INTERNATIONAL JOURNAL OF RESEARCH IN COMPUTER APPLICATIONS AND ROBOTICS
ISSN 2320-7345

THE MODELLING OF ACCIDENT PREDICTIVE SYSTEM USING ARTIFICIAL NEURAL NETWORK IN BENUE STATE

Esiefarienrhe Michael Bukohwo[1], Amuche Anthonia[2] and Djibo Idrissa[3]

[1]*Dept. of Math/Stat/Computer Science, UAM, Makurdi. Nigeria. esiefabukohwo@gmail.com*
[2]*Dept. of Math/Stat/Computer Science, UAM, Makurdi. Nigeria. bruce_tonia@yahoo.com*
[3]*Dept.of Computer Science Federal Polytechnic, Bauchi, Nigeria. djibo66@gmail.com*

Author Correspondence: UAM, Makurdi, Nigeria, +2348032311297, esiefabukohwo@gmail.com

Abstract: - Due to the strategic location of Benue State and given the fact that it is the food basket of Nigeria, there are always heavy vehicular movement in and out of the state 24 hours each day. Given the deplorable state of the roads, the difficult terrain, security road blocks and bad visibility, there is hardly a day that goes without a fatal accident occurring. This has made it imperative to develop a computer based modelling of accident predictive system that can be used to forecast and thus prevent accident occurrence. This paper seeks to present the design of accident prevention using artificial neural network (ANN). The overall system architecture of the proposed ANN predictive system is presented and further modelled using UML modelling tools such as use case, context diagram and data flow diagram. the essence of the paper is to present the architecture of the system and to show how the components connect and interact. This various system models from this work will be useful to system analysts and programmers who will use them as basis to developed actual software to perform the prediction. These diagrams cannot work by themselves but they can serve as input to a computer based system.

Keywords: ANN, UML, Modelling, Predictive System.

1. Introduction

Statistics of road accident worldwide is alarming. The world health organization's figure of 12 million people dying yearly from road accident and over 50 million injured is just a clue to the seriousness of which research should be directed towards investigating ways of preventing the occurrence of the global menace.
Nigeria, with a total land area of 910,771 square kilometres and human population of about 167 million, is the most populous country in Africa, and the 7th most populous nation in the world. Nigeria ranked as the country with the second largest road network in Africa in 2011. Its population density which varies in rural and urban areas (approximately 51.7% and 48.3% respectively) translates to a population- road ratio of 860 persons per square kilometres indicating intense traffic pressure on the available road network. This pressure contributes to the high road traffic accidents in the country (FRSC, 2012).

The frequency of road accident in Nigeria is on the rise daily and the mortality rate recorded is on the increase as compared to deaths registered from deadly diseases. Sumaila (2013) reported that the Nigeria situation has reached such an alarming proportion even to the point of sheer frustration and near helplessness.

The study area is Benue state. Located between longitude $6^0$32E and 10^oE and latitudes 6^o30'N and 8^o10'N in the central zone of Nigeria with a population of 4,219,244 (NPC, 2006) and total land area of about 33,955 square kilometres. The state is divided into 23 local Government Areas. The state capital is Makurdi.

Due to the high rate of accident in Benue state, this paper aim to develop a computer based system for the prediction and hence prevention of road accident UML tools. This will be useful to the FRSC and other agencies in charge of road planning and accident prevention.

This paper is set out as follows: Section two gives a review of related literature. Section three is the methodology used in the research. Section four shows the results and discussion. Section five give a brief conclusion of the paper and future work to be done on this research is given in Section six.

Figure 1: Map showing Benue State and local governments

2. Background

Various researches has been conducted over the years on relationship between drivers' age, gender, vehicle weight, vehicle speed and the fatality caused by accident in both the developed and developing nations using different models. An important characteristic of neural networks is their ability to learn from training after which they are able to be to solve problems of the same class from the experience gained during training. NN can learn by developing new connections between neurons, deleting existing neurons, changing connection between weights, changing the threshold values of neurons, varying one or more of the three neuron functions – activation, propagation, output function, developing new neurons and deleting neurons (see Buzeman, Viano & Lovsund, 1998; Kweon & Kockelman, 2003; Martin, Crandall & Pilkey, 2000; Mayhew, Ferguson, Desmond & Simpson, 2003; Tavris, Kuhn, & Layde. 2001).

The study by Abdelwahab & Abdel-Aty, (2001) focused on two-vehicle accident impact at road intersections. The data for the study was collected at Central Florida. The impact of the injuries sustained was group into three namely: Injury leading to disability, Possible injuries and no injury. The authors used ANN – Levenberg-Marguardt algorithm and Fuzzy logic to compare results and found that while ANN uses 65.6% for training data set and 60.4% for testing data set, Fuzzy logic performs less (956.1%) in impact classification.

Eze (2012) in his study revealed that the causes of road traffic accidents are multi-faceted. He divided the causes of road traffic accidents into driver factors, vehicle factors and roadway factors and that accidents can be caused by a combination of these factors. Driver factors which solely contributes to about 57 % of road traffic accidents and 93 per cent either alone or in combination with other factors.

Odugbemi (2010) defined accident as anything which happens by chance, anything occurring unexpectedly and undesigned. Road Traffic Accident (RTA) is therefore an unexpected phenomenon that occurs as a result of the use of vehicles including bicycles, tricycles, and handcarts in public highways and roads.

The degree of damage caused by an RTA depends on the cause of the accident, the level of speed and the car features. When an accident occurs, the risk of being injured increases exponentially with speed. The severity of injury depends on the vehicle speed at the point of impact, though vehicles travelling at slower speed are also at risk of road traffic accidents.

The degree of injury sustained during a road traffic accident can be classified into three namely: slight injury, serious injury and fatal.

a. **Slight Injury**: Constitutes minor injuries such as a sprain, bruise, cut or laceration.
b. **Serious Injury**: Involves injury for which a person is admitted in hospital as an "in patient", or injuries such as fractures, concussion, internal injuries, crushing, severe cuts and lacerations, severe general shock requiring medical treatment, injuries causing death within 30 days after the accident.
c. **Fatal** involving death from injuries sustained, within 30 days after the accident or death on the spot.

The frequency of road accident in Nigeria is on the rise daily and the mortality rate recorded is on the increase as compared to deaths registered from deadly diseases. Sumaila (2013) reported that the Nigeria situation has reached such an alarming proportion even to the point of sheer frustration and near helplessness.

Atubi (2012) stated that the human factor is the most potent contributor to motor vehicle accidents in Nigeria. This is not surprising because humans are involved in all aspects of traffic accident causation: from poor road construction, corrupt traffic law enforcement, to poor road user. Driver factors may include driver behavior, visual and auditory acuity, decision making ability and reaction speed, Drug and alcohol use.

An analysis done by Tolulope (2013) on Regional Determinants of Road Traffic Accident in Nigeria showed that in the northern Nigeria, Benue state is identified as one of the areas with high accident burdens. This is due to the poor state of the roads and lack of maintenance culture in the state and the country at large. Benue also has a link between the North, East, South and hence the influx of vehicles doing long distances also contributes to the high accident rate in the state.

3. Methodology

The methodology used in this research is the UML tools. UML is an industry standard graphical notation used for describing software analysis and designs. It was the Object Management Group (OMG) that released the UML around 1997. One of the purposes of UML was to provide the development community with a stable and common design language that could be used to develop and build computer applications. UML brought forth a unified standard modeling notation that IT professionals had been wanting for years. Using UML, IT professionals could now read and disseminate system structure and design plans - just as construction workers have been doing for years with blueprints of buildings (Donald, 2003).

1. Results and Discussion

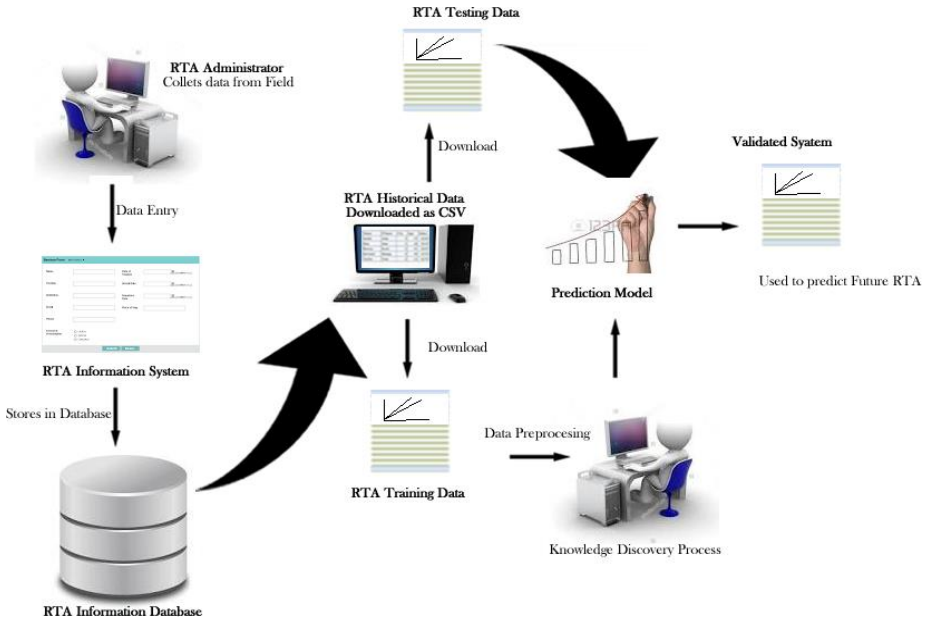

Figure 2: Architecture of the RTA Prediction system.

Figure2 shows the architecture of the RTA prediction system. The study began with the development of an information system (a web- based application) which will be used by road management agencies/RTA administrator to store and retrieve road accidents on routes in the study area. The information is stored in the RTA information database which can be downloaded from the database by the RTA administrator or a data analyst and used for training and testing .The model created by the network was further used for validating the system and creating a model useful for prediction. This model created is tested and the validated system is used to predict future RTAs.
The procedure for the ANN accident predictive system is shown in figure 3. The system consist of phases namely data collection, pre-processing, processing and prediction.

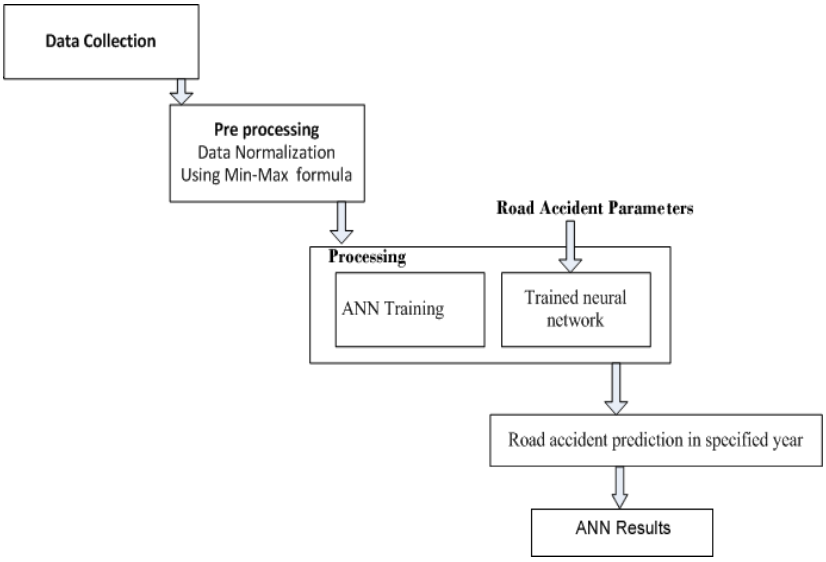

Figure 3: Design of the ANN Accident Prediction System

This requirement defines the basic actors/ users of the road accident predictive system alongside their functions. Figure 4 shows the use case of the road traffic accident prediction system.

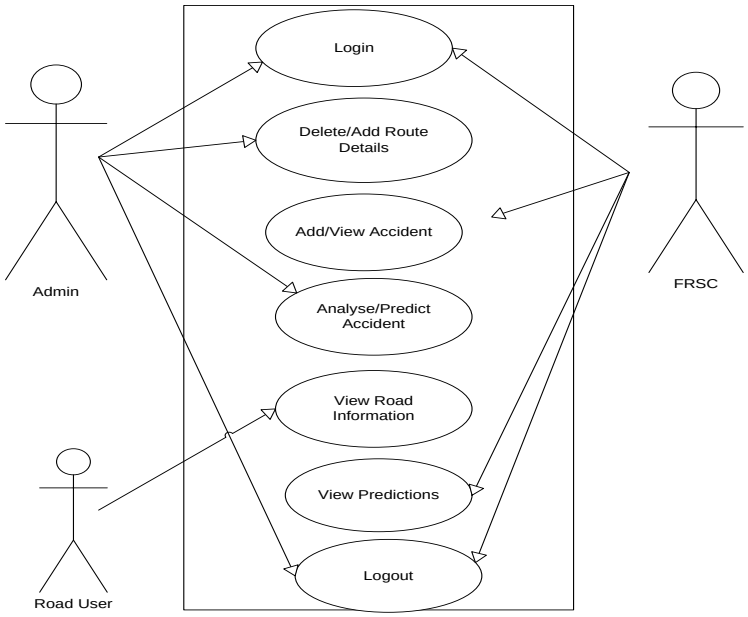

Figure 3: Use case of the system

The overall system database was created using MySQL relational database system. This helps store information concerning status of a road and accident information in the state. The database contains eleven tables which are rta_Roles table , rta_user , User _log table , Route conditions table, Predicted_Accident table, Actual_accident table, Route table, Vehicular_factor, Human_factor , Vehicular_traffic . Figure 4 shows the database structure and the relationship among these tables.

A data flow diagram (DFD) of the RTA prediction system illustrates how data is processed by the system in terms of inputs and outputs. As its name indicates its focus is on the flow of information, where data comes from, where it goes and how it gets stored. Figure 5 shows the DFD diagram of the accident predictive system.

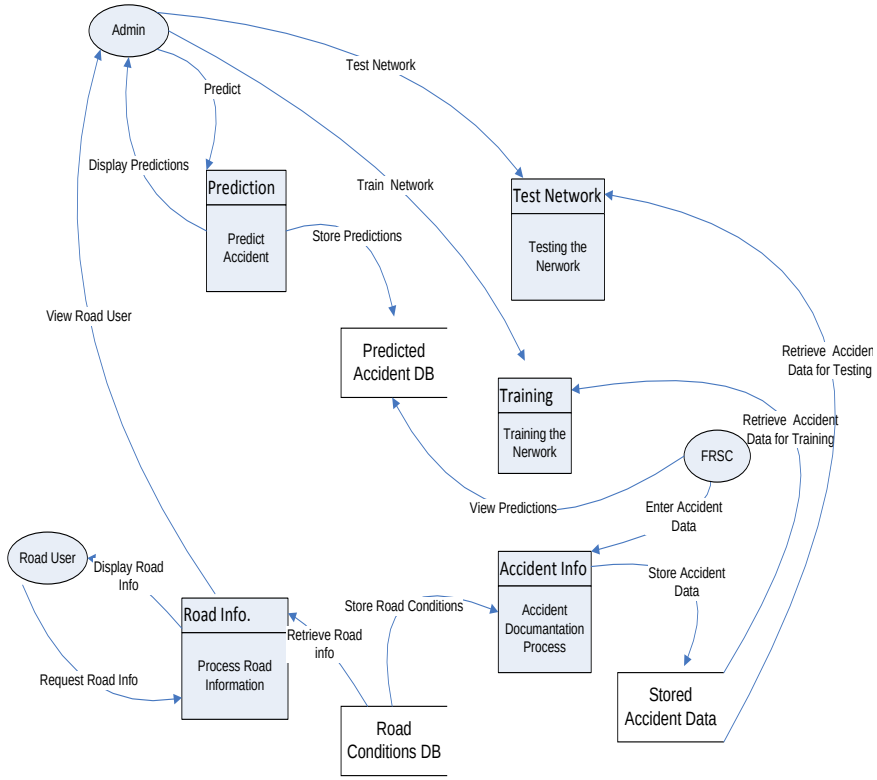

Figure 5: The data flow diagram of the system

4. Conclusion and Future Work

For any software to be effective and maintainable, it must be built on good framework and design. The designing aspect is tedious and time consuming and most software developers are likely to either make a mess of it or completely skip it. With the advocacy of rapid prototyping and its many variants, there is less emphasis on software design hence the high rate of software failure and high maintenance cost. This paper presents the design of a road accident predictive system using ANN that can be of help to system developers in building the real software. Road traffic accidents are prevalent on Benue roads hence this design will assist security agents, road users and road traffic personnel to be able to predict and prevent the occurrence of accidents. The next phase of this work will be to develop a computer based system for the predictive part using ANN.

REFERENCES

[1] Atubi A .O. 2012, Determinants of Road Traffic Accident Occurrences in Lagos State: Some Lessons for Nigeria**.** International Journal of Humanities and Social Science 2(6) [Special Issue – March 2012]

[2] Eze, B. Road (2012) Traffic Accidents in Nigeria: A Public Health Problem 3(2). AFRIMEDIC Journal July -December, 2012.

[3] Abdewahab, H.T. and Abdel-Aty, M.A. 2001. Development of Artificial Neural Network Models to predict driver injury severity in Traffic Accidents at Signalizes intersection. Transportation Research Records, Issue 1746, Paper No. 01-2234, pp. 6-13.
[4] David Kriesel. A brief introduction to Neural Networks. www.dkriesel.cm/en/science/neural_networks
[5] Donald B., 2003, An introduction to the Unified Modeling Language. http://www.ibm.com/developerworks/rational/library/769.html
[6] Buzeman, D. G., Viano, D. C., & Lovsund, P., 1998, Car Occupant Safety in Frontal Crashes: A Parameter Study of Vehicle Mass, Impact Speed, and Inherent Vehicle Protection. Accident Analysis and Prevention, Vol. 30, No. 6, pp. 713-722.
[7] Kweon, Y. J., & Kockelman, D. M., 2003, Overall Injury Risk to Different Drivers: Combining Exposure, Frequency, and Severity Models, Accident Analysis and Prevention, Vol. 35, pp. 441-450.
[8] Martin, P. G., Crandall, J. R., & Pilkey, W. D., 2000, Injury Trends of Passenger Car Drivers in the USA. Accident Analysis and Prevention, Vol. 32, pp. 541-557.
[9] Mayhew, D. R., Ferguson, S. A., Desmond, K. J., & Simpson, G. M., 2003, Trends In Fatal Crashes Involving Female Drivers, 1975-1998. Accident Analysis and Prevention, Vol. 35, pp. 407-415.
[10] Tavris, D. R., Kuhn, E. M, & Layde, P. M., 2001, Age and Gender Patterns In Motor Vehicle Crash injuries: Importance of Type of Crash and Occupant Role, Accident Analysis and Prevention, Vol. 33, pp. 167-172.
[11] Odugbemi, O. (2010). Road Transportation and Tourism in Nigeria, Jopa Press Lagos. ISSN:2141-1360.
[12] Tolulope O., 2013, Regional determinants of road traffic accidents in Nigeria: identifying risk areas in need of intervention, African Geographical Review, DOI:10.1080/19376812.2012.750224
[13] Sumaila A. F., 2013, Road Crashes Trends and Safety Management in Nigeria, Journal of Geography and Regional Planning, 6(3),pp. 53-52