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DEVELOPMENT OF A DEEP LEARNING MODEL FOR PROFILING AND PREDICTING TRAFFIC OFFENDERS

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Abstract: **Traffic violation has been a big challenge to mankind as many of the accidents recorded over years is as a result of traffic violation. The traffic violation monitoring systems deployed in developing countries lack adequate authentication of road users, no efficient and effective profiling system of offenders and offences, as such, traffic agents cannot generate instant traffic history of an offender. The monitoring of traffic offenders in developing countries has a lot of challenges including; lack of proper authentication of vehicles and users, lack of substantive traffic system that suits the management of traffic offenders' profile in both rural and urban areas, lack of predictable modules to forecast the tendency of an offender to cause accident in the future, poor means of communication between traffic agencies and vehicle users, poor traffic offence awareness for vehicle users and lack of a dependable traffic offenders profile database. The area of traffic offender identification using fingerprint and NIN and predicting the possibility of the traffic offender committing more traffic offence in the nearest future has not be researched on and this forms the research gap this paper is set to cover. Therefore, this thesis is providing a solution by development of a deep learning model for profiling and predicting traffic offender'sfocuses on developing a traffic offenders profiling and prediction system using deep learning algorithm to predict the likelihood of an offence to be committed by a road user.The proposed system developed a model that will profile traffic offenders in both urban and rural settings, create a traffic offender's database that will interact with existing national databases to authenticate traffic offenders, provides a module that will predict the likelihood of a road user to commit severe traffic blunder in the future and provide intelligent information necessary for timely action by law enforcement agencies. The system also createdan SMS based traffic awareness module that handles traffic offences communication between traffic agents and offenders. These designs are implemented using a web-system developed with PHP, MySQL and JavaScript. The System Design followed the OODM methodology for componentization of the system modules giving room for coupling, decoupling, modification, encapsulation and reuse, as well as easy maintainability. Unified Modeling Language was extensively used to simplify the explanation of the system modules. The software performance was tested using accuracy of traffic offender prediction and Confusion Matrix was adopted for the thesis. For the purpose of this thesis, dataset was collected from data-world (https:// data. world/ health data ny/qutr-irdf) and the data is an excel sheet dataset for Traffic offenders. The result obtained from the new system developed shows 95% accuracy of the deep learning technique for predict the likelihood of a road user to commit traffic blunder in the future.**

Keywords: **Deeping learning, NIN, Fingerprint and offenders.**

I. INTRODUCTION

Profiling of offenders is an important tool used by traffic agencies in solving traffic problems (Ibeh et al., 2012). Profiling saves traffic agents time on the investigation of offences by providing detailed demography of an offender and the past traffic offence antecedents (Ibeh et al., 2012). Gebath (1981) describes profiling as an educated attempt to provide specific information about certain types of suspect. Profiling has helped law enforcement with the application of behavioral forensic science over the years in solving crimes problems by creating psychological profiles of criminals (Houck & Siegel, 2006). Road traffic offences/offenders profiling should be able to give descriptive details of an offender, offence committed and rate the number of occurrences of an offence, and exact identification of

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vehicle used to commit the offence at a given time and location. In developing and under-developed economies where most people violate protocol and are criminally minded, most traffic offenders appear to be anonymous and it is difficult to profile such offenders. It is necessary for every vehicle user to be authenticated during registration and licensing to use the road to ensure that anonymity of vehicle users is discouraged. This is achievable by creating a synergy between traffic registration systems with a dependable national identity database to ensure that a registered vehicle owner is genuine and authentic. Traffic systems in operations are designed to operate in urban areas where there are supporting amenities such as light, availability of online features and mobile coverage. Traffic has extended from the cities to the rural areas leading to loss of lives and properties. There is every need to develop a traffic system that will support rural settings as well. In profiling traffic offenders and offences, inputs are gotten from various traffic points both in the urban and rural areas. It is therefore necessary that a profiling system should support both urban and rural traffic systems (Slavinskiennetal, 2016). Building and deploying traffic offence and offender systems will not be enough to effectively aid in the curtailing of traffic challenges. The system should be able to communicate with traffic agents and pass information to guide the agents on how to effectively manage traffic challenges. (Onah, 2017). A good traffic offender's profiling system should be able to predict risky drivers by automatically forecasting offences, the sequence of occurrence of such offences, and so on (Onah, 2017). This will enable traffic agents to tag a driver reckless status a not road user, then take the necessary actions to apprehend such a driver.

1) Traffic profiling systems should not just be a database of traffic offenders and offences. Rather the system should be able to communicate offenders to remind them of their traffic rating from time to time (Ibe et al., 2012). The system should be able to communicate with traffic agents and the vehicle users on current trends in traffic managements. This will inform the duo and create proper traffic awareness. In recent times, deep learning techniques have been vastly used in modeling and monitoring complex applications. Deep Learning has also shown outstanding performances in many fields including crime profiling, by providing useful descriptive and predictive information. The main advantage of Deep learning methods is their ability to create models that may be integrated into the decision-making process. To achieve the set target of this thesis, data mining and deep learning based methods will be develop to aid in promoting effective and efficient traffic offender's profiling and prediction. The new system framework allows road traffic agents to profile a road user and predict the possibility of committing traffic offence in nearest future.The traditional and age-old system of intelligence and traffic offender record maintenance has failed to live up to the requirements of the existing crime scenario. Manual processes neither provide accurate, reliable and comprehensive data round the clock nor does it help in trend prediction and decision support. It also results in lower productivity and ineffective utilization of manpower. Technology and computer system has allowed us to track and report (analyze) every details of our live and environment. Technology has numerously helped in combating crime via divert measures. This is true only when technology and computer systems are positively used in our society. Moreover, the presence of increased computing technology and well-nurtured mind in the technological aspect of today's world has automated almost every aspect of life. The solution to this ever-increasing problem lies in the effective use of Information Technology. Traffic offender record management system uses computer-generated records as an interface for integrating and accessing massive amounts of location-based information for traffic offender profiling. The ability to access and process information quickly while displaying it in a spatial and visual medium allows agencies to allocate resources quickly and more effectively. It enables the user to layer the data and view the data most critical to the particular issue or mission. The invention of cars, aero-planes, ships, radios, television sets, telephones, computers, etc. are innovations that have taken the world to where it is today. The important fact to note is that, development has its positive and negative sides. The application of technology in our ecosystem has great impact on the natural system. Muzhir et al. (2011) noted that the growth of technology and modern innovations have led to a big problem all over the world. The objective is to provide a module that will predict the likelihood of a road user to commit severe traffic blunder in the future using deep learning and provide intelligent information necessary for timely action by law enforcement agencies. It to create and integrate SMS based Traffic awareness module that handles traffic offences communication between traffic agents and offenders.

II. THEORETICAL REVIEW

Road safety profile of Nigeria

Road transport accounts for over 90% of the subsector contribution to the gross domestic product in Nigeria. With a total of 193,200km of roads (Paved: 28,980km and Unpaved: 164, 220km) (KPMG, 2014), Nigeria has the largest road network in West Africa and the second largest south of the Sahara. According to the WHO (2013a), there are approximately 12 million registered vehicles using Nigeria's roads, at 85 cars per 1000 people. It has a population-road ratio of 860 persons per square kilometer,

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indicating intense traffic pressure on the available road network (Ukoji, 2014). With an estimated population of 190 million (NBS, 2017), Nigeria is Africa's most populous nation and the seventh most populous country in the world. It shares borders with Niger in the north, Chad in the northeast, Cameroon in the east, and Benin in the west. Its coast in the south is located on the Gulf of Guinea in the Atlantic Ocean. It has a land mass of 923,768km2 and comprises of 36 states and 1 Federal Capital Territory, where Abuja, the capital is located. As of 2017, Nigeria's gross domestic product (GDP) stood at an estimated $375.77 billion (World Bank, 2018). RTCs have been identified as a major public health problem in Nigeria and as such require urgent attention as not much success in tackling this problem has been achieved. The Federal Road Safety Corps (FRSC) is the lead agency in charge of road safety in Nigeria. It is tasked with the responsibility of ensuring a safe motoring road environment in Nigeria. This is achieved by its programmes on road safety administration, road safety educational campaigns by government agencies and charities, promotion of stake holders' cooperation etc. The number of RTCs keeps increasing despite the programmes the Federal Road Safety Commission has implemented in the past. Nigerians depend majorly on the road transport system as a means of transportation as cycling and walking are not common, and the rail system is not developed. Most movements are on the road, that is why the road transport system in Nigeria should be made safer than it is today for every road user. Figure 2.16, shows the trend in traffic crashes in Nigeria from 2000 - 2017 depicting a lot of variation in the pattern. For example, between 2003 and 2004, there was a significant drop in total casualty and persons even though the crash rate remained high. The same pattern was also observed between 2009 and 2010 but with a significant reduction in the number of crashes. The Figure also shows that the number of fatalities has remained fairly stable from 2000 up to 2017 compared with the other crash types. Despite the variation in most of the crash types, generally the casualty rate has remained very high.

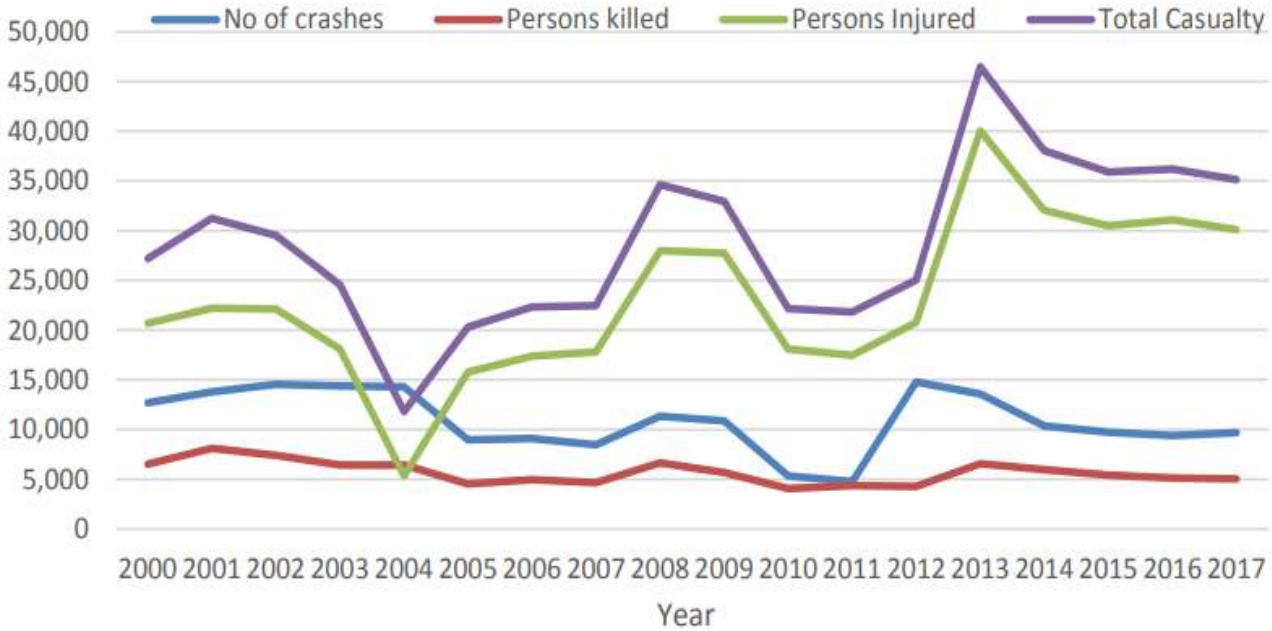

Figure 1: Trend in road traffic crashes, persons killed, injured and total casualty 2000- 2017 (FRSC, 2018)

The differences in statistics provided by the FRSC and WHO has revealed the underreporting and unreliability of crash data. Studies have consistently pointed these out for developing countries (Ameratunga et al., 2006), and Nigeria is not an exception (Figure 1). In the year 2015, the WHO estimate of fatalities (39, 802) was seven times higher than those reported by the FESC (5, 053). The reason for the differences in numbers is because the WHO adjusts for under-reporting which is not done by the FRSC.

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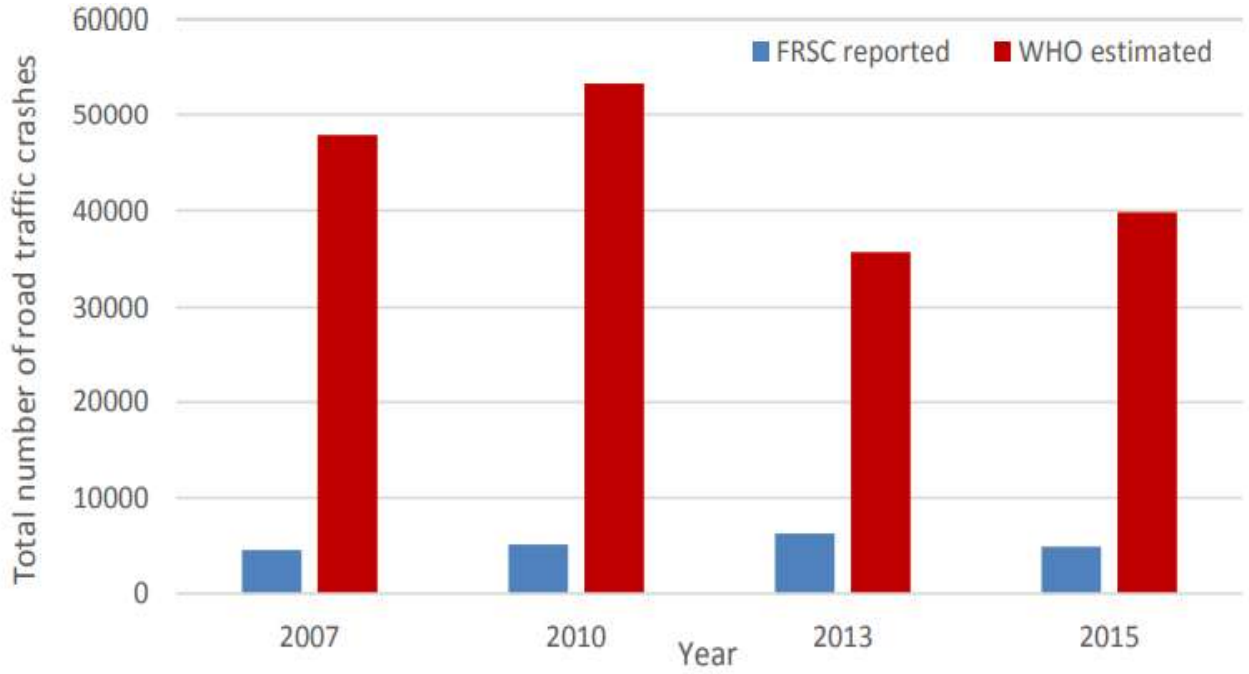

Figure 2: Reported and estimated number of road traffic fatalities for selected years in Nigeria (WHO, 2010; 2013; 2015, 2018)

Causes of Road Traffic Crashes in Nigeria

Several factors contribute to RTCs in Nigeria. Compared with the traffic in Nigeria, traffic flows in most countries are smooth because the majority of drivers behave in a consistent and predictable way (Li & Zuylen, 2014). Obedience to the traffic rules and driving in a disciplined way can help drivers to know and predict each other's movement. To drive a vehicle safely requires that one must possess specific skills that must be learnt properly. When one drives with the right skills, there is a higher chance that the person will be safe and getting into a crash is reduced to an extent. To improve the safety performance of drivers, training and education are very important. Most drivers in Nigeria are inexperienced and unqualified, do not understand and obey simple road rules and as a result, crash rate is high. They are unqualified in that drivers do not do the necessary training and tests stipulated as a prerequisite for obtaining a license and driving. Analysis of the 2012 casualty rates in the country showed that unlicensed drivers had a fatality rate which was twice as high as those drivers with formal training (FRSC, 2016). More than 80% of respondents on a 1991 Gallup Poll Survey in the UK supported compulsory driver training for learner drivers (Quim by et al., 1991) and according to Kinnear (2009) pre-training serves the purpose of shaping driver attitudes and requires the new driver to take ownership of his behavior before being granted the privilege of driving without restrictions. Research (Atubi and Onokala, 2009) has identified Nigeria as having the highest RTC rates in Africa. The percentage of all deaths as a result of road traffic crashes in Nigeria increased from 38.2% to 60.2% in ten years between 1999 and 2009. Table 1 shows the most recent data on probable causes of RTCs in Nigeria in 2017.

Table 1: Probable causes of road traffic crashes in Nigeria in 2017 (FRSC, 2018)

Probable causes of road traffic crash	Number of crashes caused (%)
Speed Violation	44
Loss of Control	12
Dangerous Driving	8
Wrong overtaking	7
Tyre burst	6
Brake failure	5
Routes violation	5
0thers	11

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Driver factors account for up to 90% of crashes in Nigeria: this includes inappropriate speeding and speed-related factors, poor knowledge of traffic regulations including road signs and markings, drink driving, driver fatigue, wrongful overtaking etc. (Ukoji, 2014). The first four which are linked to driver behavior have consistently been the highest probable causes of road traffic crashes in Nigeria in a long time. These are speed violation, loss of control, dangerous driving and wrong overtaking, Figure 2.18. This indicates that efforts need to be intensified in the area of driver behavior in the country. A study conducted by Atubi (2010) to examine the variation patterns of road traffic crashes in Lagos state Nigeria, with the use of secondary data from the FRSC and Nigerian Police, found that more than 90% of road traffic crashes in Lagos could be attributed to over speeding and recklessness on the part of drivers.

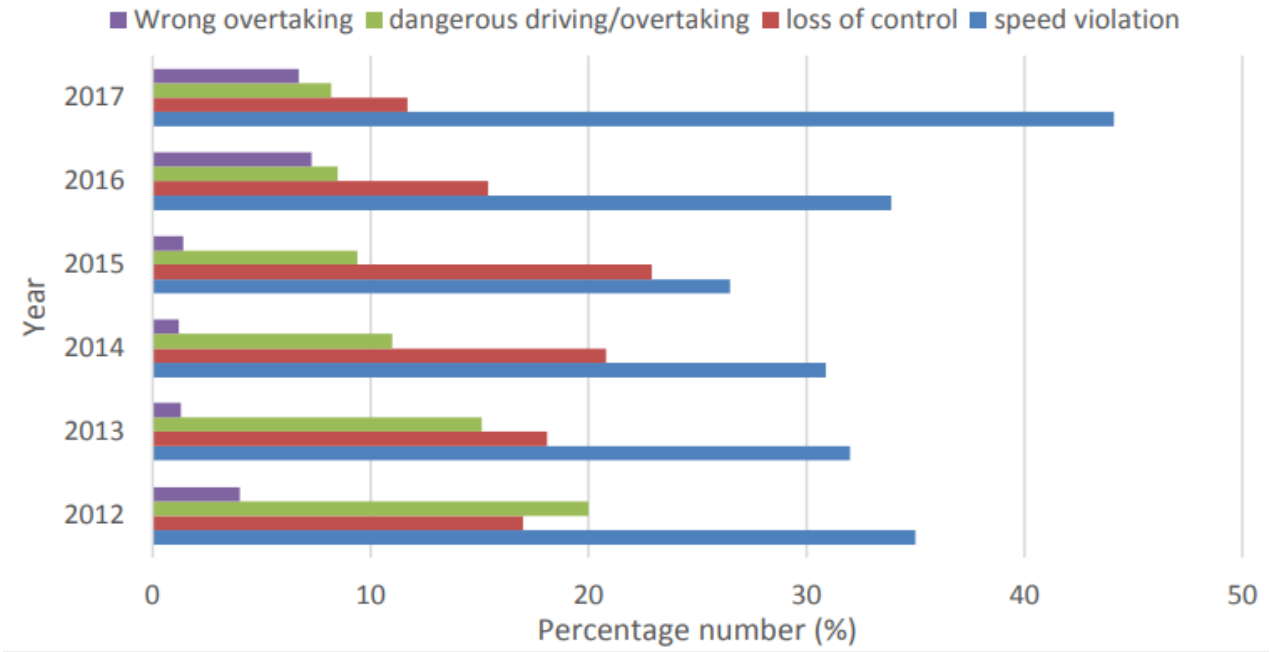

Figure 3: Top four probable causes of road traffic crashes in Nigeria (FRSC, 2018)

Apart from these, driving behavior could also be influenced by the environment. The environment in which a driver operates can affect behavior in a lot of ways, for example, poor road designs, roads with potholes, traffic mix, weather conditions (rainy, dry), time of day, traffic layout and traffic laws (Hao et al., 2016). Generally, the Nigerian road environment lacks the basic road furniture needed to improve safety operations on the roads. Hills & Baguley (1992), have shown that most roads and road systems in developing countries are being built and upgraded with little consideration given to road safety. According to Almqvist &Hyden (1994), some road design measures dramatically reduce the number of mistakes that lead to risks and crashes, by reducing opportunities for road users to make errors; and if errors do occur, making the environment more forgiving. Similarly, factors related to the vehicle such as un-roadworthy vehicles, tyre blowouts and poor vehicle lighting also affect road traffic crashes.

III. ANALYSIS OF THE PROPOSED SYSTEM

The proposed system is an enhancement on the existing system. As such, all the features of the existing system was enhanced and improved upon by adding additional features to make the system more robust and effective. The system was modeled to collect offenders/offences profiles of traffic related data to create an authentic database to be used by traffic agents, vehicle owners and for the user of others as may be required. The process involves fingerprint scanning, handshake with the existing national database for verification and authentication of offenders recording of demographic data of offender, types and names of offence committed, characters of offenders, location of offenders, time and place of offence, cost of offence, and possible witnesses who may be required to testify against the offenders. This is achieved using rules programmed knowledge judgment base for judgment. The information gathered are filtered and forwarded to a database for further scrutiny by road traffic agents who may modify, interpret, generate reports and take necessary action as needed. The database in the traffic offenders/offence profile is forecasted periodically to generate report which is sent to traffic agents, or vehicle owners or user as may be needed. The report should be able to inform of probable traffic offence by an offender in the nearest future, new offence committed and the penalty, invitation request for an offender to visit traffic agent(s), etc. For smart application of the proposed

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system as a real time system, a deep learning algorithm developed using Long Short Term Memory Networks (LSTMs) algorithm with quick sort was used to achieve this. The system grant access to user, and traffic agent who are registered in the profile, though the message receive by users (Traffic Offenders) varies or may not be all about the information received by traffic agents. The proposed system worked with the existing traffic offender/offence database, the current identity of offenders (PIN and biometric) is used as means of identification with a handshake with the national identity database for authentication of offenders. The proposed model is designed to check vehicle user's activities to include over speeding, driving agents traffic, reckless driving, driving on the influence of alcohol and drugs, disobeying road traffic sign and rule, driving without particulars, driving vehicles that are not road worthy, etc and other related offences that may be so integrated into the system as they arise. If an offender has been labeled, a comprehensive report is generated and forwarded to the appropriate unit who will scrutinize and act accordingly. The geographical location, name and type of offence, time and place of offence and the retrospective actions of the offenders with respect to traffic related issues and the offender characters and other means of identification are all made available in the information generated. The system works in such a way that at the time of loading the application, the users enter their NIN and biometrics as requested. If the NIN and biometrics match with the one in the database, the module meant for such user (Offenders/agent) automatically loads giving the user the privilege for what they need. It is worthy to note that an offender cannot edit or modify any of the information on the page.

The feature of the proposed system includes;

1. Inclusion of modulus that allows for verification and authentication of offenders before profiling.
2. Integration of an enhanced platform for convenient application of biometrics for the purpose of verification and authentication of offenders who is to be profiled.
3. Enhancement that allows the system to communicate traffic situation of most areas to motorists as well as offences committed alongside with charges and way forward.
4. A model that peruse through the offenders profile and forecast the likelihood of committing of traffic related offences in the nearby future by offenders to traffic agents. This will enable traffic agent to timely intercept such an offender and educate him or her and bar him or her from using certain routes in any given time interval.

Data Flow Diagram (DFD) of the Proposed System

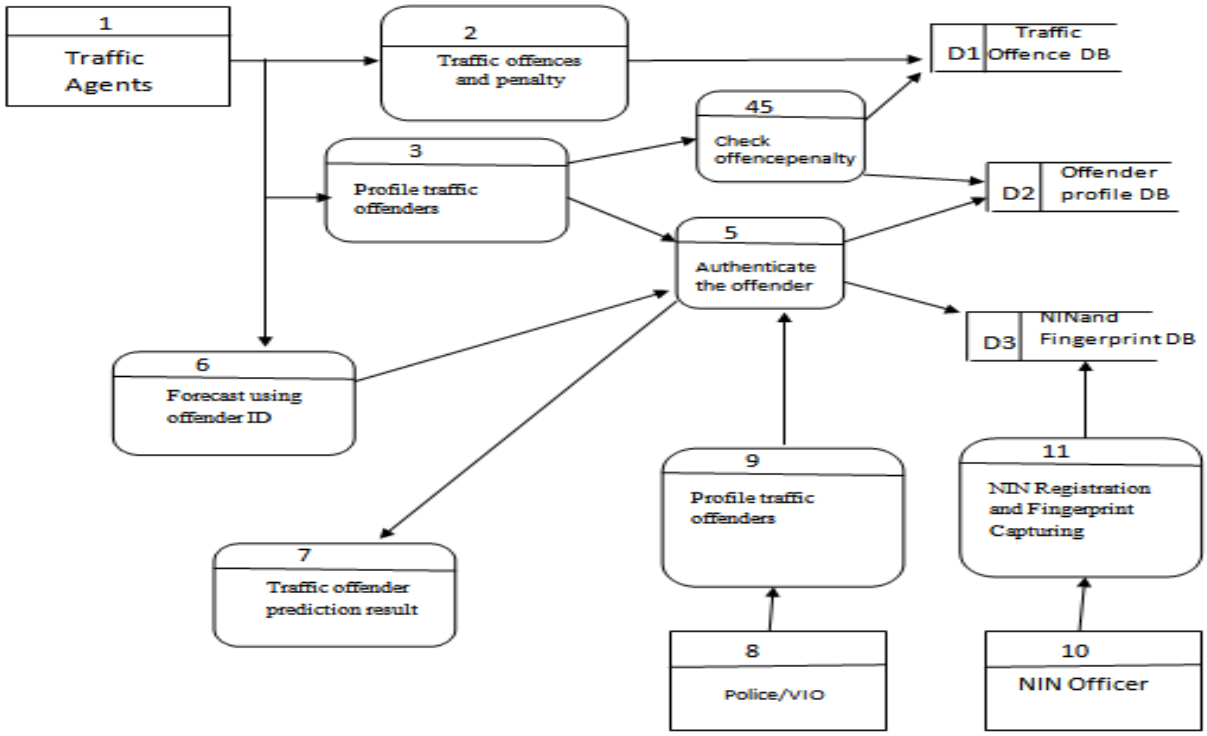

Figure 4: Data Flow Diagram of the proposed system

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IV. OBJECT DESIGN USED

Use Case Diagram

The use case diagram depicts all the actors in the development of a traffic offenders profiling and prediction system using deep learning algorithm to predict the likelihood of an offence to be committed by a road user and how they interact with the system.

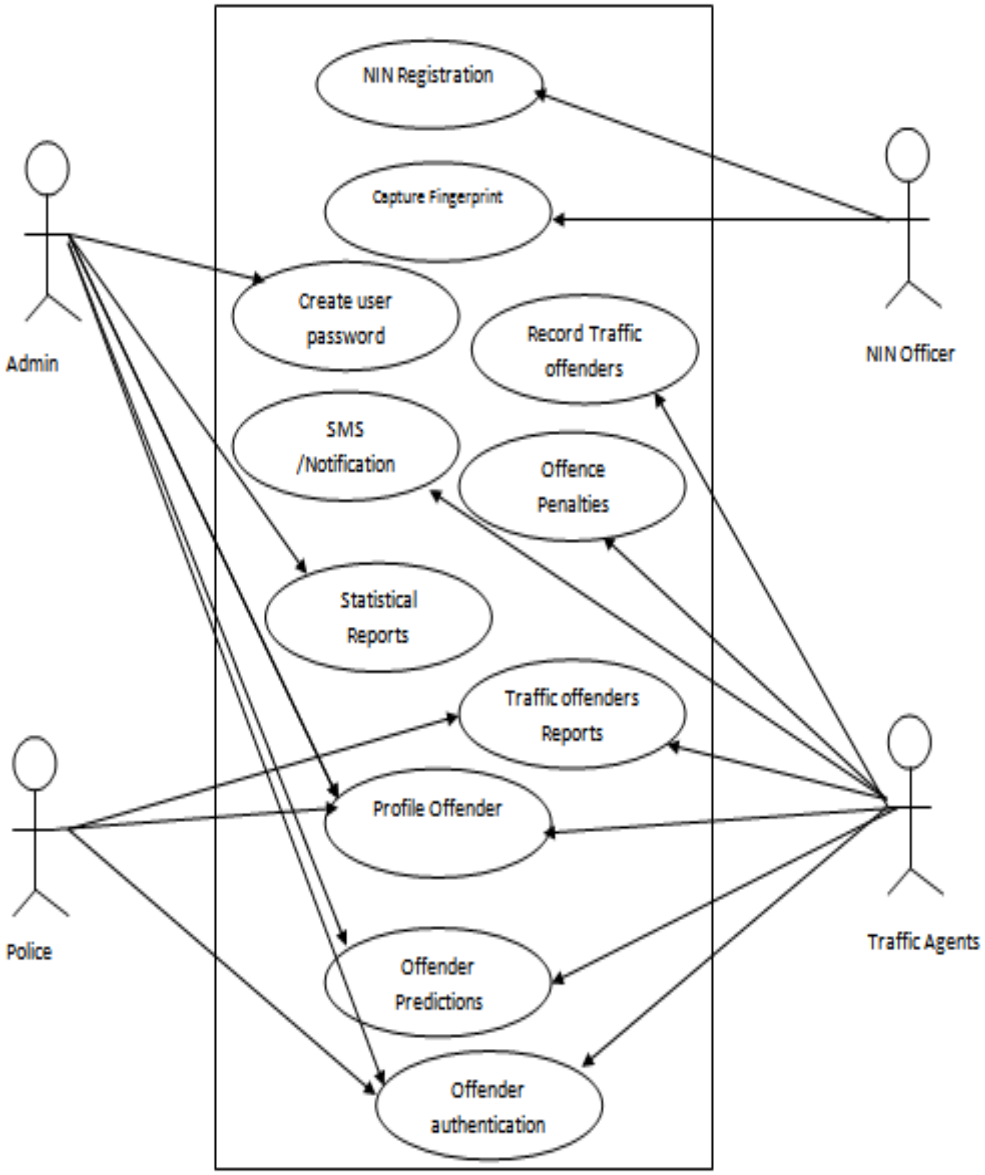

Figure 5: Use Case Diagram of the proposed system

The user requirements describe functions that are performed by the users on the system. The users of the proposed system are categorized into four levels namely Admin, traffic agent, NIN officer and Police. The activities of these users are described in figure 5 using use case diagrams.

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Activity Diagram

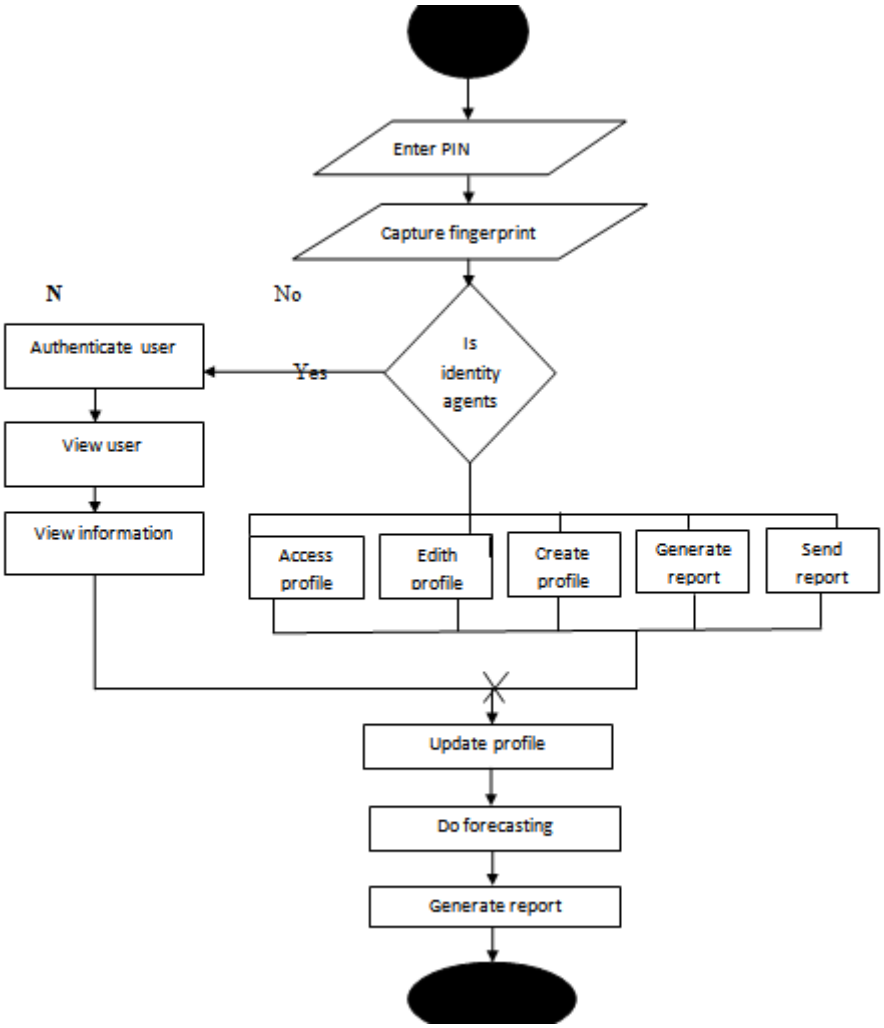

Figure 7: Activity Diagramof the proposed system

V. RESULT AND DISCUSSION

Table 2: Confusion matrix applied to test dataset of predict the possibility of committing further traffic offences

Observed

		True	**False**
Predicted	**True**	18	0
	False	1	1

Table 2 shows that out of 20 different predictions was carried out using deep learning technique; 18 results are True Positive and returned the needed intelligent information necessary for timely action by law enforcement agencies correctly, 0 predictions returned forecast that is not accurate, 1 predictions was unable to return a particular prediction result from the data set. Finally, 1 False was detected where there was no traffic offence. A model of performance metrics can be derived from the confusion matrix as show in equation 1, which show the level of accuracy of the deep learning technique for predict the likelihood of a road user to commit traffic blunder in the future.

Substituting the values we have

AC = (18+1) / (18+0+1+1) Equation 1

AC = 0.95

i.e. 95% accuracy of the deep learning technique for predict the likelihood of a road user to commit traffic blunder in the future.

VI. CONCLUSION

Profiling is the recording of activities in an orderly manner such that a comprehensive record can be tracked about subject of interest. In recent years, Forensic Science based profiling has gained a lot of popularity particularly in the media as seen today in most top rated television shows such as criminal minds. Profiling techniques have become a valuable tool helping law enforcement agencies to fight against violent criminals. Profiling in its origin was to keep detail characteristics of individual to serve as a guide into his antecedents which can be used to infer and draw conclusion about him/her in a criminal accusation. Primarily profiling is to help law enforcement to draw near precision conclusion about an offender or criminal. It is a reality that offenders and criminals do not accept responsibility for their acts. This makes it difficult to draw a conclusion that will be satisfactory about an offender or criminal that is standing trail. With profiling, such offender or criminal can be traced from his past records to ascertain whether or not he has the potentials or traits that can lead to the act he is being accused of. Profiling equally serve as a detail description of an individual who tends to be anonymous. Road traffic offences have led to a reasonable number of casualties leaving so many homes in pains. Traffic jam has given hood-lumps, kidnappers and rubbers the opportunity to take advantage of their victims. Traffic challenge is a global issue and needs to be given a serious attention. Aside from narrow roads, absence of traffic indicators by the road sides, absence of traffic control system at junctions, it is worthy of note that accident and traffic jam on the roads are caused by reckless driving and vehement refusal to obey traffic rules by drivers on the roads. This situation is worst in the under-developed and developing countries. It is therefore imperative to ensure that drivers especially in the under-developed and developing countries are compelled to obey traffic rules and regulations on the roads as in the developed countries in order to check the excesses of drivers on the roads. Traffic police alone cannot effectively control traffic. They need traffic system and a well-organized procedure that can help the traffic police to identify offenders even when they are not physically present on the road to be able to effectively control traffic and reduce the rate of traffic jam and accident on the road. One of the instruments that can help to identify traffic offenders is the profiling of offenders and their offences. So, the traffic offenders profiling system as developed in this thesis will assist the traffic agents to profile traffic offenders and in so doing, they can predict the possibility of the traffic offender committing traffic offence in the nearest future. This will assist them to take action before the offence predicted is committed.

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