attribute table to be displayed and define all the attribute data includes station name, country, receiver type, receiver elevation cutoff and data downloading links. JavaScript used to create and define the attribute table function.

3.3.2.2 Design of the user database

By using Laravel Breeze user authentication and its database is designed using JavaScript computer language, the user database includes the attributes which are name, email address and password for system registration as well as system database access. User authentication is designed using JavaScript computer language as shown in APPENDIX B, and piece of authentication code is shown in Figure 3.4.

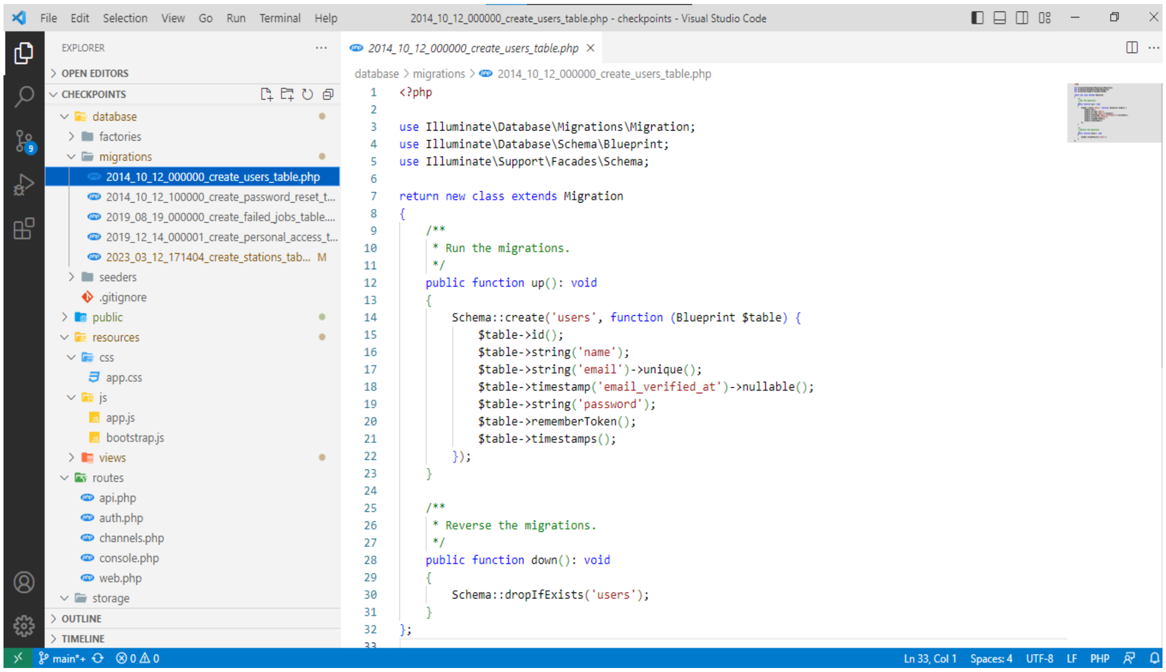


Figure 3.4 User authentication; JavaScript computer language code

Figure 3.4 shows user authentication piece of JavaScript computer language that involves the combination of client-side and server-side code. JavaScript is primarily used on client-side to handle user input and interact with server-side, which performs the authentication and manages user credential. The overview of the process is as follows;

I. User Registration: Create a registration form with fields username, email, and password. When the user submits the form, capture the input values using JavaScript and send them to the server as shown in the Figure 3.5

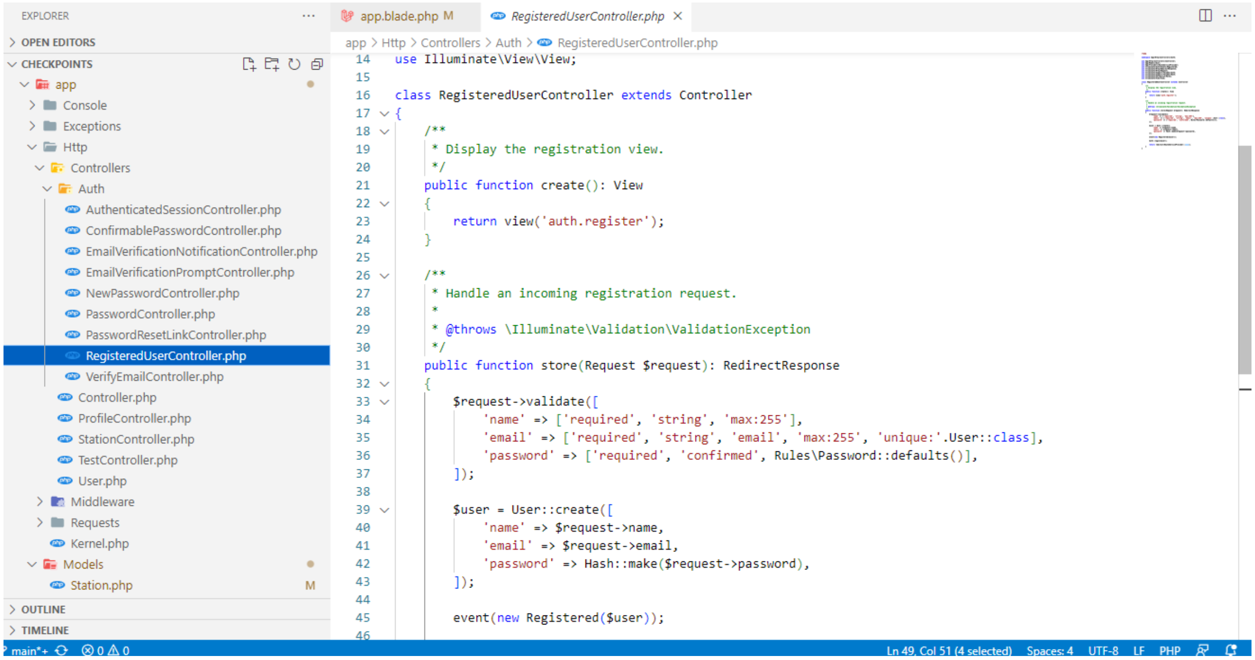


Figure 3.5 User registration; JavaScript computer language code

II. Server-side Validation and Storage: On the server-side, validate the received user input, such as checking if the username or email is already taken. If the input is valid, securely store the user's credentials (e.g., by hashing the password) in a database.

III. User Login: Create a login form with fields for username/email and password. When the user submits the form, capture the input values using JavaScript as it shown in the Figure 3.6.

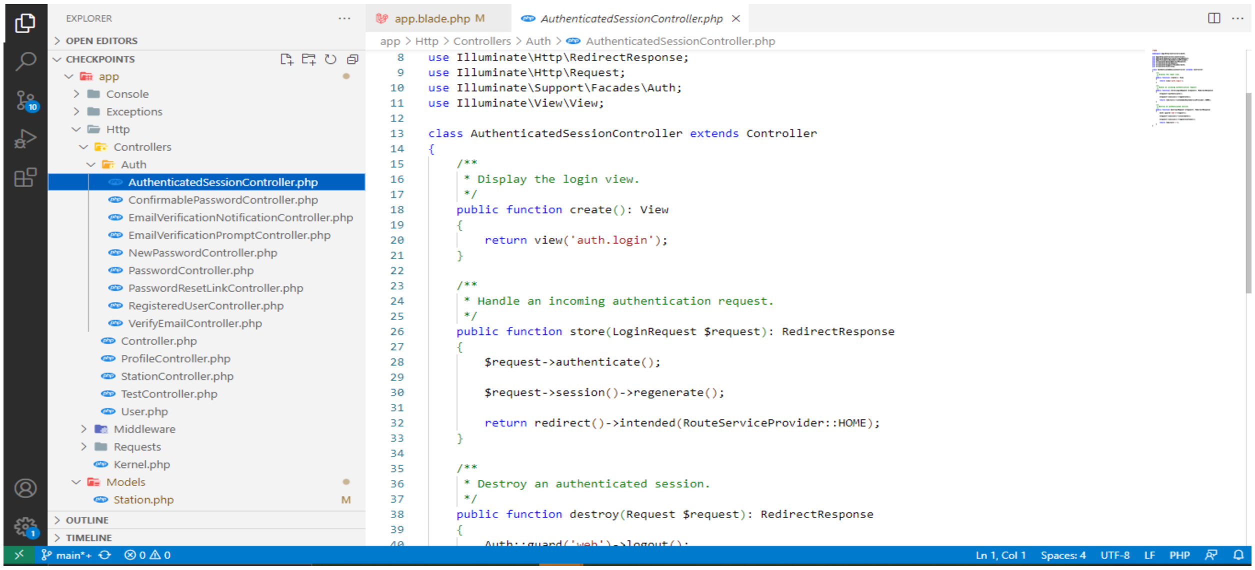


Figure 3.6 User login; JavaScript computer language code

IV. Client-side Validation: Perform client-side validation, such as checking if the required fields are filled and performing any necessary formatting checks. This helps to provide immediate feedback to the user before sending the data to the server as it shown in Figure 3.7

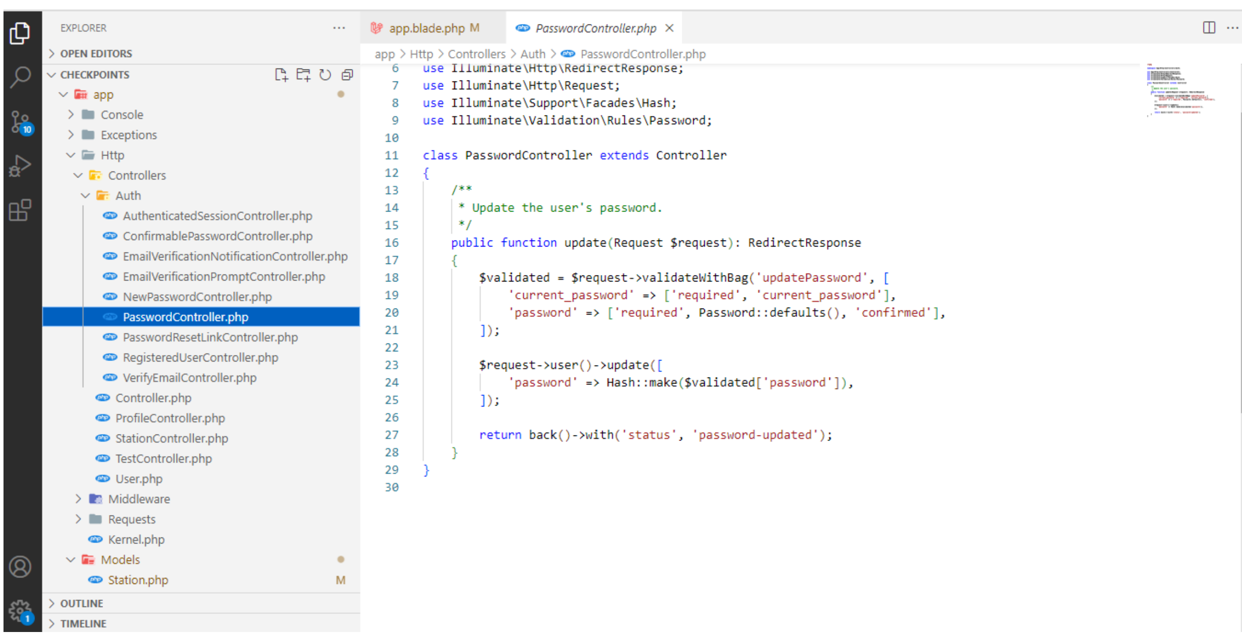


Figure 3.7 Client-side validation; JavaScript computer language code

V. Sending Login Data to the Server: Use JavaScript to send the login credentials to the server via an HTTP request.

VI. Server-side Authentication: On the server-side, verify the received login credentials against the stored user credentials. If the authentication is successful, generate a session token or set a cookie to maintain the user's authenticated state as shown in Figure 3.8.

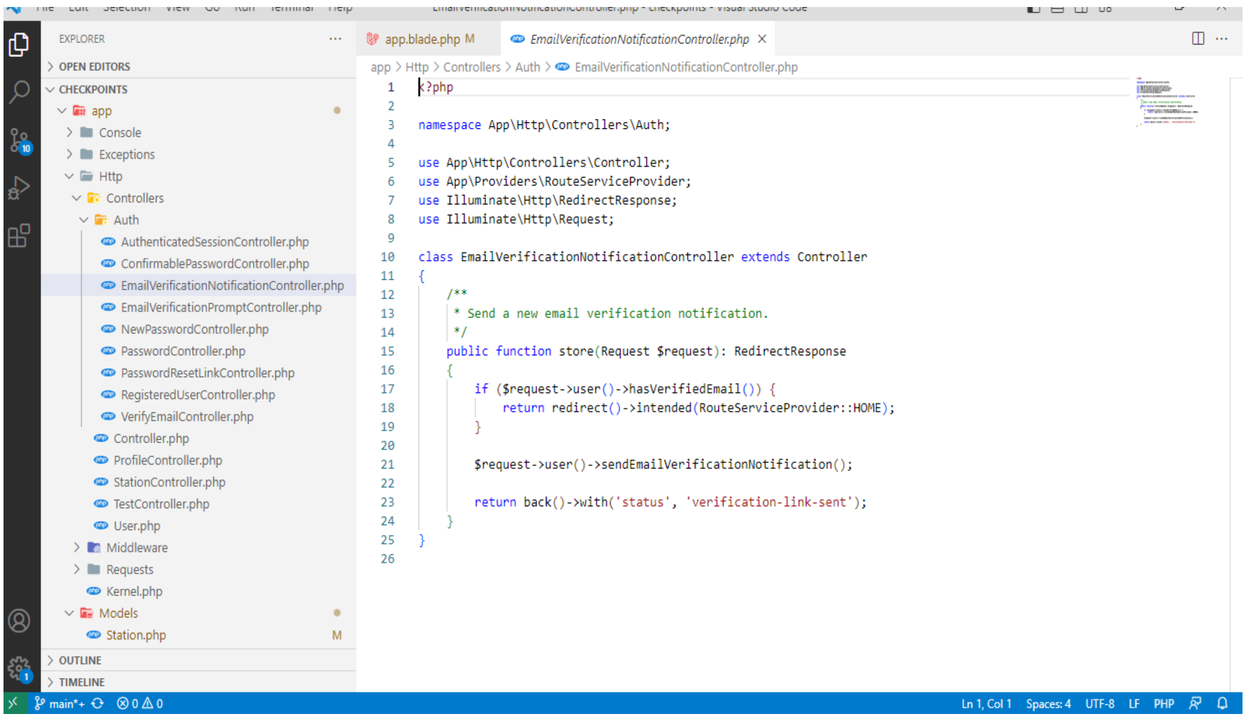


Figure 3.8 Server-side authentication; JavaScript computer language code

VII. User Authentication State: On the client-side, handle the response from the server. If the authentication is successful, it redirects the user to a protected area of the website or perform any necessary client-side actions to indicate the user's authenticated state

3.3.2.3 Design of the database layout

This involve the design of appearance of database, in this stage combination of JavaScript and HTML computer language is used to integrate point information (vector data) and interactive map (raster data) which is open-source Leaflet JS framework to present station on map so as to create general appearance of the web-database in addition the layout also includes station pop-up once clicked by the user. The layout HTML and JavaScript computer language code is shown in APPENDIX C, and a piece of code is shown in Figure 3.9.

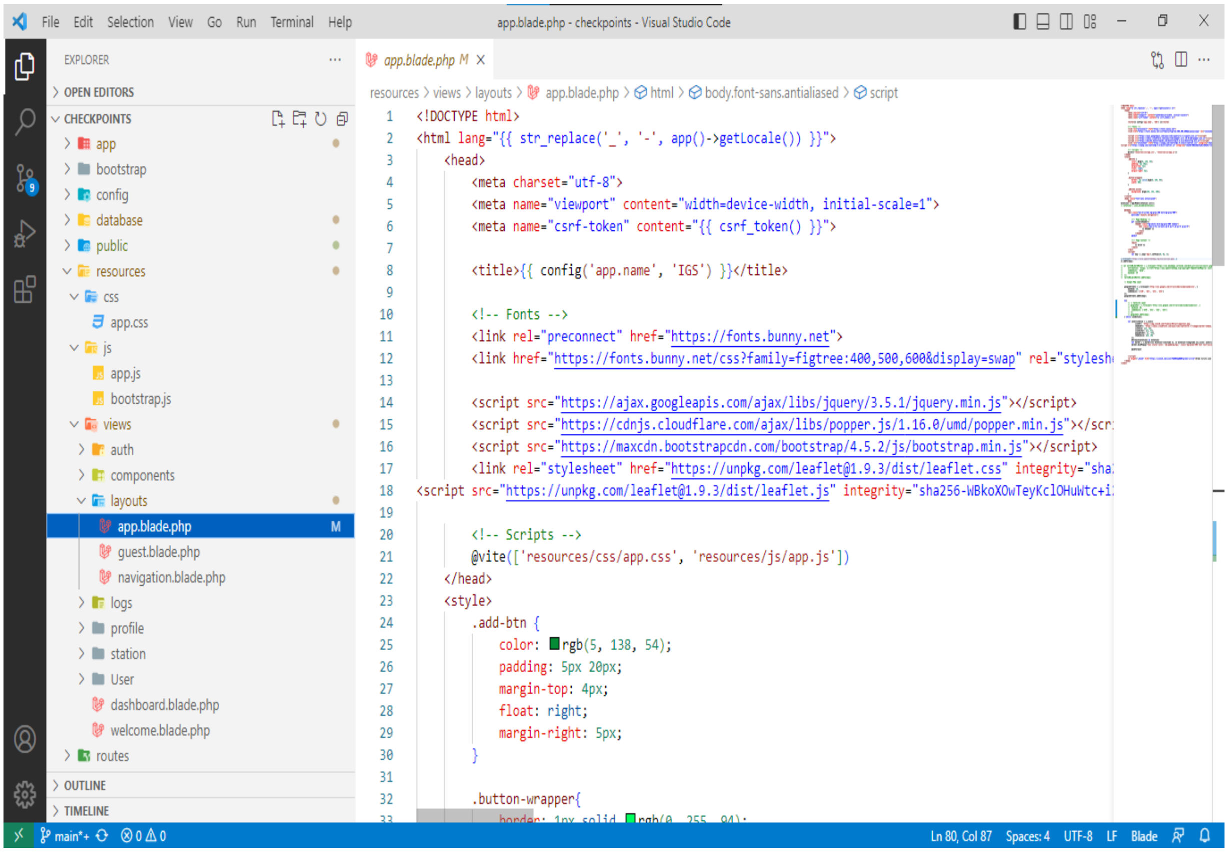


Figure 3.9 Layout; JavaScript and HTML computer languages code

Figure 3.9 shows the layout designing using JavaScript and HTML computer languages to create layout for the web-database. The JavaScript code uses the Leaflet library to create a map instance and add an OpenStreetMap tile layer to it. In the HTML part, we have divided the layout into three sections: the map, the sidebar, and the main content. The Cascading Style Sheets (CSS) styles define the width and positioning of the sidebar and main content sections, as well as the height and width of the map container.

3.3.3 Database model design

This is where the logical structure of the database is determined, its fundamentally determines in which manner data can be stored, organized and manipulated. In this database relational model is used to determine database structure.in this stage web-based database structure is designed and implemented by using a series of JavaScript computer language codes to connect logical tables of station to the user authentication table as well as layout table together with their respective attributes. The JavaScript computer language code for station model is shown in

APPENDIX D, a piece of JavaScript code is shown in Figure 3.10 and for the user model JavaScript computer language piece of code is shown in APPENDIX E, a piece of code in Figure 3.11.

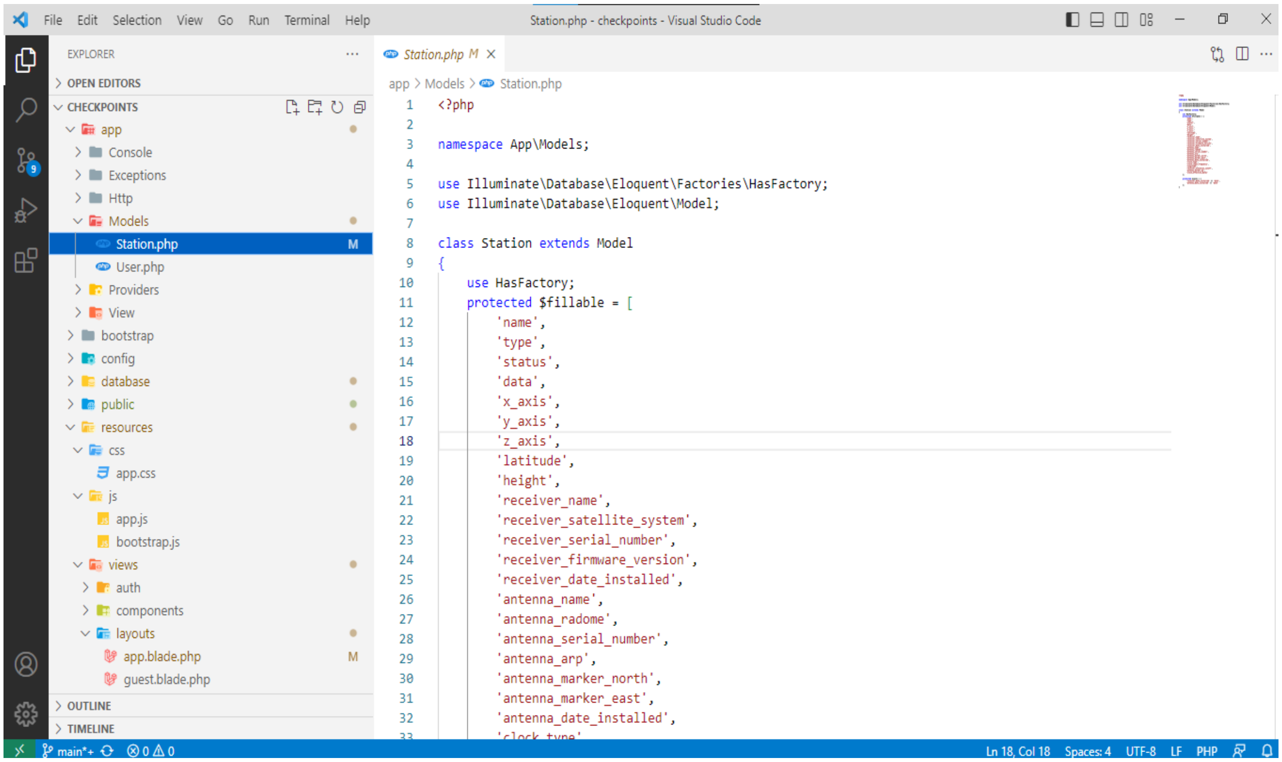


Figure 3.10 station model: JavaScript computer language code

Figure 3.10 above shows the station model creation using JavaScript computer language, in this model, we have entities such as station name, type, status, latitude, longitude and height. Each entity is represented by a JavaScript object with properties corresponding to the entity's attributes.

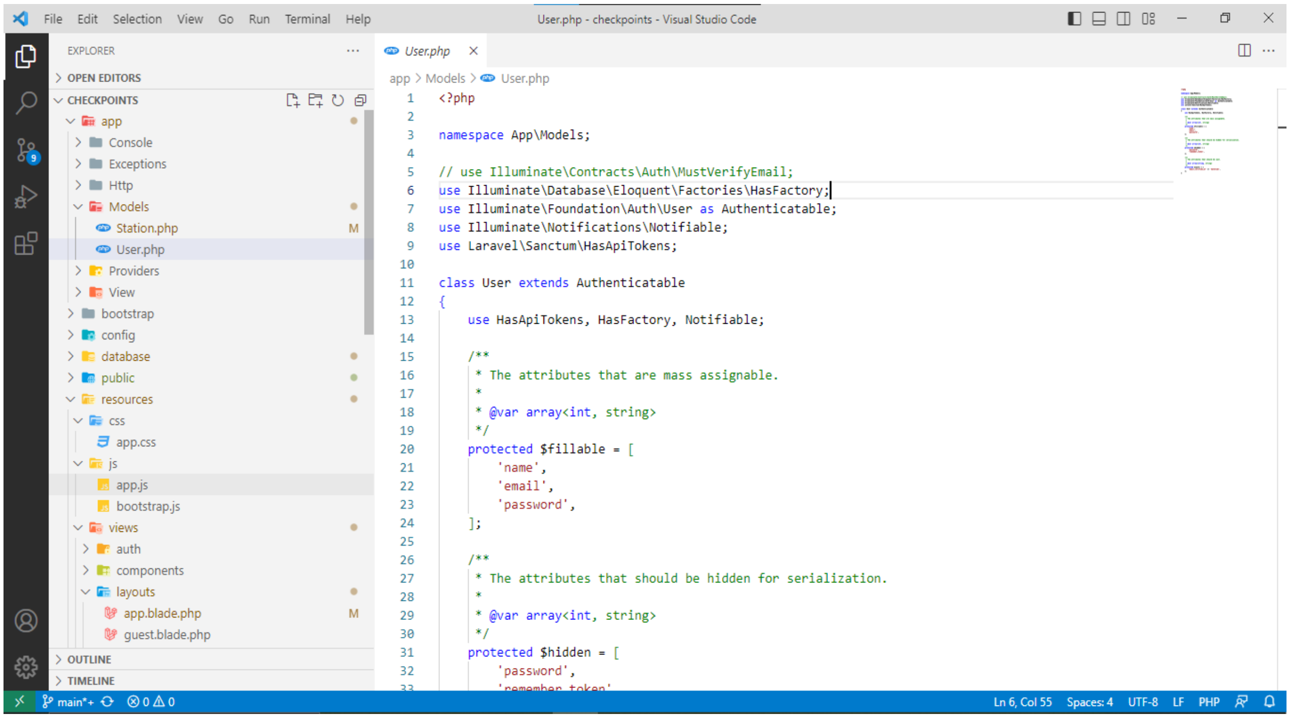


Figure 3.11 User model; JavaScript computer language code

Figure 3.11 above shows the user model creation using JavaScript computer language, in this model we have entities such as user name, email and password. Each entity is represented by a JavaScript object with properties corresponding to the entity's attributes.

3.3.4 Database routes design

This refers to the paths or connection that allows users to access data stored in a database, in web application, a database route typically maps to a specific URLs (Uniform Resource Locators) and HTTP (Hypertext Transfer Protocol) method such as GET, POST, PUT or DELETE that correspond to a specific operation on the data stored in the database. For example, a GET request to the/ users' route might retrieve a list of all users in the database.

This stage involves the designing of the path to which the user may access the dedicated database, it uses the combination of JavaScript and HTML computer language in creating database path as shown in APPENDIX F, and a piece of code in Figure 3.12;

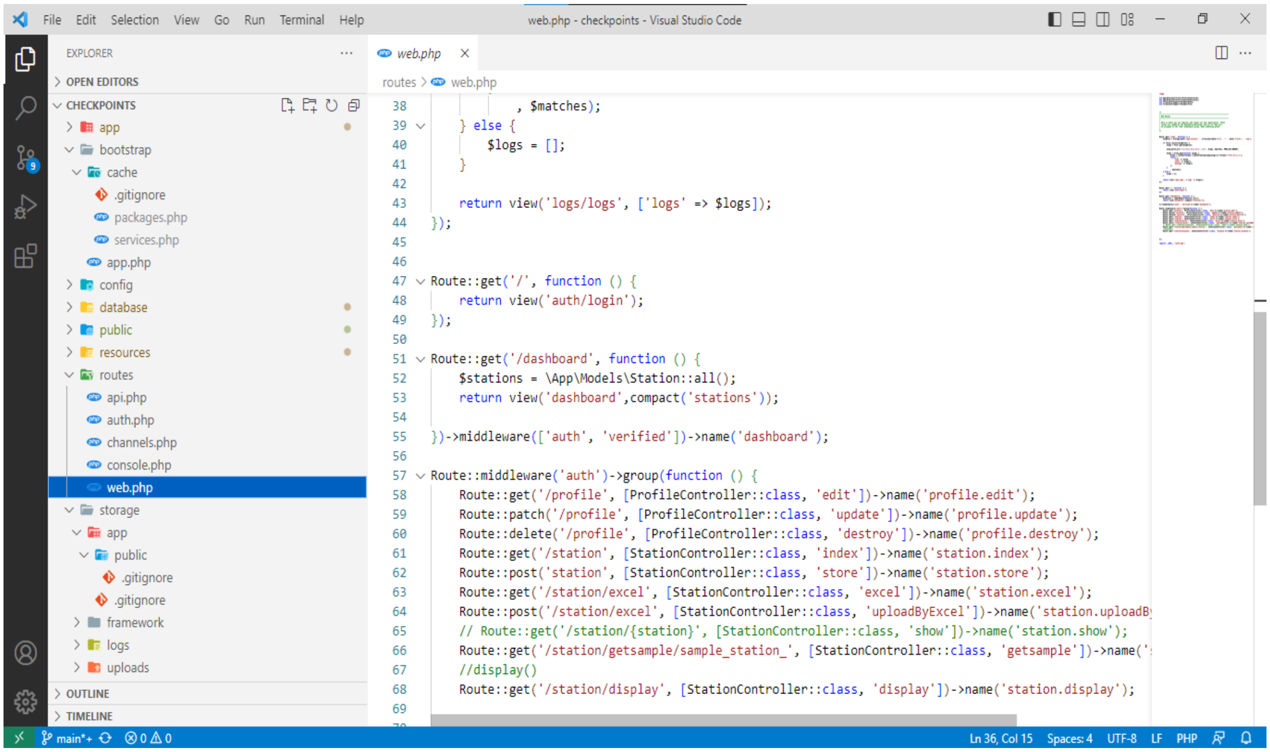


Figure 3.12 Database routes design; HTML and JavaScript computer language code

Figure 3.12 above shows route design using JavaScript computer language that involves implementing an Application Program Interface (API) layer that handles the communication between the client and the database. This is done using a server-side framework along with an ORM (Object-Relational Mapping) library or a query builder to interact with the database.

CHAPTER FOUR

RESULTS AND DISCUSSION

The development of a web-based database for the African Geodetic Reference Frame (AFREF), Continuously Observing Reference Stations (CORS), and International GNSS Stations (IGS) marks a significant milestone in advancing geodetic infrastructure and applications in Africa. This chapter presents the outcomes of the research project which include web-based database and functionalities within it.

4.1 Output of the study

The end result of the study was a unified web-based database and mapping for AFREF CORS and IGS, database provides link for downloading stations data and can be accessed through any browser by using link https://igscorsafrica.com/

4.2 Database

Databases created were station database as well as user database. The station database created so as to store descriptive information about CORS and IGS station installed in the African continent such as station name, station location, date of station installed, station status, station data downloading link and antenna type. Also, a user database created so as to store user information such as user name, password and email so as to enhance database security system as shown in the table 4.1 below.

Table 4. 1 Station database

Name	**Data Download link**	**Country**	**Receiver Name**	**Receiver Satellite System**
ACRG00GHA	<a class="text-blue-600" h	GHANA	JAVAD TRE_3S	GPS+GLO+GAL+BDS+IRNSS+SBAS
ADIS00ETH	<a class="text-blue-600" h	ETHIOPIA	LEICA GR50	GPS+GLO+GAL+BDS+SBAS
BJCO00BEN	<a class="text-blue-600" h	BENIN	TRIMBLE NETR5	GPS+GLO
DEAR00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	TRIMBLE ALLOY	GPS+GLO
HNUS00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	TRIMBLE ALLOY	GPS+GLO
HRAG00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	JAVAD TRE_G3TH DELTA	GPS+GLO+GAL+IRNSS+SBAS
HRAO00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	SEPT POLARX5TR	GPS+GLO+GAL+BDS+SBAS+IRNSS
JCTW00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	TRIMBLE NETR9	GPS+GLO+GAL+BDS
JPRE00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	TRIMBLE NETR9	GPS+GLO+GAL+BDS
MAL200KEN	<a class="text-blue-600" h	KENYA	SEPT POLARX5	GPS+GLO+GAL+BDS+SBAS
MFKG00ZAF	<a class="text-blue-600" h	SOUTH AFRICA	TRIMBLE ALLOY	GPS+GLO
MOIU00KEN	<a class="text-blue-600" h	KENYA	JAVAD TRE_3 DELTA	GPS+GLO+GAL+BDS
NKLG00GAB	<a class="text-blue-600" h	GABON	SEPT POLARX5	GPS+GLO+GAL+BDS+SBAS+IRNSS
MBAR00UGA	<a class="text-blue-600" h	GABON	JAVAD TRE_3 DELTA	GPS+GLO+GAL+BDS+IRNSS

4.3 Functionalities within web-based database

4.3.1 Stations control

The database enables user to switch on and off the stations depending on the user`s need. That is, if the user needs CORS only, can switch off IGS and when needs IGS only can switch off CORS while when needs both CORS and IGS the user can switch on both stations. It also shows the summary for station that active station, dormant station and total number of stations in a particular switch on. The layout of the station control is shown in the figure 4.1 below.

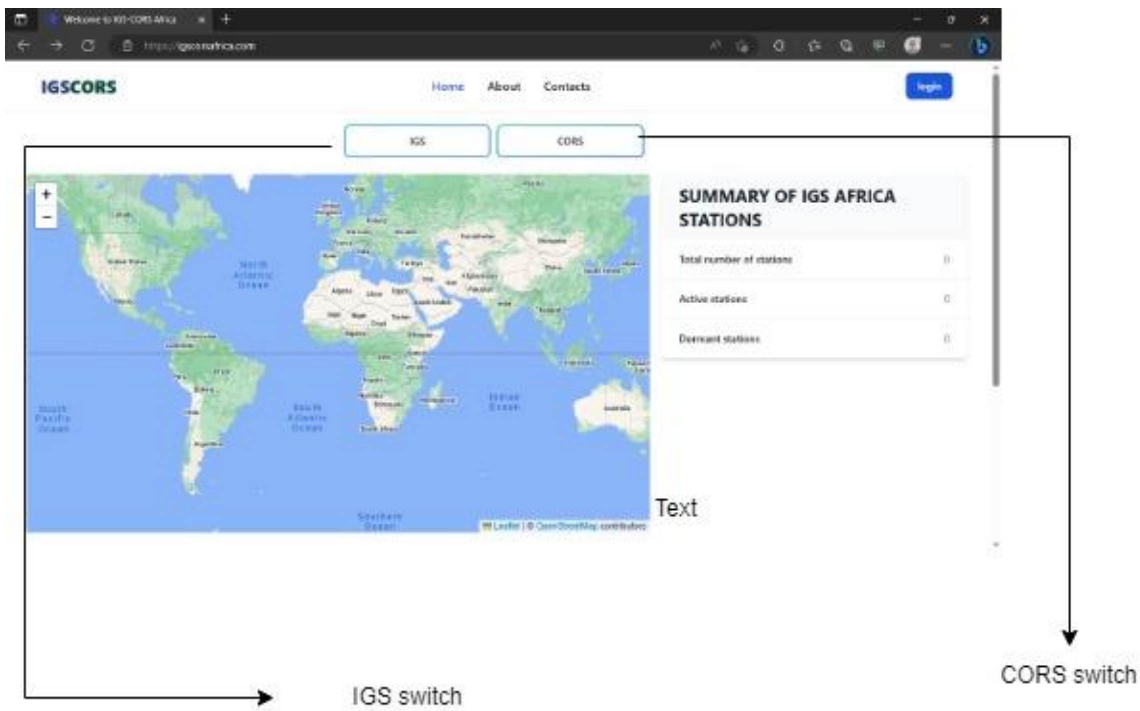


Figure 4.1 Station control

4.3.2 Station search

The database system enables users to search station information by using station name or station location, this function helps easy obtaining of station information. Also allow the downloading of the station information in excel format or export as pdf, as shown in the figure 4.2 below.

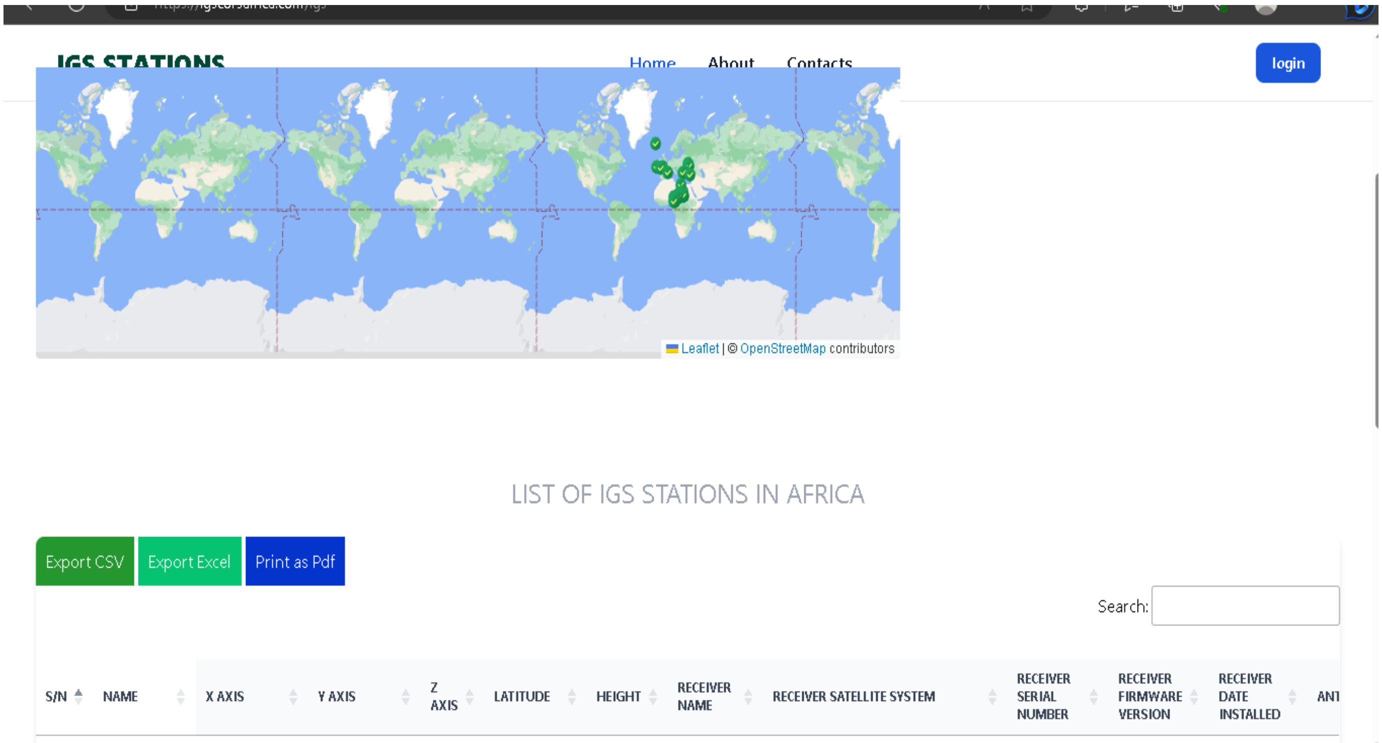


Figure 4.2 Stations search

4.3.3 Pop-up

The system also includes a pop-up tool that will display on clicking station symbol within the database. The pop-up displays station information which are name, status, location, and data downloading link, as shown in the figure 4.3 below.

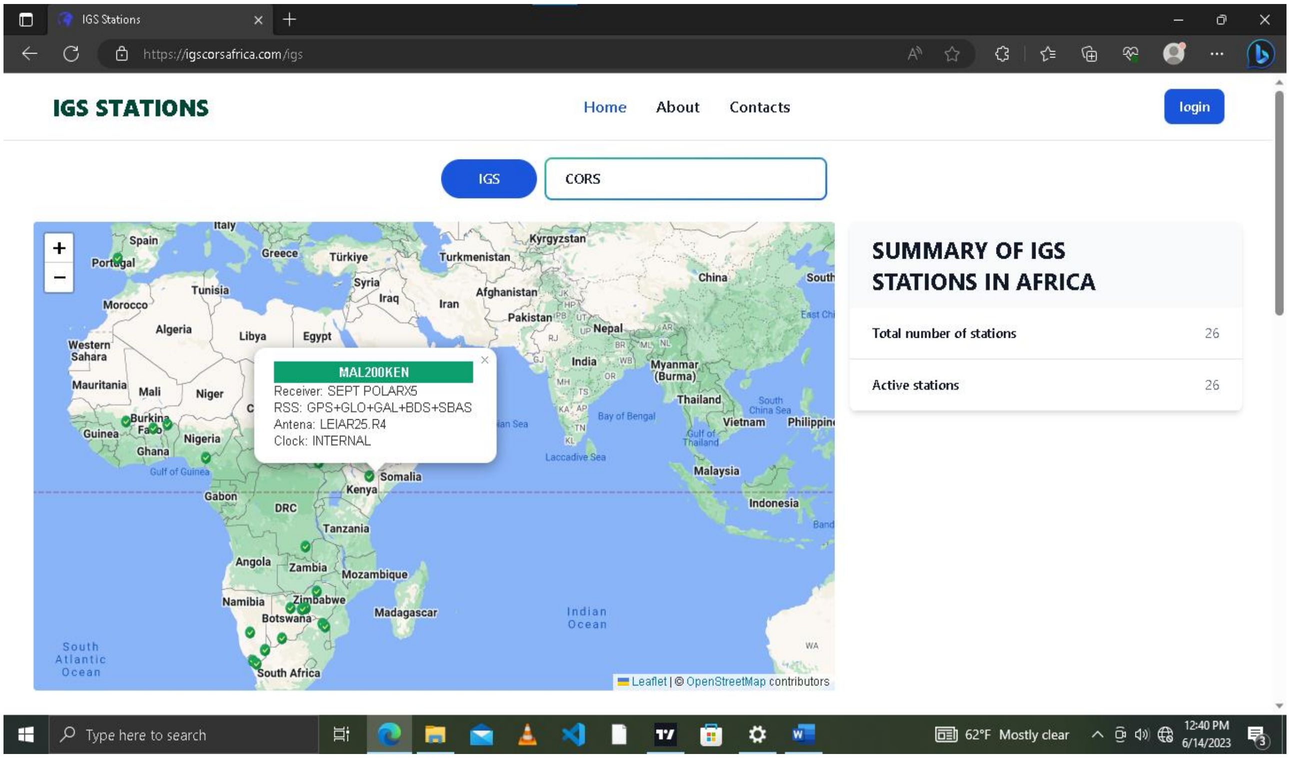
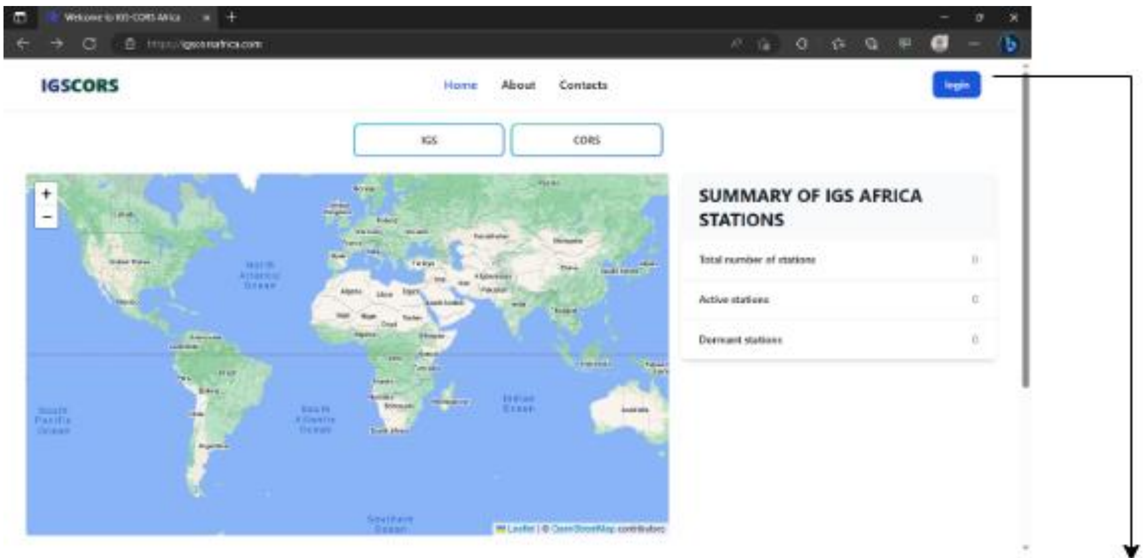


Figure 4.3 Station pop-up

4.4 Database management

The developed web-based database provides a database management system such that only authenticated user may enter through database management site, by using login credentials given by super admin (developer) so that to ensure database security. To login the database management dashboard database managers press the login switch as shown in the Figure 4.4 below.



Login

Figure 4.4 Database management login

4.4.1 database manager login

Here the database manager can input the login credentials given by super admin so as to inter to the management dashboard, as shown in the Figure 4.5 below.

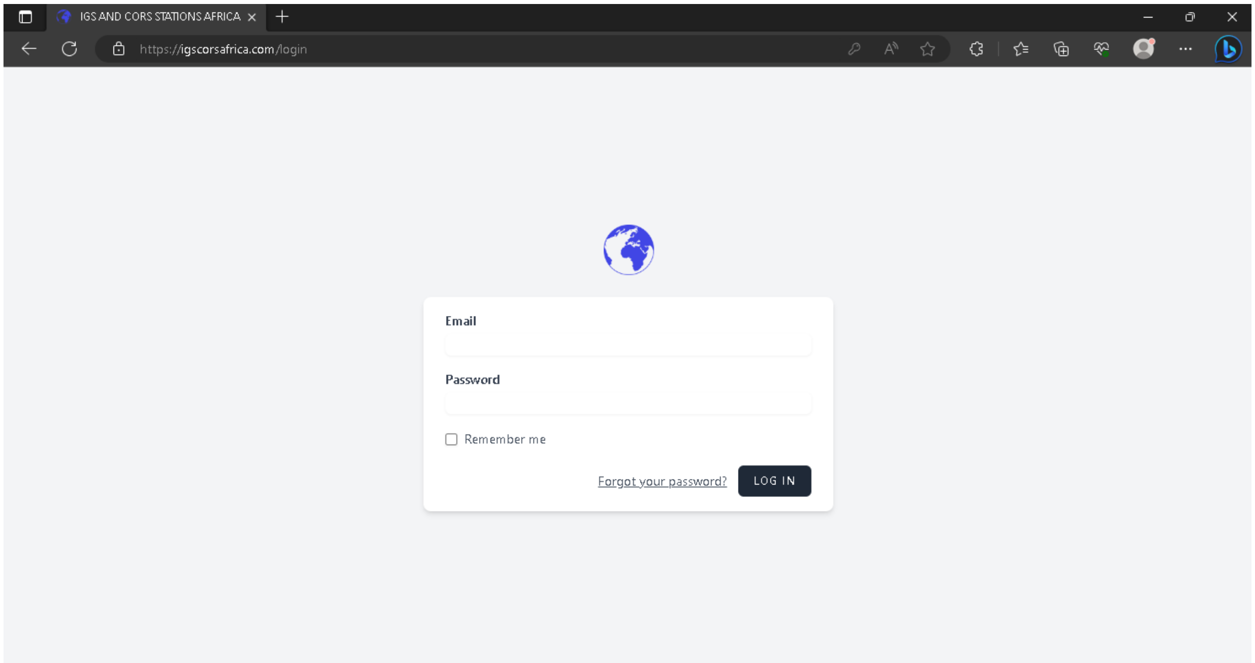


Figure 4.5 Management login

4.4.2 database management dashboard

Database managers can manage IGS stations, CORS stations, users as well as providing roles and permission to the user. Also, the database manager can leave comments to the super admin for the improvement of the database. The database management dashboard appears as shown in Figure 4.6

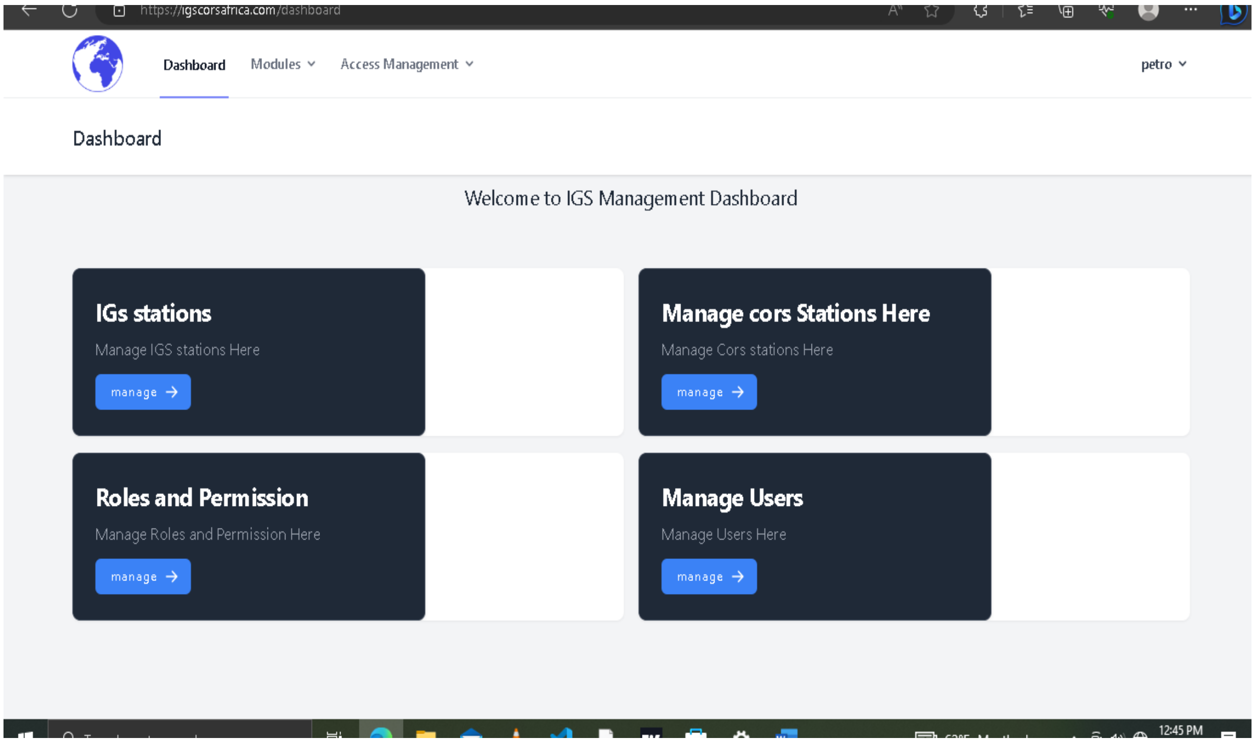


Figure 4.6 Database management dashboard

4.5 Discussion

The web-based database was designed with a robust and efficient architecture that allows for seamless data storage, retrieval, and visualization. The user interface proved to be user-friendly, providing easy navigation and access to geodetic data. The database architecture and user interface were essential in ensuring that users, including pilots, researchers, and geospatial experts, could efficiently interact with the platform and obtain the required information.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The study has endeavored unified web-based database for AFREF CORS and IGS which provide stations information's to the users, it allows creation and management of stations information's through a special dedicated form or excel, the station data is displayed using an open-source Leaflet JS framework that present stations on map with pop-up when clicked. The system has also integrated Laravel Breeze to provide a secure authentication system where users can register and log-in to the system.

The database system developed in this research is an excellent example of a modern web application that leverages the power of Laravel 10 and open-source technologies to provide a powerful and easy to use solution for managing station data. The database can be accessed in any browser using computer, tablets or phones with internet connection.

5.2 Recommendations

With the increase in advancement of technology where a lot of people have great access to the internet, this research recommends the increase the use of web-based databases and open-source street map (leaflet JS framework) to store and visualize geographical information.

The research also recommends the other research should be done so that to upload all the CORS and IGS stations installed in Africa, and fill all the information required as well as provide full access to the organizations who are responsible in installing this station, so as to enable easy update of the installed and installing stations.

Information present in the developed system uses the English Language and not all people understand this language, therefore the research recommends further research should be done to provide translation to the user.

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APPENDICES

APPENDIX A: Station database structure; JavaScript and HTML computer code.

APPENDIX B: User authentication; JavaScript computer language code.

APPENDIX C: Layout; JavaScript and HTML computer languages code.

APPENDIX D: station model: JavaScript computer language code.

APPENDIX E: User model; JavaScript computer language code.

APPENDIX F: Database routes design; HTML and JavaScript computer language code.

APPENDIX A: Station database structure; JavaScript and HTML computer code.

```php
use Illuminate\Database\Migrations\Migration;
use Illuminate\Database\Schema\Blueprint;
use Illuminate\Support\Facades\Schema;
return new class extends Migration
{
    /**
     * Run the migrations.
     */
    public function up(): void
    {
        Schema::create('stations', function (Blueprint $table) {
            $table->id();
            $table->string('name');
            $table->string('type')->nullable();
            $table->string('status')->nullable();
            $table->string('data')->nullable();
            $table->decimal('x_axis', 11, 4);
            $table->decimal('y_axis', 11, 4);
            $table->decimal('z_axis', 11, 4);
            $table->decimal('latitude', 10, 7);
            $table->decimal('height', 10, 2);
            $table->string('receiver_name');
            $table->string('receiver_satellite_system');
            $table->string('receiver_serial_number');
            $table->string('receiver_firmware_version');
            $table->datetime('receiver_date_installed');
            $table->string('antenna_name');
            $table->string('antenna_radome')->nullable();
            $table->string('antenna_serial_number');
            $table->string('antenna_arp')->nullable();
            $table->decimal('antenna_marker_north', 10, 7);
            $table->decimal('antenna_marker_east', 10, 7);
            $table->datetime('antenna_date_installed');
            $table->string('clock_type')->nullable();
            $table->integer('clock_input_frequency')->nullable();
            $table->decimal('longitude', 10, 7);
            $table->integer('receiver_elevation_cutoff')->nullable();
            $table->decimal('antenna_marker_up', 10, 7);
            $table->string('clock_effective_dates')->nullable();
            $table->timestamps();
        });
    }

    /**
     * Reverse the migrations.
     */
    public function down(): void
    {
        Schema::dropIfExists('stations');
    }
};
```

APPENDIX B: User authentication; JavaScript computer language code.

```php
use Illuminate\Database\Migrations\Migration;
use Illuminate\Database\Schema\Blueprint;
use Illuminate\Support\Facades\Schema;

return new class extends Migration
{
    /**
     * Run the migrations.
     */
    public function up(): void
    {
        Schema::create('personal_access_tokens', function (Blueprint $table) {
            $table->id();
            $table->morphs('tokenable');
            $table->string('name');
            $table->string('token', 64)->unique();
            $table->text('abilities')->nullable();
            $table->timestamp('last_used_at')->nullable();
            $table->timestamp('expires_at')->nullable();
            $table->timestamps();
        });
    }

    /**
     * Reverse the migrations.
     */
    public function down(): void
    {
        Schema::dropIfExists('personal_access_tokens');
    }
};
```

APPENDIX C: Layout; JavaScript and HTML computer languages code.

```
<!DOCTYPE html>
<html lang="{{ str_replace('_', '-', app()->getLocale()) }}">
    <head>
        <meta charset="utf-8">
        <meta name="viewport" content="width=device-width, initial-scale=1">
        <meta name="csrf-token" content="{{ csrf_token() }}">

        <title>{{ config('app.name', 'IGS') }}</title>

        <!-- Fonts -->
        <link rel="preconnect" href="https://fonts.bunny.net">
        <link
href="https://fonts.bunny.net/css?family=figtree:400,500,600&display=swap"
rel="stylesheet" />

        <script
src="https://ajax.googleapis.com/ajax/libs/jquery/3.5.1/jquery.min.js"></script>
        <script
src="https://cdnjs.cloudflare.com/ajax/libs/popper.js/1.16.0/umd/popper.min.js"><
/script>
        <script
src="https://maxcdn.bootstrapcdn.com/bootstrap/4.5.2/js/bootstrap.min.js"></scrip
t>
        <link rel="stylesheet"
href="https://unpkg.com/leaflet@1.9.3/dist/leaflet.css" integrity="sha256-
kLaT2GOSpHechhsozzB+flnD+zUyjE2LlfWPgU04xyI=" crossorigin="" />
<script src="https://unpkg.com/leaflet@1.9.3/dist/leaflet.js" integrity="sha256-
WBkoXOwTeyKclOHuWtc+i2uENFpDZ9YPdf5Hf+D7ewM=" crossorigin=""></script>

        <!-- Scripts -->
        @vite(['resources/css/app.css', 'resources/js/app.js'])
    </head>
    <style>
        .add-btn {
            color: rgb(5, 138, 54);
            padding: 5px 20px;
            margin-top: 4px;
            float: right;
            margin-right: 5px;
        }

        .button-wrapper{
            border: 1px solid rgb(0, 255, 94);
            width: 90%;
        }

        .add-btn.excel{
            background: rgb(183, 245, 206);
        }
    </style>
    <body class="font-sans antialiased">
        @php
```

```
$stations = App\Models\Station::all();
// $stations = json_encode($stations);

    @endphp
        <div class="min-h-screen bg-gray-100 dark:bg-gray-900">
            @include('layouts.navigation')

            <!-- Page Heading -->
            @if (isset($header))
                <header class="bg-white dark:bg-gray-800 shadow">
                    <div class="max-w-7xl mx-auto py-6 px-4 sm:px-6 lg:px-8">
                        {{ $header }}
                    </div>
                </header>
            @endif

            <!-- Page Content -->
            <main>
                {{ $slot }}
            </main>
        </div>
        <script>
            var map = L.map('map').setView([0, 0], 2);

L.tileLayer('https://tile.openstreetmap.org/{z}/{x}/{y}.png', {
    attribution: '&copy; <a
href="https://www.openstreetmap.org/copyright">OpenStreetMap</a> contributors'
}).addTo(map);

// var CartoDB_DarkMatter =
L.tileLayer('https://{s}.basemaps.cartocdn.com/dark_all/{z}/{x}/{y}{r}.png', {
//      attribution: '&copy; <a
href="https://www.openstreetmap.org/copyright">OpenStreetMap</a> contributors
&copy; <a href="https://carto.com/attributions">CARTO</a>',
//      subdomains: 'abcd',
//      maxZoom: 19
//  });
//  CartoDB_DarkMatter.addTo(map);

    // Google Map Layer

    googleStreets =
L.tileLayer('http://{s}.google.com/vt/lyrs=m&x={x}&y={y}&z={z}', {
        maxZoom: 20,
        subdomains: ['mt0', 'mt1', 'mt2', 'mt3']
    });
    googleStreets.addTo(map);

    do{
        // // Satelite Layer
        // googleSat =
L.tileLayer('http://{s}.google.com/vt/lyrs=s&x={x}&y={y}&z={z}', {
```

```
        //  maxZoom: 20,
        //  subdomains: ['mt0', 'mt1', 'mt2', 'mt3']
        // });
        // googleSat.addTo(map);
    } while (condition);

        var satelliteIcon = L.icon({
                iconUrl: 'https://img.icons8.com/fluency/48/null/approval.png',
                shadowUrl:
'https://cdnjs.cloudflare.com/ajax/libs/leaflet/0.7.7/images/marker-shadow.png',
                iconSize: [13, 15],
                iconAnchor: [12, 41],
                popupAnchor: [1, -34],
                shadowSize: [10, 10]
            });
            @foreach($stations as $station)
            var marker = L.marker([{{ $station->latitude }}, {{ $station-
>longitude }}],{icon: satelliteIcon}).addTo(map);
            marker.bindPopup("<div style='color: red;padding:3px;' class='bg-
green-500 text text-success text-center'>{{ $station->name }}</div><div
class='text-success'>Type: {{ $station->type }}</div><div class='text-
success'>Status: {{ $station->status }}</div><div class='text-success'>Data: {{
$station->data }}</div><div class='text-success'>Receiver: {{ $station-
>receiver_name }}</div><div class='text-success'>RSS: {{ $station-
>receiver_satellite_system }}</div><div class='text-success'>Antena: {{ $station-
>antenna_name }}</div><div class='text-success'>Clock: {{ $station->clock_type
}}</div>");

            @endforeach


        </script>
        <a target="_blank" href="https://icons8.com/icon/FkQHNSmqWQWH/green-
circle">Green Circle icon by Icons8</a>
    </body>
</html>
```

APPENDIX D: station model: JavaScript computer language code.

```php
namespace App\Models;

use Illuminate\Database\Eloquent\Factories\HasFactory;
use Illuminate\Database\Eloquent\Model;

class Station extends Model
{
    use HasFactory;
    protected $fillable = [
        'name',
        'type',
        'status',
        'data',
        'x_axis',
        'y_axis',
        'z_axis',
        'latitude',
        'height',
        'receiver_name',
        'receiver_satellite_system',
        'receiver_serial_number',
        'receiver_firmware_version',
        'receiver_date_installed',
        'antenna_name',
        'antenna_radome',
        'antenna_serial_number',
        'antenna_arp',
        'antenna_marker_north',
        'antenna_marker_east',
        'antenna_date_installed',
        'clock_type',
        'clock_input_frequency',
        'longitude',
        'receiver_elevation_cutoff',
        'antenna_marker_up',
        'clock_effective_dates'
    ];

    protected $casts = [
        'receiver_date_installed' => 'date',
        'antenna_date_installed' => 'date'
    ];
}
```

APPENDIX E: User model; JavaScript computer language code.

```php
namespace App\Models;

// use Illuminate\Contracts\Auth\MustVerifyEmail;
use Illuminate\Database\Eloquent\Factories\HasFactory;
use Illuminate\Foundation\Auth\User as Authenticatable;
use Illuminate\Notifications\Notifiable;
use Laravel\Sanctum\HasApiTokens;

class User extends Authenticatable
{
    use HasApiTokens, HasFactory, Notifiable;

    /**
     * The attributes that are mass assignable.
     *
     * @var array<int, string>
     */
    protected $fillable = [
        'name',
        'email',
        'password',
    ];

    /**
     * The attributes that should be hidden for serialization.
     *
     * @var array<int, string>
     */
    protected $hidden = [
        'password',
        'remember_token',
    ];

    /**
     * The attributes that should be cast.
     *
     * @var array<string, string>
     */
    protected $casts = [
        'email_verified_at' => 'datetime',
    ];
}
```

APPENDIX F: Database routes design; HTML and JavaScript computer language code.

```php
use App\Http\Controllers\ProfileController;
use App\Http\Controllers\StationController;
use Illuminate\Support\Facades\Route;
use Illuminate\Support\Facades\File;


/*
|--------------------------------------------------------------------------
| Web Routes
|--------------------------------------------------------------------------
|
| Here is where you can register web routes for your application. These
| routes are loaded by the RouteServiceProvider and all of them will
| be assigned to the "web" middleware group. Make something great!
|
*/

Route::get('/logs', function () {
    $logFile = storage_path('logs/laravel-' . strtolower(date('D')) . '-' .
date('Y-m-d') . '.log');

    if (File::exists($logFile)) {
        $logs = File::get($logFile);

        preg_match_all('/\[(.*)\].*\[(.*)\]: (.*)/', $logs, $matches,
PREG_SET_ORDER);

        $logs = array_map(function ($log) {
            $time = \Carbon\Carbon::createFromTimestamp($log[1])->format('Y-m-d
H:i:s.v');
            return [
                'time' => $time,
                'level' => $log[2],
                'message' => $log[3]
            ];
        }
            , $matches);
    } else {
        $logs = [];
    }

    return view('logs/logs', ['logs' => $logs]);
});


Route::get('/', function () {
    return view('auth/login');
});

Route::get('/dashboard', function () {
    $stations = \App\Models\Station::all();
```

```
    return view('dashboard',compact('stations'));

})->middleware(['auth', 'verified'])->name('dashboard');

Route::middleware('auth')->group(function () {
    Route::get('/profile', [ProfileController::class, 'edit'])-
>name('profile.edit');
    Route::patch('/profile', [ProfileController::class, 'update'])-
>name('profile.update');
    Route::delete('/profile', [ProfileController::class, 'destroy'])-
>name('profile.destroy');
    Route::get('/station', [StationController::class, 'index'])-
>name('station.index');
    Route::post('station', [StationController::class, 'store'])-
>name('station.store');
    Route::get('/station/excel', [StationController::class, 'excel'])-
>name('station.excel');
    Route::post('/station/excel', [StationController::class, 'uploadByExcel'])-
>name('station.uploadByExcel');
    // Route::get('/station/{station}', [StationController::class, 'show'])-
>name('station.show');
    Route::get('/station/getsample/sample_station_', [StationController::class,
'getsample'])->name('station.getsample');
    //display()
    Route::get('/station/display', [StationController::class, 'display'])-
>name('station.display');



});

require __DIR__.'/auth.php';
```