DEVELOPMENT OF AN ANDROID-BASED INEC SMART CARD READER TRACKING SYSTEM USING A GLOBAL POSITIONING WIRELESS TECHNOLOGY

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ABSTRACT

The conduct of elections in Nigeria is still at it crude stage. This is not unconnected to the high level of desperation by the political class and the absence of infrastructure capable of supporting smooth and transparent processes. Unholy activities such as snatching and damaging of election materials, manipulation of results, violence and vote buying are common treats to democracy. This has badly affected the overall results and credibility of electoral processes consistently over the years. Fortunately, smart card readers (SCRs) were introduced to sanitize the accreditation stage of the electoral process. This to a large extent brought some rays of hope in electioneering management in Nigeria. Unfortunately, the security of these devices is now of great concern as the political class now hijacks these card readers with the aim of manipulating election results. Through a structured system analysis and design methodology, this work developed a Global Positioning System (GPS) based SCR monitoring system using My SQL as the backend and Google application programming interface at the frontend. Report from the system can be in hard and softcopy. The result present the opportunity for INEC to monitor the movement of their SCRs in real time, keep records of its movements for emergency purposes, receive sensitive information such as card reader's serial number, location, altitude, latitude, longitude, bearing and so on for security purposes and future references.

INTRODUCTION

The Independent Electoral Commission (INEC) made history in Nigeria by adopting technology in the accreditation phase of the electoral process with the aid of INEC Voters Identification System (IVAS). Improved Automated Fingerprints Identification System (AFIS) was introduced to identify similar fingerprints on the register used for 2011 elections. Business rule was also applied in addition to further clean the register. The business rule required that at least two fingers must be captured for a voter to be included in the register. Temporary Voters' Cards (TVCs) which were issued to voters for 2011 elections were replaced with the Permanent Voter Cards (PVCs). According to INEC, quality, security; durability and cost effectiveness were underlying factors in the production of the Permanent Voter Cards (PVC) by INEC. These cards have many components and specialized features and were designed with an average life span of ten (10) years. With the Smart Card Readers (SCRs), accreditation process spans three phases;— identification, verification and authentication. Verification stage involves reading the information on the chip of the PVC presented. Authentication, comparison of the fingerprint stored on the card with what was physically presented and scanned by the reader. Once PVC has been read and accredited by the SCR, the Voter Identification Number (VIN) is stored in the reader and it does not allow the accreditation of that VIN on that particular reader any longer.

In Nigeria today, violence during elections is very common which sometimes results to the tempering and snatching of electoral materials among others. INEC currently tracks her SCRs manually and as a result of this, many challenges are being faced.
These include:

i.) Large number of stolen SCR recorded during election,
ii.) Individuals or politicians now have access to SCR,
iii) Fake voters are being accredited,
iv) Elections results are being questions as a result of stolen sensitive materials
v) Insufficient security personnel
vi) Security personnel are being threatened and eventually killed.
vii) It is time consuming in providing the locations of all card readers deployed for an election.
viii) Major loss of data due to manual tracking of card-reader.

Based on the important functionalities being provided by the SCR as earlier explained, it is of great importance that a means of security is provided for SCRs so as to ensure it safety and judicious use both to the electoral body and the Nigerian electorates. The solution to the securing of SCR prompted the development of a mobile based electoral card reader tracking system using wireless technology is reported in this paper.

Global Positioning System (GPS) is a worldwide radio-navigation system formed from the constellation of twenty-four satellites and their ground stations. It identifies the specific location of things. A Global System for Mobile Communications (GSM) modem is used to send the position coordinates (latitude and longitude) of the entity from a remote place. The GPS modem will continuously supply the data (i.e. the latitude and longitude indicating the position of the entity). The data is sent to the mobile from where the position of the entity was demanded. When the request by user is sent to the number at the GSM modem, the system automatically sends a return reply to that mobile indicating the position of the entity in terms of latitude and longitude in real time. A passive system monitors and stores data about the movement of the device which it has been installed, based on incident. A passive system may store or record data based on the events like when the device was switched on and offing of the device, data storage procedure for storing data in this type of tracking system is stored in an internal memory or a memory card which can be accessed with the aid of a computer if the need for assessment of tracking details arise. Passive GPS tracking system does not require the transmission of signals from the user to the satellite. According to Devyani and Gupta (2012), an Active GPS tracking system also called a real-time tracking system sends information to a host computer, of what is happening and going on around the GPS tracking system in actual time of occurrence. This type of tracking device is the best choice by travelling agencies, business oriented companies, private individuals and government agencies. It allows the company that has the resources to house a host computer to know the whereabouts of whatever device is installed in it at that actual hour, minute, and second. Active GPS tracking system also serve as an aid to employers of labour to be able to monitor the behavior of their employees.

In Ramani and Valarmathy (2013), GPS is a satellite- based navigation system consists of a network of twenty four satellites located into orbit to determine the precise location of an item, vehicle, person, or other asset to which it is attached and to record the position of the asset at regular intervals. The recorded location data can be stored within the tracking unit, or it may be transmitted to a central location data base, or internet-connected computer, using a cellular, radio, or satellite modem embedded in the unit. This allows the asset's location to be displayed against a map backdrop either in real-time or when analyzing the track later, using customized software. A GPS tracking system uses the Global Navigation Satellite System (GNSS) network that integrates range of satellites that use microwave signals which are transmitted to GPS devices to give information on location, speed, time and direction (Ambade and Shaikh, 2011). A GPS tracking system can applied in various ways; —record positions of a package sent through a carrier service or transportation vehicles embarking on journeys. Some systems will store the data within the GPS tracking system itself and some send the information to a centralized database or system via a modem within the GPS system unit on a regular basis (Damani, *et al.*, 2015). A GPS receiver uses the messages received from an attached device to determine the

transit time of each message and compute the distance to each satellite and for the computation of the location. This operation is based on a simple mathematical principle called Trilateration. The accuracy of a position determined with GPS depends on the type of receiver (Devyani and Gupta, 2012). The most significant difference between GPS receivers is the numbers of satellites they can simultaneously communicate with. In Kunal *et al.,* (2010), proposed a tracking system that works using GPS and GSM technology as an anti-theft system. This design continuously monitors a moving entity and report the status of the entity on demand. Similarly, Al-Rashed, *et al.* (2013) implemented a related application for vehicle unauthorized movement detection and maximum speed alerts. Others include GPS-GSM based studies for monitoring and tracking children movement (Sambanthan and Saravanan, 2015), for dynamic signals of structures) (Zhao and Shi, 2013. Shruthi, *et al*, 2015) focused on anti-theft vehicle tracking system with a smartphone application. Alzahri and Sabudin (2016) on the other hand developed a system for the handicapped. Similarly, while studying how voluntary organizations in Norway exploited land-based search and rescue operations with tracking system, Øyvind (2017) observed that tracking and visualization assist greatly in the following areas: (a) the safety of search and rescue personnel (b) need for coordinating resources and monitoring the operation and (c) post-operation analysis, planning and documentation. In their work, Devyani and Gupta, (2012) designed and implemented an object moving tracking system over a geographical area using GPS and GSM technologies that is not dependent on the internet. The findings showed that the highest uncertainty in the positions obtained is the radius of 16m of a circle seen as an acceptable result for tracking the movement of objects in wide and open environments.

System Framework and Methodological Workflow

The methodology used in this paper is the structured system analysis and design. This section describes the tools that were used to develop and implement the system. These include android application software installed on an android device, application/ activation of GPS/GPRS, and a web application that serve as the base station. These tools helped in designing the system explaining the logic behind the system. The SCR was designed specifically for the accreditation process, authentication of eligible voters before voting. The machine is usually configured to read only the PVCs of a particular Polling Unit (PU) and can only work on elections day. The device uses a cryptographic technology with ultra-low power consumption and processing frequency of 1.2 GHz and uses Android 4.0.0. This PVC is placed into the SCR device, which then displays the voter's details if the voter is in the database. The voter places their thumb on the device, and their identity is confirmed through fingerprint authentication. On completion of the accreditation process, a "Close V" key is used to complete the accreditation process and the total number of voters accredited can be previewed using a "Query" key. Thereafter, the results may be forwarded to INEC using the "Communication" key.

Due to the recent concerns raised from the European Union report about wide spread of violence and the safety of election materials in Nigerian general elections which took place in February, 2019, it has been observed that the existing system have some loopholes. Some of the weaknesses in the existing system are: (i) not having real-time information about the where about of the card reader, (ii) the tendency for political players to influence the security agent providing security to the card reader into doing their bidding while delivering the election materials, (iii) The tendency for political players to influence INEC officials to also manipulate the card reader in their favour and (iv) not having database that provides detailed record about the card reader and its movements etc.

In consideration of these drawbacks, the proposed system has the following features; (1) mechanisms that track SCR across the nation without the knowledge or interference of the custodians, (2) provision of locations and other details of all devices, (3) detection device status, web-based monitoring dashboard for tracking information and exporting them for reporting purpose, (4) robust central database that will serve both the mobile apps and monitoring web-

based dashboard, (5) access rights to the right users, (6) user-friendly graphical user interface and (7) alarm system at any point in time with the use of a mobile phone via SMS for security and safety purpose.

This mobile app will be installed and tested on Android devices (phones, tablets) to evaluate the performance. Once the app is launched on the device and location tracking start button is activated, the device name is registered to the tracking system and the system gets the geo-coordinates of the location of devices where the App is installed in interval base of sixty seconds. The system uses Google Application programming interface (API) to convert these coordinates into readable addresses for storage in the central database. A secured web-based monitoring dashboard is also developed to display the output of the tracking system stored in the central database. The tracking details stored in the database are: device name, longitude and latitude of the device, altitude of the device, the speed at which the device is moving and timestamp. The output can be read and printed from the dashboard and exported in reporting formats such as PDF and excel for administrative and analytic purposes. The system provides a security module; a login form that prevents the system from being accessed unauthorized users.

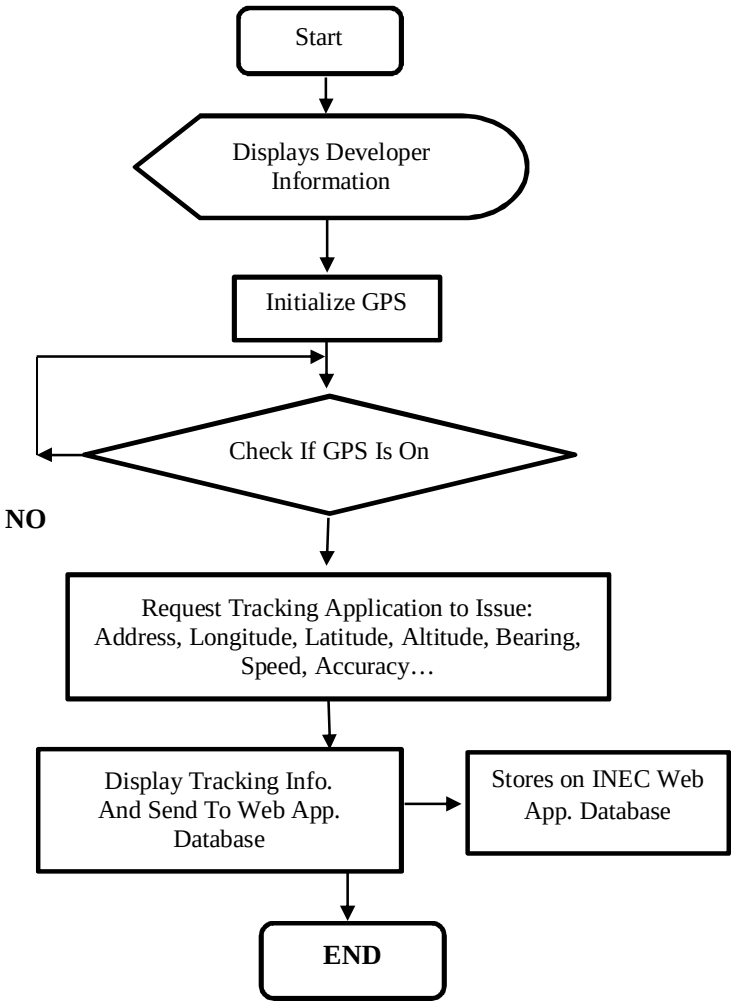

Figure 1: INEC Andriod Application Flowchart

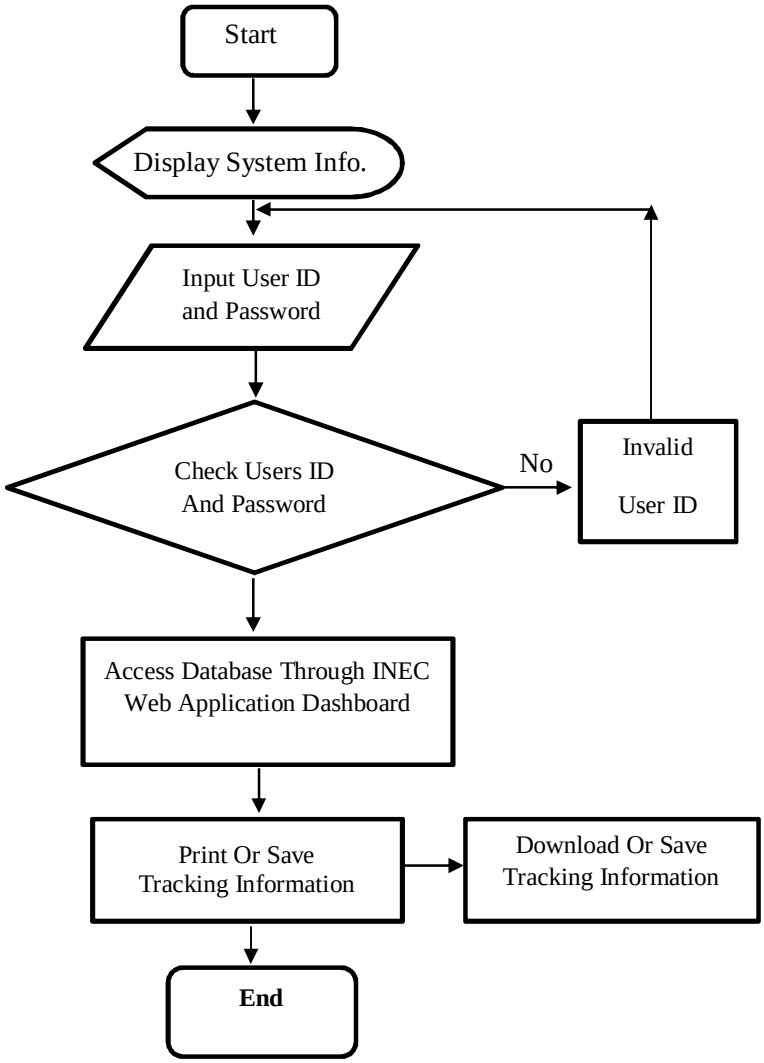

Figure 2: SCR Web Application Dashboard Flowchart

Implementation procedure and Interface

The result of the mobile based INEC electoral card reader tracking system with wireless technology showed that INEC can now monitor the movement of the card reader in real time, keep records of its movements for emergency for security purposes and future references. Thus, the development of a mobile based INEC card reader tracking system using wireless technology is an enhancement to the conventional manual method of tracking the SCRs.

i. **Dashboard Login Interface:**
In this form, the INEC official is required to input user's username and password. If the login details are authentic, the user would be granted access to the tracking dashboard and can manipulate the dashboard freely.

ii Monitoring Dashboard Interface:
This is a platform that enables INEC officials see important information about the SCRs in tabulated format. This information includes the card reader's serial number, latitude, longitude, altitude, bearing, address, speed and date

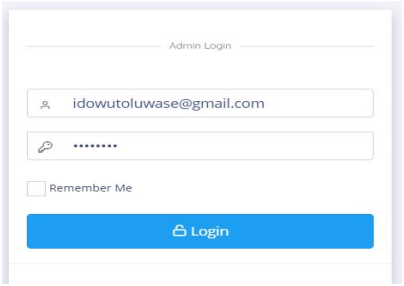

Figure 3: Dashboard Login Form

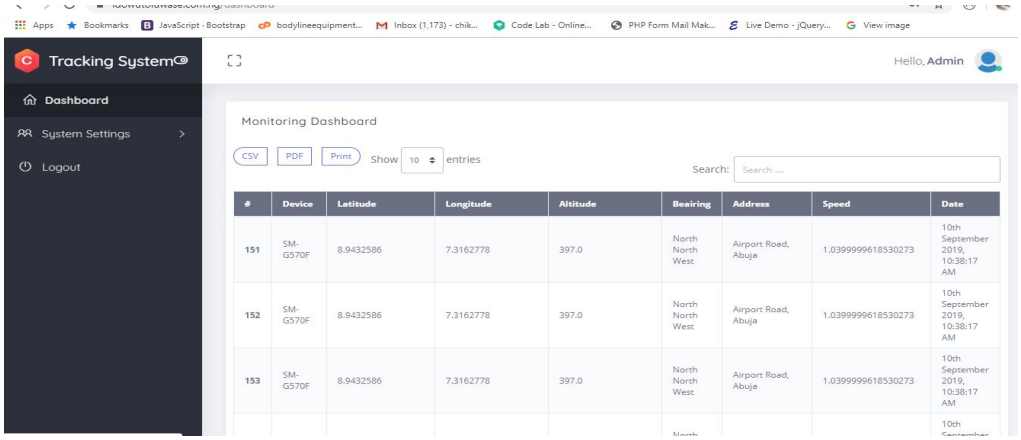

Figure 4: Monitoring Dashboard

iii. Device Tracking Interface:

This is the software that will be installed in the card reader in order to allow INEC track the device SCR device. This software provides the functionality of tracking the card reader and other vital information once switched on.

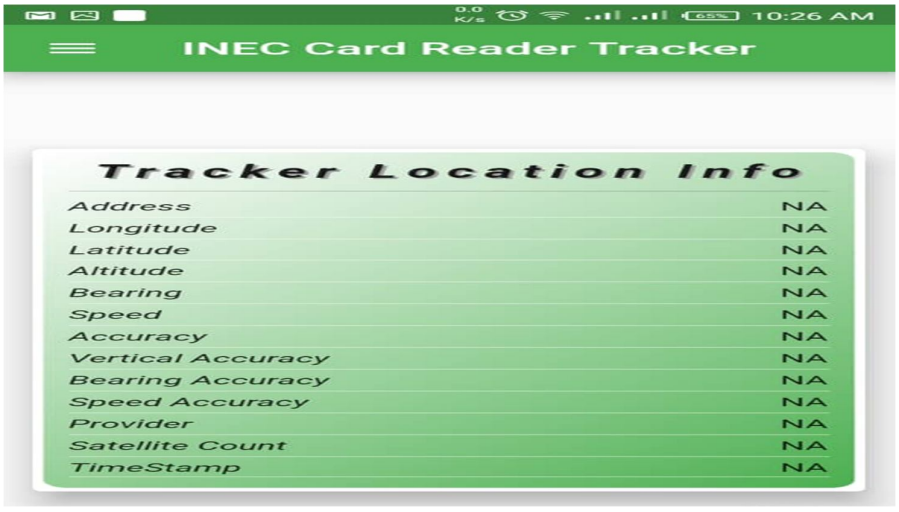

Figure 5: Device Tracking Startup

Assessment of the INEC Electoral Card Reader Tracking System Using Wireless Technology

The data collection of the developed INEC SCR tracking system was tested. The result is shown in Figures 6 and 7.

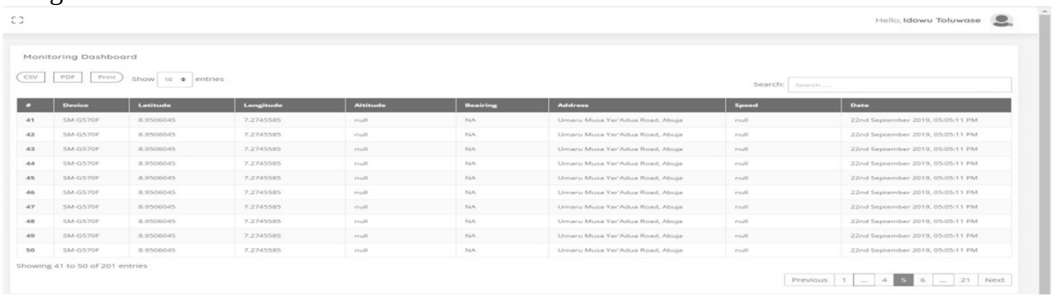

Figure 6: Monitoring Dashboard

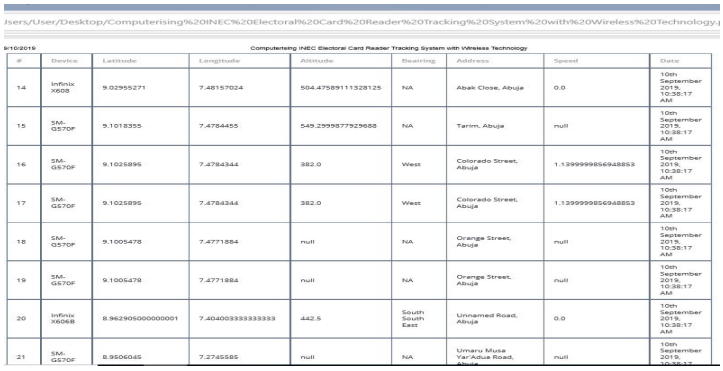

Figure 7: Exported Output in pdf file format

CONCLUSION AND RECOMMENDATION

This paper reported the development of a proposed mobile INEC SCR tracking system with wireless technology capability of improving SCR monitoring services. In terms of security, the system requires a username and password assigned to authorized employees before gaining access to the system. A system administrator is in charge of overseeing the activity of authorized persons using the system and the all-round maintenance of the system. The application interfaces are user friendly in such a way that users would have little or zero training in using the apps. The proposed system would to a large extent reduce incidences of SCR diversion and hijack before, during and after elections thereby restoring the dwindling image of INEC and the Nigerian electoral process in general. Although this work intended to cover performance analysis, further research should be geared towards comparing the developed system with the existing system. In addition integrating copra of local languages and dialects such as Hausa, Yoruba, Igbo, and some others are not in the directions of future work.

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